UTAH DEPARTMENT OF TRANSPORTATION
REGION 2

HIGHWAY AVALANCHE SAFETY PLAN
for SR-190, and SR-210
BIG AND LITTLE COTTONWOOD CANYONS

2012

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Utah Department of Transportation, Region Two Director,
Jason Davis — Date: 8/21/12

UDOT Region Two, Snow Avalanche Safety Supervisor
Liam FitzGerald — Date: 9/10/12

Forest Supervisor, Uinta-Wasatch-Cache National Forest,
Dave Whittekiend — Date: 9/21/12

District Ranger, Salt Lake Ranger District,
Uinta-Wasatch-Cache National Forest,
Catherine Kahlow — Date: 9/21/12

Cover Photo: Mt. Superior Avalanche:
Adam Naisbit

HIGHWAY AVALANCHE SAFETY PLAN

This plan is submitted as an attachment to the United States Forest Service, Uinta-Wasatch-Cache National Forest, Salt Lake Ranger District, Special Use Permit issued to the Utah Department of Transportation. This Permit authorizes UDOT to carry out artillery and explosives avalanche control work on Forest Service administered land, and to use specific areas on USFS administered land, as well USFS facilities in support of the Highway Avalanche Safety Program in Big and Little Cottonwood Canyons.

This plan describes the activities of UDOT as well as other agencies, organizations and private corporations involved in the co-operative effort to provide safe winter travel on Utah State Roads 190, and 210.

This publication replaces two proceeding documents. The original document entitled *Highway Safety Plan, Cottonwood Canyons, Wasatch National Forest, Salt Lake City Utah*, was published July 1979, by von Allmen and Partners in Salt Lake City, Utah. It consisted of two volumes: Volume I, titled *Highway Safety Plan*, and Volume II titled *Highway Operations Data*. The second publication, *Utah Department of Transportation Highway Safety Plan, State Roads 190 & 210, Big and Little Cottonwood Canyons,* was published in 2002. The UDOT publication described the changes to the Highway Avalanche Safety Program that had occurred in the 23 years since the original document by von Allmen and Partners. This latest version of the Highway Avalanche Safety plan will include changes and additions to the Highway Avalanche Safety Program in the Cottonwood Canyons that have occurred during the past 10 years.

In the two previous plans, reference is frequently made to the excessive number of private vehicles traveling the canyon roads. The ADT (average daily traffic) volume in Big and Lt. Cottonwood Canyons exceeds the capacity of those roads on a regular basis. This situation is especially true in Little Cottonwood Canyon where the excessive number of vehicles creates slow moving and stationary traffic conditions that may last for several hours, and contribute to air pollution, detract from the experience most visitors hope to find when traveling to scenic recreation areas, and when accompanied by an increasing avalanche hazard above the canyon road, create a significant threat to public safety.

There have been subsequent studies of transportation issues in the canyons, most notable being the *Little Cottonwood Canyon SR 210 Transportation Study*, published August 2006, by Fehr & Peers Associates, that describe this problem in detail. In that publication, as well as studies included in the 2002 *UDOT Highway Safety Plan*, the Highway Avalanche Hazard Index Rating (a numerical value obtained from several contributing factors that rates the avalanche threat to transportation corridors in mountainous areas) is discussed. Studies indicate that the road in Little Cottonwood Canyon has a Hazard Index Rating that exceeds that of other major roadways in North America. This rating suggests that at times insuring the safety of motorists traveling on the canyon road is extremely challenging and that a serious effort should be mounted to somehow reduce the Very High, Hazard Index Rating. Of all the options available to reduce this rating the most cost efficient, and perhaps the most practical would be to reduce the number of vehicles traveling on the canyon road.

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VOLUME I – HIGHWAY AVALANCHE SAFETY PLAN

RECENT HISTORY- 2002-2012

During the 10 years since the last Highway Avalanche Safety Plan was published, the UDOT Highway Avalanche Safety program for Big and Little Cottonwood Canyons has undergone several important changes. Most of these changes involve improvements to the gathering of critical weather data, monitoring avalanche activity, and additions or changes in active avalanche control methods. As always, life in the canyons is determined to a large degree by the weather, and the weather during the past 10 seasons has, as would be expected, been "about" normal. Average seasonal snowfall (November 1- April 30) for Lt. Cottonwood Canyon, measured at the Guard Station Study Plot, during the past 10 years has been 1882cm (478") which is slightly below the 50 year average [1949-1999] of 505". The average seasonal snowfall for Big Cottonwood Canyon (measured at the Spruces Study Plot) during the past 10 years is 757cm (298").

Some of the more notable weather and avalanche events of the past decade include:

March 2002- A strong, late winter storm deposited a total of 151cm (59") of snow in a three day period. Several large avalanches resulted from this storm including one from Toledo Face in Lt. Cottonwood Canyon, that hit the Alta Peruvian Lodge causing extensive damage. This event prompted changes in the Inter-Lodge, Maximum Security policy within the Town of Alta, with decisions made in advance of control work if certain amounts of snow, and/or snow water equivalent are exceeded.

January 2005- Weak snowpack layering formed in November and December 2004, set the stage for widespread avalanching. The storm of January 7th through January 12th, 2005 saw the greatest Snow Water Equivalent, 232mm (9.13"), of any numbered storm(1), in the past 10 years. This combination of a weak snowpack and a large amount of heavy, wet snow, produced a major avalanche cycle throughout the Wasatch Range. Several avalanches occurring during this period could be categorized as "100 year events" with extensive destruction to wide swaths of timber, as well as at least one chair lift hit and damaged.

April 2010- A large avalanche from Mt. Superior (involving much of the lower apron) released by artillery, took a path further to the west than had been previously observed. The avalanche overran the Snowbird Employee Housing building, the Snowbird Fire Station, destroyed a UTA bus stop shelter and one unoccupied vehicle, and hit the east end of the Cliff Lodge. This was the first time the Cliff Lodge had been hit by an avalanche since its construction in 1974.

2010-11 Season- Snow Water Equivalent (SWE) totals for the period November 1, through April 30, of 1614mm (63.54") recorded at the Guard Station Study Plot in Alta, were the

1 Numbered Storm refers to a period of weather meeting certain requirements in order to be given a number.

third highest in the past 50 years. There was an additional 236mm (9.29") of SWE recorded during the month of May 2011, bringing the 7 month total to over 6' of SWE. On May 31, 2011 there was a total of 345cm (136") of snow on the ground at the Guard Station Study Plot.

2011-12 Season- Total Snowfall measured at the Guard Station Study Plot, from November 1, 2011 to April 30, 2012 was 838cm (330"). This is the second lowest total snowfall for the period of Nov 1, to April 30, since 1945-46. The only season with less total snowfall was the infamous "Drought Winter" of 1976-77, which recorded 800cm (315") Total Snowfall.

Avalanches have played a major role in shaping the lives of individuals, their activities, and the communities in Big and Little Cottonwood Canyons for the past 150 years. Those, who in the past have devoted their careers to keeping the canyon roads, buildings located in avalanche areas, and their occupants, safe from avalanches are to be acknowledged for creating the foundation of the current Highway Avalanche Safety Program. It is the hope of those of us presently charged with these important tasks that we will measure up to their past performance, and that the future generation of avalanche workers will inherit a program that functions well, and serves the best interests of canyon residents, employees, local business, and visitors alike.

THE CURRENT HIGHWAY AVALANCHE SAFETY PROGRAM

The current UDOT Highway Avalanche Safety Program has three primary components: Development of an Avalanche Hazard Forecast, Avalanche Control/Stability Evaluation, and Avalanche Rescue.

I-Developing an Avalanche Hazard Forecast

The development of an Avalanche Hazard Forecast requires input/information from four fundamental components, Snowpack Observations, Local Weather Observations, a Weather Forecast, and Observations of Recent Avalanche Activity.

Snowpack Observations

Snowpack observations are concentrated in avalanche starting zones that affect the roads in Big and Little Cottonwood Canyons. Attention is given to individual layers within the snowpack, the evolution of those layers, and how they are bonded to adjacent layers. Much of the information derived from snowpack analysis comes from tests of shear strength of buried layers. Snowpack observations and shear strength tests are conducted in accordance with practices included in *Snow, Weather, and Avalanches: Observational Guidelines for Avalanche Programs in the United States*, Prepared by the Working Group on Observational Guidelines and Issued by The American Avalanche Association. Although it is often difficult to extract definitive information on snowpack stability from snowpits, they

remain an important part in the development of an avalanche hazard forecast.

Local Weather Observations

Weather factors known to contribute to the development of hazardous avalanche conditions are monitored on a continual basis from the fall to late spring each year. Several remote, automated weather stations, as well as manual observations from Snow Study Plots, provide critical information of wind speed and direction, temperature, new snow and snow water equivalent, precipitation intensity, new snow settlement, and total snow depth. Weather data gathering locations include upper, mid, and lower elevation sites.

Weather Forecasts

UDOT Avalanche Forecasters receive weather forecasts from several sources. The National Weather Service, Salt Lake City, prepares a weather forecast for the Cottonwood Canyons that is issued twice daily. A professional meteorologist stationed at the Upper Guard Station at Alta, also provides a twice daily weather forecast, specifically for Lt. Cottonwood Canyon. And the UDOT Traffic Operations Center, also makes a weather forecast available twice a day. The two primary forecasts, NWS, and Upper Guard, focus on snow and snow water equivalent amounts, rate of snowfall, temperatures, and upper elevation winds. Direct phone contact to the individuals who create these forecasts is also available to UDOT. During the past 10 years, the detail and accuracy of these forecasts has improved significantly.

Recent Avalanche Activity

Recent avalanche activity is the primary indicator of snowpack stability. If avalanches are occurring, or have recently occurred in areas similar to those affecting the canyon roads, then any or all avalanche paths affecting the canyon roads may become suspect. Natural avalanche activity accompanied by weather conditions that suggest the trend will continue often becomes the primary factor in determining the timing of road closures and avalanche control work. The ability to monitor avalanche activity regardless of weather and visibility is critical in order to assess the developing avalanche hazard.

In 2006 UDOT installed an **Infrasonic Avalanche Detection System** that provides near-real time information of avalanche activity in the mid-portion of Lt. Cottonwood Canyon. This system displays information regarding the time, location, and references to the magnitude, of avalanche events. It provides information regarding the onset of Natural avalanche activity as well as the accuracy and effectiveness of artillery avalanche control work. It has become one of the most valuable tools available to UDOT Avalanche Forecasters in monitoring avalanche activity and contributes significantly to the decision making process regarding safety of the canyon road.

Recording Snowpack, Weather, and Avalanche Information:

All pertinent Snowpack, Weather and Avalanche information is recorded on written forms, as well as being stored in computer files. The data base available to UDOT Avalanche Forecasters includes 25 years of records for Big Cottonwood Canyon and more than 65 years for Lt. Cottonwood Canyon. Continued accurate recording of information will hopefully provide a basis for decision making by future generations of UDOT Forecasters.

Issuing a Highway Avalanche Hazard Forecast:

Based on snowpack and weather observations, an accurate weather forecast, and information of recent avalanche activity, the UDOT avalanche forecast staff will develop a forecast for the avalanche hazard affecting the roads in Big and Lt. Cottonwood Canyons. This forecast is normally issued for 12 hour periods, and considers the likelihood of avalanche events reaching the canyon road. Consideration is also given to the size and type of avalanche event, and the area(s) of the canyon where they are likely to occur. The forecast is expressed in the form of a notification or advisory as to whether or not a road closure and subsequent control work is eminent or is expected to become necessary during the period, and the extent of avalanche control work to be carried out.

When it is felt that the potential exists, or is developing, that would allow for avalanches to reach the road. Or when it is felt to be necessary to carry out some form of stability evaluation in particular avalanche starting zones in order to obtain information needed to maintain an understanding of current snowpack stability, and to make a forecast of future stability, notification is given of the plan to close the canyon roads. Attempts are made to issue this warning enough in advance so as to allow for a safe and orderly exit from the canyons by those who wish to leave. And to allow for canyon residents, guests, and those individuals and employees considered critical to canyon operations to arrive at their destinations within the canyons prior to the closure. At times the hazard may develop so rapidly as to require an immediate closure, or one that becomes necessary before the majority of day skiers, residents, or necessary personnel can exit or enter the canyons. This situation while undesirable, is at times necessary. Properly equipped vehicles (4x4 or chains) entering or exiting the canyons during these critical times greatly increases the safety and efficiency of the evacuation of day skiers as well as the arrival of essential personnel.

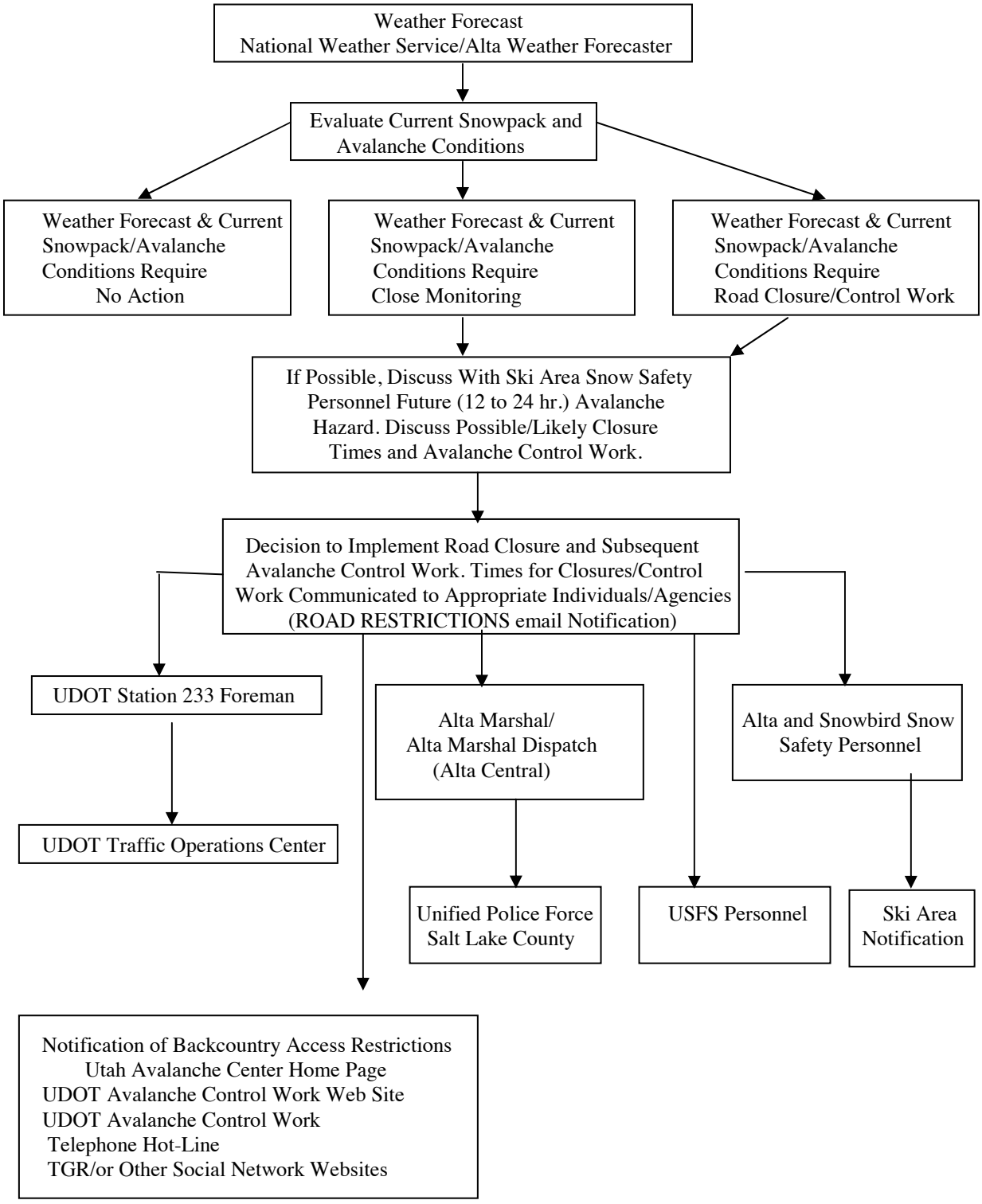
When conditions allow for a timely and less immediate closure, discussions regarding the developing hazard take place between the UDOT Avalanche Forecast staff and the Snow Safety personnel from the local ski resorts. An attempt is made to reach a consensus regarding when the road closure should be implemented, with public safety as the determining factor. However, in the end it is the UDOT Avalanche Forecast staff that makes the final decision as to when closures will take place, the timing and extent of avalanche control work, and whether that work has been effective and the road can be reopened. The timing of the closure is given to all appropriate agencies and individuals

through the Alta Marshal Dispatch Office, UPD Salt Lake County, and the UDOT Traffic Operations Center.

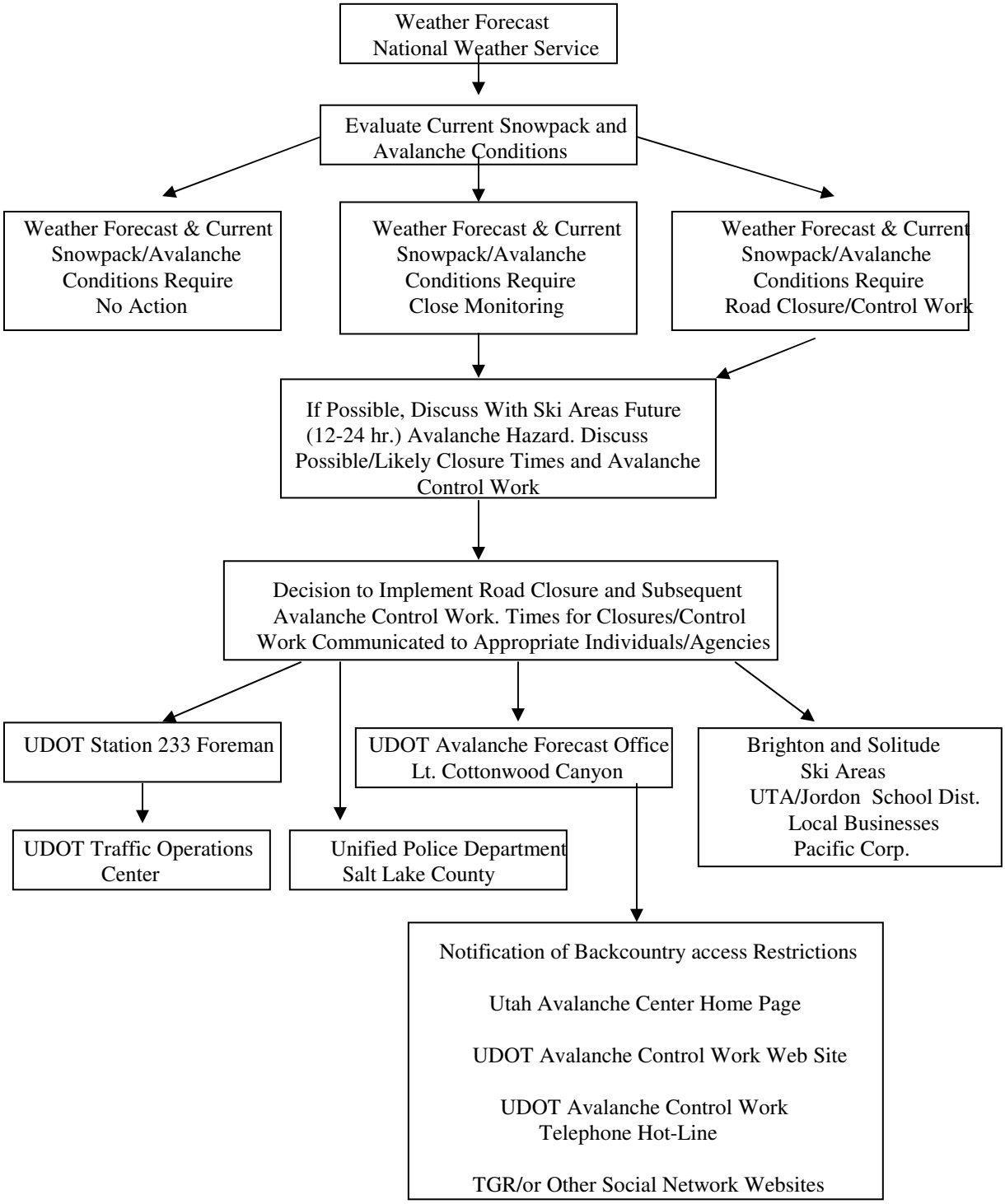
Backcountry Access Closures and Notification Process:

An important part of the notification process regarding planed avalanche control work is reaching the backcountry skiing community. In order to prevent ski touring parties or individuals from being in or near avalanche starting zones when artillery or other forms of avalanche control are taking place, a broad range of information messaging is implemented. Various internet websites associated with, or specifically created for the dissemination of information regarding planned avalanche control work are available to the backcountry skiing community. These include the Utah Avalanche Center, the UDOT Avalanche Control Work website, the UDOT Avalanche Control Work telephone recording, Twitter and text messaging from the UDOT Traffic Operations and the Unified Police Department (UPD), as well as social media sites frequently used by backcountry skiers. In addition, trail-head and roadside message signs provide information as to planned avalanche control work. As of the winter of 2011/12, UDOT, through the authority of the UPD, and the Alta Town Marshal, will implement a **backcountry access closure** in those areas where avalanche control work is planned. These closures can be implemented several hours prior to control work being carried out, and are lifted once control work has been completed. The final defense against possible backcountry skier and avalanche control work conflicts is in the form of physically traveling along the canyon roads prior to the commencement of control work, informing skiers of planned control work and directing them to areas not affected by that work.

SR 210 Lt. Cottonwood Canyon Road Closure and Avalanche Control Work Notification Flow Chart



SR 190 Big Cottonwood Canyon Road Closure and Avalanche Control Work Notification Flow Chart



II-Avalanche Control and Stability Evaluation

It is often difficult to make a distinction between Stability Evaluation with explosives, and Avalanche Control with explosives. In an avalanche safety program that relies on Active Avalanche Control measures to mitigate hazardous conditions, when it has been determined through the development of an Avalanche Forecast, that avalanches are likely or possible, some form of test (usually with explosives) is carried out to determine whether the forecast is correct. Once these tests determine that avalanches are occurring, then avalanche release becomes the primary objective.

Road Closure

If possible, the decision to close the road will be made well enough in advance to provide for the timely notification to all concerned agencies, individuals, and local businesses. The Unified Police Department (UPD) Salt Lake County, will assist UDOT in clearing the roads of all traffic, and securing the avalanche closure gates. Within the Town of Alta, these duties will be carried out by the Alta Marshal's Office. Road closures are implemented when it is felt the possibility exists for Natural avalanches to reach the road, or when artillery or explosives avalanche control/stability evaluation is to be carried out. Most closures last only a few hours, but on occasion, prolonged closures are necessary until such time that it is felt the hazard has been reduced to an acceptable level. The decision to close and open, all or part of the canyon roads, as well as the timing and extent of closures is made by UDOT Avalanche Forecasters.

Inter-Lodge Travel Restrictions

The location of numerous inhabited buildings within the runout zone of avalanche paths affecting the road in Lt. Cottonwood Canyon, requires a notification to building managers, owners, or occupants when explosives or artillery avalanche control work is to be implemented in areas above the Snowbird Village and Town of Alta. Salt Lake County, and Town of Alta ordinances require that all occupants of buildings remain inside during periods of High Avalanche Hazard or when avalanche control work is being carried out. UDOT Avalanche Forecasters working in conjunction with the Alta Town Marshal's Office, and Unified Police Department, Salt Lake County (2) will make a notification through the *Road Restrictions* email notification, as to when Inter-Lodge Travel restrictions will be implemented. Artillery or explosives avalanche control work above occupied buildings does not commence until all buildings are secure.

2 UPD SL County delegates authority to implement Inter-Lodge Travel Restrictions within the Snowbird Ski Area, a portion of un-incorporated Salt Lake County, to Snowbird Snow Safety personnel.

Maximum Security Restrictions

Under more extreme avalanche conditions, a higher level of restriction is implemented, with occupants of certain buildings required to relocate to "safer" areas of each building. These "safer" areas are determined by building owners or managers The decision to implement Maximum Security is made by the Alta Marshal, and Snowbird Snow Safety personnel, with input from UDOT Avalanche Forecasters. The decision is based on either certain Snow/Snow Water Equivalent totals in a 24 hour period, or observations of large, and potentially destructive avalanches during or leading up to artillery or explosives avalanche control work.

Artillery Avalanche Control

-Little Cottonwood Canyon

The inaccessibility of avalanche starting zones that affect the road as well as numerous inhabited buildings in Lt. Cottonwood Canyon requires that some method be used to test snowpack stability and release avalanches from a safe and reasonably accessible location. The need to carry out these tests during periods of reduced visibility or severe winter weather requires a system be used that is not adversely affected by these conditions. Currently, and for the past 60+ years, military artillery is the method most often used to meet the needs of the Highway Avalanche Safety Program in Lt. Cottonwood Canyon. The use of military artillery has proven to be an effective tool in testing snowpack stability, and reducing the avalanche hazard, under most all avalanche conditions. As with other *active* avalanche control methods, the intention of artillery control is to initiate numerous small to medium sized avalanches throughout the course of the avalanche season, thereby reducing the possibility of a few large and destructive avalanche events. This is achieved through a process of monitoring snowpack and weather conditions to determine when and where avalanches are possible/likely to occur, and then carrying out explosive tests to determine if the forecast was accurate.

UDOT Avalanche Forecasters will determine the timing and location of where artillery control work will be carried out. These determinations will be based on accepted methods of avalanche hazard forecasting, and will often be made in consultation with snow safety personnel from the Alta and Snowbird Ski Areas. UDOT Avalanche Forecasters will also determine whether the results from artillery (or other explosive) avalanche control work has been adequate so as to allow for the canyon road to be re-opened to traffic.

Once the canyon road has been secured, and all necessary Inter-Lodge Travel Restrictions have been put into effect, clearance is given to the gun crew(s) to commence firing. Firing missions often begin with targets that do not affect inhabited buildings, as this allows for observations to be made as to the level and extent of the avalanche hazard, and whether further security restrictions need to be implemented. Due to the necessity of locating the military weapons used for highway avalanche control work in areas outside of known avalanche areas, and the requirement for each weapon to be able to reach the maximum

number of target areas, the weapons are located within the boundaries of the Alta and Snowbird Ski Areas. To expedite the firing missions, the gun crews for the weapons located within the resort boundaries are staffed by ski area employees. Ski area employees who participate in highway avalanche control work do so under the supervision of UDOT Avalanche Forecasters. They are paid by UDOT[3] for all time spent firing, maintaining, or training with weapons used for highway avalanche control work. During firing missions, UDOT Avalanche Forecasters usually position themselves so as to observe the results from firing. This allows for determinations to be made as to the addition or deletion of certain targets, and whether or not the results from control work suggest the road can be re-opened, and-or Inter-Lodge Travel Restrictions can be lifted.

As of the end of the 2011-12 season, there were four military weapons used to control the highway avalanche paths in Lt. Cottonwood Canyon. The Peruvian Ridge Howitzer, a 105mm Howitzer located within the Alta Ski Area, the Willows Rifle, a 105mm Recoilless Rifle, located in Peruvian Gulch, within the Snowbird Ski Area, the Valley Howitzer, a 105mm Howitzer located in Gad Valley, within the Snowbird Ski Area, and the Pink Pine Howitzer, a 75mm Pack Howitzer[4], located on USFS administered land between White Pine Fork and Red Pine Fork. By the beginning of the 2012-13 season the type of weapon used for avalanche control will be limited to the M101A1, 105mm Howitzer, and the number of weapons used for highway control work in Lt. Cottonwood Canyon will be reduced to two. There are currently 170+ target points fired by artillery in Lt. Cottonwood Canyon. The distance from weapon to target varies from ~1000m to over 5400m. Many of the target points are located within the Salt Lake Twin Peaks Wilderness Area. Language in the legislation creating this Wilderness Area, allows for artillery/explosives avalanche control to be carried out within Wilderness Area Boundaries for public safety concerns. All military weapons are obtained through a lease agreement between UDOT and the US Army.

Standard Operating Procedures for the firing of military weapons, and handling and assembly of ammunition, used for avalanche control have been developed by the Avalanche Artillery Users of North America Committee (AAUNAC) and have been approved by the US Army. Likewise all Gunner Training in the use of military weapons used for avalanche control is carried out under AAUNAC guidelines. All personnel who fire military weapons for the UDOT Highway Avalanche Safety Program are trained, and operate the weapons in accordance with AAUNAC approved guidelines.

Ammunition used by UDOT for highway avalanche control work is currently obtained from the US Army through the US Forest Service, and is stored in magazines located on USFS administered land. The ammunition is stored in accordance with USFS, BATF, and US Army guidelines.

Yearly inspections of military weapons used in the UDOT Highway Avalanche Safety Program are conducted by the CSMS unit of the Draper Armory, Utah Army National Guard.

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3 Written agreement between the ski areas of Alta and Snowbird, and UDOT.
4 At the end of the 2011/12 season, the Army has mandated that all weapon systems other than the 105mm Howitzer will no longer be used for avalanche control work.

-Big Cottonwood Canyon

In contrast with the artillery avalanche control program in Lt. Cottonwood Canyon, there is only one weapon used in Big Cottonwood Canyon. A 105mm Howitzer, stored at a secure site in a UDOT Maintenance yard, is towed to three separate firing positions located along or near the canyon road.
The firing position used to control the avalanche starting zones in Stairs Gulch is located east of the USFS Amphitheatre Picnic Area, on property owned by Utah Power and Light (UP&L). This site is made available to UDOT under a separate agreement with UP&L.

A second firing position, is located on the UDOT "right-of-way" at milepost 8.8, on SR 190. This site is used to control the starting zones for the Argenta avalanche path. A third firing position also located on the "right-of-way" at milepost 9.9, is used to fire targets on the north face of Kessler Peak.

Although some specific differences exist in ammunition assembly, and weapon site preparation from those associated with fixed, and enclosed firing sites, all procedures associated with the use of the weapon in Big Cottonwood Canyon follow AAUNAC guidelines.

There are a total of 17 target points in the three avalanche paths controlled with artillery in Big Cottonwood Canyon. Several of them are located within the Salt Lake Twin Peaks Wilderness Area. As is the case in Lt. Cottonwood Canyon, language in the legislation that created this Wilderness Area, allows for explosives/artillery avalanche control work to be carried out within the Wilderness Boundary, to address public safety concerns along State Road 190.

Helicopter Avalanche Control

Although the use of helicopters for avalanche control work is limited by weather conditions, they remain a highly effective method for the delivery of explosive charges to avalanche starting zones. Currently, UDOT has access to the use of a helicopter for avalanche control work through a contract with Wasatch Powderbird Guides, a helicopter skiing operation based in Lt. Cottonwood Canyon. The need for a suitable aircraft which can be made available on short notice, the close proximity of that aircraft to an approved explosives storage facility, the availability of a support crew experienced in helicopter avalanche control procedures, and perhaps the most important, a pilot familiar with local terrain and high elevation flying conditions, are all requirements for a successful helicopter avalanche control program. The current contractor is capable of meeting the above mentioned requirements. Explosive charges are deployed from the helicopter in accordance with procedures accepted by the FAA, and USFS.

In Lt. Cottonwood Canyon, helicopter avalanche control work is usually carried out as a secondary control method, with artillery control the primary method. Helicopter control

work is especially effective in dealing with cornice development in/above the avalanche paths affecting SR 210. The "Daisy-Bell"(5) has also been used in Lt. Cottonwood Canyon with some success, and may be used more frequently in the future.

In Big Cottonwood Canyon, due to the amount of time required to carry out artillery avalanche control from any/all of the "roadside" firing pads, helicopter avalanche control work is used in preference to artillery. Helicopter avalanche control work requires road closures of much shorter duration, and is very effective in controlling the three major avalanche paths affecting SR 190, providing that suitable weather conditions exist. Helicopter Avalanche Control operations in both canyons require communication between the aircraft and UDOT Avalanche Forecasters to confirm that the road is closed and secured, as well as any necessary Inter-lodge Travel Restrictions are in place, prior to commencing the control mission. In addition pilot and crew will make a visual check of the avalanche path to be controlled, as well as any approach route, to look for backcountry skiers.

Avalauncher Avalanche Control

The Avalauncher has been successfully used in the UDOT Highway Avalanche Safety Program for the past 17 years. Although range and accuracy of the Avalauncher limits where it can successfully be used, for fairly open targets, within a range of ~1000m, the device works well. Most of the Avalauncher control work carried out by UDOT takes place in Big Cottonwood Canyon in the Circle Awl, Rock House, and Mineral Slabs, avalanche paths. The Big Cottonwood Canyon Avalauncher is mounted on a trailer, and towed to the primary firing locations. In Lt. Cottonwood Canyon, an Avalauncher is mounted on a platform, located adjacent to SR 210 at mile marker 11.7 . This Avalauncher is used to control avalanche paths in the Hellgate Bowl through East Hellgate areas.

Hand Thrown Explosives

Most all of the hand thrown explosives used in the UDOT Highway Avalanche Safety Program, are deployed from a helicopter (as described in the section on Helicopter Avalanche Control). There are however locations in both canyons where hand thrown explosives are used in a more traditional manner. These are primarily on road bank avalanche areas, in fairly close proximity to the canyon roads. The use of hand thrown explosives follows guidelines issued by the US Forest Service, and the National Ski Area Association (NSAA). As with all other forms of explosives avalanche control work, communication between the blaster and those blocking travel on the road is critical.

***Gaz-ex* Avalanche Control**

In the fall of 2007, UDOT installed two Gaz-ex exploders in the Hilton Avalanche Path above the Snowbird Village. This path affects State Road 210, the Alta Bypass Road, the

5 "Daisy-Bell" is a device similar in operation to a Gaz-ex exploder which is suspended under the helicopter and detonated above the snow surface.

Snowbird Employee Housing building, and the Snowbird Fire Station. The Gaz-ex system uses a mixture of oxygen and propane to create an explosion above the surface of the snow. The exploder tube is a large diameter, steel pipe with an opening facing the snow surface. It is controlled using a lap-top computer, and radio telemetry. The Gaz-ex system is used throughout the world and is considered to be a very effective tool in avalanche release. Although there have been operational and maintenance problems with the Gaz-ex system deployed by UDOT, overall, the system performs at an acceptable level, and has proven to be a very effective part of the Highway Avalanche Safety Program. Plans call for deploying 7 additional exploders in the near future. All of these exploders will be erected on private property above the Snowbird Village.

Recovery/Destruction of Un-Detonated Ammunition, and Explosive Charges

On occasion military ammunition, Avalauncher rounds, or hand thrown explosives fail to detonate upon delivery to avalanche starting zones. The percentage of un-detonated rounds of ammunition or explosive charges (also referred to as "Duds"), should not exceed 1% of the total number used each avalanche season. Duds are reported by members of the Gun Crew, Avalauncher Crew, or observer, who fail to audibly (or visually) detect a detonation after firing, or by the individual who has deployed the hand thrown explosive. In the case of Avalauncher rounds, or charges dropped from the helicopter, these are equipped with RECCO(6) diodes, which assist in recovery efforts. The location of the un-exploded ordnance or explosive charge, date of occurrence, ammunition or explosive type, and names of the gun crew or control team are all recorded to assist in the recovery, once the snow has melted from the target area. Artillery Duds, and most explosive charges are detonated in place, in accordance with NSAA, and USFS guidelines. Duds associated with the use of Safety Fuse, will not be approached for recovery for a minimum of 30 minutes after ignition. This 30 minute "waiting period" also applies to any section of State Highway affected by the avalanche starting zone where the Dud has occurred. Most Dud recovery efforts take place during the summer months. The amount of time spent searching for each reported Dud, the personnel involved in searching, and the results of the search are also recorded. In the case of military ammunition, it is quite likely that many of the "reported" Duds are actually low-order detonations, in which much, or most of the warhead is destroyed, but the partial detonation is not detected by the gun crew or observer. This is evident by the fact that only a small number of "reported" Duds are actually found, but the target areas show evidence of numerous low-order detonations.

Alternate Methods of Avalanche Control

Avalanche control can be divided into two categories; *Active Measures*, which usually refers to solutions applied for short term periods when avalanches are likely or expected to occur, and *Passive Measures*, which usually involve more permanent, and often more costly engineering works. Active measures require that some form of hazard evaluation or forecast be developed, and that decisions be made from that forecast. Passive Measures work independently of avalanche hazard forecasts which are based on *human* input and decisions.

6 RECCO diodes are microwave reflectors developed for the recovery of avalanche burial victims.

Active (or temporary) Avalanche Control Measures would include; road closures or restricted travel by individuals in certain areas, evacuation of parts, or all, of buildings located in known avalanche areas, artificial release of avalanches with explosives or other devices, and skier compaction of the snowpack in avalanche starting zones. Passive (or more permanent) Avalanche Control Measures would include; re-alignment of roadways to avoid known avalanche areas, the construction of snow sheds where roadways traverse known avalanche areas, the construction of berms, or catchments designed to deflect, retard, or contain avalanche debris, snow-retention devices or reforestation in avalanche starting zones, locating structures outside of known avalanche areas, and design and construction of structures located within known avalanche areas to withstand avalanche impact forces.
Currently, the UDOT Highway Avalanche Safety Program relies on Active measures to mitigate the avalanche hazard on the canyon roads. This practice, while usually providing a reasonable margin of safety, and being fairly cost effective, does not provide a 100% safety factor. Active Avalanche Control Measures require that individuals make critical decisions regarding public safety, often based on an incomplete understanding of snowpack and weather factors. It should also be noted that the Active Control Methods (i.e. explosives or military artillery) used to reduce hazardous avalanche conditions are not always effective. Road closures and Inter-lodge Travel Restrictions, an integral part of an Active Avalanche Control Program, can have a negative impact on local resort and business revenue. At this time, UDOT, along with Federal, County, and Local agencies and municipalities, the private business's that collaborate in the Highway Avalanche Safety Program, and the public at large, seem to be willing to accept these limitations and disadvantages.

Passive Avalanche Control Measures, such as the construction of Snow Sheds, or earthen diversions or catchments in the mid-canyon portion of Lt. Cottonwood Canyon, while requiring a lengthily and detailed environmental study, and representing a considerable monetary investment, would greatly increase the overall safety of travel on that portion of the canyon road.

The primary method currently used in the UDOT Highway Avalanche Safety Program for the artificial release of avalanches is military artillery. Over the past ten years there has been an average annual use of 580 rounds of military ammunition for avalanche control in Big and Lt. Cottonwood Canyons. Whereas military weapons and ammunition have proven to be a safe, effective, and relatively inexpensive method of mitigating the avalanche hazard, there are concerns over its continued use. Those concerns would include; the firing of live ammunition over inhabited structures, the proximity of population centers in relation to the maximum range of current weapons systems, the possibility of individuals or ski touring parties being in, or close to, target areas during avalanche control work carried out during periods of reduced visibility, the storage of ammunition in proximity to inhabited structures, roads, or ski area chairlifts, and shrapnel from military ammunition affecting inhabited buildings.

To address these concerns, UDOT will continue to investigate alternate methods of Active avalanche control. Some of the methods and devices that might be an effective alternative

to military weapons and ammunition would include an expansion of the current *Gaz-ex* program, devices such as the *Avalanche Guard* (a short range, explosive projectile launcher located in close proximity to the avalanche starting zone), other explosive deployment systems such as the *Wiesen Avalanche Tower*, and/or construction of chairlifts in certain areas that would allow for regular and through skier-compaction of the snowpack in avalanche starting zones. The inclusion of Passive methods of avalanche control should also be considered, these would include snow sheds, berms or catchments, snow-retention devices located in avalanche starting zones, and road realignment. Each of these alternatives would represent a significant monetary investment. It is likely that some combination of military weapons, and other alternative control methods would represent the safest, most effective, and least costly approach to the future Highway Avalanche Safety Program. **It is recommended that an independent and comprehensive study be conducted in the near future to determine the best possible choices.**

Inhabited Structures Located in Avalanche Areas

A direct connection exists between the location of inhabited structures within the boundaries of avalanche paths that affect the canyon roads, and the ability of UDOT to safely and effectively carry out explosives and artillery avalanche control work. This issue also affects other Federal, State, County, and Local Government agencies, Public Safety personnel, ski area operators, and canyon visitors and residents.

In many instances (particularly in Lt. Cottonwood Canyon) the same avalanche paths that threaten the canyon road also threaten inhabited structures. It is sometimes the case, that avalanches (both naturally occurring events as well as those released from avalanche control work) that reach the canyon road, run past the road, and hit or damage buildings located in other portions of the avalanche runout zone. Prior to the 1980's, few if any restrictions were in place to limit construction of inhabited buildings in avalanche areas. Consequently numerous buildings (54, in Lt. Cottonwood Canyon at the time this document was written) are located within the boundaries of large or major avalanche paths. Currently local zoning and building codes within the Town of Alta, and Unincorporated Salt Lake County, restrict or prohibit (to a point) construction within avalanche areas.

The UDOT Highway Avalanche Safety Program relies on the artificial release of avalanches under controlled conditions, to reduce the number of large and destructive avalanches. This is accomplished by increasing the number of small to medium sized avalanche events throughout the avalanche season. This usually results in fewer avalanche events reaching the canyon roads, and those that do are often of smaller size. In the case of buildings located within the boundaries of avalanche paths affecting the canyon road, they also benefit in the same way from regular and effective explosives avalanche control.

It is recognized that the UDOT Highway Avalanche Safety Program in Lt. Cottonwood Canyon also provides *som*e reduction of the avalanche hazard to buildings located within the Town of Alta, and the Village of Snowbird. This reduction in hazard is the result of an increase in the *return interval* of large and destructive avalanches that occurs from regular and effective avalanche control work. It should be understood however, that any structure

located in an avalanche area that relies on explosives, or other forms of artificial avalanche release, for it's safety or longevity is on borrowed time. Eventually, in spite of effective avalanche control efforts, snowpack and weather factors will combine to produce a major avalanche (either a natural occurrence, or one initiated from avalanche control work) and any building not designed to withstand the maximum forces generated by that avalanche path may be damaged or destroyed. It is for this reason that buildings should whenever possible, be located outside of known avalanche areas, and that careful consideration should be given before placing additional structures in avalanche areas that also affect the canyon roads. UDOT operates under the premise that all property owners of buildings located within the boundaries of avalanche paths affecting state roads, are aware of their situation, and that the owners accept the possibility that avalanches released during highway avalanche control work may affect their buildings. UDOT encourages thoughtful Land Use policies in the canyons, and would discourage any development that compromises the ability to conduct a safe and effective Highway Avalanche Safety Program.

III-Avalanche Rescue

In spite of the efforts of all those involved in the Highway Avalanche Safety Program in Big and Lt. Cottonwood Canyons, on occasion, naturally occurring avalanche events reach the canyon roads while they are open. Often the occurrence of one natural avalanche signals the onset of a more widespread Natural Avalanche cycle. This is especially true during periods of heavy precipitation, or rapid or prolonged warming. In the event of even one small avalanche reaching the canyon road while it is open, traffic can become blocked and very quickly, there will be scores of stationary vehicles under numerous adjacent avalanche paths where similarly hazardous conditions exist and subsequent avalanches are likely to occur. Under these conditions there is a significant and immediate threat to public safety, and quick and decisive action must be taken to avoid possibly disastrous consequences.

In Lt. Cottonwood Canyon the initial report of an avalanche on the road is likely to come from the Alta Marshal's Office Dispatch (Alta Central). In Big Cottonwood Canyon, notification may come from a variety of sources, including the Unified Police Department (UPD) Dispatch. When word is received that such an event has occurred, steps must be taken immediately to block additional traffic from entering the canyon roads from all major access points. This requires coordination between UDOT, UPD, Alta Town Marshal, and from the Parking Staff at the local ski areas. Any significant delay in this initial step will further exacerbate the problem, and make any necessary rescue efforts much more difficult.

When the alarm is sounded, the First Phase of the Rescue Operation is for individuals or agencies with the quickest response time to block traffic above and below the location of the avalanche, at all entry points. It is critical that traffic be blocked outside of known Snow Avalanche Areas. These areas are identified by large signs that give the name of the avalanche path, and warn motorists against stopping between signs during the avalanche season. The Second Phase of the Rescue Operation is the removal of vehicles which had initially stopped in known Snow Avalanche Areas, to safer locations (including designated "Staging Areas") in an orderly fashion. This also must be carried out as quickly as possible,

and will require additional personnel and vehicles to reach and relocate the stranded vehicles, or their occupants. The Third Phase of the Rescue Operation is for trained avalanche rescue personnel from Wasatch Backcountry Rescue(7) to travel to the reported location of the avalanche, assess the situation, determine whether there is any remaining threat to the rescuers, and whether or not further rescue efforts are necessary. The precise location of the avalanche, as well as manpower and equipment needs will be conveyed to the UPD, or to Alta Central. All three Phases of the Rescue Operation must be initiated nearly simultaneously, and within minutes of when the initial report of the avalanche is received.

All Search and Rescue operations taking place within Salt Lake County, including highway avalanche rescue, are the responsibility of the Unified Police Department, Salt Lake County. Rescue within the Town of Alta is the responsibility of the Alta Marshal. Past events suggest that on occasion, highway avalanche rescue operations can be hampered by organizational and logistical problems that reduce the possibility of a successful recovery, or worse, can quickly deteriorate into a situation that poses a serious risk to the safety of the rescuers and victims alike from subsequent avalanches. Highway Avalanche Rescue efforts must be carried out in a safe and expedient manner, with a minimum number of rescuers exposed to hazardous conditions. The UPD, and the Alta Marshal's Office recognize the value of a rapid response by a small number of well trained avalanche professionals from WBR in highway rescue operations.

The following plans describe procedures to be implemented in the event of an avalanche reaching either of the canyon roads, while open. Although each rescue effort will likely be somewhat different from previous operations, an attempt should be made to follow these procedures if possible.

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7 WBR is a group of avalanche professionals who operate under the authority and jurisdiction of UPD along the Wasatch Front, and specialize in snow avalanche rescue.

Highway Avalanche Alerting and Rescue Plan
Utah SR 190
Big Cottonwood Canyon

Revised June 2012

AVALANCHE ALERTING AND RESCUE PLAN FOR UTAH SR-190
BIG COTTONWOOD CANYON
Revised June 2012

FORWARD

Utah State Law decrees that the Salt Lake County Sheriff (UPD) is responsible for all Search and Rescue operations within Salt Lake County, including Highway Avalanche Rescue.

It has been determined by the Salt Lake County Sheriff, that during Highway Avalanche Rescue operations, evaluations of the avalanche hazard that may have an impact on the safety of the rescuers as well as the expertise needed to conduct Avalanche Search and Rescue efforts, can be best provided by trained and experienced avalanche hazard forecasting and avalanche rescue personnel. The Wasatch Backcountry Rescue organization (WBR) is currently the primary source for advising the UPD-Salt Lake County, in determining the level of avalanche hazard affecting rescuers as well as providing the manpower needed to carry out Highway Avalanche Rescue operations. WBR operates under the authority and direction of UPD-Salt Lake County, and will be utilized by UPD-Salt Lake County, during Highway Avalanche Rescue operations.

AVALANCHE ALERTING AND RESCUE PLAN UTAH SR-190

I- ACCIDENT REPORTED

A- Notify UPD Dispatch, (801) 743-7000, **AND** Alta Marshal Dispatch (Alta Central) (801) 742-2033, or dial 911.

B- Notify UDOT Avalanche Forecaster in Big Cottonwood Canyon-

Greg Dollhausen (801) 910-2493 or (435) 647-9613

C- UPD Dispatch or Alta Central will instruct Official Vehicles or Personnel with quickest response time, to block traffic onto Canyon Road above and below reported accident site.

D- Notify WBR* through Alta Central (801) 742-2033, Solitude Ski Patrol dispatch (801) 536-5753, or Brighton Ski Patrol dispatch (801) 889-9806.

***Approval must be obtained from UPD, SL County, in order for WBR personnel to be dispatched to any Highway Avalanche Rescue operation.**

II- ARRIVAL AT ACCIDENT SITE

A- WBR personnel (including UDOT Avalanche Forecasters) proceed to the reported accident site.

B- Determine and report exact location of avalanche.

C- Determine if size of avalanche warrants further avalanche rescue efforts.

D- If further rescue efforts are necessary, WITH THE SAFETY OF RESCUERS IN MIND, call for necessary personnel, equipment, rescue dogs, etc. to proceed to the nearest Staging Area.

III- CLEARING TRAFFIC FROM ROAD

A- With access to Canyon Road closed at appropriate locations, use Official Vehicles and/or Personnel to clear traffic from under all designated Snow Avalanche Areas. Send vehicles or their occupants to designated Staging Areas, or other safe locations.

IV- RESCUE OPERATIONS

A- WITH THE SAFETY OF THE RESCUERS IN MIND, and the appropriate type and amount of rescue equipment, rescue dogs, etc. for the situation, conduct rescue efforts in an orderly and methodical fashion.

INSTRUCTIONS FOR ANY PERSON OBSERVING OR RECEIVING FIRST REPORT OF AN AVALANCHE ON THE CANYON ROAD-

I- IMMEDIATE ACTION- *MAKE SURE YOU ARE IN A SAFE LOCATION,* then-

A- Call UPD Dispatch (801) 743-7000, **AND** Alta Marshal Dispatch (Alta Central) (801) 742-2033, **or** UDOT Traffic Operations Center Dispatch (801) 887-3705, **or** dial 911.

1- Identify yourself, give your location, and location of the avalanche.

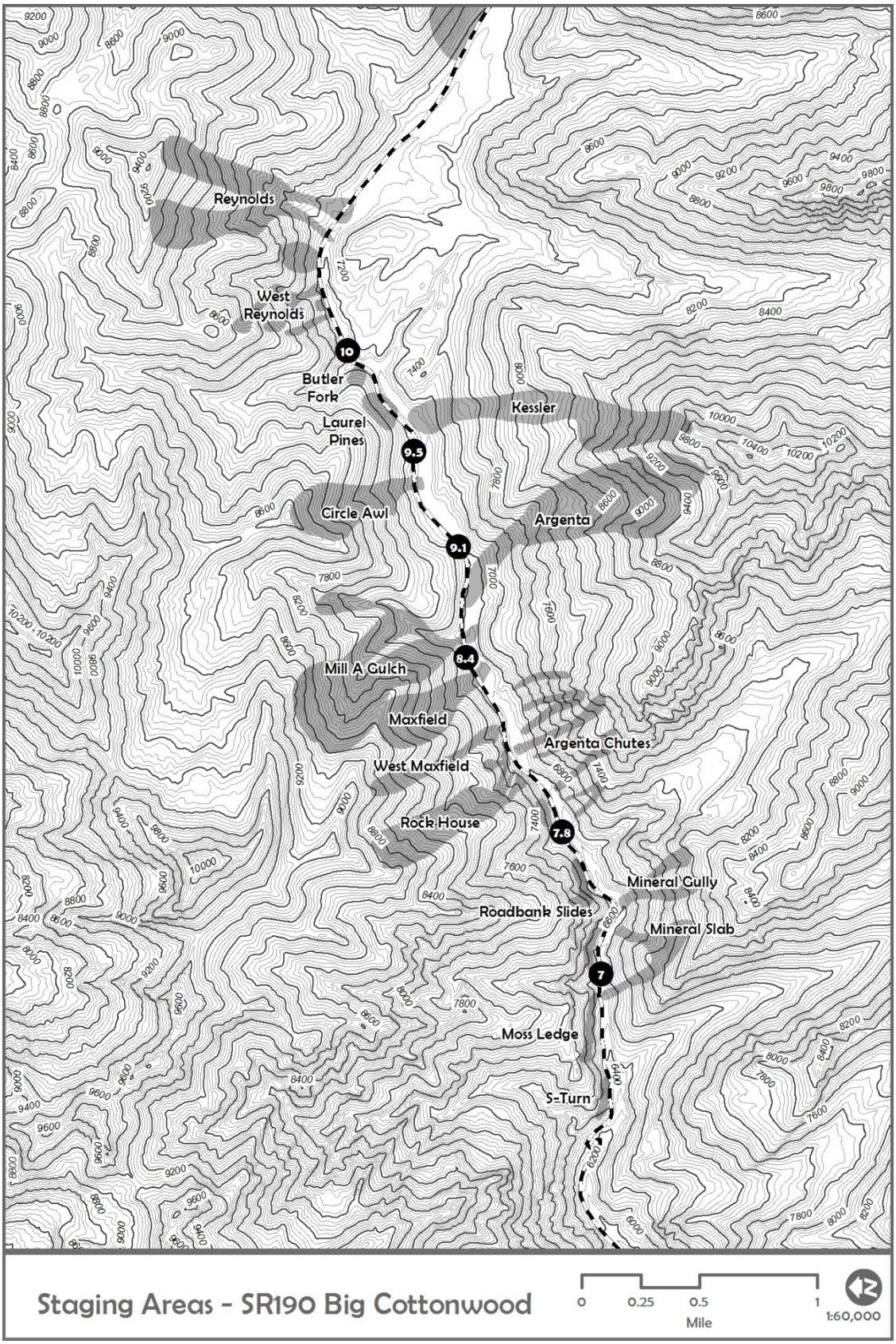
2- If known, give number of vehicles/individuals involved, and the time the avalanche occurred.

3- If known, give approximate dimensions of avalanche (depth and width on road).

4- If there is a witness (other than you), **DETAIN THAT WITNESS**.

5- Move to nearest Staging Area (or other safe location) with witness and any other individuals who may be within the designated Snow Avalanche Area, inform UPD and/or Alta Central dispatcher of your new location.

6- Question witness as to what they may have seen, and wait with witness and any other individuals on site for the arrival of WBR Rescue Personnel, or UPD.


Reynolds
West Reynolds
10
Butler Fork
Laurel Pines
9.5
Kessler
Circle Awl
Argenta
9.1
Mill A Gulch
8.4
Maxfield
West Maxfield
Argenta Chutes
Rock House
7.8
Mineral Gully
Roadbank Slides
Mineral Slab
7
Moss Ledge
S-Turn
Staging Areas - SR190 Big Cottonwood
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INSTRUCTIONS FOR ACCIDENT SITE COMMANDER-

(Accident Site Commander will be the MOST qualified WBR member or other individual designated by UPD)

I- If UPD, and Alta Central Have Not Been Notified, CALL THEM.

A- Identify yourself, and give your location.

1- Ask UPD to dispatch vehicles/officers to appropriate locations to block traffic above and below reported avalanche site.

2- Have Alta Central or UPD notify the following:

- UDOT Avalanche Forecaster in Big Cottonwood Canyon:
  Greg Dollhausen (801) 910-2403 or (435) 647-9613

- UDOT Shed #233 Foreman: (801) 910-2330

- US Forest Service, Salt Lake Ranger District Office

II- Proceed to Reported Location of Avalanche by Most Appropriate Means of Transportation

A- Determine and report the exact location of the avalanche.

B- Determine if further rescue efforts are necessary.

C- Determine if possible, number of vehicles and/or individuals involved in avalanche.

D- Determine type and amount of rescue equipment, personnel, rescue dogs, etc. necessary to carry out rescue, and direct them to nearest Staging Area.

III- Accident Site Procedures

A- Limit exposure from subsequent avalanches to **AS FEW PEOPLE AS POSSIBLE**

B- If appropriate, post (and establish un-interrupted communication with) an Avalanche Guard.

C-Determine Escape Route, and convey that route to **ALL** rescue personnel.

D- Bring the appropriate number of rescuers, dogs, and equipment to the location of the avalanche, record the names of all rescuers on site.

E- While maintaining a balance between the safety of the rescuers, and the effectiveness of the rescue, conduct a through and expedient search of the avalanche debris, concentrating on those areas where vehicles/individuals would most likely be buried.

F- Ensure that all areas that have been adequately searched have been flagged.

G- Conclude rescue when debris has been adequately searched, or when all vehicles and individuals have been accounted for.

H- If necessary, due to increasing avalanche hazard to rescuers, remove personnel and equipment from hazardous areas and return to Staging Areas.

I- If the rescue has been called off due to a threat to the safety of the rescuers, prior to resuming operations, determinations of the avalanche hazard will be made by UDOT Avalanche Forecasters or other qualified rescue personnel. Recommendations and an assessment of the hazard will be given to UPD personnel in charge of the rescue.

Highway Avalanche Alerting and Rescue Plan for Utah SR-210 Little Cottonwood Canyon

Revised June 2012

AVALANCHE ALERTING AND RESCUE PLAN FOR UTAH SR-210
LITTLE COTTONWOOD CANYON
(Revised June 2012)

FORWARD

Utah State Law degrees that the Salt Lake County Sheriff (UPD) is responsible for all Highway Avalanche Rescue operations in Lt. Cottonwood Canyon, outside the Town of Alta. Highway Avalanche Rescue operations within the Town of Alta will be the responsibility of the Alta Town Marshal.

It has been determined by the Salt Lake County Sheriff that during Highway Avalanche Rescue operations, evaluations of hazardous avalanche conditions that may affect the safety of the rescuers, as well as the expertise needed to conduct Avalanche Search and Rescue efforts, can be best provided by trained and experienced avalanche hazard forecasting and avalanche rescue personnel. The Wasatch Backcountry Rescue organization (WBR) is currently the primary source for advising the UPD-Salt Lake County, in determining the level of avalanche hazard affecting rescuers as well as providing the manpower needed to carry out Highway Avalanche Rescue operations. WBR operates under the authority and direction of UPD-Salt Lake County, and will be utilized by UPD-Salt Lake County, during Highway Avalanche Rescue operations.

AVALANCHE ALERTING AND RESCUE PLAN UTAH SR-210

I- ACCIDENT REPORTED

A- Alta Central and UPD-Salt Lake County notified

1- Alta Central will dispatch UPD and/or Alta Town Marshal, or other Official Vehicles/Personnel to block traffic at appropriate locations, including resort parking lots.

2- Alta Central will notify UDOT Avalanche Forecasters

3- Alta Central will issue WBR call-out through Alta and Snowbird Ski Patrol dispatch, or through WBR night time call list*

***Approval must be obtained from UPD-SL County, in order for WBR personnel to be dispatched to any Highway Avalanche Rescue operation**

II- CLEARING TRAFFIC ON ROAD

A- With access to Canyon Road closed at appropriate locations, use Official Vehicles and/or Personnel to clear traffic from under all designated Snow Avalanche Areas. Send vehicles, or their occupants to designated Staging Areas, or other safe locations.

III- ARRIVAL AT ACCIDENT SITE

A- WBR personnel (including UDOT Avalanche Forecasters) proceed to the reported accident site.

1- Determine and report exact location of avalanche.

2- Determine if size of avalanche warrants further avalanche rescue efforts.

3- If further rescue efforts are necessary, WITH THE SAFETY OF THE RESCUERS IN MIND, call for necessary personnel, equipment, rescue dogs, etc., to proceed to the nearest Staging Area.

IV- RESCUE OPERATIONS

A- WITH THE SAFETY OF THE RESCURES IN MIND, and the appropriate amount and type of rescue equipment, rescue dogs, manpower, etc., for the situation, conduct rescue efforts in an orderly and methodical fashion.

INSTRUCTIONS FOR ANY PERSON OBSERVING OR RECEIVING FIRST REPORT OF AN AVALANCHE ON THE CANYON ROAD-

I- IMMEDIATE ACTION- *MAKE SURE YOU ARE IN A SAFE LOCATION*, then-

A- Call Alta Marshal's Office Dispatch (Alta Central) **(801) 742-2033**

1- Identify yourself, give your location and the location of the avalanche.

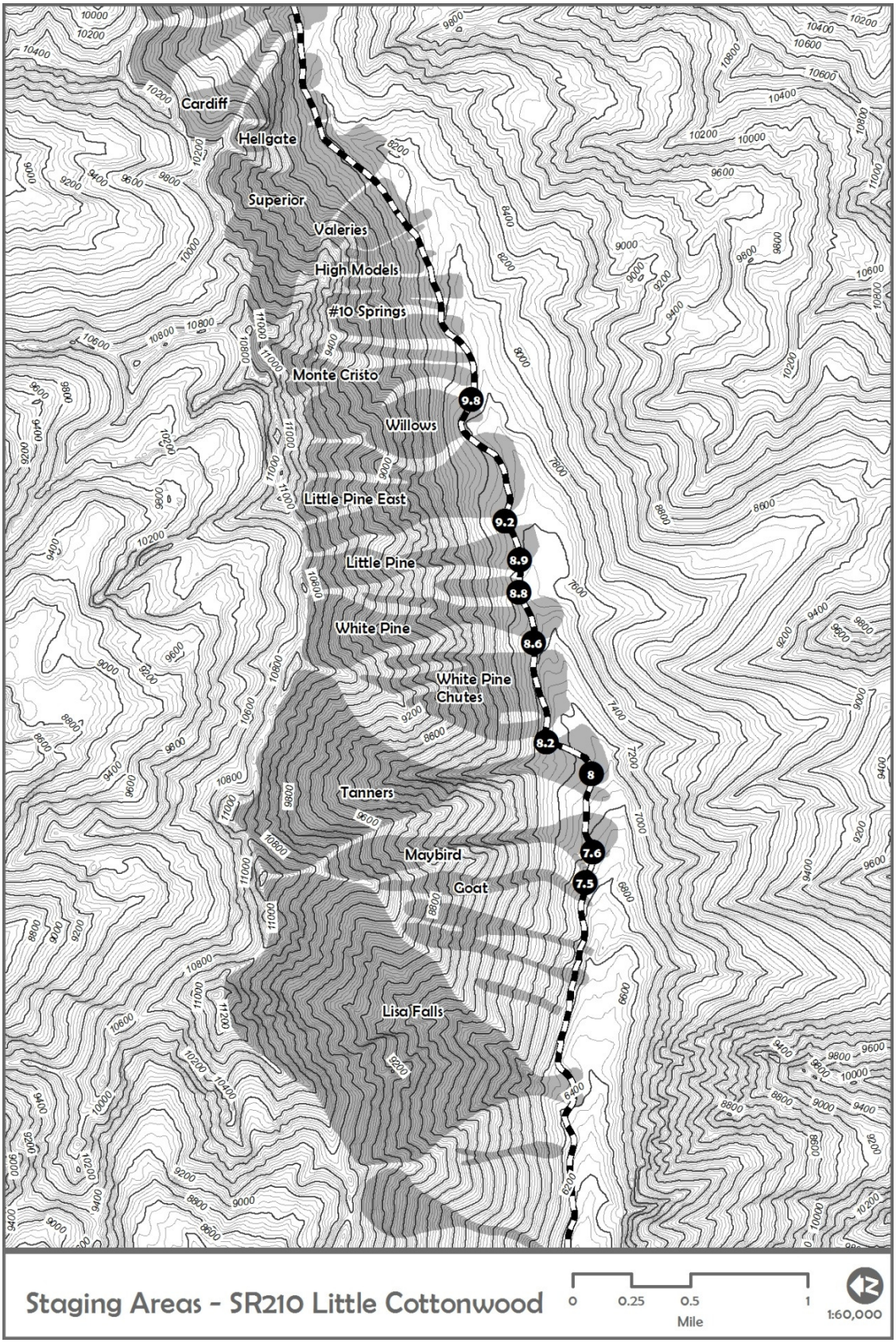
2- If known, give the number of vehicles/individuals involved, and the time the avalanche occurred.

3- If known give approximate dimensions of avalanche (depth and width on road).

4- If there is a witness (other than you) **DETAIN THAT WITNESS**.

5- Move to nearest Staging Area (or other safe location) with witness, and any other individuals who may be within the designated Snow Avalanche Area, inform Alta Central dispatcher of your new location.

6- Question witness as to what they may have seen, and wait with witness and any other individuals on site for the arrival of WBR Rescue Personnel, or UPD.


Cardiff
Hellgate
Superior
Valeries
High Models
#10 Springs
Monte Cristo
Willows
Little Pine East
Little Pine
White Pine
White Pine Chutes
Tanners
Maybird
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Staging Areas - SR210 Little Cottonwood
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Mile
1:60,000

INSTRUCTIONS FOR ACCIDENT SITE COMMANDER-

(Accident Site Commander will be MOST qualified WBR member, or other individual designated by UPD)

I- **If Alta Central, and UPD Have Not Been Notified, CALL THEM.**

A- Identify yourself, and give your location.

1- Direct Alta Central to dispatch officers to appropriate locations to block traffic above and below reported avalanche site.

2- Direct Alta Central to contact the following:
-UDOT Avalanche Forecasters in Lt. Cottonwood Canyon
Call "ANY 249 UNIT" via Alta Central Radio Channel 10-
or call UDOT Avalanche Forecast Office (801) 742-2927 or UDOT Forecaster cell phone #'s. (801) 910-2490 Liam
(801) 910-2466 Chris
(801) 897-9468 Adam
(801) 560-1686 Paul
(801) 910-2492 Matt

- UDOT Shed #233 Foreman, (801) 910-2330

- US Forest Service, Salt Lake Ranger District Office.

II- Proceed to Reported Location of Avalanche by Most Appropriate Means of Transportation.

A- Determine and report the exact location of the avalanche.

B- Determine if further rescue efforts are necessary.

C- Determine if possible, number of vehicles/individuals involved in the avalanche.

D- Determine type and amount of rescue equipment, personnel, rescue dogs, etc. necessary to carry out rescue, and direct them to nearest Staging Area.

III- Accident Site Procedures

A- Limit exposure from subsequent avalanches to **AS FEW PEOPLE AS POSSIBLE**

B- If appropriate, post (and establish un-interrupted communication with) an Avalanche Guard.

C- Determine Escape Route, and convey that route to **ALL** rescue personnel.

D- Bring the appropriate number of rescuers, dogs, and equipment to the location of the avalanche, record the names of all rescuers on site.

E- While maintaining a balance between the safety of the rescuers, and the effectiveness of the rescue, conduct a through and expedient search of the avalanche debris, concentrating on those areas where vehicles/individuals would most likely be buried.

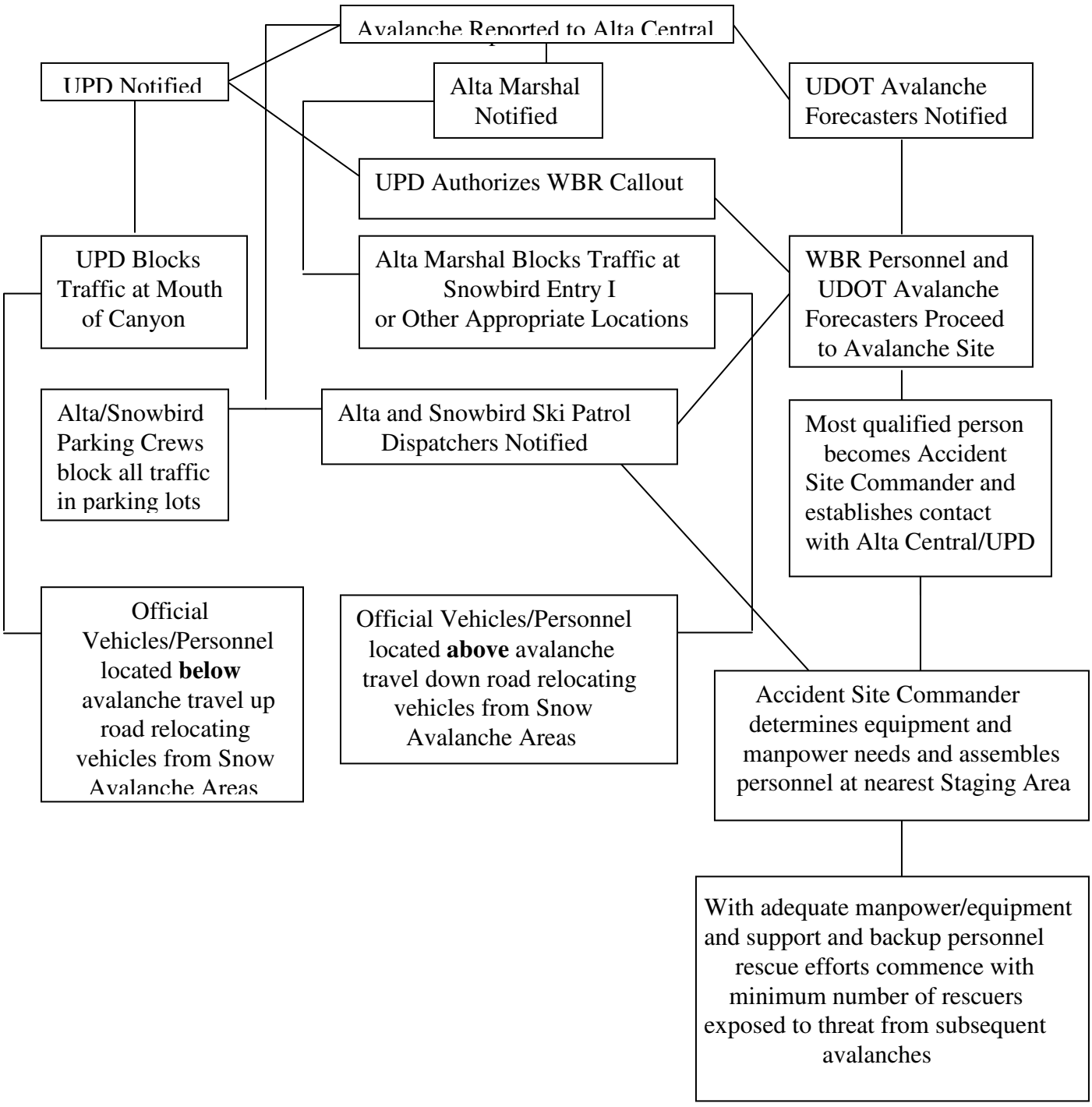
F- Ensure that all areas that have been adequately searched have been flagged.

G- Conclude rescue when debris has been adequately searched, or when all vehicles and individuals have been accounted for.

H- If necessary, due to increasing avalanche hazard to rescuers, remove personnel and equipment from hazardous areas and return to Staging Areas.

I- If the rescue has been called off due to a threat to the safety of the rescuers, prior to resuming operations, a determination of the avalanche hazard will be made by UDOT Avalanche Forecasters or other qualified rescue personnel. Recommendations and an assessment of the hazard will be given to UPD personnel in charge of the rescue.

HIGHWAY AVALANCHE NOTIFICATION AND RESCUE FLOW CHART
UTATH SR-210 LT. COTTONWOOD CANYON



The Avalanche Alerting and Rescue Plans for SR 190, and SR 210 will be on file as a Public Record with the following:

-Unified Police Department
-Alta Town Marshal's Office
-UDOT Avalanche Forecast Offices, Big and Little Cottonwood Canyons

It is recommended that the portion of this document titled: *Instructions for Any Person Observing or Receiving First Report of an Avalanche on the Canyon Road,* as well as maps of the Staging Areas in Big and Lt. Cottonwood Canyons, be given to those individuals likely to receive early notification of an avalanche event. (i.e. UPD Canyon Operation Vehicles, UDOT Snowplows, Ski Patrol Dispatchers at Solitude, Brighton, Snowbird, and Alta Ski Areas, Silver Fork Lodge in Big Cottonwood Canyon)

The following agencies or organizations have reviewed these documents, and agree to support the plans as written:

Salt Lake County Sheriff:

Signature

6/19/12
Date

Utah Department of Transportation Region 2:

Liam Fitzpatrick
Signature

7/11/12
Date

U S Forest Service, Wasatch, Cache, Uinta National Forest, Salt Lake RD

Signature

6/27/12
Date

Alta Marshal's Office

Signature

6-14-12
Date

IV-THE FUTURE OF THE HIGHWAY AVALANCHE SAFETY PROGRAM

The future of the Utah Department of Transportation Highway Avalanche Safety Program will remain dependent upon the willingness of all the current partners to work together towards the continual evolution of the program. As always, predictions of future developments can be inaccurate. What is certain however, is that avalanches will continue to be a threat to the canyon roads, and that the population along the Wasatch Front will continue to increase. And that this increase in population will no doubt lead to an increase in the number of visitors to the canyons during the winter months. This would suggest that without a new approach to transportation and avalanche control in the canyons, the problems faced today will worsen. It is reasonable to assume that this will lead to an increased negative impact to residents in and around the mouth of Big and Little Cottonwood Canyons, increased travel time and major traffic congestion for ski resort visitors, the possible deterioration of air and water quality, and without question, an increased risk to vehicles traveling on the canyon roads from avalanches.

Possible advancements in the field of Avalanche Hazard Forecasting, and improvements to existing Active Avalanche Control methods would seem to be limited, and it is unlikely that any advancements that might be made in these areas would match the increased traffic volume, and increased demands that will be placed on the program in the future.

It is therefore crucial that all interested parties acknowledge the fact that fundamental changes are needed, and that without those changes the Highway Avalanche Safety Program will eventually fail to meet the needs of the public, of Federal, State, County and Local government agencies, and of private enterprise.

TOPICS FOR CONSIDERATION

The following ideas and suggestions may contribute to an improvement to the Highway Avalanche Safety Program. Very few of these ideas are new. Most of them would require a significant financial commitment, a thorough Environmental Analysis, or change in current transportation habits. And they all require a commitment to wanting to improve the system.

Many of the ideas presented in this section have been more thoroughly addressed in the *Little Cottonwood Canyon SR-210, Transportation Study*, published in August 2006, by Fehr & Peers Associates. Readers are encouraged to review that Study by using the following link: http://www.udot.utah.gov/main/f?p=100:pg:0::1:T,V:1720

REDUCTION IN AVERAGE DAILY TRAFFIC VOLUME

Average Daily Traffic (ADT) frequently exceeds design capacity for the canyon roads during the ski season. The primary contribution to this is the number of personal vehicles used by day skiers/snowboards to travel to and from the resorts, and the fact that most of these vehicles travel to and from the resorts with only one occupant. Improvements and additions to Mass Transit options as well as some form of incentive for car-pooling could result in a reduction of the ADT volume.

SNOW SHEDS

The construction of Snow Sheds, particularly in the Mid- Canyon section of Lt. Cottonwood Canyon, would significantly improve public safety on the canyon road. Much of the preliminary work needed to begin this project has already been completed.

IMPROVEMENTS TO EXISTING AVALANCHE DEFENSE STRUCTURES

Improvements to the existing catchment structure known as the "China Wall" in the Runout Zone of the White Pine avalanche path, in Lt. Cottonwood Canyon, could greatly improve to ability to retain avalanche debris from small to medium sized avalanches occurring in that area.

Similar improvements could be made in the runout of the Lt. Pine avalanche path.

REALIGNMENT OF CANYON ROADS

A realignment of the canyon roads, in particular SR-210, would allow for avoidance of many small to medium sized avalanches from reaching the road.

EXPANSION OF THE INFRASONIC AVALANCHE DETECTION SYSTEM

The Infrasonic Avalanche Detection System currently deployed in the mid-canyon portion of Lt. Cottonwood Canyon, has proven to be of significant benefit in monitoring avalanche activity. This system helps UDOT Avalanche Forecasters determine when road closures are necessary, as well as the effectiveness of artillery avalanche control work. Expansion of this system in Lt. Cottonwood Canyon, or the introduction of a similar system in Big Cottonwood Canyon would provide additional improvements to the ability to monitor avalanche activity, and help in the decision making process involved in management of the canyon roads.

ALTERNATIVE METHODS OF ACTIVE AVALANCHE CONTROL

-*Gaz-ex* System

Plans call for the expansion to the existing Gaz-ex system above the Snowbird village beginning in the summer of 2012. The *Gaz-ex* system offers an effective alternative to artillery avalanche control, and would be well suited for numerous other avalanche paths that affect the roads in both Big and Little Cottonwood Canyons.

-Chirlift Construction

Chairlift construction in certain areas would allow for regular skier compaction of the snowpack in avalanche starting zones that affect SR-210, as well as the Town of Alta.

Thorough and regular skier compaction will not completely eliminate the possibility of avalanches but would increase the Return Interval of large and destructive avalanches.

-The *Avalanche Guard*, and *Wiesen Tower*

The *Avalanche Guard* and *Wiesen Tower* are examples of alternate methods of active avalanche control that should be explored to determine if they would be suitable for either Big of Lt. Cottonwood Canyons.

WEATHER STATIONS

Additional stations, as well improvements to existing stations, could improve the ability to monitor weather factors know to contribute to the development of hazardous avalanche conditions.

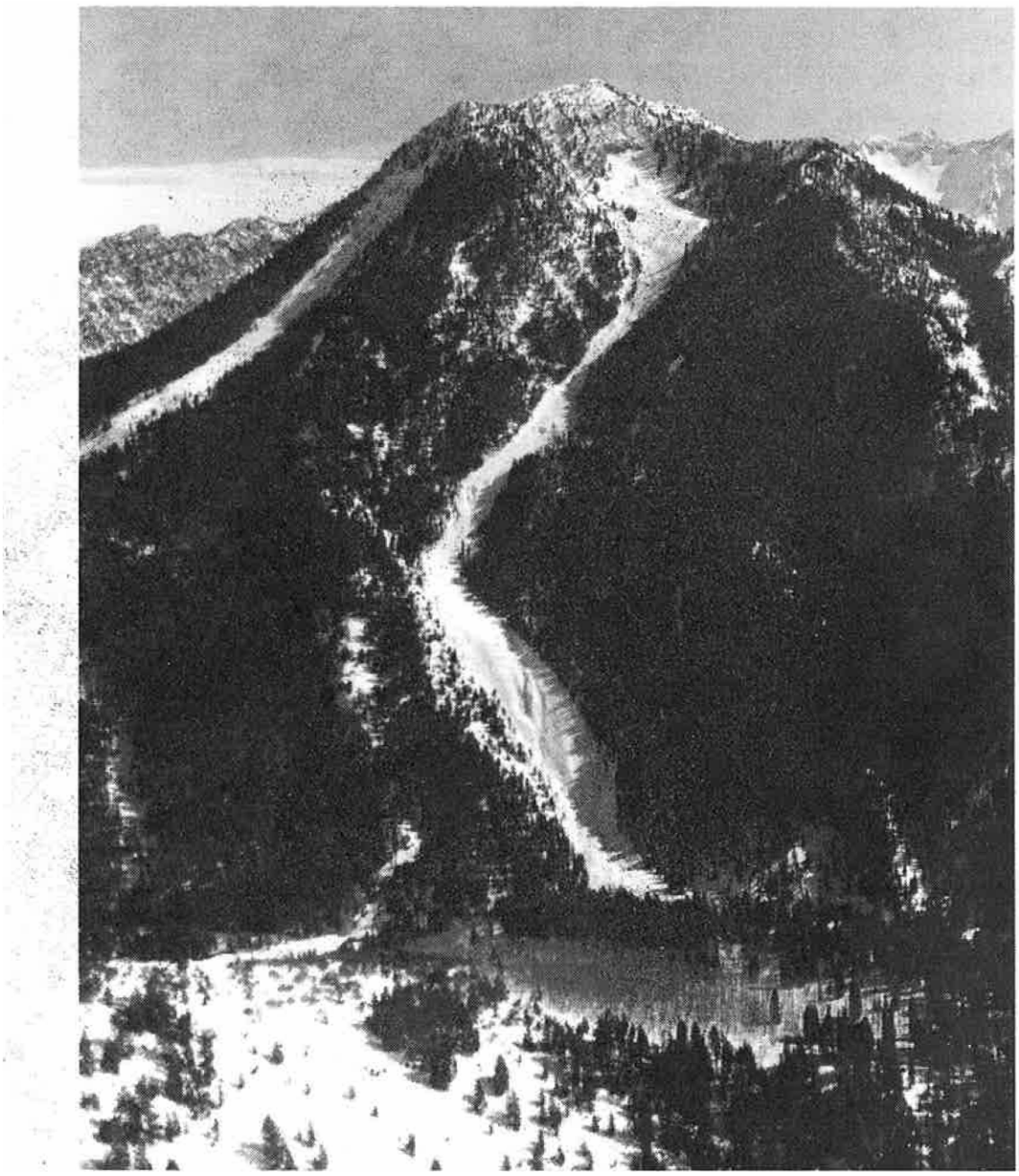
ITS TECHNOLOGY

Intelligent Transportation Systems employ cameras, road temperature sensors, automated de-icing solutions, and other technology to help manage traffic during winter driving conditions. Implementation of this type of technology could help reduce the occurrence of slow moving or stationary traffic under avalanche paths during periods of increasing avalanche danger.

It is likely that some combination of the possibilities listed above would represent the best solution to future transportation safety, and avalanche control concerns in Big and Little Cottonwood Canyons. **It is strongly recommended that an independent group conduct a thorough and comprehensive study of these and any other reasonable options, and develop a plan for the future needs of the Highway Avalanche Safety Program in Big and Lt. Cottonwood Canyons**.

Snow Avalanche Atlas

Big Cottonwood Canyon
SR-190



March 2001
Utah Department of Transportation

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Laurel Pines	9.78	57
Bus Comer Road Bank	9.9	59
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Cardiff Low Road Bank	10.07	63
West Reynolds Chutes	10.36	65
Reynolds Rock	10.70	67
Cardiff High Road Bank	10.44	69
Grand Central	10.77	71
Brighton Hill	15.69	75

INTRODUCTION

The avalanche atlas is intended as an operational guide to avalanche paths located in Big Cottonwood Canyon that threaten SR-190. It is primarily for the use of highway avalanche forecasting and maintenance, personnel. The atlas standardizes names and descriptions of the various avalanche paths to avoid confusion, particularly in avalanche occurrence reporting.

THIS ATLAS IS NOT FOR ZONING OR DEVELOPMENT USE.

This atlas contains photographs, maps, and summary sheets on avalanche paths affecting the highway. It is produced on the basis of current knowledge of avalanches and existing records. They are catalogued in this atlas according to their road mile position on the Route Reference SR-190 map on page 5.

PRIMARY CONTRIBUTORS

Originally compiled and edited in 1983 by Rick Wyatt, UDOT Avalanche Forecaster and Peter Lev, UDOT Avalanche Specialist with contributions by Bengt Sandahl, Ray Linquist, Larry Bullock, Mike Doyle, and William Hale. Obliques taken April1986.

Revised, compiled, and edited in 2001 by Greg Dollhausen, UDOT Avalanche Forecaster and Steve Conger, UDOT Avalanche Specialist with contributions by Ralph Patterson. New aerial oblique photography by Melanie Buck, UDOT and Thad Moore, Pilot.
Layout by James Yount. Obliques taken February 1997.

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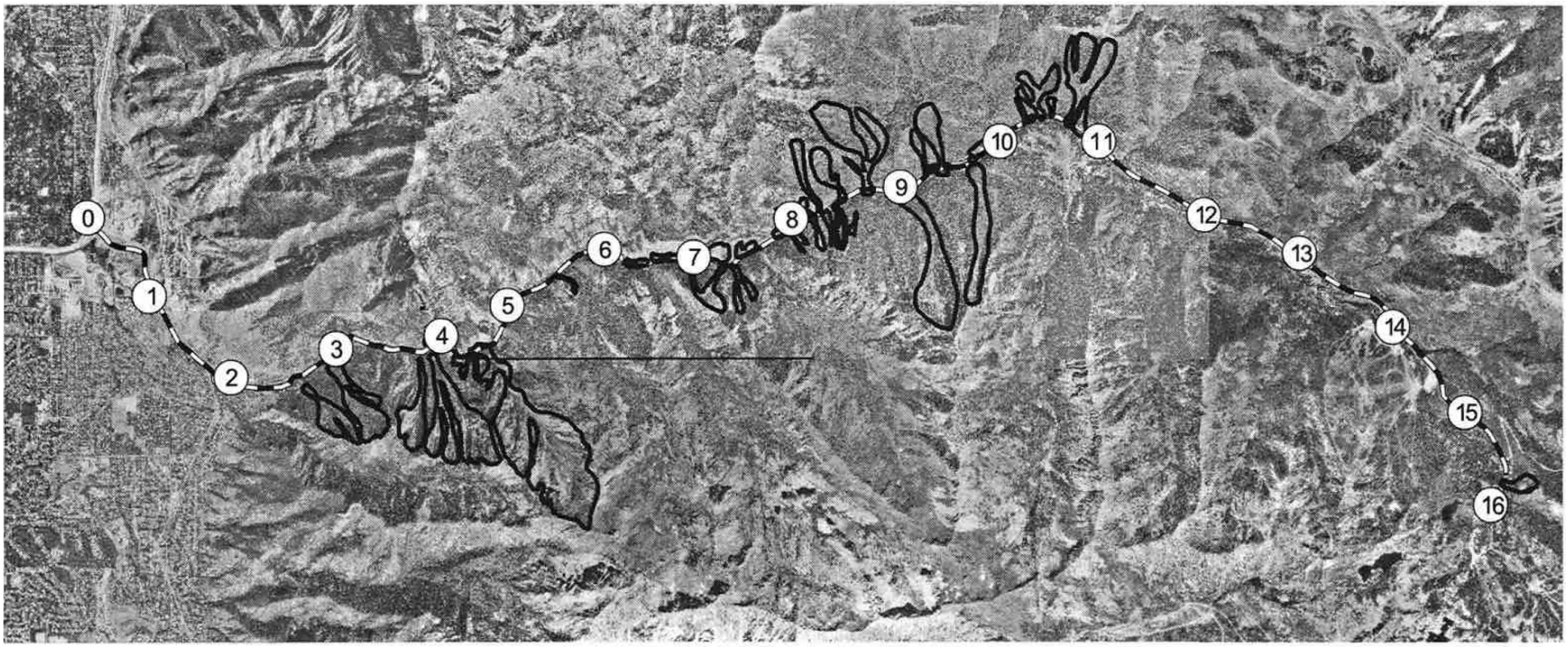
The Avalanche Handbook, 1993, by David McClung and Peter Schaerer.

State Route 190 - Big Cottonwood Canyon, Utah
Highway Reference Posts



0 1 2 3 4 5 6 7 8 Miles

N

AVALANCHE AND WEATHER HISTORY

State road 190 begins at the 6200 south I-215 south bound off ramp. Moving south and east 1.83 miles it reaches the mouth of Big Cottonwood Canyon at an elevation of 4,915 feet. SR-190 curves 14 miles and 3,735 feet eastward up Big Cottonwood Canyon to Brighton at 8,735 feet.

The canyon has diverse rock, vegetation, and land formations with changing elevations and localities. The upper six miles of the canyon from Reynolds Flat to Brighton was glacier cut and is wide and open. The lower, stream cut portion of the canyon, is where most of the active avalanche paths effect the highway.

The avalanche paths on the uphill side of the highway or north of the creek are generally south facing with relatively low starting zones. These paths usually have a shallow snow pack with a variety of crusts, but a more direct line to the highway compared to the north facing paths. On the other side of the creek, the north facing paths are generally higher in elevation and maintain a deeper snow pack. Some of these paths are quite large and have long tracks to absorb slide energy before reaching the highway. These north facing paths usually have a weak snow structure with temperature gradient or faceted snow through the end of each season. Road banks are found on the uphill side of the highway and are a threat to motorists during precipitation events and intense heating.

Weather conditions vary greatly from location to location in the canyon. A storm from the southwest typically affects the upper canyon with little or no snow below Silver Fork. Conversely, a northwest flow can put down three times as much snow with high precipitation intensity events from Spruces to the mouth of the canyon.

Avalanche history affecting the highway in Big Cottonwood Canyon has not been well documented prior to 1985 and the addition of a UDOT Avalanche Forecaster to the canyon. Traffic flow has tripled in the 1990s as a result of increased population along the Wasatch Front. Ski area expansion along with year round residency has put an extra burden on UDOT crews to keep canyon roads open 24hrs a day. These factors have consequently increased the avalanche hazard, or index, in Big Cottonwood Canyon.

DEFINITIONS OF TERMS USED IN AVALANCHE PATH SUMMARIES

Base Maps: USGS 7.5 minute series quadrangle sheets; Dromedary Peak, Brighton, Mount Aire, and Park City West.

Return Interval:

Frequent-	Release to highway once in five years. Release
Occasional-	to highway at least once in 14 years.
Infrequent-	Release to highway once or less in 14 years, or significant re-growth of vegetation.

Vertical Fall: The vertical fall is the vertical distance from the highest to the lowest elevation of an avalanche path.

Distance to Highway: The distance to highway is the distance estimated from the map along the sighting angle from the highway to the starting zone.

Starting Zone: The starting zone is the area at the top of the avalanche path where the unstable snow breaks away from the more stable part of the snow cover and begins to move down the slope.

Track: The track is the area between the starting zone and the runout zone where the avalanche reaches its maximum velocity.

Runout Zone: The runout zone is the area at the bottom of an avalanche path where the moving snow and debris decelerates and comes to a stop.

Elevation: Elevations are taken from 7.5 minute series mapping.

Aspect: The aspect is the direction of avalanche flow.

Incline: The incline is the slope angle of a path for each of the three portions of the path: starting zones, tracks, and runout zones. Slopes have either been measured in the field with inclinometers, or estimated from the map.

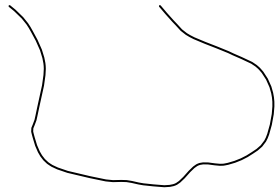
Acreage: Approximate acreage has been estimated from the map.

Topography: Local topography has been subjectively described for starting zones, tracks, and runout zones. Descriptions are a result of oblique aerial photographs, interpretations, and field observations.

Length of Highway Effected: The length of highway effected is the maximum length affected by past observed avalanche occurrences. Future occurrences may affect the highway over greater length.

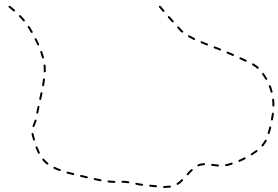
History: The history of a given path is based on personal account, previous avalanche documents, vegetation re-growth, and avalanche observations.

MAP KEY



Solid Line:

Actual observation by at least one of the contributors to this atlas, with dates given on the data sheet.



Dashed Line:

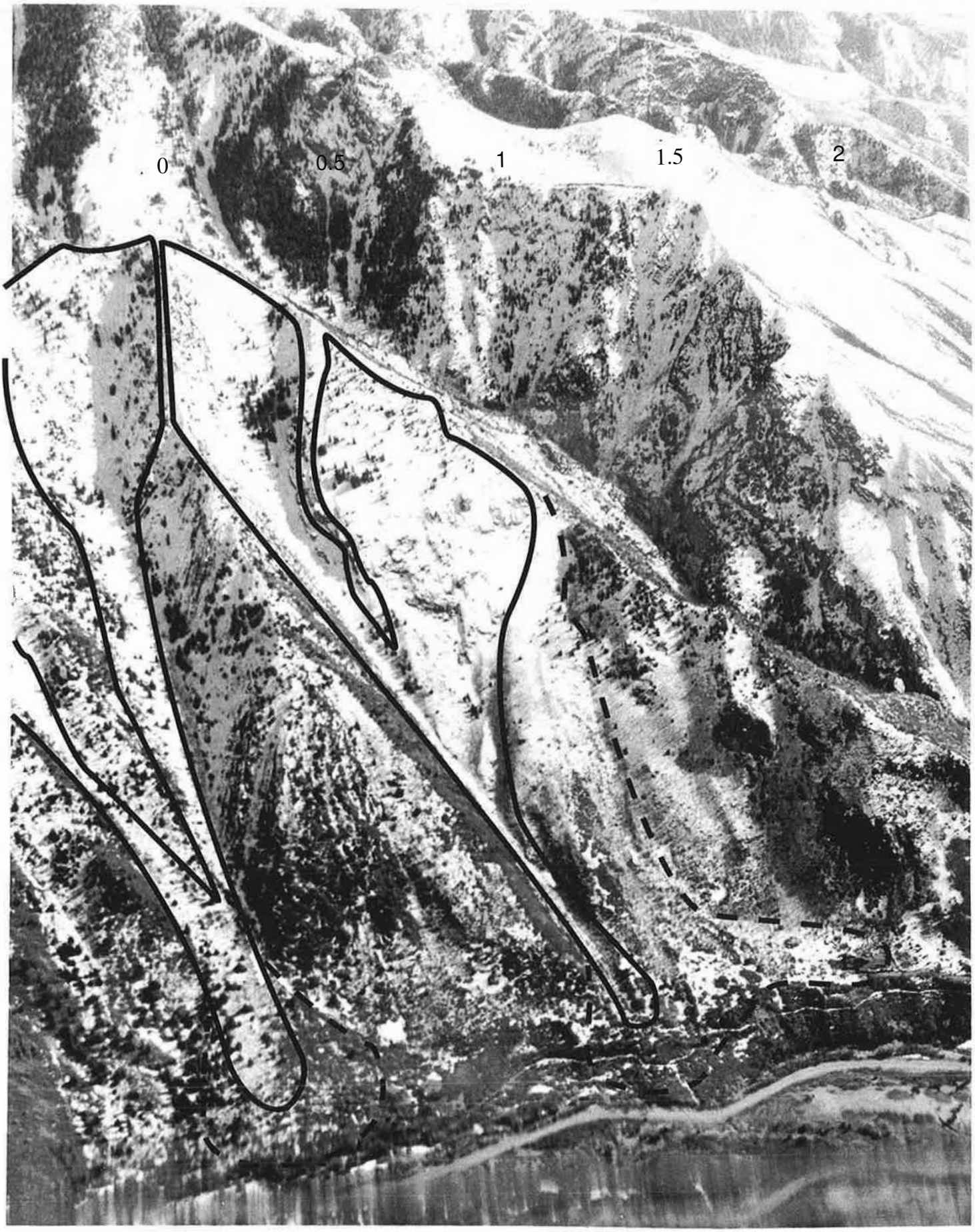
Probable based on terrain feature, vegetation damage, or unverified historical account.

Aerial photo interpretation was done without stereo pairs, only an ortho- recrified quad.

HISTORICAL ERA AVALANCHES (PRE-1950) ARE LIKELY TO HAVE RUN FURTHER AND BEEN MORE EXTENSIVE THAN THE OBSERVED (SOLID LINE) RUNOUTS DELINEATED IN THIS ATLAS.

MAXIMUM RUNOUT DISTANCES HAVE NOT BEEN CALCULATED FOR THESE PATHS.


Hollow
Hidden Falls
Mill B South Fk Picnic Ground
S-Turn
Broads Chute
Santa Claus Rock
Maxfield Lodge
Storm Mtn Picnic Ground
Outside Corner Chute
Canyon
The Birches Picnic Ground
Oak Ridge Picnic Ground
Storm Mountain
B I G
Ferguson
Ferguson Canyon
PRESERVE
Smith
Canyon
North
Fork
Twin Peaks
BOUNDARY


0
0.5
1
1.5
2

AVALANCHE PATH SUMMARY

NAME: Ferguson Chutes MILEPOST: 2.54

RETURN INTERVAL: Infrequent

VERTICAL FALL: 2,680 ft.

DISTANCE TO HIGHWAY: 4,880 ft.

STARTING ZONE

ELEVATION: 7,680 ft. (ASL)

ASPECT: North/Northwest

INCLINE: 45 to 35

ACREAGE: 90

TOPOGRAPHY: Complex slope with mixed talus and brush with conifer.

TRACK:

ELEVATION: 7,000 ft. to 5,500 ft.

ASPECT: North

INCLINE: 30 to 10

TOPOGRAPHY: Long channeled gullies with mixed brush and conifer.

RUNOUT:

ELEVATION: 5,500 ft. to 5,000 ft.

INCLINE: 10

TOPOGRAPHY: Alluvial fans with mixed brush and conifer

LENGTH OF HIGHWAY EFFECTED: 240ft.

HISTORY: No history of reaching highway.

AVALANCHE PATH SUMMARY

NAME: Power Plant Road Bank MILEPOST: 3.87

RETURN INTERVAL: Frequent; once a year

VERTICAL FALL: 400ft.

DISTANCE TO HIGHWAY: 680ft.

STARTING ZONE

ELEVATION: 5,500 ft. (A.S.L.)

ASPECT: South INCLINE:

45

ACREAGE: 2

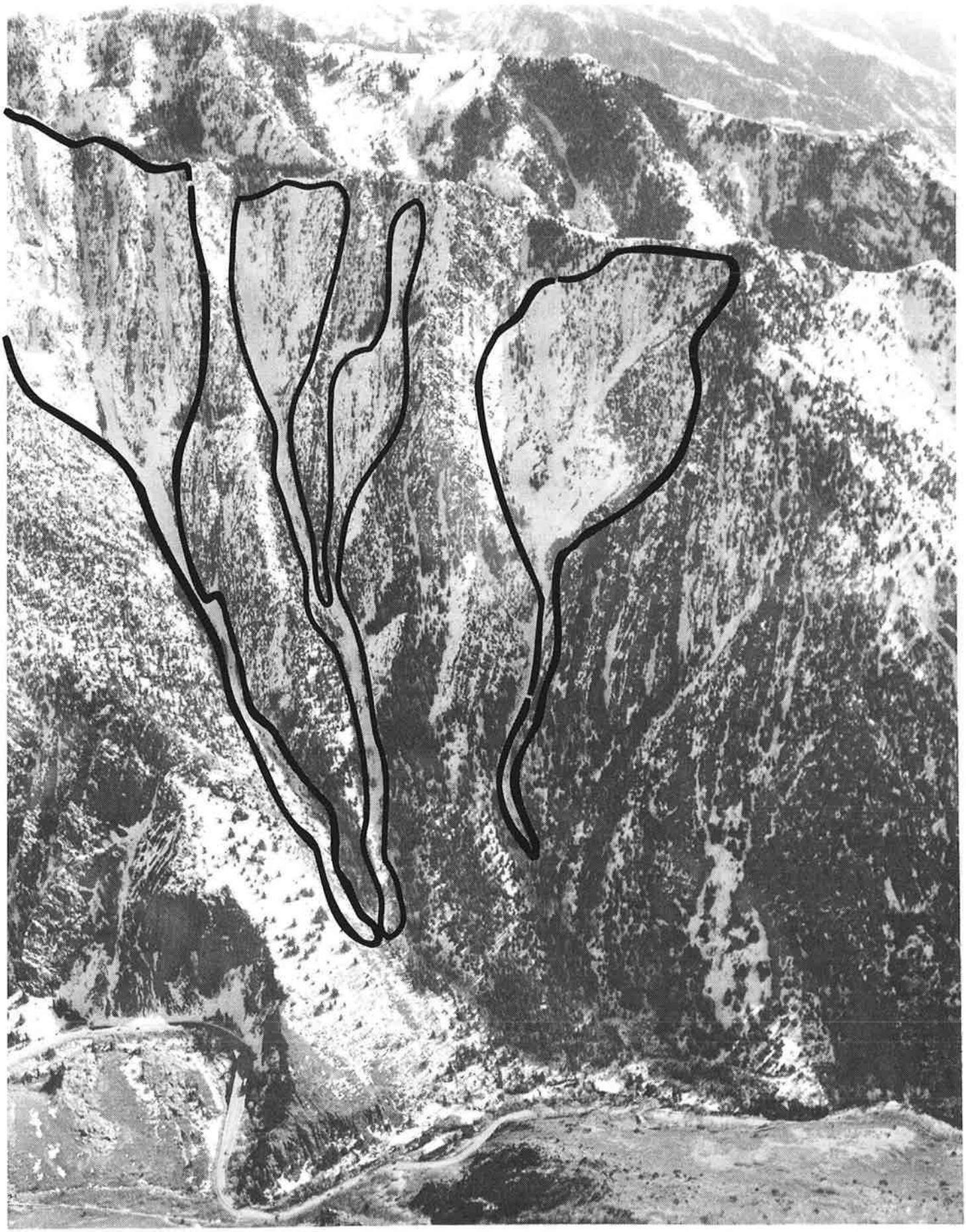
TOPOGRAPHY: Loose talus slope, mixed brush, and conifer

TRACK: Unconfined

RUNOUT ZONE: Highway

LENGTH OF HIGHWAY AFFECTED: 150ft.

HISTORY: Frequently runs to centerline of highway with loose snow sloughs and small soft slabs especially during down canyon or lake effect precipitation events.



AVALANCHE PATH SUMMARY

NAME: Power Plant Chutes MILEPOST: 3.87

RETURN INTERVAL: Infrequent

VERTICAL FALL: 3,650 ft.

DISTANCE TO HIGHWAY: 5,400 to 6,700 ft.

STARTING ZONE

ELEVATION: 8,800 ft. (A.S.L.)

ASPECT: North/Northwest to Northeast

INCLINE: 50 to 35

ACREAGE: 160

TOPOGRAPHY: Steep talus slopes with mixed rock slabs, conifer, and gullies.

TRACK:

ELEVATION: 8,000 ft. to 5,500 ft.

ASPECT: North/Northeast

INCLINE: 30 to 10

TOPOGRAPHY: Three confined gullies.

RUNOUT ZONE:

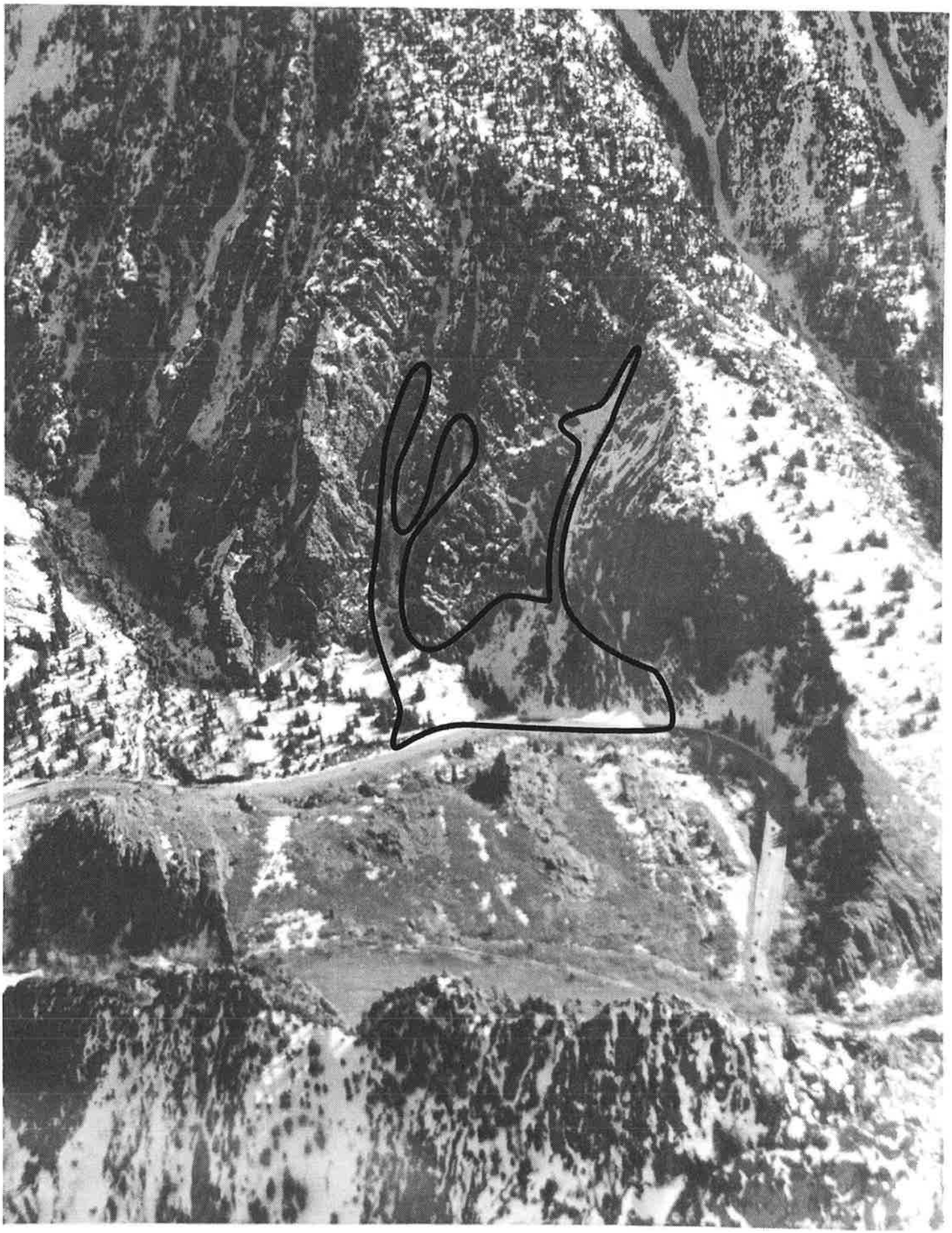
ELEVATION: 5,500 ft. to 5, 400ft.

INCLINE: 10

TOPOGRAPHY: Confined conifer slopes.

LENGTH OF HIGHWAY AFFECTED: 190ft.

HISTORY: No history of reaching highway.



AVALANCHE PATH SUMMARY

NAME: Outside Corner Chutes MILEPOST: 4.32

RETURN INTERVAL: Frequent; 1-2 year return

VERTICAL FALL: 920ft.

DISTANCE TO HIGHWAY: 1,300 ft.

STARTING ZONE

ELEVATION: 6,600 ft. (A.S.L.)

ASPECT: North/Northeast
INCLINE: 45

ACREAGE: 9

TOPOGRAPHY: Mixed talus and conifer in channeled gullies.

TRACK:

ELEVATION: 6,800 ft. to 5,900 ft.

ASPECT: North

INCLINE: 40

TOPOGRAPHY: Loose talus slope.

RUNOUT ZONE:

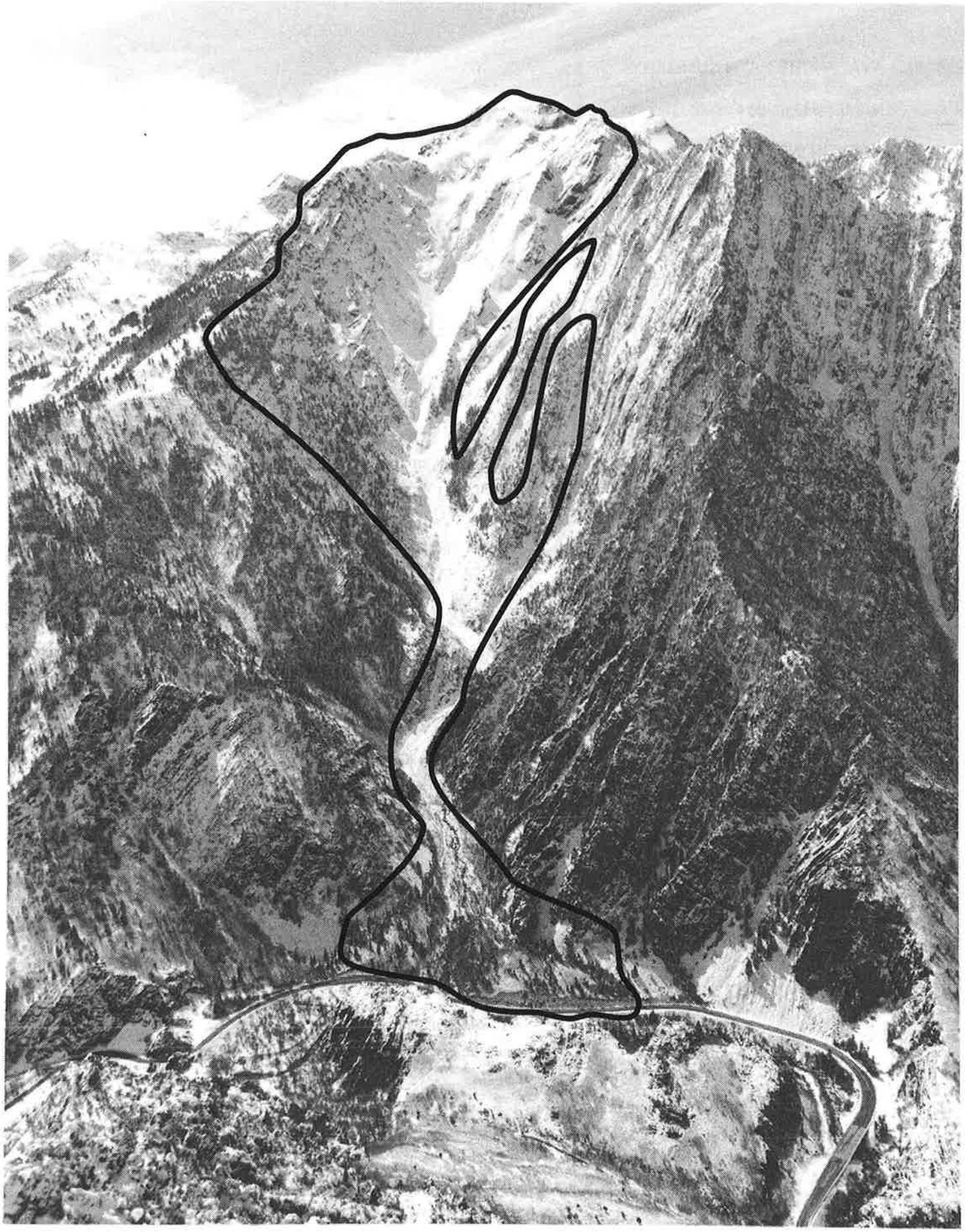
ELEVATION: 5,900 ft. To highway

INCLINE: 35

TOPOGRAPHY: Loose talus slope.

LENGTH OF HIGHWAY AFFECTED: 390ft.

HISTORY: Frequently runs to centerline of highway with loose snow sloughs especially during down canyon or lake effect precipitation events.



AVALANCHE PATH SUMMARY

NAME: Storm Mountain MILEPOST: 4.52

RETURN INTERVAL: Infrequent

VERTICAL FALL: 4,720 ft.

DISTANCE TO HIGHWAY: 10,400 ft.

STARTING ZONE

ELEVATION: 10,450 ft. to 8,800 ft. (A.S.L.)

ASPECT: North/Northeast to Northwest

INCLINE: 50 to 32

ACREAGE: 280

TOPOGRAPHY: Complex talus slopes with mixed rock slabs and channeled talus gullies.

TRACK:

ELEVATION: 8,800 ft. to 6,000 ft.

ASPECT: North

INCLINE: 25 to 10

TOPOGRAPHY: Large channeled talus gully with two major changes in direction. Large bend in middle.

RUNOUT ZONE:

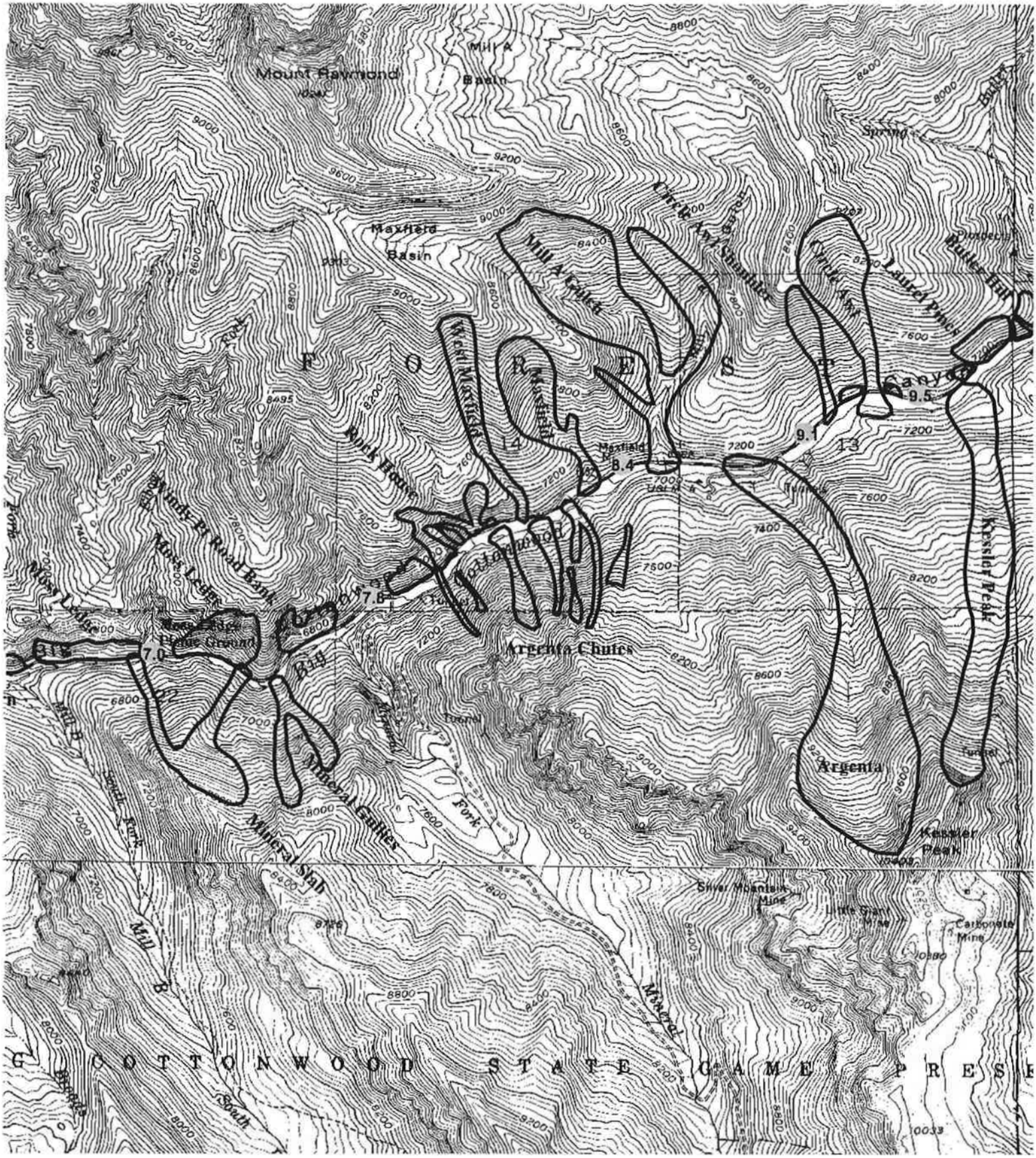
ELEVATION: 6,000 ft. to 5,760 ft.

INCLINE: 10

TOPOGRAPHY: Alluvial fan with mixed talus and brush.

LENGTH OF HIGHWAY AFFECTED: 570ft.

HISTORY: Slides frequently with long track absorbing energy before reaching highway. Crossed highway in January, 1991. 2 climbers killed in avalanche April 28, 2001.


Mount Raymond
Mill A Basin
Maxfield Basin
Mill A Chute
West Maxfield
Maxfield
Rock House
Bandy Pt Road Bank
Mine Ledge
Mine Ledge Picnic Ground
Yellowjacket
Argenta Chutes
Argenta
Kessler Peak
Laurel Pinch
Butler Hall
Spring
Tunnel
Mineral Gullies
Mineral Slab
South Fork
Mill B
Silver Mountain Mine
Little Giant Mine
Carbonate Mine
COTTONWOOD STATE GAME PRES
0
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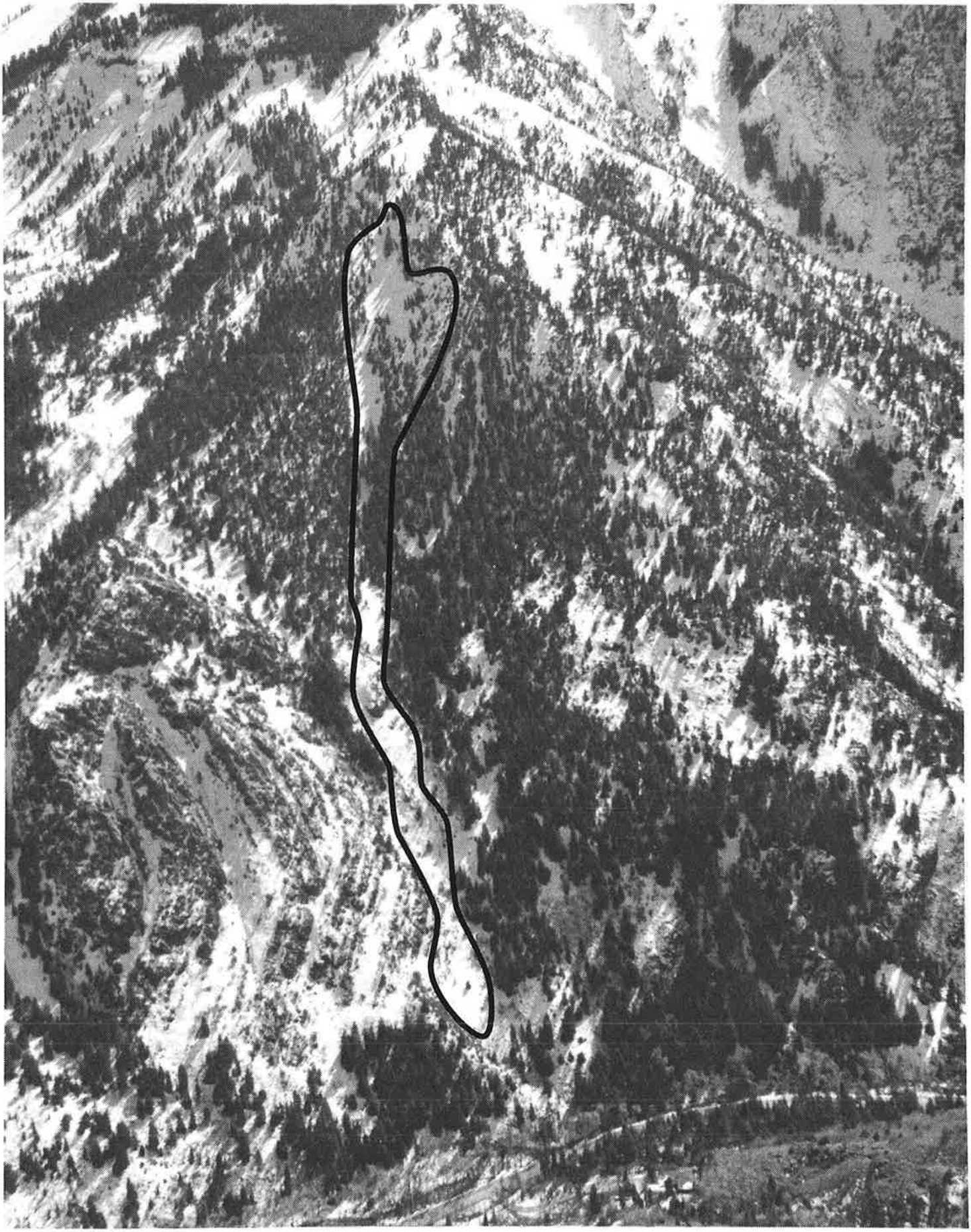


AVALANCHE PATH SUMMARY

NAME: Broads Chute MILEPOST: 5.00

RETURN INTERVAL: Infrequent

VERTICAL FALL: 940ft.

DISTANCE TO HIGHWAY: 1,600 ft.

STARTING ZONE

ELEVATION: 6,800 ft. to 6,600 ft. (A.S.L.)

ASPECT: North

INCLINE: 38

ACREAGE: 3

TOPOGRAPHY: Mixed talus and conifer slope.

TRACK:

ELEVATION: 6,600 ft. to 6,000 ft.

ASPECT: North

INCLINE; 30

TOPOGRAPHY: Channeled conifer slope.

RUNOUT ZONE:

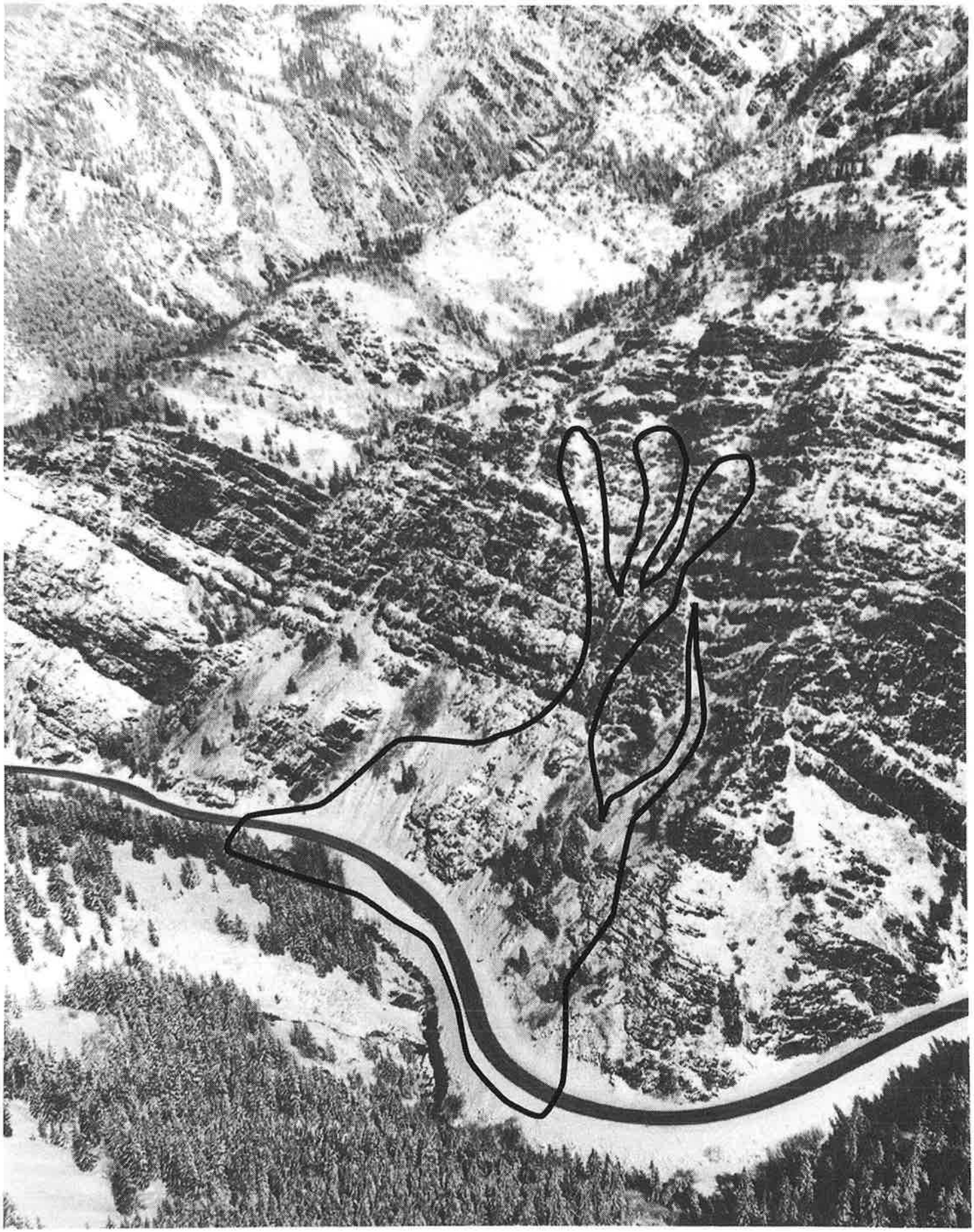
ELEVATION: 6,000 ft. to 5,800 ft.

INCLINE: 5

TOPOGRAPHY: Mixed conifer and brush slope.

LENGTH OF HIGHWAY AFFECTED: 190ft.

HISTORY: No history of reaching highway. Unconfirmed history of reaching creek; April 1974.



AVALANCHE PATH SUMMARY

NAME: Moss Ledge MILEPOST: 7.10

RETURN INTERVAL: Frequent; 1-2 year return interval

VERTICAL FALL: 800ft.

DISTANCE TO HIGHWAY: 1,302 ft.

STARTING ZONE

ELEVATION: 7,400 ft. to 6,750 ft. (A.S.L.)

ASPECT: Southwest

INCLINE: 50 to 35

ACREAGE: 16

TOPOGRAPHY: Mixed talus slope and rock slabs.

TRACK:

ELEVATION: 6,750 ft. to 6,600 ft.

ASPECT: Southwest

INCLINE: 35 to 10

TOPOGRAPHY: Talus slope.

RUNOUT ZONE:

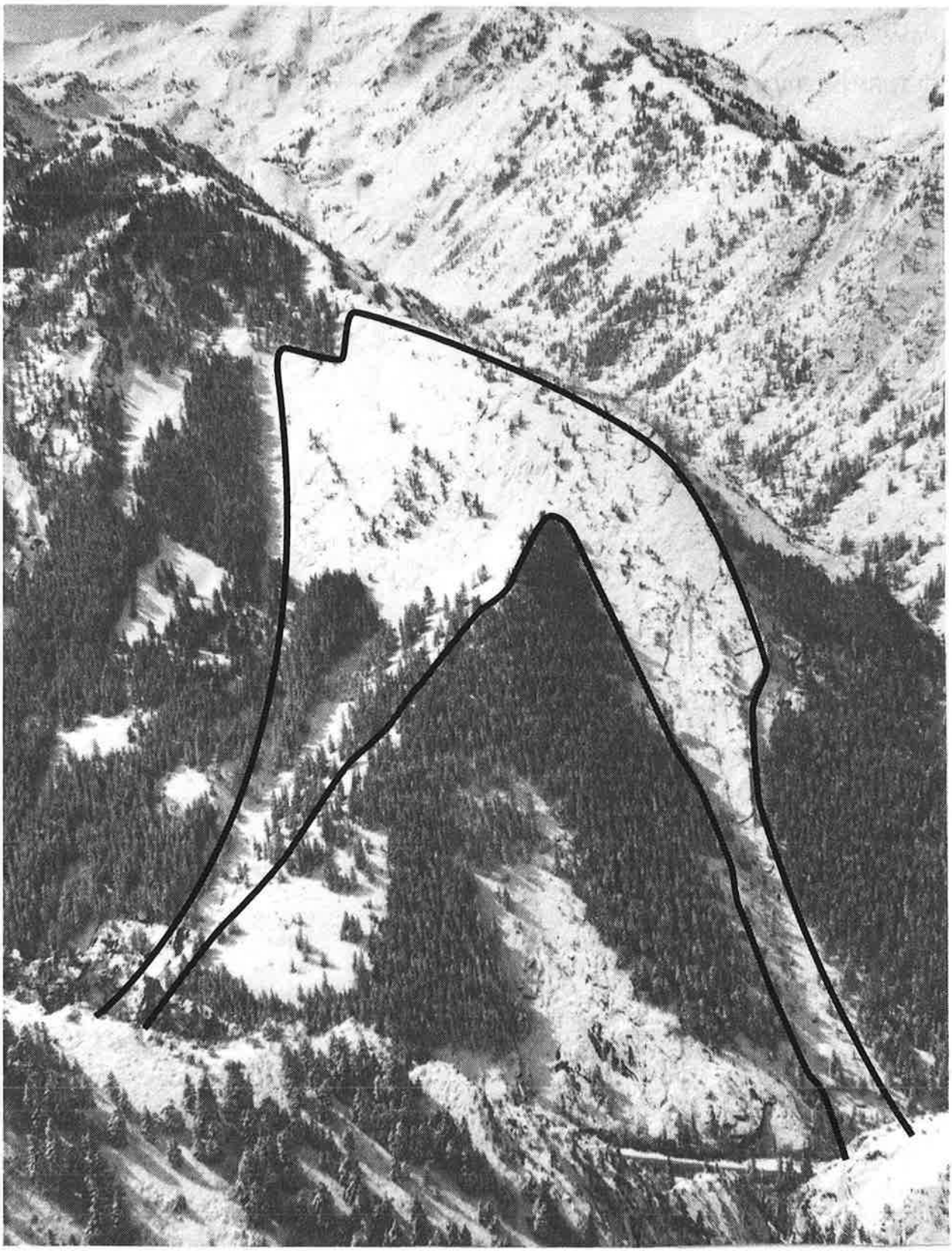
ELEVATION: 6,600 .ft. to highway

INCLINE: 10

TOPOGRAPHY: Talus slope.

LENGTH OF HIGHWAY AFFECTED: 600ft.

HISTORY: Frequently runs to center line of highway with loose snow sloughs and soft slabs during down canyon or lake effect precipitation events.



AVALANCHE PATH SUMMARY

NAME: Mineral Slab Milepost: 7.23

RETURN INTERVAL: Infrequent

VERTICAL FALL: 1,200 ft.

DISTANCE TO HIGHWAY: 2,240 ft.

STARTING ZONE:

ELEVATION: 8,000 to 7,400 ft. (A.S.L.)

ASPECT: Northwest

INCLINE: 45 to 40

ACERAGE: 34

TOPOGRAPHY: Large rock slabs with small horizontal benches.

TRACK:

ELEVATION: 7,400 to 6,600 ft.

ASPECT: Northwest/Northeast

INCLINE: 35 to 28

TOPOGRAPHY: Two separate channeled gullies with mixed brush and conifer.

RUNOUT ZONE:

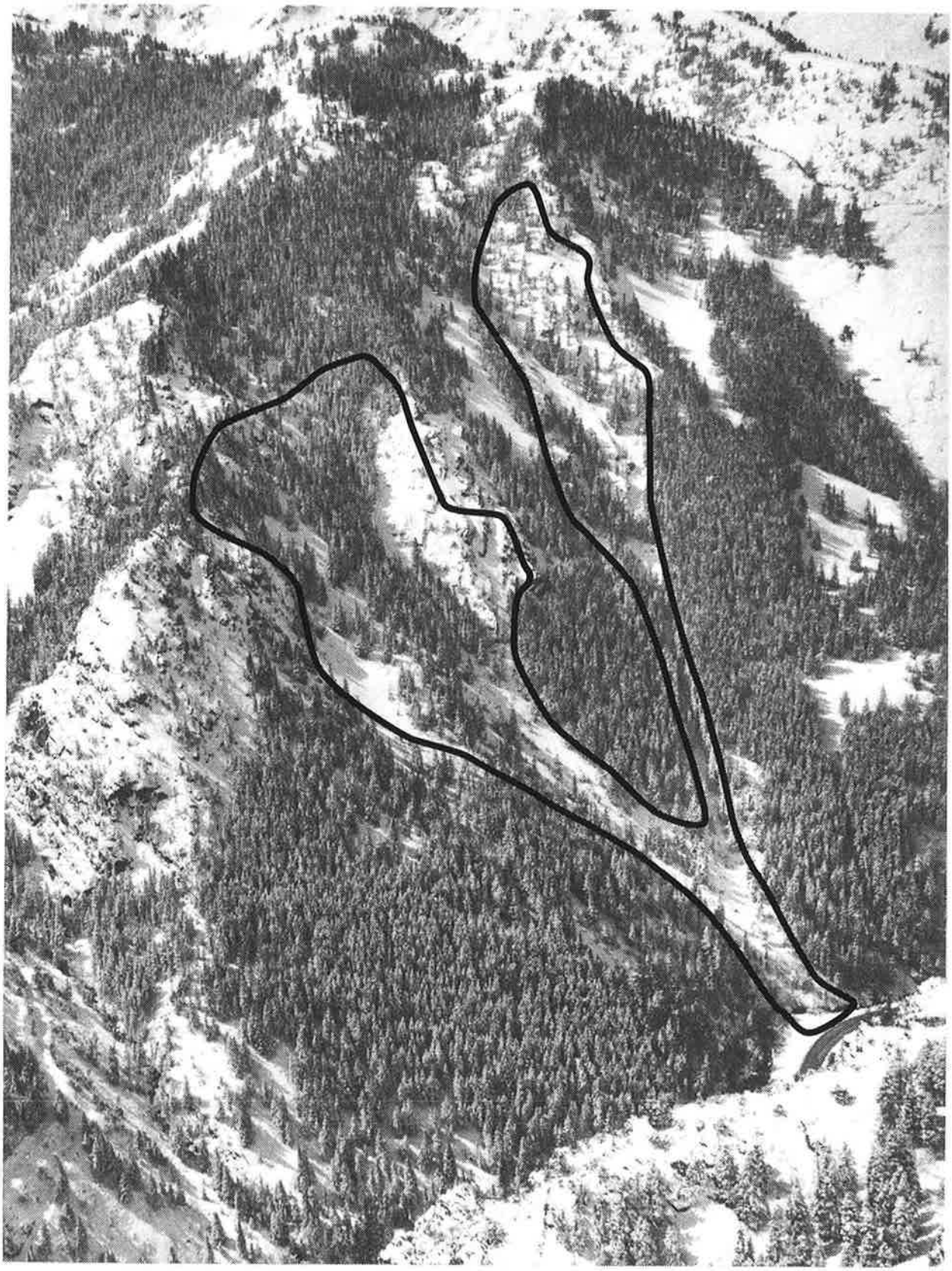
ELEVATION: 6,600 ft. to Creek

INCLINE: 20 to Creek

TOPOGRAPHY: Creek at two separate locations.

LENGTH OF HIGHWAY AFFECTED: 200ft. (at each of two locations).

HISTORY: Slides frequently to top of tracks. Unconfirmed history of reaching creek April 1974. Crossed highway in February 1994.



AVALANCHE PATH SUMMARY

NAME: Mineral Gullies MILEPOST: 7.27

RETURN INTERVAL: Infrequent

VERTICAL FALL: 1,000 ft.

DISTANCE TO HIGHWAY: 1,940 ft.

ELEVATION: 7,600 ft. to 7,400 ft. (A.S.L.)

ASPECT: North

INCLINE: 45 to 35

ACREAGE: 13

TOPOGRAPHY: Two separate slopes, mixed talus and conifer.

TRACK:

ELEVATION: 7,400 ft. to 6,600 ft.

ASPECT: North

INCLINE: 35to 25

TOPOGRAPHY: Two separate Channeled gullies with mixed brush and conifer.

RUNOUT ZONE:

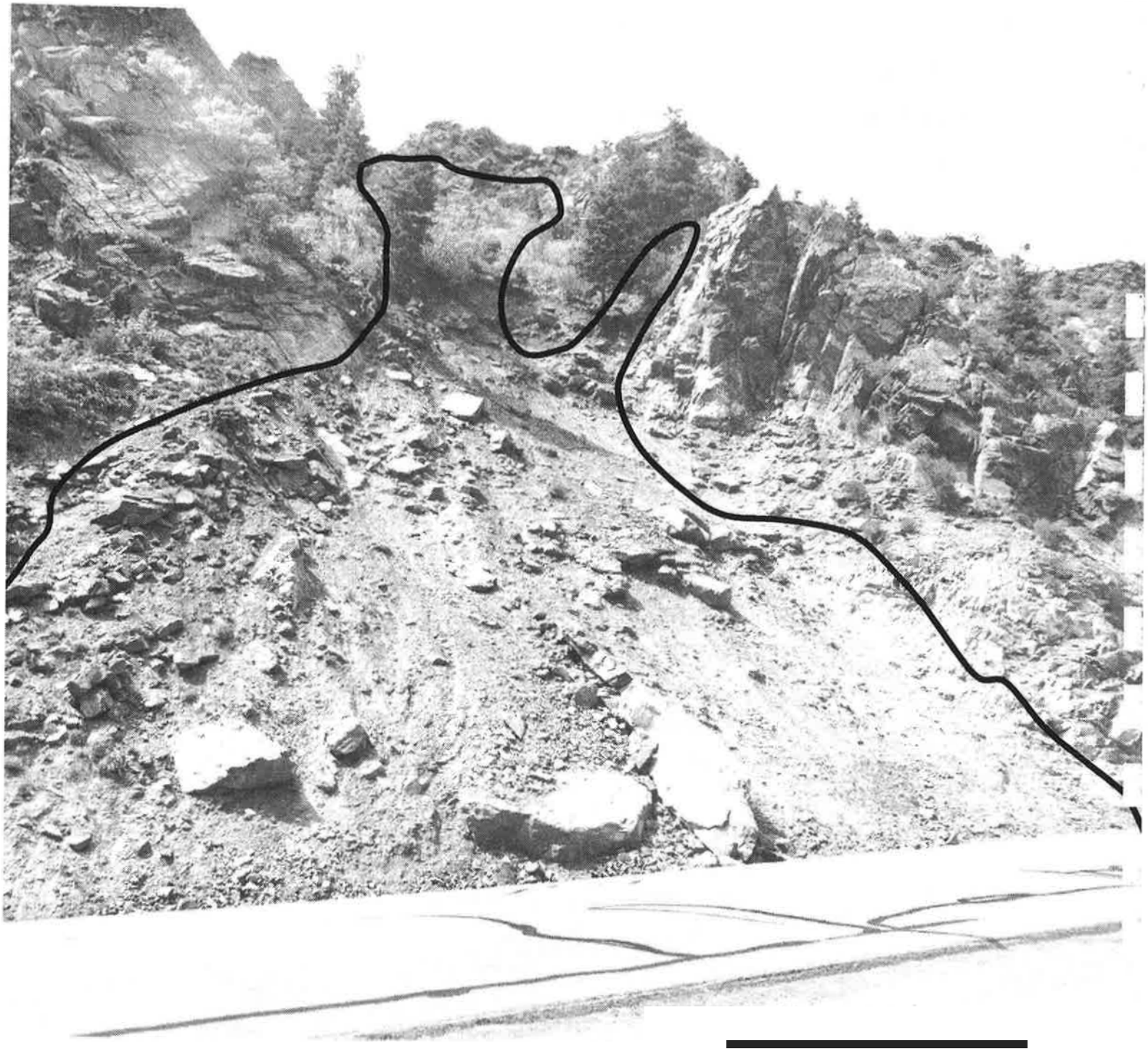
ELEVATION: 6,600 ft. to creek

INCLINE: 25 to creek

TOPOGRAPHY: Creek..

LENGTH OF HIGHWAY AFFECTED: 150ft.

HISTORY: No history of reaching highway.



AVALANCHE PATH SUMMARY

NAME: Death Rock Road Bank MILEPOST: 7.90

RETURN INTERVAL: Frequent; 1 year return interval

VERTICAL FALL: 350ft.

DISTANCE TO HIGHWAY: 510ft.

STARTING ZONE

ELEVATION: 7,150 ft. to 7,000 ft. (A.S.L.)

ASPECT: South

INCLINE: 45 to 35

ACREAGE: 5

TOPOGRAPHY: Loose talus and rock slope.

TRACK:

ELEVATION: 7,000 ft. to 6,800 ft.

ASPECT: South

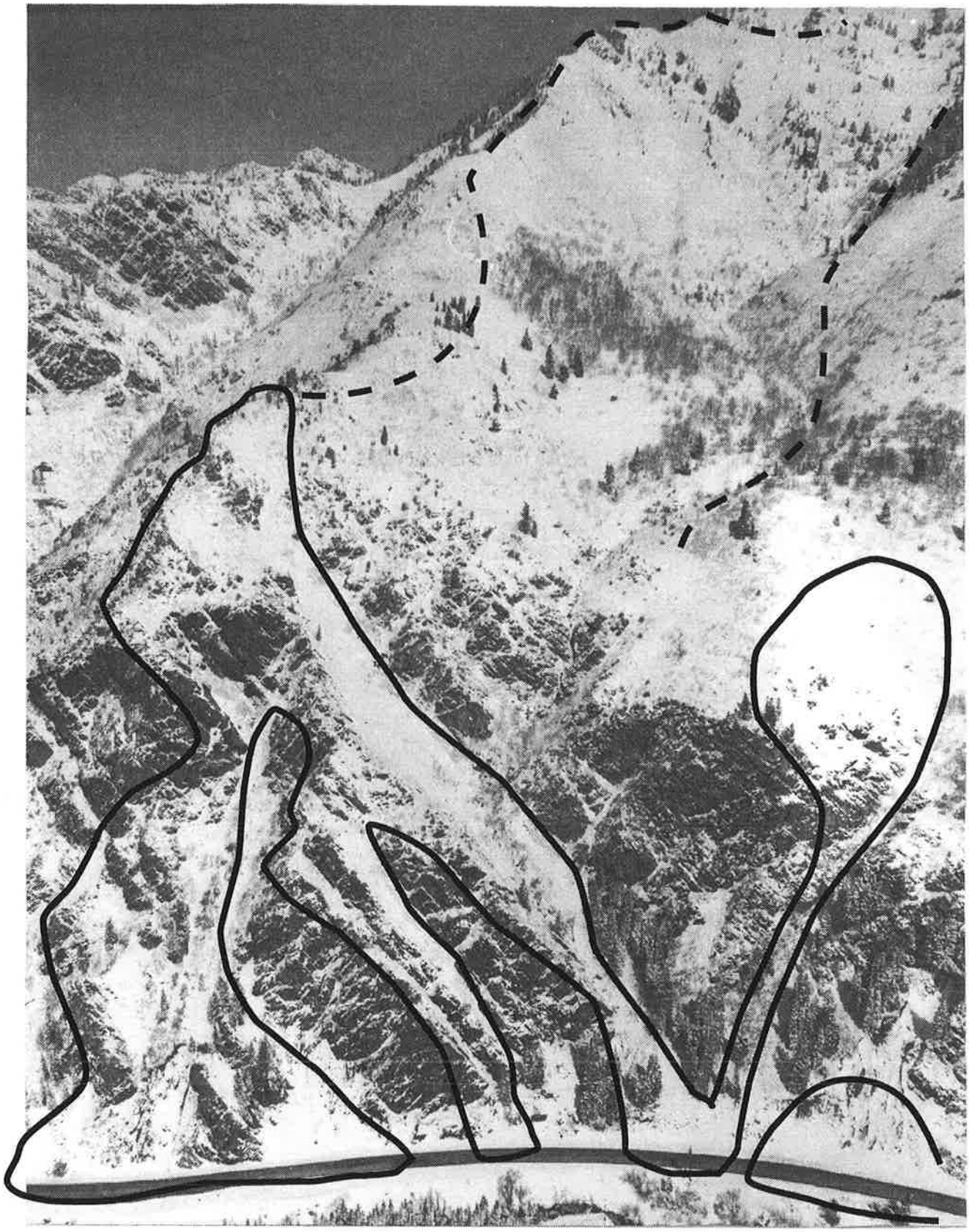
INCLINE: 35 to 15

TOPOGRAPHY: Loose talus slope.

RUNOUT ZONE: Highway.

LENGTH OF HIGHWAY AFFECTED: 340ft.

HISTORY: Frequently runs to downhill lane of highway with loose snow sloughs and soft slabs. Rock avalanche January 1995, 1 killed and 1 injured.



AVALANCHE PATH SUMMARY

NAME: Rock House MILEPOST: 8.01

RETURN INTERVAL: Occasional (lower), Infrequent (upper)

VERTICAL FALL: 680ft., 1,920 ft.

DISTANCE TO HIGHWAY: 900 ft., 3,800 ft.

STARTING ZONE

ELEVATION: 7,600 ft. to 8,800 ft. (A.S.L.)

ASPECT: Southeast/East

INCLINE: 45 to 35

ACREAGE: 15 to 60

TOPOGRAPHY: Lower Path; brush filled gullies and rock slabs. Upper path; mixed brush, conifer, and rock slopes.

TRACK:

ELEVATION: 7,400 ft. to 7,000 ft. and 8,000 ft. to 7,4000 ft.

ASPECT: Southwest/East

INCLINE: 35 to 15

TOPOGRAPHY: Channeled gullies and slopes. Mixed brush and rock.

RUNOUT ZONE:

ELEVATION: 7,000 ft. to 6,800 ft. and 7,400 ft. to 6,800 ft.

INCLINE: 15 to rock ledge and highway

TOPOGRAPHY: Channeled gully with mixed brush and rock.

LENGTH OF HIGHWAY AFFECTED: 50 ft. to 300ft.

HISTORY: Slides occasionally with energy being absorbed in tracks. Lower path crossed highway January 1991, 2 injured.

AVALANCHE PATH SUMMARY

NAME: Rock House Road Bank MILEPOST: 8.09

RETURN INTERVAL: Frequent;1-2 year return interval

VERTICAL FALL: 500ft.

DISTANCE TO HIGHWAY: 780ft.

STARTING ZONE

ELEVATION: 7,300 ft. to 7,150 ft. (A.S.L.)

ASPECT: South

INCLINE: 45 to 35

ACREAGE: 2

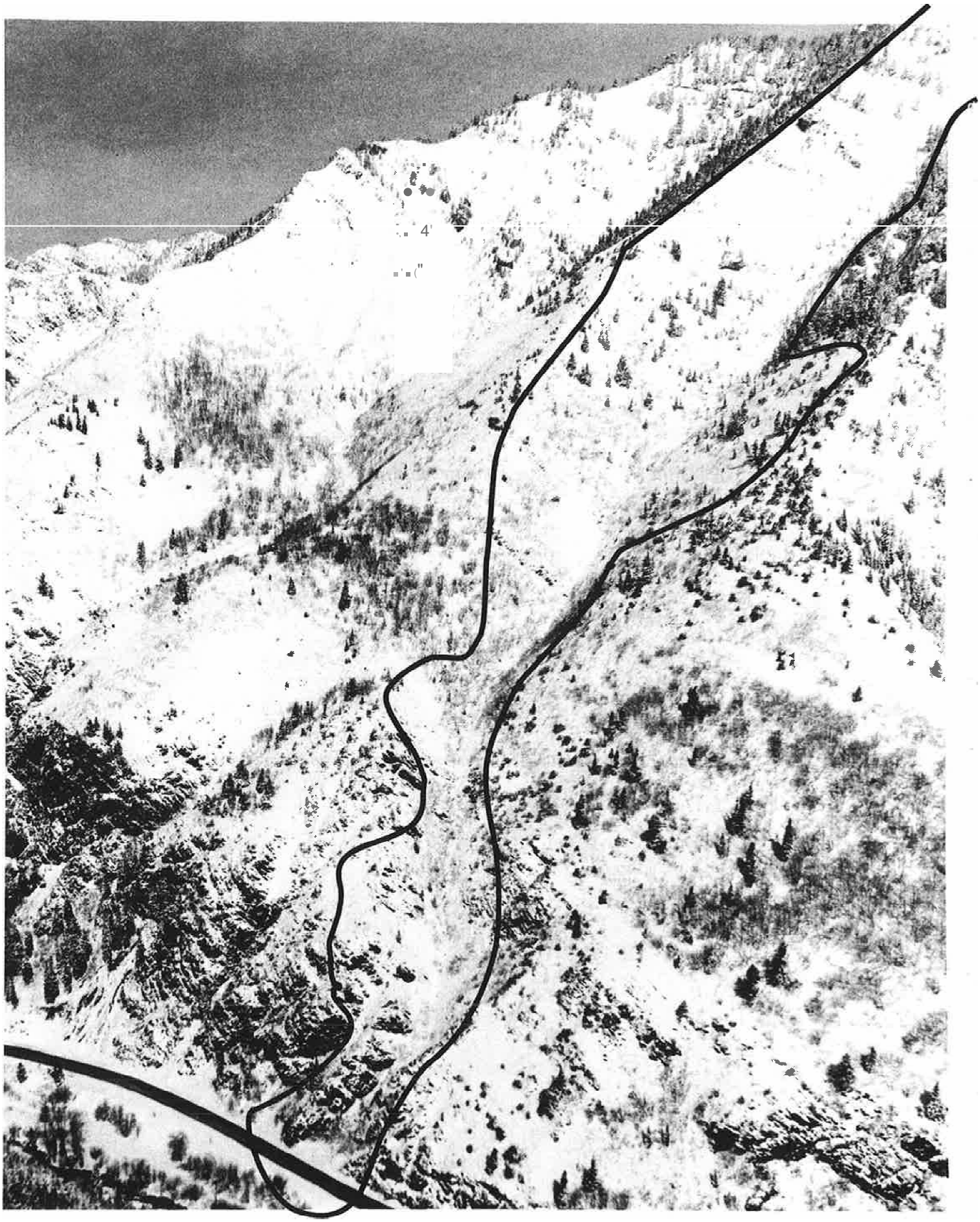
TOPOGRAPHY: Mixed talus and brush slope.

TRACK: Unconfined

RUNOUT ZONE: Highway

LENGTH OF HIGHWAY AFFECTED: 250ft.

HISTORY: Frequently runs to centerline of highway with loose snow sloughs and soft slabs.



NAME: West Maxfield MILEPOST: 8.19

RETURN INTERVAL: Infrequent

VERTICAL FALL: 1,900 ft.

DISTANCE TO HIGHWAY: 4,000 ft.

STARTING ZONE

ELEVATION: 8,800 ft. To 8,400 ft. (A.S.L.)

ASPECT: Southeast

INCLINE: 40 to 34

ACREAGE: 31

TOPOGRAPHY: Mixed brush and conifer slope with descending ridge feeding into narrow drainage.

TRACK:

ELEVATION: 8,400 ft. to 7,000 ft.

ASPECT: South

INCLINE: 30 to 20

TOPOGRAPHY: Channeled narrow gully with mixed brush and conifer.

RUNOUT ZONE:

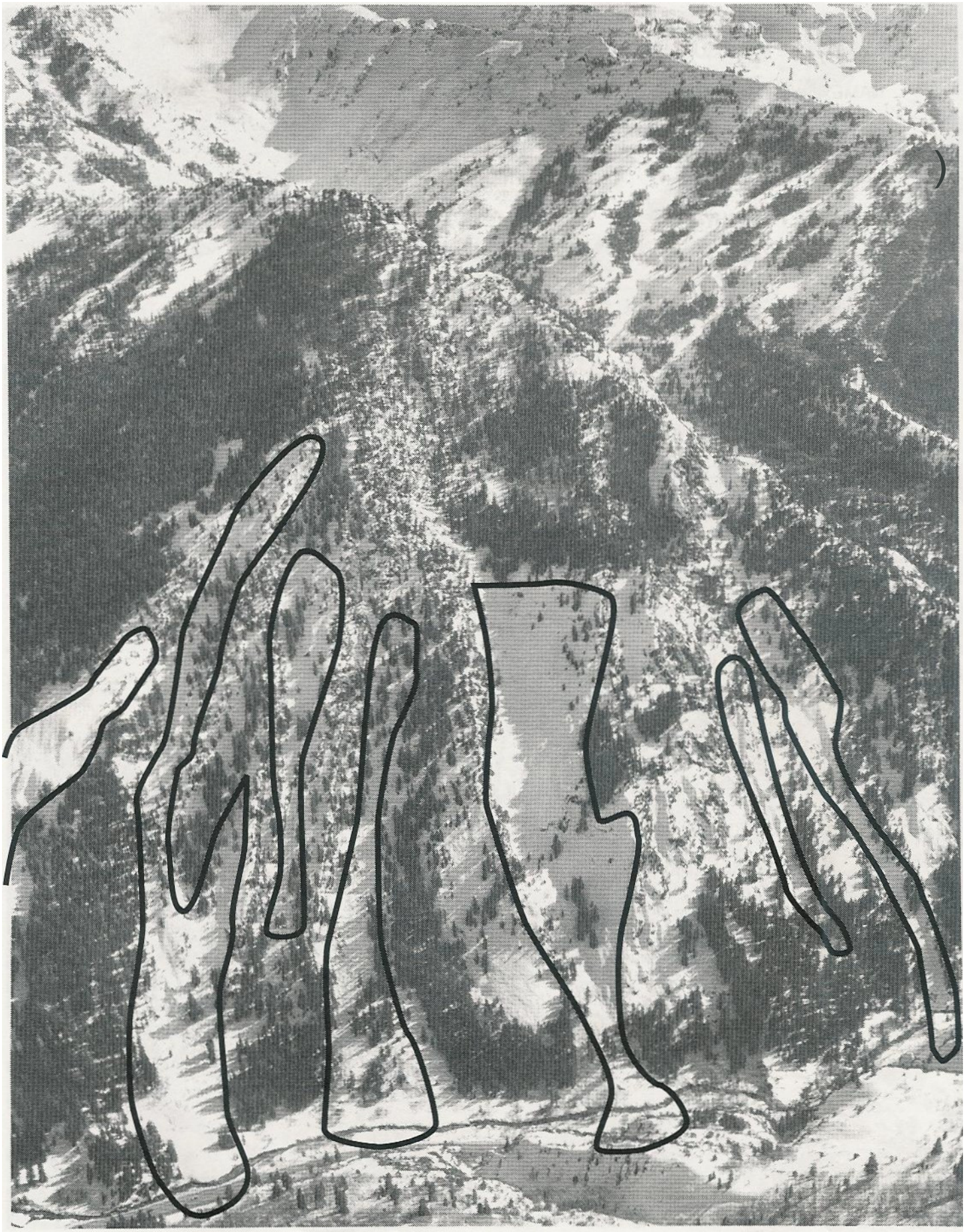
ELEVATION: 7,000 ft. to highway

INCLINE: 20 to 5

TOPOGRAPHY: Highway.

LENGTH OF HIGHWAY AFFECTED: 120ft.

HISTORY: Crossed highway January 1991 1 injured.



AVALANCHE PATH SUMMARY

NAME: Argenta Chutes MILEPOST: 8.27

RETURN INTERVAL: Infrequent

VERTICAL FALL: 640 TO 1,000 ft.

DISTANCE TO HIGHWAY: 1,360 to 1,840 ft.

STARTING ZONE:

ELEVATION: 7,440 ft. to 7,800 ft (A.S.L.)

ASPECT: NORTH

INCLINE: 35

ACERAGE: 22

TOPOGRAPHY: Series of seven-channeled talus slopes with conifer.

TRACK:

ELEVATION: 7,400 ft. to 7,200 ft.

ASPECT: NORTH

INCLINE: 30 to 20

TOPOGRAPHY: Channeled talus slopes with conifer and rock.

RUNOUT ZONE:

ELEVATION: 7,200 ft. to creek

INCLINE: 20 to 10

TOPOGRAPHY: Mixed brush and conifer slope into creek.

LENGTH OF HIGHWAY AFFECTED: 3,000 ft.

HISTORY: No history of reaching highway.

AVALANCHE PATH SUMMARY

AVALANCHE PATH SUMMARY

NAME: Maxfield MILEPOST: 8.38

RETURN INTERVAL: Occasional; 5-10 year return interval

VERTICAL FALL: 1,280ft.

DISTANCE TO HIGHWAY: 2,900 ft.

STARTING ZONE

ELEVATION: 8,400 ft. to 7,800 ft. (A.S.L.)

ASPECT: Southeast

INCLINE: 40 to 30

ACREAGE: 34

TOPOGRAPHY: Mixed brush and conifer slope with descending ridgeline.

TRACK:

ELEVATION: 7,800 ft. to 7,100 ft.

ASPECT: Southeast

INCLINE: 30 to 15

TOPOGRAPHY: Channeled gully with mixed brush and conifer.

RUNOUT ZONE:

ELEVATION: 7,100 ft. to highway

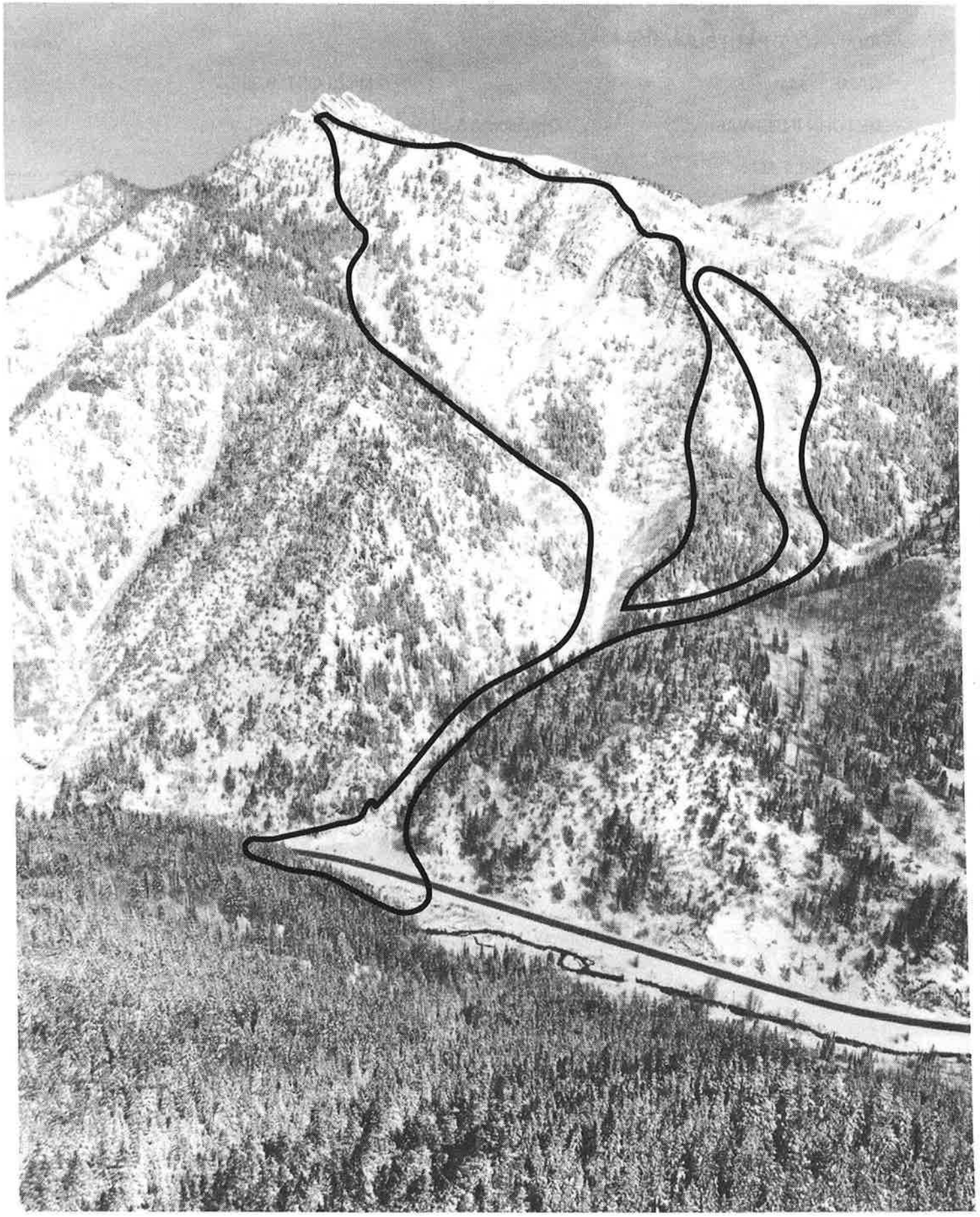
INCLINE: 15 to highway

TOPOGRAPHY: Small alluvial fan with mixed brush and conifer, road bank, and highway.

LENGTH OF HIGHWAY AFFECTED: 170ft.

HISTORY: History of reaching highway.

AVALANCHE PATH SUMMARY



AVALANCHE PATH SUMMARY

NAME: Mill A Gulch MILEPOST: 8.61

RETURN INTERVAL: Occasional

VERTICAL FALL: 1,840 ft.

DISTANCE TO HIGHWAY: 4,770 ft.

STARTING ZONE

ELEVATION: 8,800 ft. to 8,200 ft. (A.S.L.)

ASPECT: South

INCLINE: 40 to 32

ACREAGE: 84

TOPOGRAPHY: Large mixed brush and conifer slopes.

TRACK:

ELEVATION: 8,200 ft. to 7,200 ft.

ASPECT: South

INCLINE: 30 to 5

TOPOGRAPHY: Channeled narrow gully with numerous bends. Mixed brush and conifer.

RUNOUT ZONE:

ELEVATION: 7,200 ft. to highway

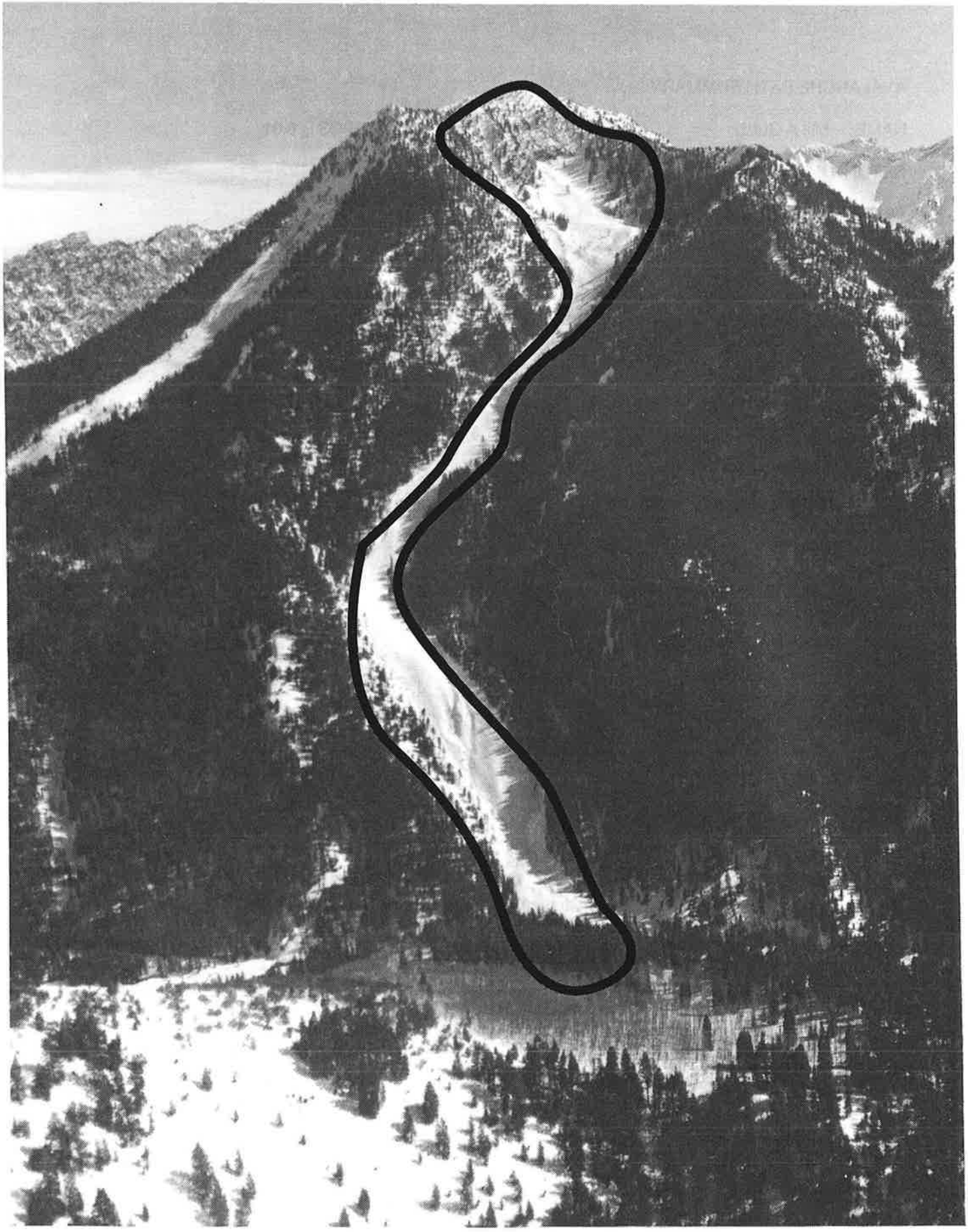
INCLINE: 5 to highway

TOPOGRAPHY: Channeled gully with mine dump, small alluvial fan, and highway.

LENGTH OF HIGHWAY AFFECTED: 200ft.

HISTORY: Slides occasionally with long track absorbing energy before reaching highway. Came within 300ft. of highway January 26, 1996. Crossed highway turn of the century destroying house and sawmill, 4 killed.

AVALANCHE PATH SUMMARY



AVALANCHE PATH SUMMARY

NAME: Argenta MILEPOST: 8.93

RETURN INTERVAL: Infrequent

VERTICAL FALL: 3,400 ft.

DISTANCE TO HIGHWAY: 7,340 ft.

STARTING ZONE

ELEVATION: 10,400 ft. to 9,200 ft. (A.S.L.)

ASPECT: Northwest

INCLINE: 50 to 32

ACREAGE: 100

TOPOGRAPHY: Convex and concave talus slope with conifer and rock.

TRACK:

ELEVATION: 9,200 ft. to 7,200 ft.

ASPECT: Northwest/West

INCUNE: 35 to 10

TOPOGRAPHY: Series of four benches with conifer.

RUNOUT ZONE:

ELEVATION: 7,200 ft. to creek

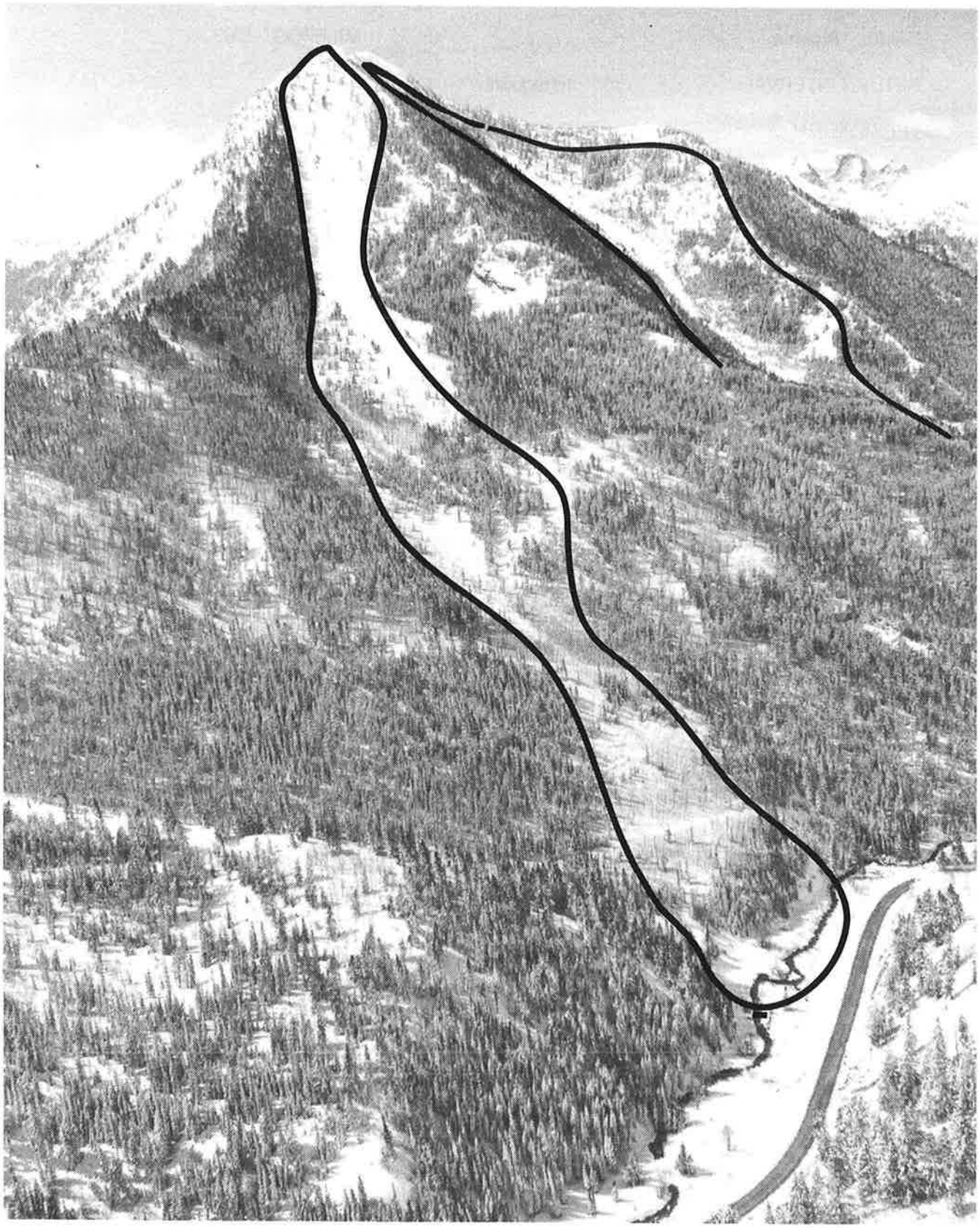
INCLINE: 10 to creek

TOPOGRAPHY: Creek, conifers; and highway.

LENGTH OF HIGHWAY AFFECTED: 800 ft.

HISTORY: Climax slides crossed highway March 25, 1948 and January 26, 1996.

AVALANCHE PATH SUMMARY



AVALANCHE PATH SUMMARY

NAME: Kessler Peak MILEPOST: 9.62

RETURN INTERVAL: Infrequent

VERTICAL FALL: 2,920 ft.

DISTANCE TO HIGHWAY: 7,035ft.

STARTING ZONE:

ELEVATION: 10,000 ft. to 8,800 ft.

ASPECT: North

INCLINE: 50 to 35

ACREAGE: 45

TOPOGRAPHY: Steep talus and rock slope drops into a series of chutes, mixed talus, rock, and conifer.

TRACK:

ELEVATION: 8,800 ft. to 7,600 ft.

ASPECT: North

INCLINE: 30 to 10

TOPOGRAPHY: Series of benches with mixed brush, aspen, and conifer.

RUNOUT ZONE:

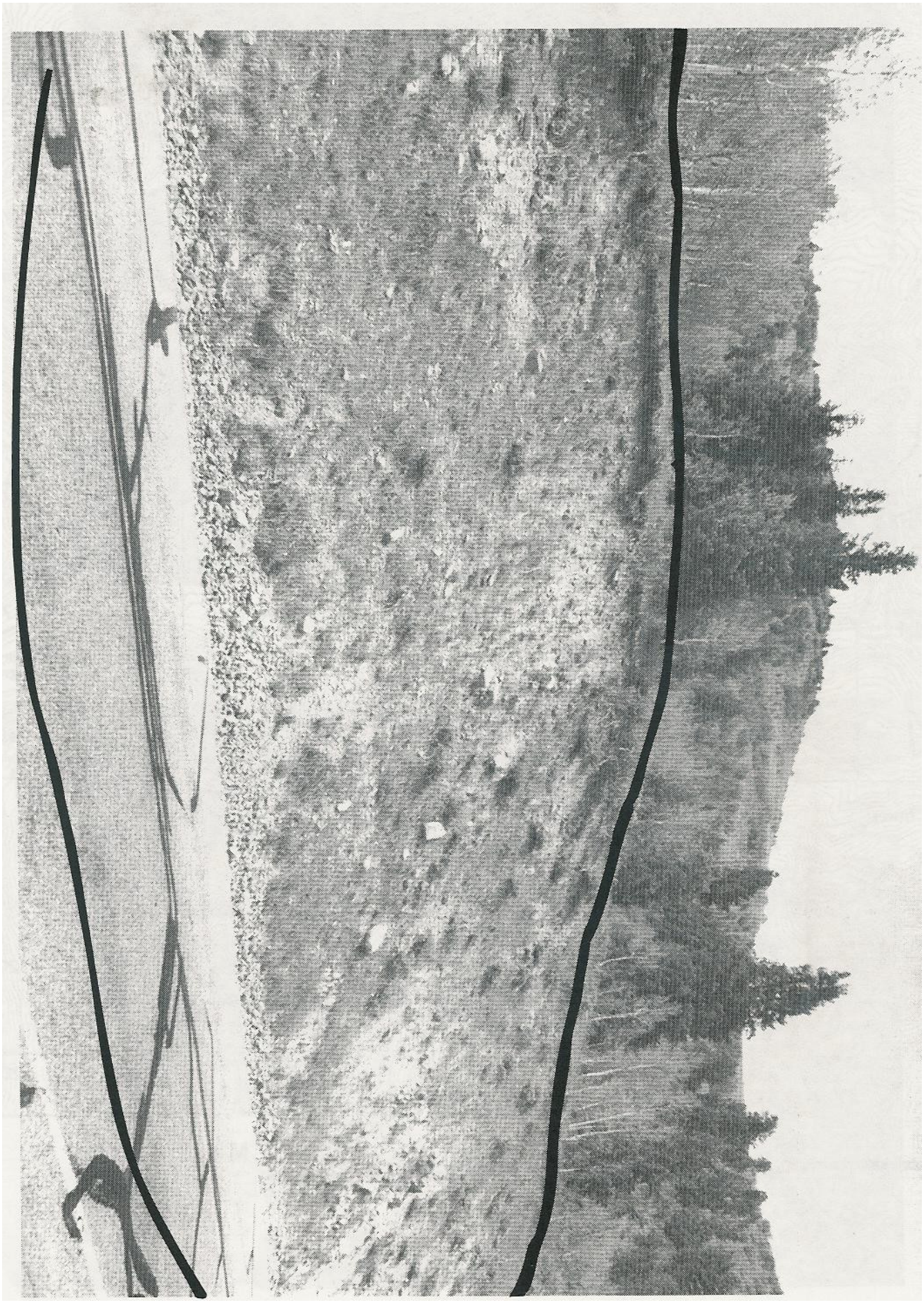
ELEVATION: 7,600 ft. to creek

INCLINE: 10 to creek

TOPOGRAPHY: Mixed aspen and conifer to creek.

LENGTH OF HIGHWAY AFFECTED: 400ft.

HISTORY: Climax slide reached creek, March 25, 1948. Slides frequently, but stops on benches.



AVALANCHE PATH SUMMARY

NAME: Circle Awl Road Bank MILEPOST: 9.26

RETURN INTERVAL: Frequent, 1 year return interval

VERTICAL FALL: 75 ft.

DISTANCE TO HIGHWAY: 120 ft.

STARTING ZONE:

ELEVATION: 7,100 ft. to 7,050 ft.

ASPECT: South

INCLINE: 40 to 35

ACERAGE: 2

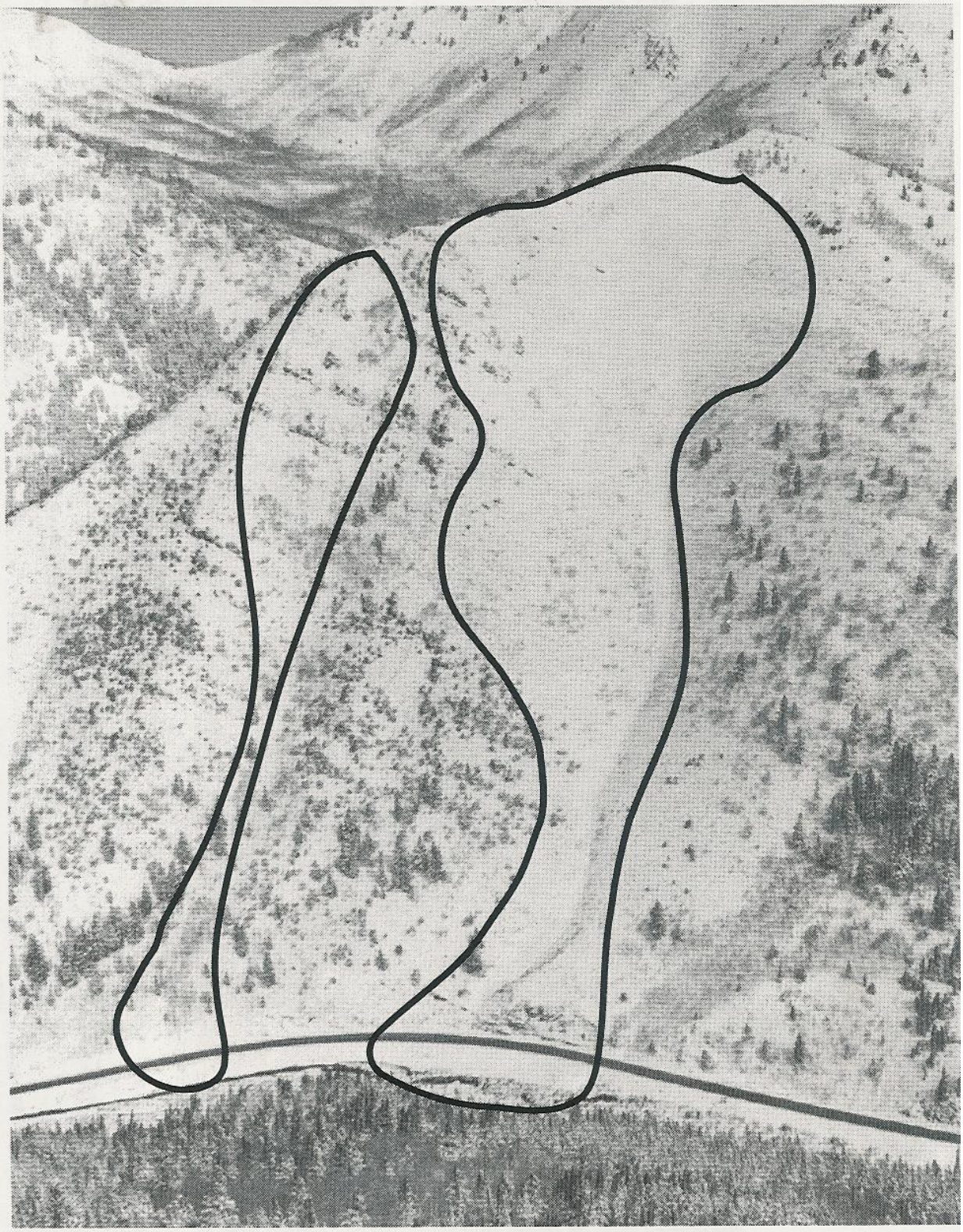
TOPOGRAPHY: Talus slope

TRACK: Unconfined

RUNOUT ZONE: Highway

LENGTH OF HIGHWAY AFFECTED: 230 ft.

HISTORY: Frequently runs to centerline of highway with loose snow sloughs and soft slabs.



AVALANCHE PATH SUMMARY

NAME: Circle Awl MILEPOST: 9.34

RETURN INTERVAL: Frequent; 1-2 year return interval

VERTICAL FALL: 1,560 ft.

DISTANCE TO HIGHWAY: 3,290 ft.

STARTING ZONE:

ELEVATION: 8,600 ft.

ASPECT: Southwest through East

INCLINE: 40 to 32

ACERAGE: 44

TOPOGRAPHY: Concave slope with mixed talus and brush, small rock and tree outcrops separate zone into multi-starting zones.

TRACK:

ELEVATION: 7,900 to 7,300 ft.

ASPECT: South through Southwest

INCLINE 38 to 50

TOPOGRAPHY Channeled gully with large alluvial fan, road bank, highway to creek and road bank.

RUNOUT ZONE:

ELEVATION: 7,300 ft. to creek

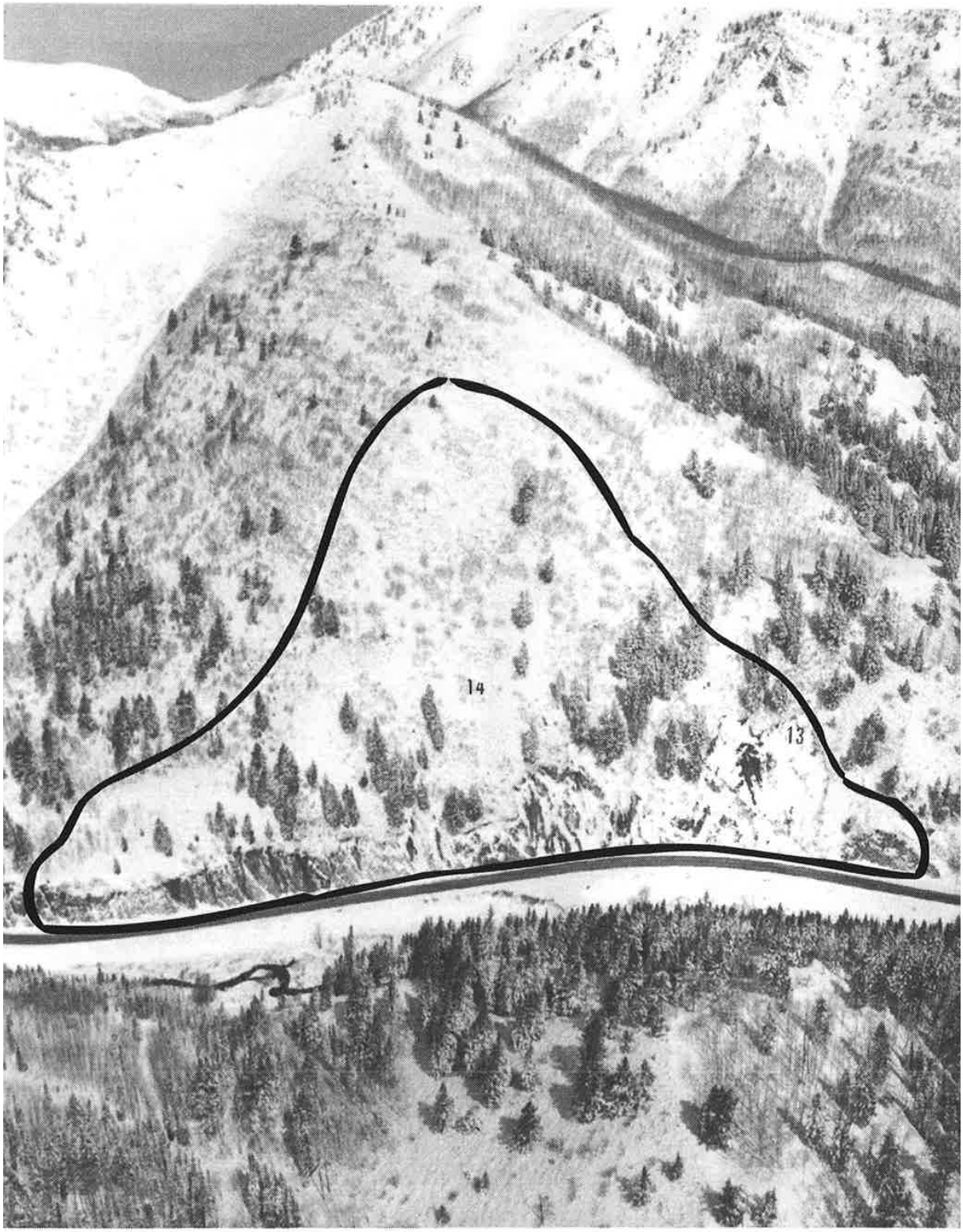
INCLINE: 35 TO 50

TOPOGRAPHY: Channeled gully with large alluvial fan, road bank, highway to creek and conifers.

LENGTH OF HIGHWAY AFFECTED: 300 ft.

HISTORY: Frequently runs to highway as loose dry and wet snow sloughs and soft slabs. Can reach highway with slab depths as shallow as 8". Larger slides will jump channeled track and fan out across highway, across the creek and up the other side of the canyon. Unconfirmed event from path to west (down canyon) reaching highway.

AVALANCHE PATH SUMMARY



AVALANCHE PATH SUMMARY

NAME: Laurel Pines MILEPOST: 9.78

RETURN INTERVAL: Frequent; 1-3 per year return interval.

VERTICAL FALL: 530ft.

DISTANCE TO HIGHWAY: 900ft.

STARTING ZONE:

ELEVATION: 7,700 ft to 7,400 ft.

ASPECT: South through Southeast

INCLINE: 45 to 35

ACREAGE: 10

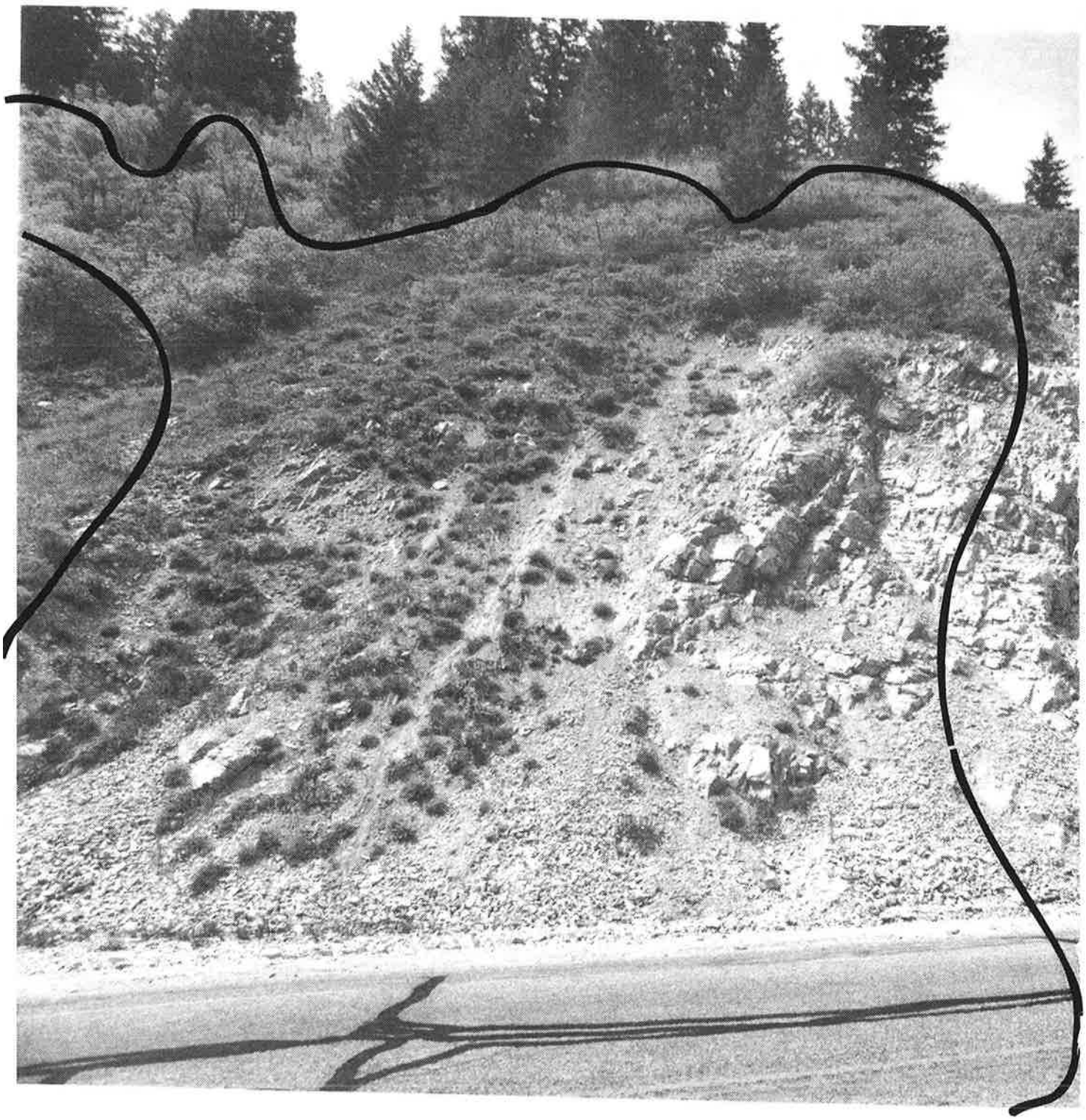
TOPOGRAPHY: Steep brush covered slope.

TRACK: Unconfined

RUNOUT ZONE: Highway

LENGTH OF HIGHWAY AFFECTED: 600ft.

HISTORY: Frequently runs to downhill lane of highway with loose dry and wet snow sloughs. Generally releases. Early in storm cycle. Good indicator slope.



AVALANCHE PATH SUMMARY

NAME: Bus Corner Road Bank MILEPOST: 9.90

RETURN INTERVAL: Occasional

VERTICAL FALL: 300ft.

DISTANCE TO HIGHWAY: 487ft

STARTING ZONE:

ELEVATION: 7,400 ft. to 7,300 ft.

ASPECT: Southeast through East

INCLINE: 30 to 10

ACREAGE:

TOPOGRAPHY: Mixed talus, brush, and conifer.

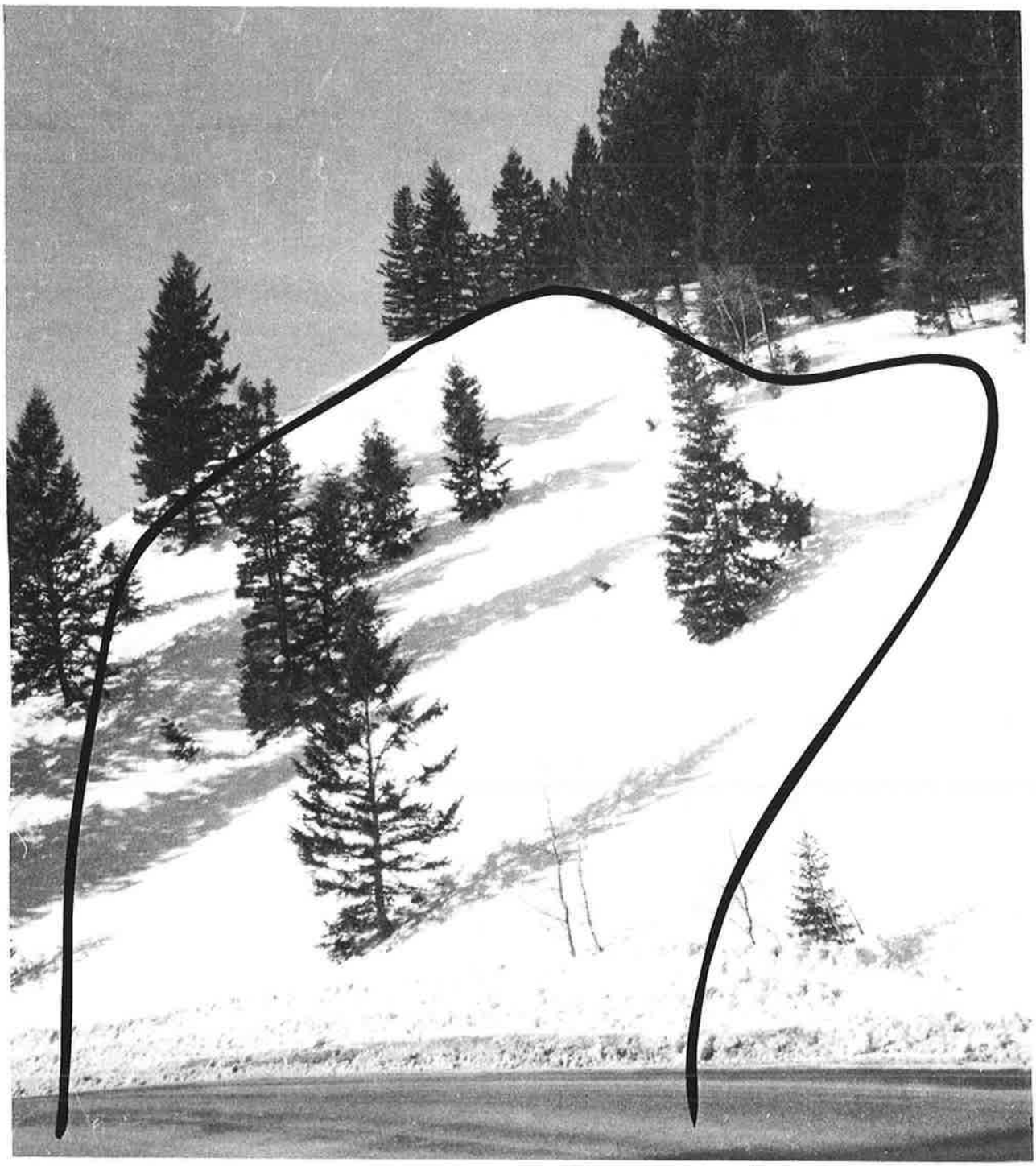
TRACK: Unconfined

RUNOUT ZONE: Highway

LENGTH OF HIGHWAY AFFECTED: 150ft.

HISTORY: Occasionally runs to centerline of highway with loose snow sloughs. Crossed highway January 1991, blocking bus and UDOT plow.

AVALANCHE PATH SUMMARY



AVALANCHE PATH SUMMARY

NAME: Butler Hill MILEPOST: 9.99

RETURN INTERVAL: Frequent; 1-2 year return interval.

VERTICAL FALL: 300ft.

DISTANCE TO HIGHWAY: 500ft.

STARTING ZONE:

ELEVATION: 7,420 ft. to 7,300 ft.

ASPECT: East

INCLINE: 42 to 35

ACREAGE: 4

TOPOGRAPHY: Mixd grass, brush, and conifer slope.

TRACK: Unconfined

RUNOUT ZONE: Highway

LENGTH OF HIGHWAY AFFECTED: 100ft;

HISTORY: Frequently runs to downhill lane of highway with loose snow sloughs and soft slabs. Good indicator slope.

AVALANCHE PATH SUMMARY

NAME: Cardiff Road Bank MILEPOST: 10.07

RETURN INTERVAL: Frequent; 1-3 year return interval

VERTICAL FALL: 300ft.

DISTANCE TO HIGHWAY: 424ft.

STARTING ZONE:

ELEVATION: 7,300 ft. to 7,250 ft.

ASPECT: South

INCLINE: 50 to 35

ACREAGE: 2

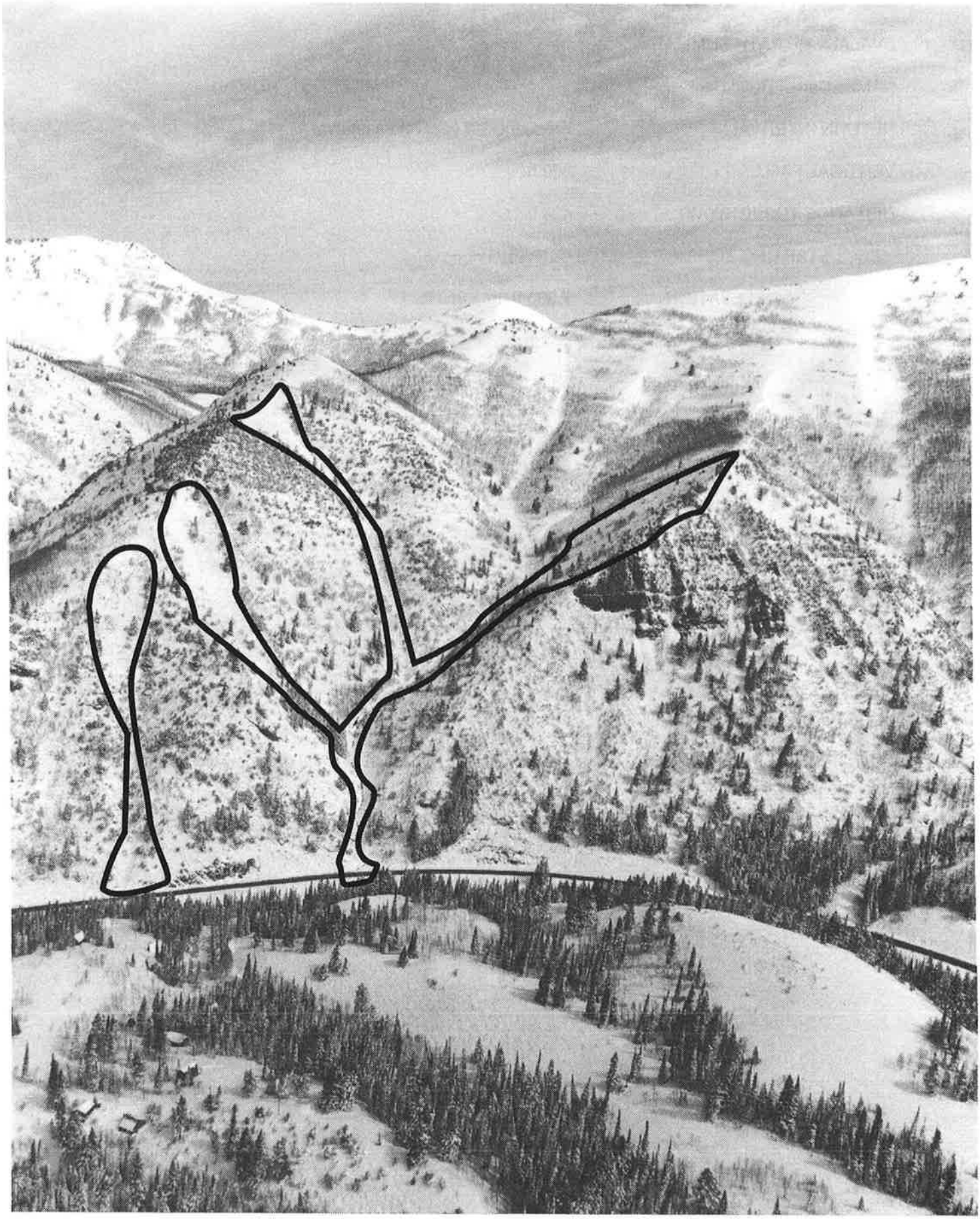
TOPOGRAPHY: Steep talus Slope.

TRACK: Unconfined

RUNOUT ZONE: Highway

LENGTH OF HIGHWAY AFFECTED: 400ft.

HISTORY: Frequently runs to centerline of highway with loose wet and dry snow sloughs and soft slabs.



AVALANCHE PATH SUMMARY

NAME: West Reynolds Chutes MILEPOST: 10.11 & 10.36

RETURN INTERVAL: Occasional

VERTICAL FALL: 1,220 ft.

DISTANCE TO HIGHWAY: 2,500 ft.

STARTING ZONE:

ELEVATION: 8,000 ft. to 7,600 ft.

ASPECT: South and East

INCLINE: 38 to 34

ACREAGE: 8

TOPOGRAPHY: Series of three concave slopes, mixed conifer, and brush.

TRACK:

ELEVATION: 7,600 ft. to 7,200 ft.

ASPECT: South and East

INCLINE: 35 to 15

TOPOGRAPHY: Channeled gullies with mixed brush and conifer.

RUNOUT ZONE:

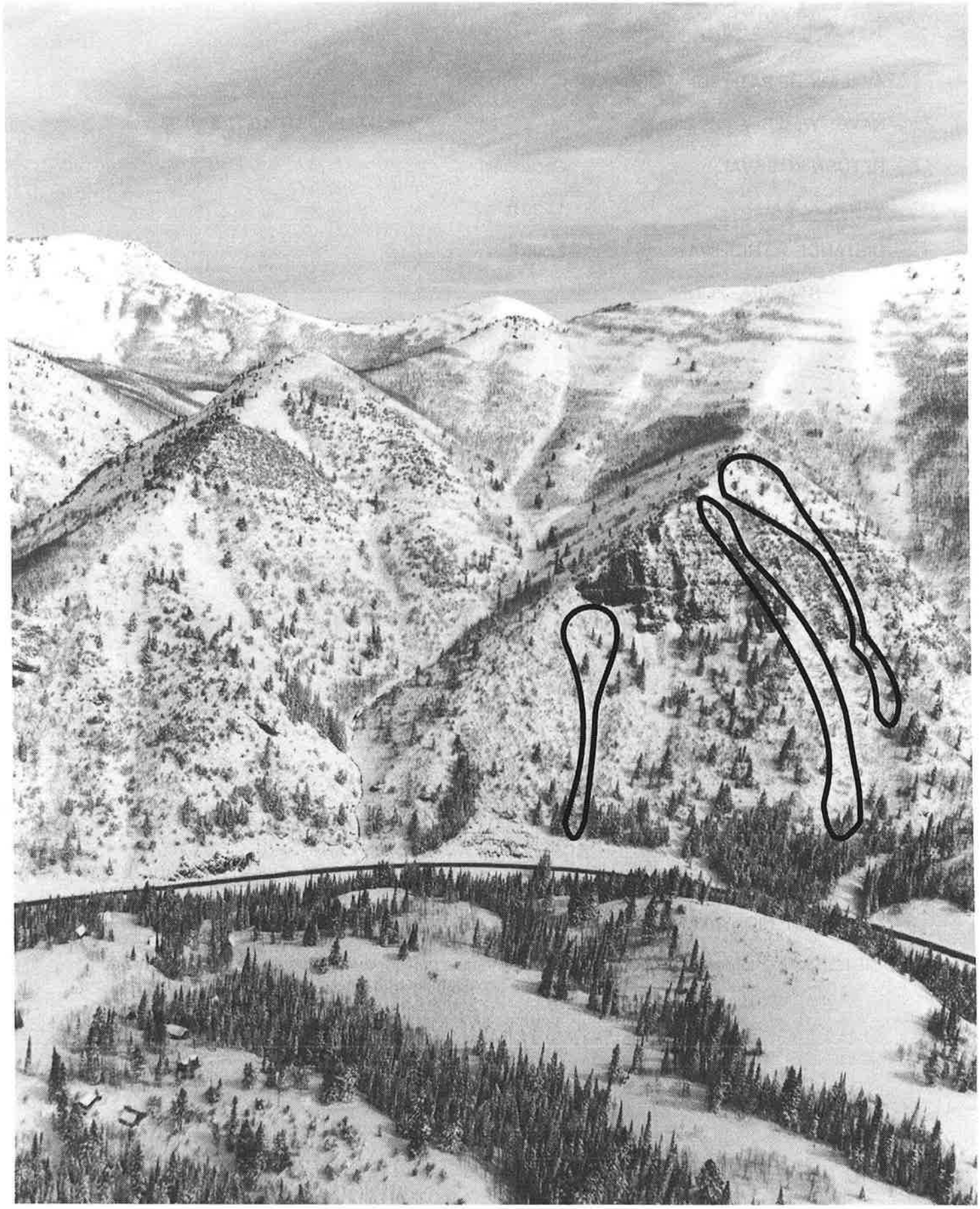
ELEVATION: 7,200 ft. to highway

INCLINE: 15 to 5

TOPOGRAPHY: Channeled gullies with mixed brush and conifer.

LENGTH OF HIGHWAY AFFECTED: Chute #1 =70ft, Chute #2 & #3 =100ft.

HISTORY: Chute #1 occasionally runs to centerline of highway with loose snow sloughs and soft slabs. Chutes #2 and #3 slides occasionally with longer track absorbing energy before reaching highway.



AVALANCHE PATH SUMMARY

NAME: Reynolds Rock MILEPOST: 10.70

RETURN INTERVAL: Infrequent

VERTICAL FALL: 900ft.

DISTANCE TO HIGHWAY: 1,700 ft.

STARTING ZONE:

ELEVATION: 8,200 ft. to 8,000 ft.

ASPECT: East through South

INCLINE: 38 to 32

ACREAGE: 4

TOPOGRAPHY: Brush covered slope with large cliff on south side.

TRACK:

ELEVATION: 8,00 ft. to 7,400 ft.

ASPECT: East through South

INCLINE: 30 to 15

TOPOGRAPHY: Brush covered slope.

RUNOUT ZONE:

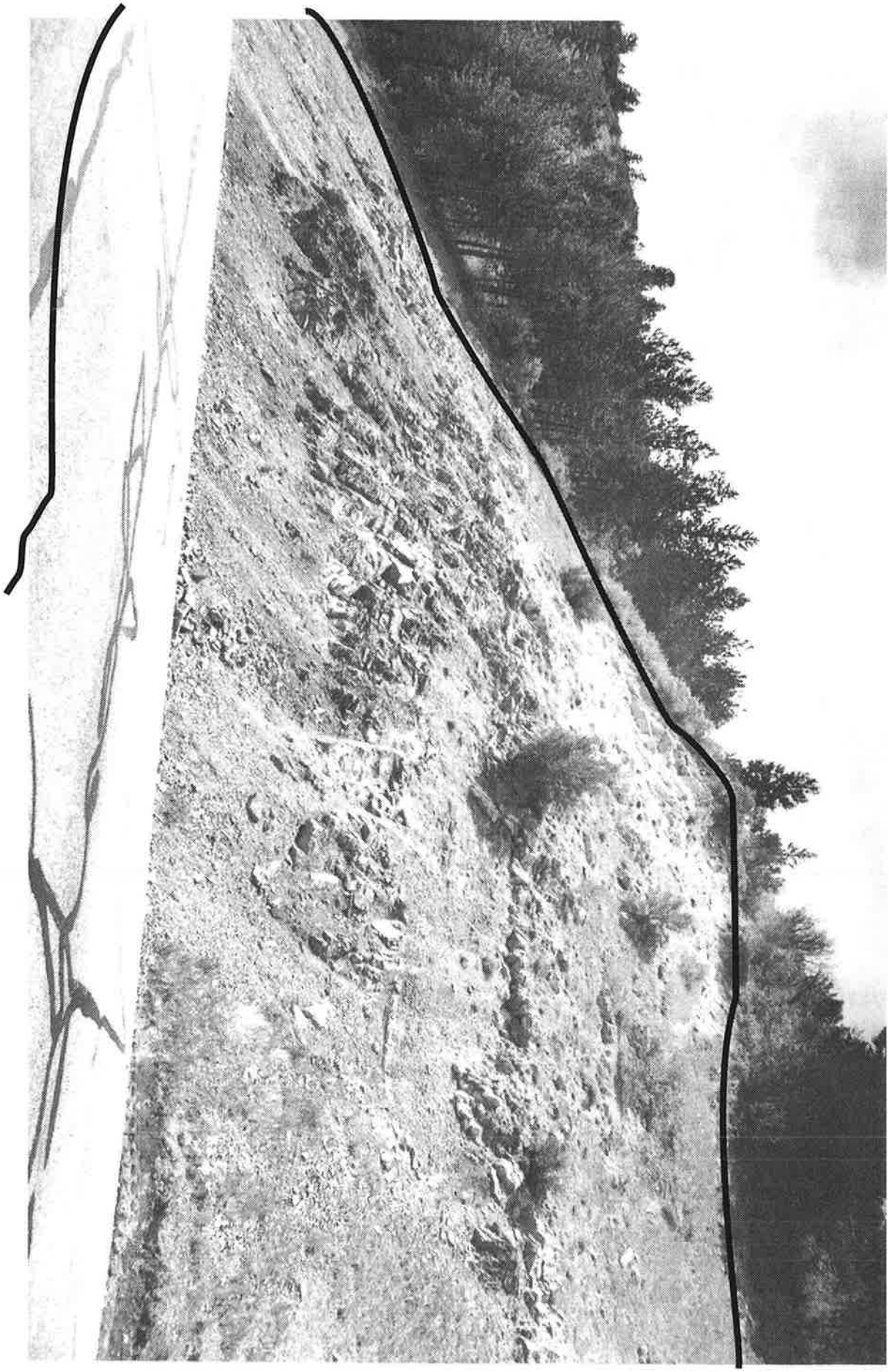
ELEVATION: 7,400 ft. to 7,300 ft.

INCLINE: 15 to 5

TOPOGRAPHY: Mixed brush and conifer.

LENGTH OF HIGHWAY AFFECTED: 300ft.

HISTORY: No history of reaching the highway. Frequent wet activity. West facing has potential of combining with West Reynolds Chutes and reaching highway.



AVALANCHE PATH SUMMARY

NAME: Cardiff High Road Bank MILEPOST: 10.44

RETURN INTERVAL: VERTICAL Frequent; 1 year return interval.

FALL: 180ft.

DISTANCE TO HIGHWAY: 264ft.

STARTING ZONE:

ELEVATION: 7,400 ft. to 7,320 ft.

ASPECT: South

INCLINE: 50 to 35

ACREAGE: 2

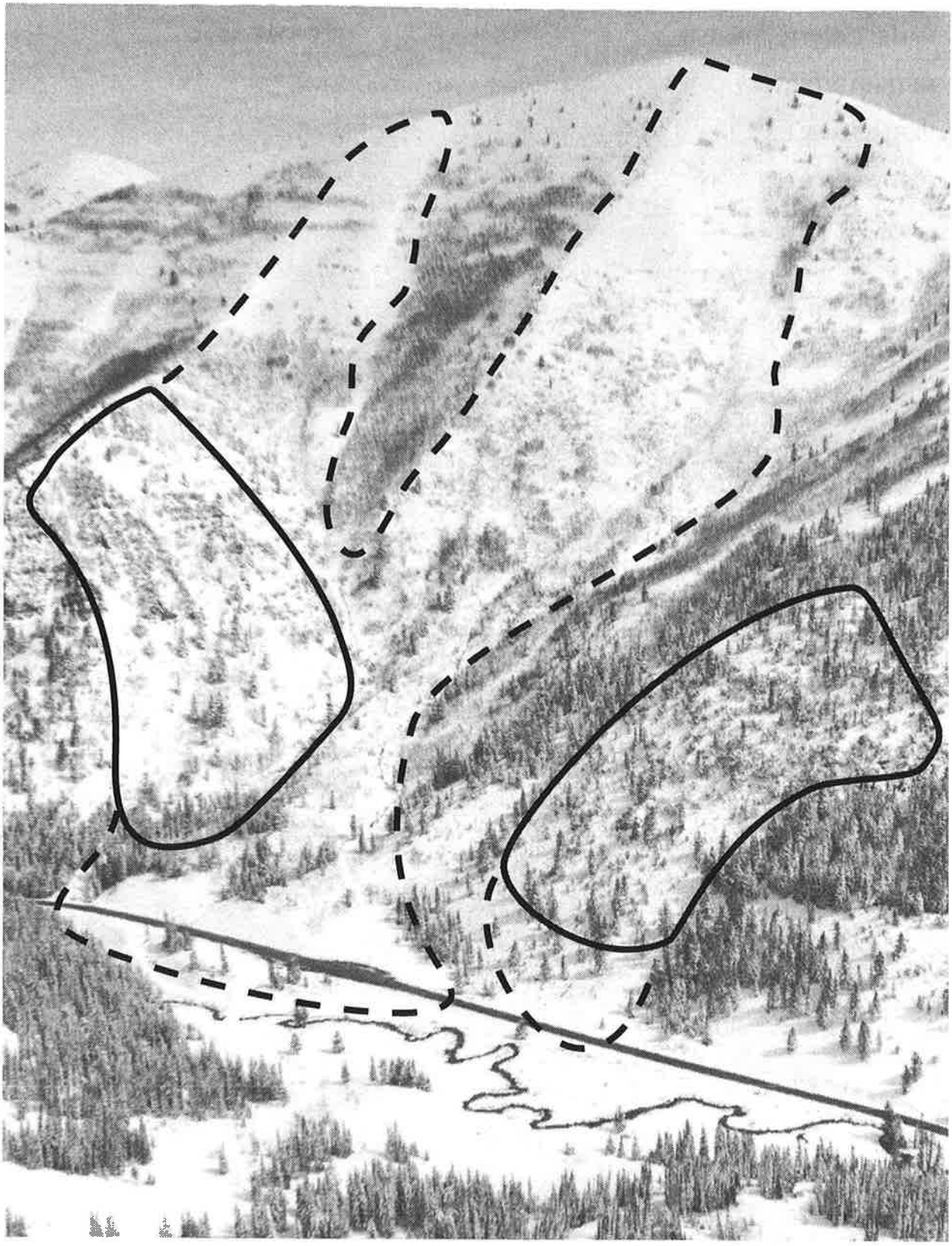
TOPOGRAPHY: Steep talus slope, mixed grass, and brush.

TRACK: Unconfined

RUNOUT ZONE: Highway

LENGTH OF HIGHWAY AFFECTED: 450ft.

HISTORY: Frequently runs to centerline of highway with loose dry and wet sloughs and soft slabs.



AVALANCHE PATH SUMMARY

NAME: Grand Central MILEPOST: 10.77

RETURN INTERVAL: Infrequent

VERTICAL FALL: 1,960 ft.

DISTANCE TO HIGHWAY: 4,640 ft.

STARTING ZONE:

ELEVATION: 9,200 ft. to 8,400 ft.

ASPECT: East through Southwest

INCLINE: 38 to 34

ACREAGE: 84

TOPOGRAPHY: Open grass slopes, mixed brush, and aspen.

TRACK:

ELEVATION: 8,400 ft. to 7,800 ft.

ASPECT: East through South

INCLINE; 34 to 10

TOPOGRAPHY: Mixed grass, brush, and aspen.

RUNOUT ZONE:

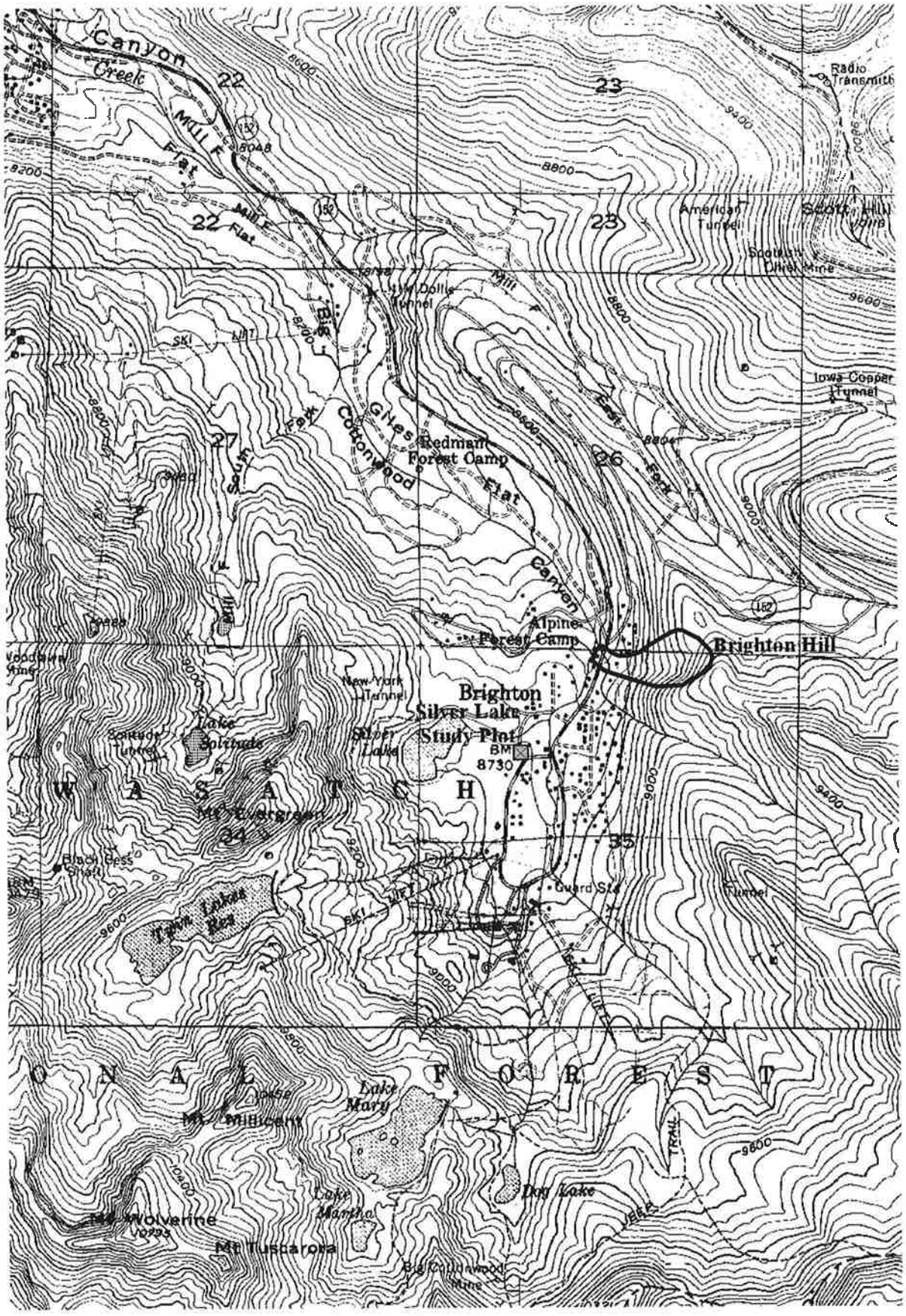
ELEVATION: 7,800 ft. to 7,300 ft.

INCLINE: 10 to 5

TOPOGRAPHY: Mixed grass, brush, aspen, and conifer.

LENGTH OF HIGHWAY AFFECTED: 500ft.

HISTORY: Unconfirmed history of reaching highway.


Canyon Creek
Mill F Flat
Mill F
Big Cottonwood Canyon
Cottonwood Flat
Redman Forest Camp
Alpine Forest Camp
Brighton Hill
Brighton
Silver Lake
Study Plot
BM 8730
Lake Solitude
Mt Evergreen
Guard Sta
Lake Mary
Mt Millicent
Mt Wolverine
Mt Tuscarora
Dog Lake
Lake Martha
Radio Transmitter
American Tunnel
Scotch Hill Tunnel
Iowa Copper Tunnel
New York Tunnel
Solitude Tunnel
Woodlawn Mine
Big Cottonwood Mine
Ski Lift
Jeep Trail
WASATCH
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0
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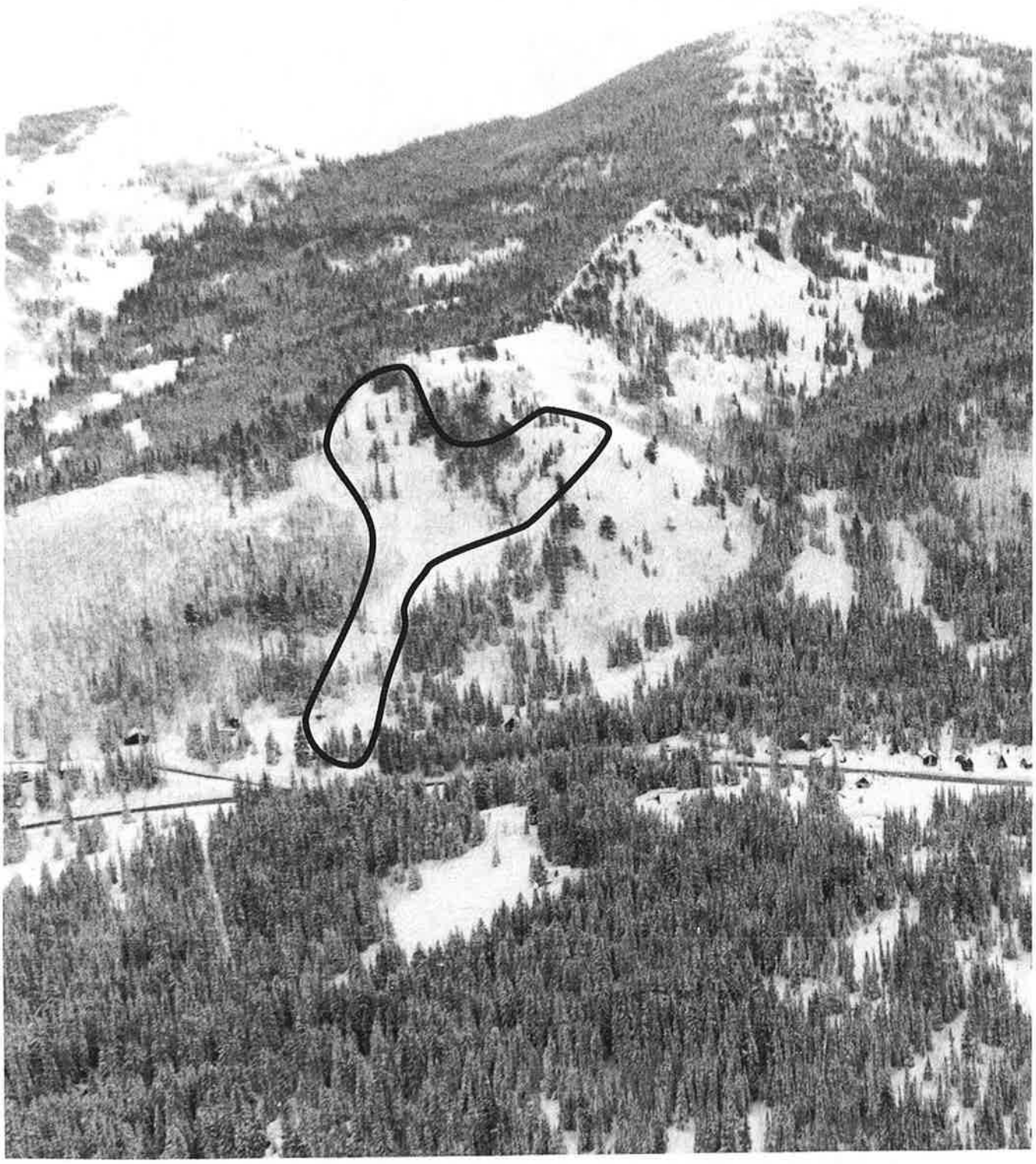
1.5
2 Miles



AVALANCHE PATH SUMMARY

NAME: Brighton Hill MILEPOST: 15.69

RETURN INTERVAL: Infrequent

VERTICAL FALL: 540ft.

DISTANCE TO HIGHWAY: 1,500 ft.

STARTING ZONE:

ELEVATION: 9,200 ft. to 9,000 ft.

ASPECT: West through Northwest

INCLINE: 45 to 35

ACREAGE: 18

TOPOGRAPHY: Convex slope with mixed grass and conifers.

TRACK:

ELEVATION: 9,000 ft. to 8,000 ft.

ASPECT: West

INCLINE: 35 to 15

TOPOGRAPHY: Mixed grass and conifer.

RUNOUT ZONE:

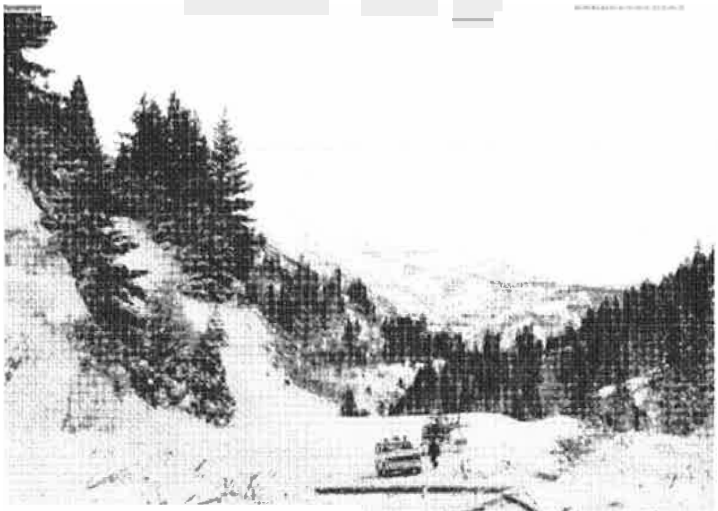
ELEVATION: 8,800 ft. to 8,700 ft.

INCLINE: 15 to 5

TOPOGRAPHY: Mixed grass and conifer.

LENGTH OF HIGHWAY AFFECTED: 50 ft.

HISTORY: No history of reaching the highway. February 17, 1986, 2 skiers caught, 1injured and 1 killed. Easy access from Brighton Ski Resort and Guardsman Pass road.



Snow Avalanche Path Atlas
Utah SR-210

Little Cottonwood Canyon

Utah Department of Transportation
Region 2

Snow Avalanche Path Atlas

Utah SR-210

Little Cottonwood Canyon

(Revised June 2012)

Utah Department of Transportation
Region 2

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INTRODUCTION

This atlas is intended to be used as a reference to snow avalanche paths in Little Cottonwood Canyon that threaten SR-210. This atlas standardizes names, locations, and descriptions of the various avalanche paths, their approximate runout distance, and the approximate length of highway they affect.

THIS ATLAS IS NOT INTENDED TO BE USED FOR ZONING OR DEVELOPMENT PLANNING

This Atlas is based upon observations of avalanche activity in the past, both recent and distant, as well as analysis of terrain, and evidence of tree damage. Historical accounts of major avalanche events have been gathered from conversations with avalanche professionals and other observers who's experience reaches back in some instances, to the first half of the 20th Century. Tree damage and growth patterns can provide some empirical information of events prior to that time. Most of the descriptions and information have come from observations over the past 50 years, a period which has witnessed significant development and expansion of the Highway Avalanche Safety Program.

There are 41 named avalanche paths known to have crossed SR-210, listed in this Atlas, as well as several other paths, either visible from SR-210, or having the potential to reach the road in the future.

Some of the avalanche paths listed have multiple Starting Zones, which may be known locally by separate names. The most common, and most frequently used names are listed whenever possible.

Primary Contributors

Originally compiled and edited in 1987 by Peter Lev, UDOT Avalanche Specialist with contributions by Liam Fitzgerald, William R. Hale, Ed LaChapelle, Ray Lindquist, Bengt Sandahl, and Onno Wieringa**.** Special thanks to the late Elbert Despain for historical information.

Revised, compiled, and edited in 2003 by Greg Dollhausen, UDOT Avalanche Forecaster, Liam Fitzgerald, UDOT Avalanche Safety Supervisor, Glen Merrill, UDOT Avalanche Forecaster with contributions by Ralph Patterson. Layout by Glen Merrill.

Revised and edited in 2012 by Liam FitzGerald, UDOT Avalanche Safety Supervisor, Adam Naisbitt UDOT Avalanche Forecaster, and Matt McKee UDOT Avalanche Forecaster.

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Wasatch National Forest and Utah Department of Transportation, 1979, by Beat von Allmen

Salt Lake County Avalanche Hazard Map, Lower Little Cottonwood Canyon,
1985, by Liam Fitzgerald

Little Cottonwood Canyon, Selected Storm Reports U-210, 1950-1990
Compiled, circa 1990; from past reports by USFS Salt Lake Ranger Dist. Snow Rangers, and Utah Department of Transportation Avalanche Forecasters.

Avalanche Terrain, Weather, and History

The nature of the avalanche paths that affect the canyon road tend to vary considerably in description and behavior depending on their geological history. For example, the paths in the Mid-Canyon area, are defined by steep, rugged, terrain, with numerous, well defined and relatively narrow, chutes. Given sufficient snow cover, these paths tend to become active with sudden increases in precipitation or snowfall intensity. Small amounts of new snow may break free in the Starting Zone and entrain a considerable amount of additional snow from the Track during the descent. As the road in this section of the canyon tends to be located at the bottom of the Track, or top of the Runout Zone portions of these avalanche paths, relatively small amounts of new snow can often produce avalanche events that reach the road. The White Pine Chutes and Little Pine avalanche paths frequently display this type of behavior. By contrast, the terrain above the Town of Alta, is less steep, and is characterized by broad open slopes, with sparse ground cover and few significant rock outcroppings. This terrain, in general, produces fewer avalanches, but those that do occur, are often the result of prolonged periods of snowfall which at times may be deposited on a structurally weak snowpack. Under these conditions, avalanches may release over a wide area and involve a significant volume of snow presenting a serious threat to anything located in their path.

The avalanche hazard to SR-210, the Village of Snowbird, and the Town of Alta, most frequently develops as the result of prolonged storms, where significant amounts of snow are deposited, accompanied by moderate to strong winds from the west through north. Storm events that deposit significant amounts of snow with a high Snow Water Equivalent can be especially problematic. Under the right snowpack and weather conditions, avalanche releases may involve several individual avalanche starting zones and create an unusually large event. It is this type of event that has in the past, destroyed stands of timber adjacent to Lt. Cottonwood Canyon Creek, and in more recent times has damaged or destroyed buildings. Avalanche events from January 1965 [8]; December 1973; and January 2005 are examples of this condition. Most of the avalanche paths described in this Atlas have a southerly aspect, and therefore can be significantly affected by the sun. During the winter months this can at times have a positive effect on snowpack stability, due to an increased rate of settlement of the new snow. During late winter and spring however, the affect of the sun can have a destabilizing affect due to rapid warming of the new snow, or periods of continual thaw. The large avalanche events that occurred above the Town of Alta in May, 1983, are examples of this condition.

It should be understood that avalanches are a poorly understood phenomena, and that on occasion they may involve terrain, and/or run further than previously observed or considered possible. For that reason, this Atlas is intended to be amended and revised in the future.

8 Of the period from 1950 to 2012, records indicate that the Storm with the greatest Snow Water Equivalent occurred during January 1965, when a total of 13.30” of SWE was deposited in 206 hours.

DEFINITION OF TERMS USED IN AVALANCHE PATH SUMMARIES

MAP: Created using *TOPO*, interactive maps on CD-ROM., USGS 7.5 minute series quadrangle sheets, Dromedary Peak and Brighton.

SIZE OF SLIDEPATH:

Major
Significant
Minor

Classification determined by vertical fall, size of starting zone, and potential volume of snow involved. Classification is relative to avalanche paths in Little Cottonwood Canyon that threaten SR-210.

RETURN INTERVAL: (Relative to Lt. Cottonwood Canyon)

Frequent - Avalanche reaches highway on average once in five years.
Occasional - Avalanche reaches highway at least once in 15 years.
Infrequent - Avalanche reaches highway less than once in15 years, or evidence of significant re-growth of vegetation.

VERTICAL FALL: The vertical fall is the vertical distance from the top of the starting zone to the furthest extent of the runout zone.

DISTANCE TO HIGHWAY: The distance to highway is the distance estimated from a map along the sighting angle from the top of the starting zone to the highway.

ALPHA ANGLE: In this document, the Alpha Angle is the angle from the top of the starting zone to the road. Measured with an inclinometer, or estimated from maps.

STARTING ZONE: The starting zone is the area at the top of the avalanche path where the snow initially breaks away and begins to travel down-slope.

TRACK: The track is the area connecting the starting zone and the runout zone, where the avalanche reaches its maximum velocity.

RUNOUT ZONE: The runout zone is the area at the bottom of the avalanche path where the moving snow decelerates and eventually comes to a stop.

ELEVATION: Elevations are taken from 7.5 minute series mapping.

ASPECT: The aspect is the compass direction to which the starting zone is oriented.

INCLINE: The incline is the slope angle for each of the three portions of the path: starting zone, track, and runout zone. Slope angles have either been measured in the field by inclinometer, or estimated from maps.

ACREAGE: Approximate acreage has been estimated from maps.

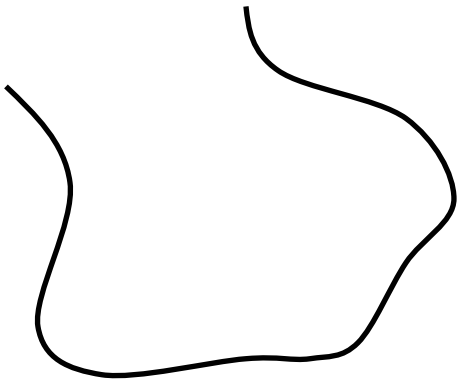
TOPOGRAPHY: Topography has been subjectively described for starting zones, tracks, and runout zones, and includes ground cover and vegetation. General descriptions are based on aerial photographs, interpretations from maps, and field observations.

LENGTH OF HIGHWAY AFFECTED: The length of highway affected is the maximum length of roadway affected from observed avalanche events, or by estimates of what is reasonably possible, in the event of a major or maximum avalanche. Future occurrences may affect the highway over greater length than is currently considered possible or likely.

HISTORY: The history of a given path is based on personal accounts, historical avalanche documents, vegetation patterns and tree damage, and recent avalanche observations. It includes dates of notable events, and structures or facilities that may be threatened.

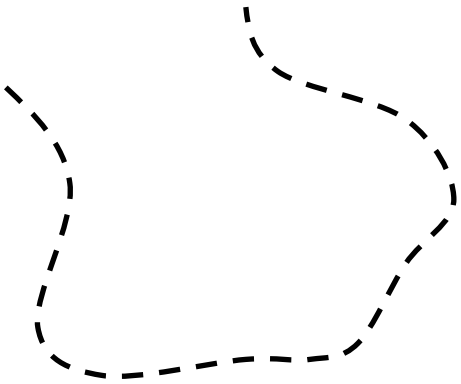
METHOD OF CONTROL: Indicates the method used to artificially initiate avalanche release, i.e, charges dropped from helicopter, military artillery, Gaz-ex, etc.

MAP KEY



Solid Line:

Indicates *Observed* Runout distance, from observations by at least one of the contributors to this atlas, with dates given on data sheet.



Dashed Line:

Indicates *Probable* Runout distance based on terrain features, vegetation damage, or unverified historical events. Not actually observed.

Evidence of Historical avalanche events in and around the Village of Snowbird, and Town of Alta in some cases may have been lost due to development and construction.

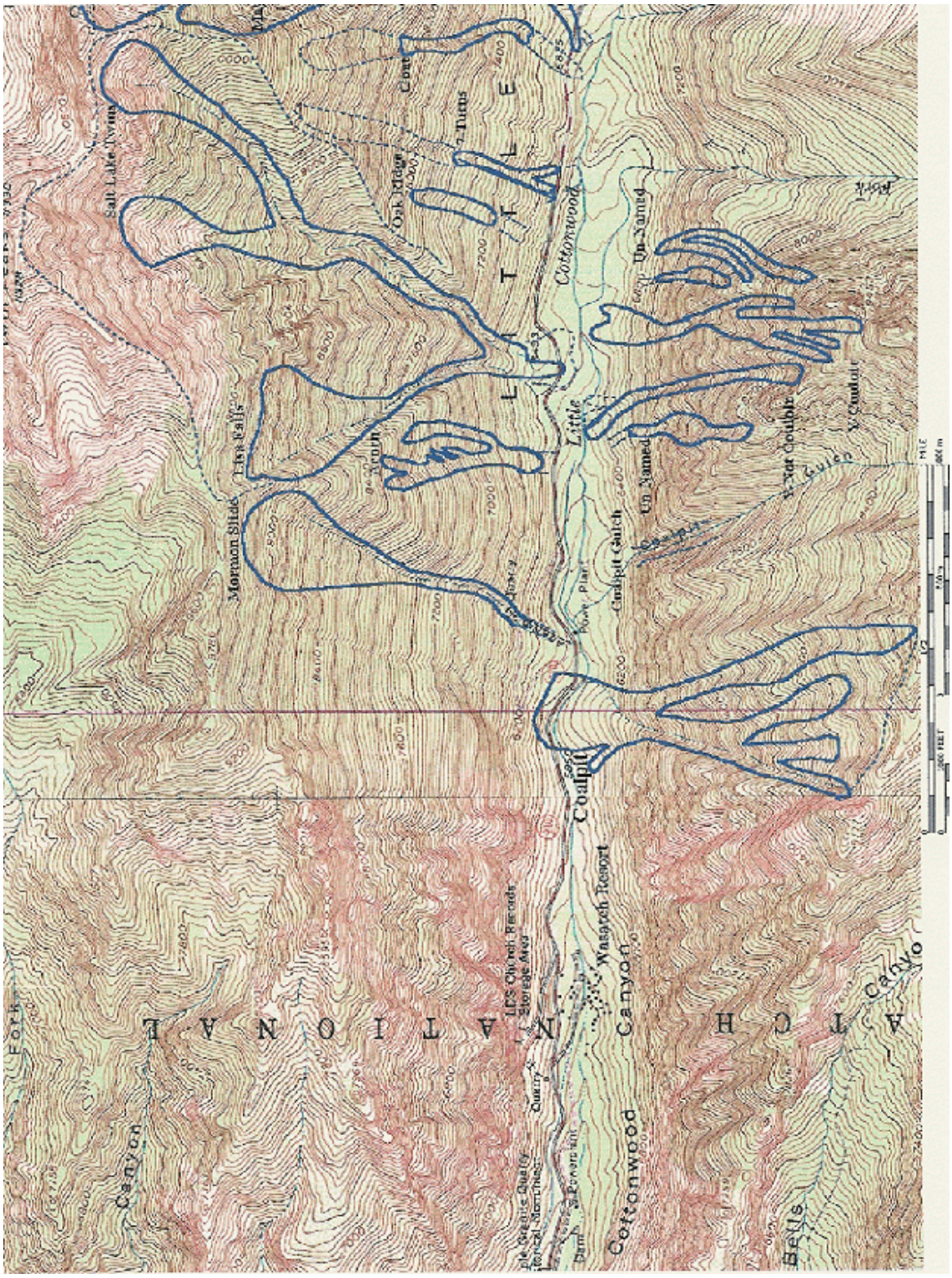
Photographic Credits:

Most of the photos in this Atlas were taken during April 1986 by G.E. Peterson, UDOT staff photographer, from a fixed wing aircraft, and using a Hasselblad camera.

Lower Canyon

Avalanche Path	Mile Marker
Coalpit	**5.5**
Mormon Slide	**Perpetual Storage Road**
Lisa Falls	**6.7**
Salt Lake Twins	**6.7**
Seven Turns	**7.2**

Lower Canyon Topographical Map




MILEPOST 5.5
Coalpit

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Coalpit **MILEPOST:** 5.5

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Infrequent

VERTICAL FALL: 3,500 ft

DISTANCE TO HIGHWAY: 6,500 ft **ALPHA ANGLE:** 32.3°

STARTING ZONE:

ELEVATION: 9,500 ft (ASL)

ASPECT: NE-N-NW

INCLINE: 37

ACREAGE: 104

TOPOGRAPHY: Three rocky tree lined chutes which can include the open forested slopes between the chutes.

TRACK:

INCLINE: 34

TOPOGRAPHY: Confined, rocky gully.

RUNOUT ZONE:

INCLINE: 20

TOPOGRAPHY: Alluvial fan with central erosion gully, damaged aspen and mountain brush on fan.

ACREAGE: 30.5

LENGTH OF HIGHWAY AFFECTED: 1,000 ft

HISTORY: Ran to extent indicated in March, 1948.

Crossed highway again in March, 1983.

METHOD OF CONTROL:

PRIMARY: Helicopter

SECONDARY: None


PERPETUAL STORAGE ROAD
Mormon Slide
Acorn

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Mormon Slide **MILEPOST:** Perpetual Storage Road

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Infrequent

VERTICAL FALL: 3,350 ft

DISTANCE TO HIGHWAY: 5,300 ft **ALPHA ANGLE:** 34.0°

STARTING ZONE:

ELEVATION: 9,400 ft (ASL)

ASPECT: SE-S

INCLINE: 36

ACREAGE: 10

TOPOGRAPHY: Mostly granite faces and tree lined chutes.

TRACK:

INCLINE: 26

TOPOGRAPHY: Rocky gully with numerous small ledges.

RUNOUT ZONE:

INCLINE: 17

TOPOGRAPHY: Thick brush and deciduous trees.

ACREAGE: 2

LENGTH OF HIGHWAY AFFECTED: Not known, no observations

HISTORY: Ran to extent indicated in April, 1974.

Not known to have reached highway.

Endangers commercial building (Perpetual Storage). Ran to backside of building in April 1974.

METHOD OF CONTROL:

PRIMARY: Not Controlled

SECONDARY: N/A


MILEPOST 6.7
Salt Lake Twins
Lisa Falls

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Lisa Falls **MILEPOST:** 6.7

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Infrequent

VERTICAL FALL: 3,350 ft

DISTANCE TO HIGHWAY: 6,500 ft **ALPHA ANGLE** 32.5°

STARTING ZONE:

ELEVATION: 9,800 ft (ASL)

ASPECT: SE-S-SW

INCLINE: 36

ACREAGE: 13

TOPOGRAPHY: Rock faces, numerous rocky ribs and gullies.

TRACK:

INCLINE: 28

TOPOGRAPHY: Confined, narrow rock slab gully.

RUNOUT ZONE:

INCLINE: 17

TOPOGRAPHY: Thick mountain brush. Aspen and some fir trees show extensive damage.

ACREAGE: 8.5

LENGTH OF HIGHWAY AFFECTED: 250 ft

HISTORY: First recorded event to reach the highway was April, 1974.

Ran into the Lisa Falls Recreation Area in May, 1983.

METHOD OF CONTROL:

PRIMARY: Helicopter

SECONDARY: None


MILEPOST 7.2
7 -Turns

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Salt Lake Twins **MILEPOST:** 6.7

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Infrequent

VERTICAL FALL: 4,700 ft

DISTANCE TO HIGHWAY: 9,000 ft **ALPHA ANGLE:** 28.7°

STARTING ZONE:

ELEVATION: 10,980 ft (ASL)

ASPECT: SE-S-SW

INCLINE: 36

ACREAGE: 13

TOPOGRAPHY: Rock faces, numerous rocky ribs and gullies.

TRACK:

INCLINE: 28

TOPOGRAPHY: Confined, narrow rock slab gully.

RUNOUT ZONE:

INCLINE: 17

TOPOGRAPHY: Thick mountain brush. Aspen and some fir trees show extensive damage.

ACREAGE: 8.5

LENGTH OF HIGHWAY AFFECTED: Unknown

HISTORY: No recorded history of reaching highway.

METHOD OF CONTROL:

PRIMARY: Not Controlled

SECONDARY: N/A

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: 7-Turns **MILEPOST:** 7.2

SIZE CLASSIFICATION: Significant

RETURN INTERVAL: Infrequent

VERTICAL FALL: 900 ft

DISTANCE TO HIGHWAY: 1,900 ft **ALPHA ANGLE:** 31.0°

STARTING ZONE:

ELEVATION: 7,680 ft (ASL)

ASPECT: S

INCLINE: 35

ACREAGE: 1

TOPOGRAPHY: Rock faces, numerous rocky ribs and gullies.

TRACK:

INCLINE: 32

TOPOGRAPHY: Shallow gully, mountain brush.

RUNOUT ZONE:

INCLINE: 16

TOPOGRAPHY: Open gully, considerable mountain brush.

ACREAGE: 1.5

LENGTH OF HIGHWAY AFFECTED: 170 ft

HISTORY: Ran to extent indicated in December, 1983.

METHOD OF CONTROL:

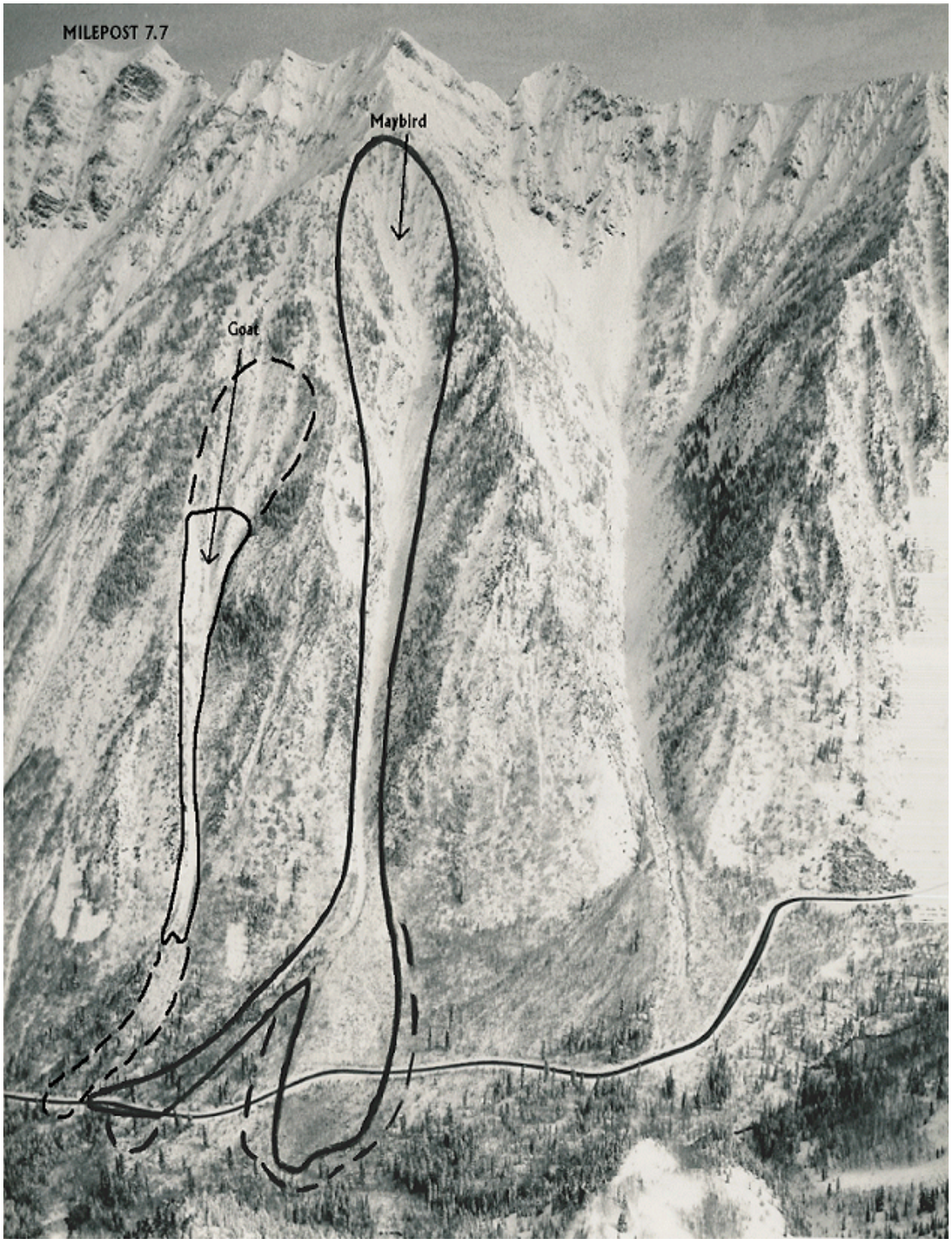
PRIMARY: Helicopter

SECONDARY: None

Mid Canyon

Avalanche Path	Mile Marker
Maybird	**7.7**
Tanners	**8.0**
White Pine Chutes	**8.1-8.6**
White Pine	**8.9**
Little Pine	**9.3**
Little Pine East	**9.7**
Willows	**9.8**

Mid Canyon Topographical Map


MILEPOST 7.7
Maybird
Goat

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Maybird **MILEPOST:** 7.7

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Occasional

VERTICAL FALL: 3,450 ft

DISTANCE TO HIGHWAY: 7,050 ft **ALPHA ANGLE:** 28.7 °

STARTING ZONE:

ELEVATION: 10,450 ft (ASL)

ASPECT: S-SE

INCLINE: 37

ACREAGE: 36

TOPOGRAPHY: Rocky, tree lined area.

TRACK:

INCLINE: 32

TOPOGRAPHY: Confined tree lined gully.

RUNOUT ZONE:

INCLINE: 16

TOPOGRAPHY: Fan type, damaged mountain birch and aspen.

ACREAGE: 17

LENGTH OF HIGHWAY AFFECTED: 900 ft

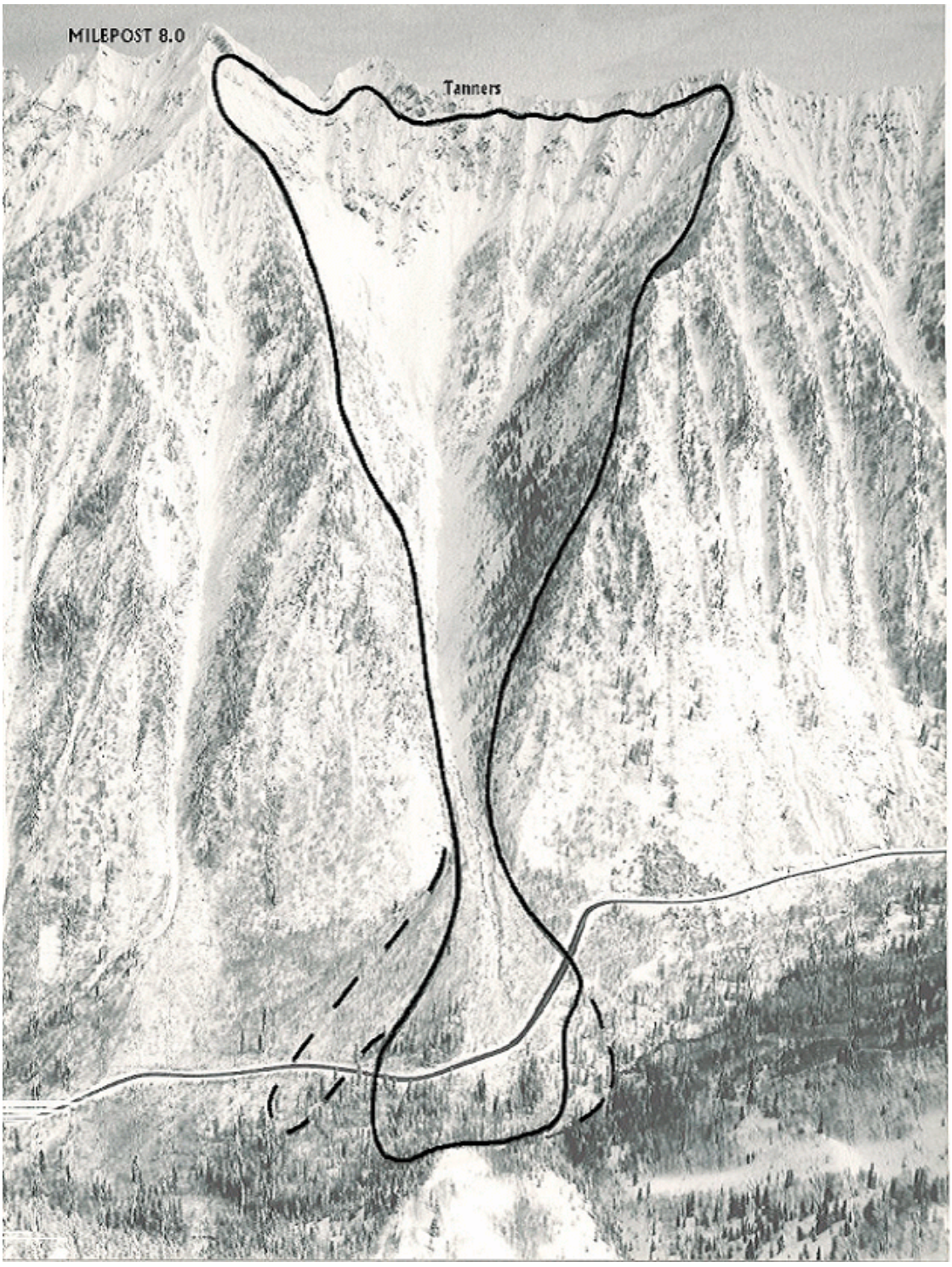
HISTORY: West arm and main path ran to extent indicated in January,1965. West arm also ran to highway in March 2004, and April 2006

METHOD OF CONTROL:

PRIMARY: Artillery

SECONDARY: Helicopter

UTAH SR-10 AVALANCHE PATH SUMMARY



NAME: Tanners **MILEPOST:** 8.0

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Occasional

VERTICAL FALL: 4,000 ft

DISTANCE TO HIGHWAY: 8,900 ft **ALPHA ANGLE:** 24.6°

STARTING ZONE:

ELEVATION: 11,100 ft (ASL)

ASPECT: SE-S-SW

INCLINE: 36

ACREAGE: 210

TOPOGRAPHY: Very large bowl with rugged terrain, cliffs, and sparse vegetation.

TRACK:

INCLINE: 24

TOPOGRAPHY: Confined deep narrow draw.

RUNOUT ZONE:

INCLINE: 8

TOPOGRAPHY: Alluvial fan, dense vegetation outside main erosion gully, with mountain brush and aspen showing considerable damage.

ACREAGE: 31

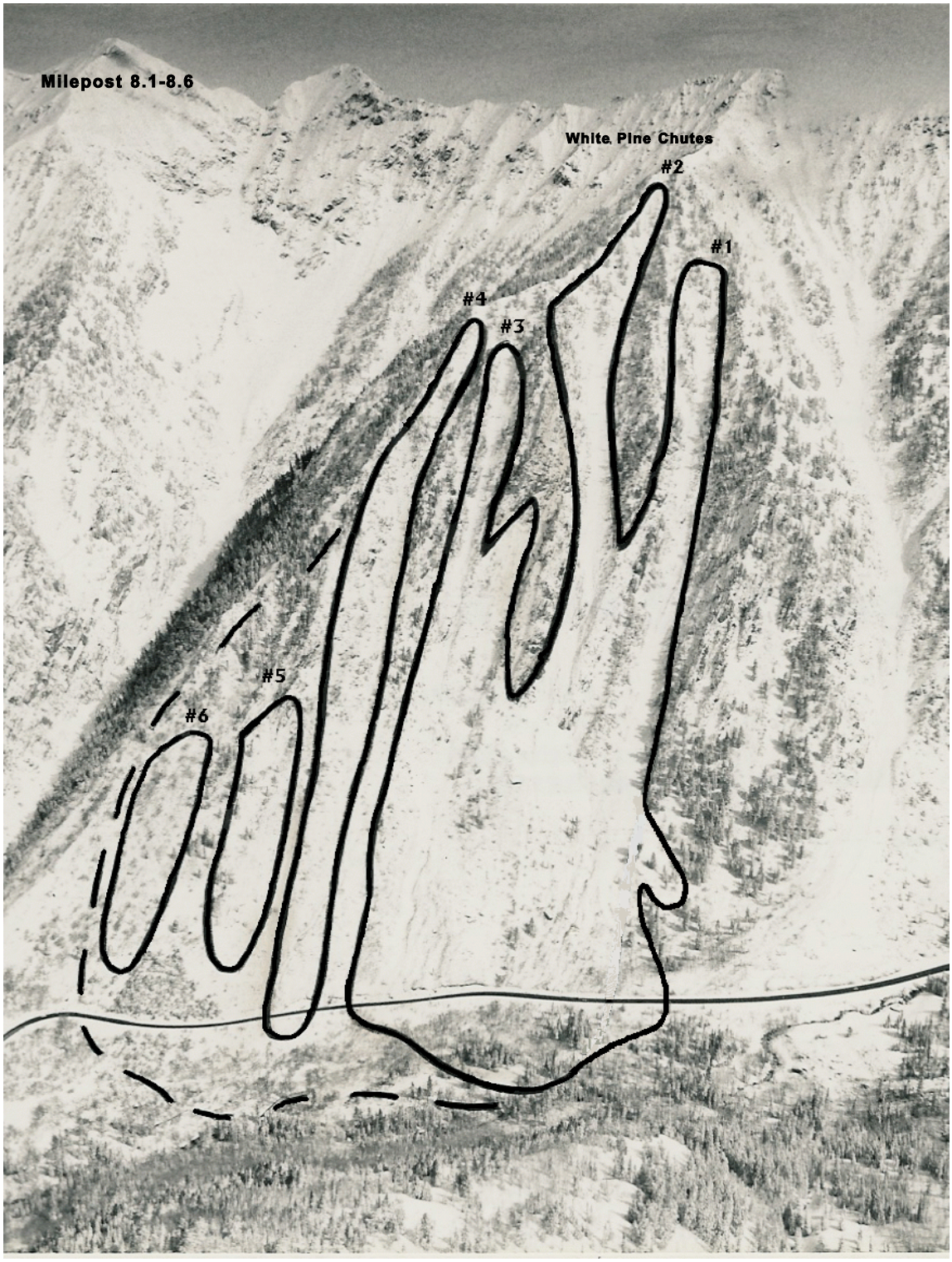
LENGTH OF HIGHWAY AFFECTED: 1,400 ft

HISTORY:

-Ran to extent indicated in 1952.
-Crossed highway in March, 1971, five days after storm, during clear weather, at 9:00 p.m.
-Natural avalanches have reached road more often than avalanches from control work.
-Numerous starting zones can avalanche simultaneously or separately.

METHOD OF CONTROL:

PRIMARY: Artillery
SECONDARY: Helicopter


Milepost 8.1-8.6
White Pine Chutes
#2
#1
#4
#3
#5
#6

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: White Pine Chutes (#'s 1-4) **MILEPOST:** 8.1-8.6

SIZE CLASSIFICATION: Significant

RETURN INTERVAL: Frequent

VERTICAL FALL: 2,800 ft

DISTANCE TO HIGHWAY: 4,800 ft **ALPHA ANGLES (1-4):** 32.9°, 34.6°, 35.8°, 35.9°

STARTING ZONE:

ELEVATION: 10,120 ft (ASL)

ASPECT: S

INCLINE: 37

ACREAGE: 28

TOPOGRAPHY: Four primary, and two secondary, small to moderate sized starting zones. Steep rocky terrain with moderate vegetation.

TRACK:

INCLINE: 33

TOPOGRAPHY: Rocky, tree lined gullies.

RUNOUT ZONE:

INCLINE: 21

TOPOGRAPHY: Directly above highway, damaged mountain brush.

ACREAGE: 19.5

LENGTH OF HIGHWAY AFFECTED: 1,100 ft

HISTORY: Ran to extent indicated in March, 1983.
Natural release from chute #4 overran stationary vehicles waiting for avalanche debris to be removed from road under chute #1. Several individuals were caught, buried, or injured.

Often first paths to reach road in natural avalanche cycle.

METHOD OF CONTROL:

PRIMARY: Artillery
SECONDARY: Helicopter


MILEPOST 8.9
White Pine
Elberts

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: White Pine **MILEPOST:** 8.9

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Frequent

VERTICAL FALL: 3,220 ft

DISTANCE TO HIGHWAY: 6,000 ft **ALPHA ANGLE:** 31.1°

STARTING ZONE:

ELEVATION: 10,700 ft (ASL)

ASPECT: SE-S-SW

INCLINE: 37

ACREAGE: 60

TOPOGRAPHY: Large rocky bowl with several chutes.

TRACK:

INCLINE: 35

TOPOGRAPHY: Narrow, confined gully fed by separate starting zones.

RUNOUT ZONE:

INCLINE: 14

TOPOGRAPHY: Alluvial fan, scattered damaged aspen.

ACREAGE: 24

LENGTH OF HIGHWAY AFFECTED: 800 ft

HISTORY: Ran to extent indicated several times, including January,1965.

Has released second time shortly after initial release. A UDOT pickup and rotary plow were buried by a repeater slide (1st one approximately 12 hours earlier) on March 27, 1950, killing one.

Old retaining wall absorbs initial smaller slides.

METHOD OF CONTROL:

PRIMARY: Artillery
SECONDARY: Helicopter


MILEPOST 9.3
Little Pine

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Little Pine **MILEPOST:** 9.3

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Frequent

VERTICAL FALL: 3,120 ft

DISTANCE TO HIGHWAY: 5,800 ft **ALPHA ANGLE:** 32.3°

STARTING ZONE:

ELEVATION: 10,700 ft (ASL)

ASPECT: SE-S-SW

INCLINE: 38

ACREAGE: 18

TOPOGRAPHY: Rocky bowl and chutes.

TRACK:

INCLINE: 34

TOPOGRAPHY: Narrow confined straight with no break in pitch.

RUNOUT ZONE:

INCLINE: 23

TOPOGRAPHY: Slight alluvial fan, with few damaged aspen.

ACREAGE: 13

LENGTH OF HIGHWAY AFFECTED: 650 ft

HISTORY: Ran to extent indicated in January,1965.

Little Pine has released a second time shortly after the initial release on several occasions.

Due to straight, confined track, and location of road near top of runout zone, small avalanches from this path can reach the road.

METHOD OF CONTROL:

PRIMARY: Artillery
SECONDARY: Helicopter


MILEPOST 9.7
Little Pine East
Limber Pine
Jedediah's

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Little Pine East **MILEPOST:** 9.7
(Three individual starting zones, Limber Pine, Lt. Pine East, and Jedediah, all share one common runout designated as Little Pine East)

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Occasional

VERTICAL FALL: 2,960 ft

DISTANCE TO HIGHWAY: 5,860 ft **ALPHA ANGLE:** 30.9°

STARTING ZONE:

ELEVATION: 10,640 ft (ASL)

ASPECT: SE-S-SW

INCLINE: 38

ACREAGE: 18

TOPOGRAPHY: Three separate large, starting zones, steep rocky, rugged terrain.

TRACK:

INCLINE: 34

TOPOGRAPHY: Three separate confined gullies.

RUNOUT ZONE:

INCLINE: 13

TOPOGRAPHY: Track gullies join and feed open slope well above highway.

ACREAGE: 45

LENGTH OF HIGHWAY AFFECTED: 1800 ft

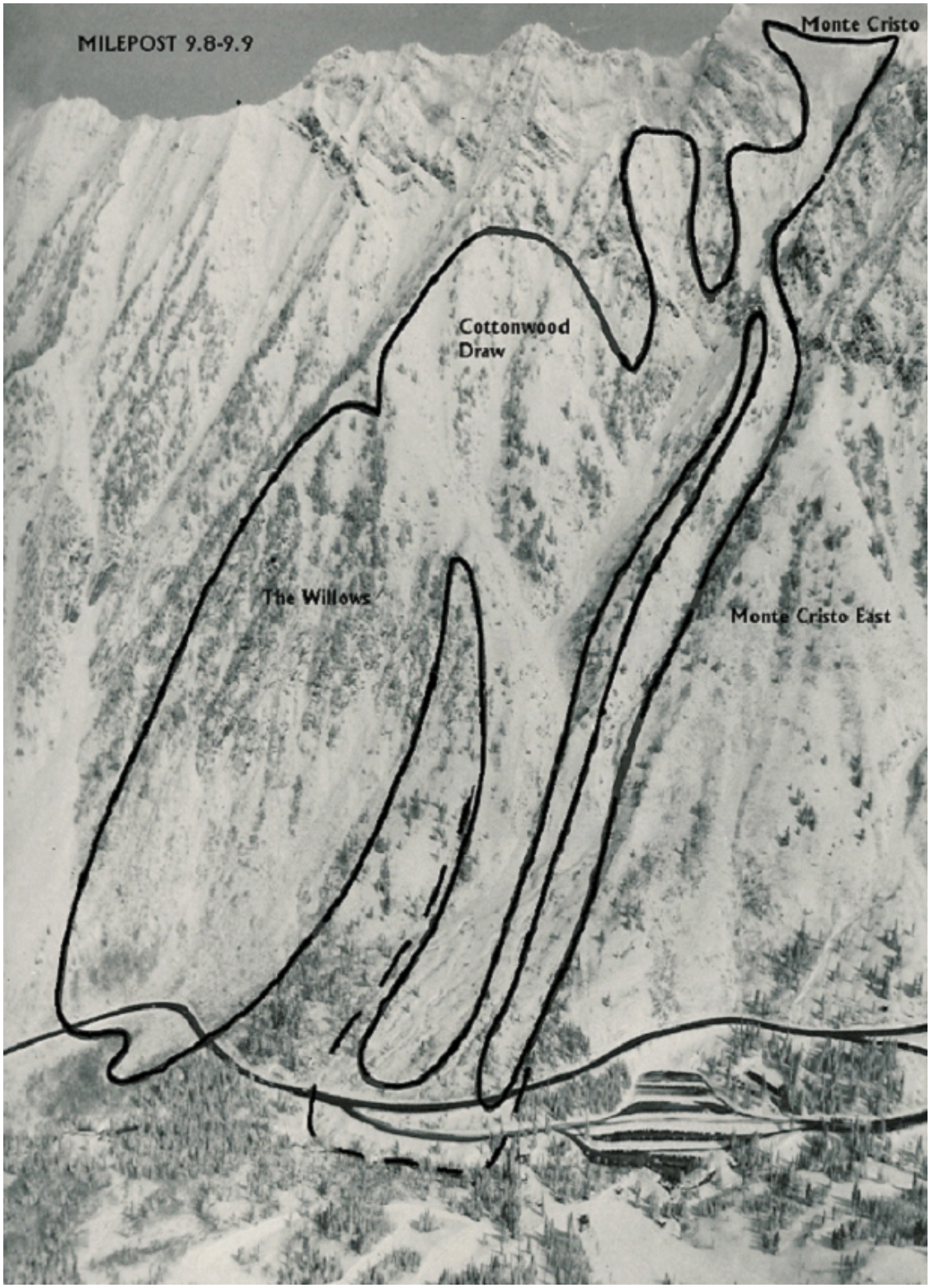
HISTORY: Ran to extent indicated in January,1965.

Historically, avalanche debris has combined with debris from Thunder Face, on south side of LCC creek.

METHOD OF CONTROL:

PRIMARY: Artillery

SECONDARY: Helicopter


MILEPOST 9.8-9.9
Monte Cristo
Cottonwood
Draw
The Willows
Monte Cristo East

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Willows **MILEPOST:** 9.8

SIZE CLASSIFICATION: Significant

RETURN INTERVAL: Frequent

VERTICAL FALL: 1,700 ft

DISTANCE TO HIGHWAY: 2,600 ft **ALPHA ANGLE:** 37.2°

STARTING ZONE:

ELEVATION: 9,500 ft (ASL)

ASPECT: S-SW

INCLINE: 37

ACREAGE: 40

TOPOGRAPHY: Tree lined, hanging snowfield.

TRACK:

INCLINE: 37

TOPOGRAPHY: Narrow confined gully above cliff band.

RUNOUT ZONE:

INCLINE: 24

TOPOGRAPHY: Bowl shaped slope with damaged aspen and mountain brush.

ACREAGE: 19

LENGTH OF HIGHWAY AFFECTED: 600 ft

HISTORY: Ran to extent indicated in January, 1965, and April, 1979.

Can combine with Cottonwood Draw in major release.

METHOD OF CONTROL:

PRIMARY: Artillery

SECONDARY: Helicopter

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Cottonwood Draw **MILEPOST:** 9.9

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Infrequent

VERTICAL FALL: 2,300 ft

DISTANCE TO HIGHWAY: 4,600 ft **ALPHA ANGLE:** 26.8°

STARTING ZONE:

ELEVATION: 10,320 ft (ASL)

ASPECT: SE-S

INCLINE: 42

ACREAGE: 30

TOPOGRAPHY: Two starting zones; rocky chutes at 10,320 ft, deep gully at 9,400 ft.

TRACK:

INCLINE: 32

TOPOGRAPHY: Confined, curving, large, deep, gully .

RUNOUT ZONE:

INCLINE: 14

TOPOGRAPHY: Low angle fan with damaged fir and aspen. Shares runout with the Monte Cristo path.

ACREAGE: 5

LENGTH OF HIGHWAY AFFECTED: 600 ft

HISTORY: Ran to extent indicated in January,1965 and April, 1979.

Release from Cottonwood Draw can run over cliffs of The Willows path and initiate a secondary release in that area.

METHOD OF CONTROL:

PRIMARY: Artillery

SECONDARY: Helicopter

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Monte Cristo **MILEPOST:** 9.9
(Includes Monti Cristo Gully East)

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Infrequent

VERTICAL FALL: 3,100 ft

DISTANCE TO HIGHWAY: 5,800 ft **ALPHA ANGLE:** 29.9°

STARTING ZONE:

ELEVATION: 11,000 ft (ASL)

ASPECT: S-SW

INCLINE: 37

ACREAGE: 17

TOPOGRAPHY: Large talus bowl with several secondary feeder gullies.

TRACK:

INCLINE: 35

TOPOGRAPHY: Large confined gully with short cliffs.

RUNOUT ZONE:

INCLINE: 14

TOPOGRAPHY: Low angle fan with damaged fir and aspen. Same as Cottonwood Draw.

ACREAGE: 5

LENGTH OF HIGHWAY AFFECTED: 150 ft

HISTORY:
- Ran to extent indicated in February,1993.
- Long runout zone with low angle terrain prevents most avalanche events from this path from reaching road.
- Major avalanche from this path may threaten Creekside facilities at Snowbird

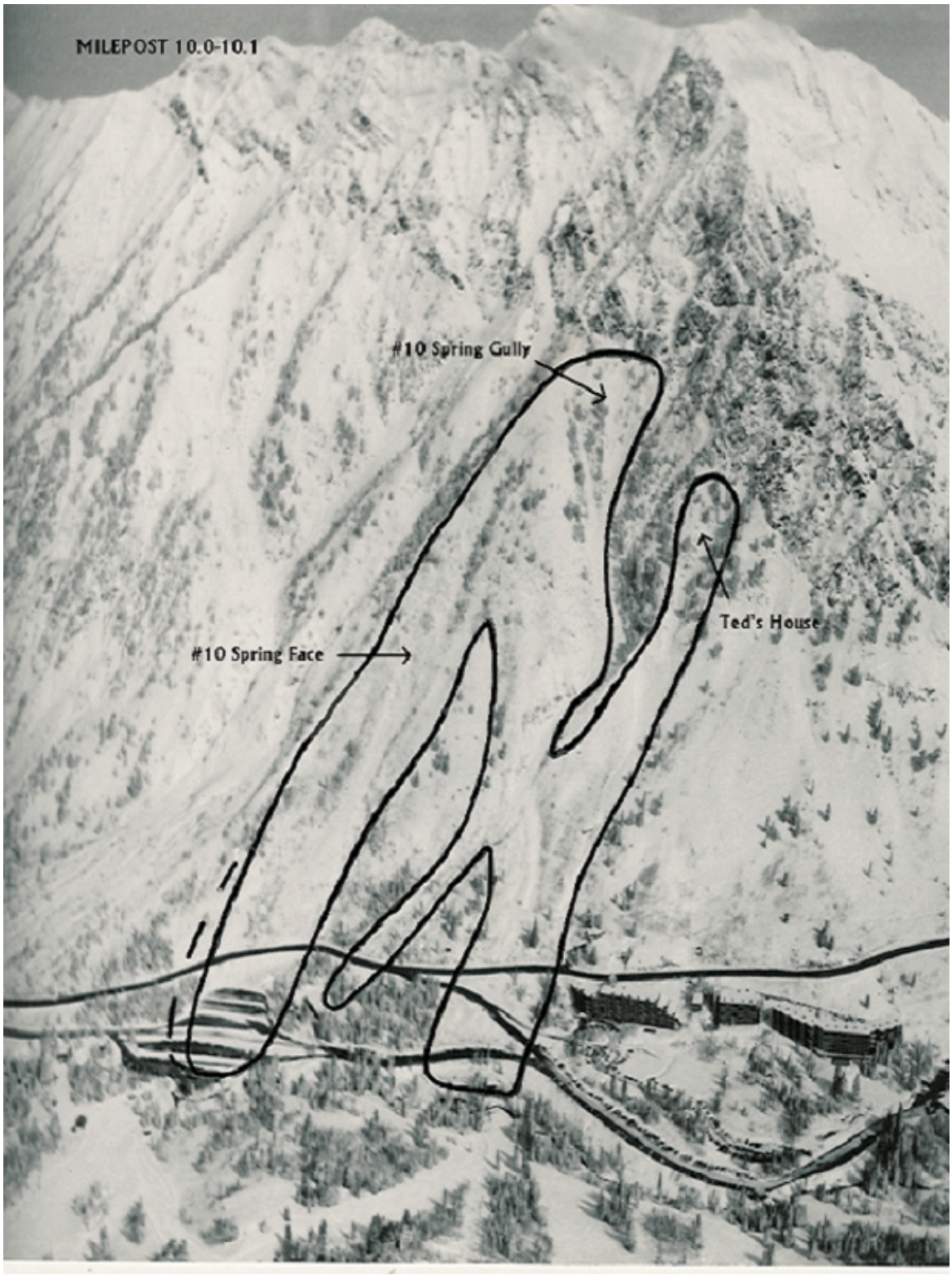
METHOD OF CONTROL:

PRIMARY: Artillery

SECONDARY: Helicopter

Snowbird Village

Avalanche Path	Mile Marker
#10 Spring Face	**10.0**
#10 Spring Gully	**10.0**
Ted's House	**10.1**
High Models	**10.2**
Valerie's	**10.4**
Valerie's East	**10.5**
Hilton	**10.6**


MILEPOST 10.0-10.1
#10 Spring Gully
Ted's House
#10 Spring Face

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: #10 Springs Face **MILEPOST:** 10.0

SIZE CLASSIFICATION: Significant

RETURN INTERVAL: Occasional

VERTICAL FALL: 1,500 ft

DISTANCE TO HIGHWAY: 2,700 ft **ALPHA ANGLE:** 33.1°

STARTING ZONE:

ELEVATION: 9,400 ft (ASL)

ASPECT: S-SW

INCLINE: 35

ACREAGE: 19 (Includes #10 Spring Gully)

TOPOGRAPHY: Open tree slope.

TRACK:

INCLINE: 32

TOPOGRAPHY: Semi confined with some trees.

RUNOUT ZONE:

INCLINE: 16

TOPOGRAPHY: Damaged aspen.

ACREAGE: 11

LENGTH OF HIGHWAY AFFECTED: 600 ft

HISTORY: Ran to extent indicated in April,1974.

Can combine with #10 Springs Gully.
Usually not a threat until later in the snow season due to tree cover.

Endangers Gad Valley Parking Lot at Snowbird, and Snowbird Maintenance Building.

METHOD OF CONTROL:

PRIMARY: Artillery
SECONDARY: Helicopter

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: #10 Springs Gully **MILEPOST:** 10.0

SIZE CLASSIFICATION: Significant

RETURN INTERVAL: Frequent

VERTICAL FALL: 1,400 ft

DISTANCE TO HIGHWAY: 2,900 ft **ALPHA ANGLE:** 28.2°

STARTING ZONE:

ELEVATION: 9,400 ft (ASL)

ASPECT: S-SE

INCLINE: 38

ACREAGE: 19 (Includes #10 Springs Face)

TOPOGRAPHY: Large deep gully with grass and tree cover.

TRACK:

INCLINE: 29

TOPOGRAPHY: Confined gully.

RUNOUT ZONE:

INCLINE: 17

TOPOGRAPHY: Open slope, sparse damaged trees.

ACREAGE: 20

LENGTH OF HIGHWAY AFFECTED: 150 ft (West Arm), 450 ft (Main Path)

HISTORY: Ran to extent indicated in February,1979.
Can combine with #10 Springs Face and Ted's House in major release.

Often splits to east or west above road, with wet of dry avalanches.

Endangers Snowbird Maintenance Bldg. Gad Valley Parking Lot, Bottom Station of Wilbure Chairlift, and private residence in runout.

METHOD OF CONTROL:

PRIMARY: Artillery
SECONDARY: Helicopter

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Ted's House **MILEPOST:** 10.1

SIZE CLASSIFICATION: Significant

RETURN INTERVAL: Frequent

VERTICAL FALL: 1,320 ft

DISTANCE TO HIGHWAY: 2,350 ft **ALPHA ANGLE:** 30.3°

STARTING ZONE:

ELEVATION: 9,280 ft (ASL)

ASPECT: S-SW

INCLINE: 37

ACREAGE: 3.5

TOPOGRAPHY: Rocky gully.

TRACK:

INCLINE: 32

TOPOGRAPHY: Open gully, sparse, small trees.

RUNOUT ZONE:

INCLINE: 20

TOPOGRAPHY: Open gully, sparse, small trees.

ACREAGE: 11.5

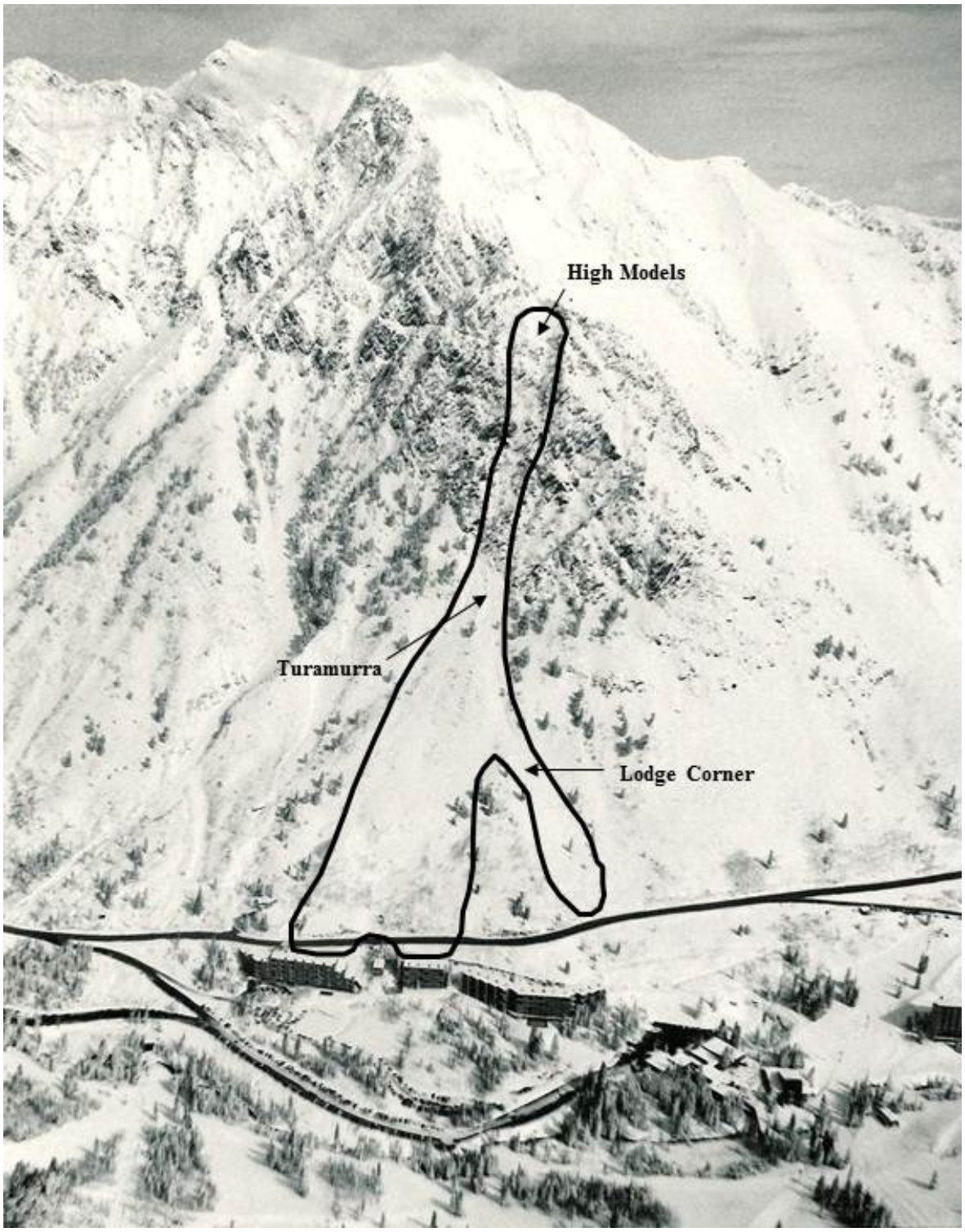
LENGTH OF HIGHWAY AFFECTED: 450 ft

HISTORY: Ran to extent indicated in December, 1983.
Endangers private residence in runout, and bottom station of Wilbur Ridge Chairlift.
Avalanche from #10 Springs Gully can overrun terrain in runout zone of Ted's House path.

METHOD OF CONTROL:

PRIMARY: Artillery

SECONDARY: Helicopter


High Models
Turamurra
Lodge Corner

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: High Models **MILEPOST:** 10.2
(Includes lower elevation Turamurra starting zone below cliffs)

SIZE CLASSIFICATION: Significant

RETURN INTERVAL: Frequent

VERTICAL FALL: 1,500 ft

DISTANCE TO HIGHWAY: 2,500 ft **ALPHA ANGLE:** 35.3°

STARTING ZONE:

ELEVATION: 9,560 ft (ASL)

ASPECT: S-SW

INCLINE: 49

ACREAGE: 6

TOPOGRAPHY: Hanging Snowfield.

TRACK:

INCLINE: 32

TOPOGRAPHY: Plunging avalanche over cliffs onto lower slope (Turamurra Starting Zone) then descending into partly confined gully.

RUNOUT ZONE:

INCLINE: 20

TOPOGRAPHY: Open slope, damaged aspen.

ACREAGE: 3

LENGTH OF HIGHWAY AFFECTED: 175 ft

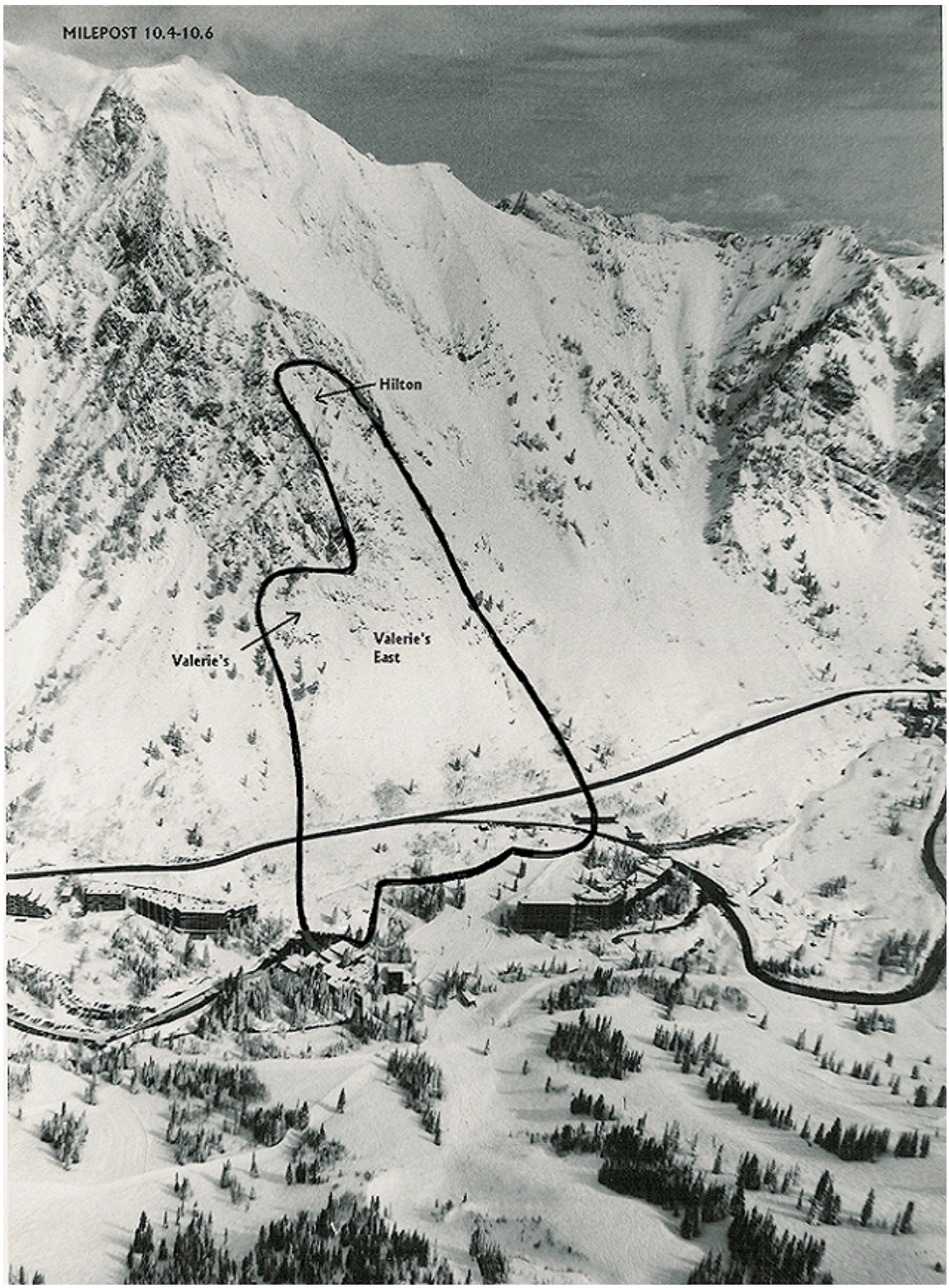
HISTORY: Ran to extent indicated in December, 1983.

Endangers private residence (Model Building), Iron Blossom Lodge, and The Inn at Snowbird.

METHOD OF CONTROL:

PRIMARY: Artillery

SECONDARY: Helicopter


MILEPOST 10.4-10.6
Hilton
Valerie's
Valerie's East

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Valerie's **MILEPOST:** 10.4

SIZE CLASSIFICATION: Significant

RETURN INTERVAL: Frequent

VERTICAL FALL: 900 ft

DISTANCE TO HIGHWAY: 1,400 ft **ALPHA ANGLE:**

STARTING ZONE:

ELEVATION: 9,000 ft (ASL)

ASPECT: S-SE

INCLINE: 45

ACREAGE: 4

TOPOGRAPHY: Open slope, rock slab, and talus.

TRACK:

INCLINE: 34

TOPOGRAPHY: Open slope.

RUNOUT ZONE:

INCLINE: 15

TOPOGRAPHY: Open slope, sparse damaged aspen.

ACREAGE: 17 (includes Hilton runout)

LENGTH OF HIGHWAY AFFECTED: 1400 ft (includes Hilton runout)

HISTORY: Ran to extent indicated in December, 1973.

Endangers Snowbird Base facilities and parking area.

METHOD OF CONTROL:

PRIMARY: Artillery

SECONDARY: Helicopter

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Valerie's East **MILEPOST:** 10.5

SIZE CLASSIFICATION: Significant

RETURN INTERVAL: Frequent

VERTICAL FALL: 800 ft

DISTANCE TO HIGHWAY: 1,350 ft **ALPHA ANGLE:**

STARTING ZONE:

ELEVATION: 9,000 ft (ASL)

ASPECT: S-SE

INCLINE: 33

ACREAGE: 2

TOPOGRAPHY: Open slope, rock slab, and talus.

TRACK:

INCLINE: 27

TOPOGRAPHY: Open slope, unconfined.

RUNOUT ZONE:

INCLINE: 16

TOPOGRAPHY: Open slope, sparse damaged aspen.

ACREAGE: 17 (includes through Hilton)

LENGTH OF HIGHWAY AFFECTED: 1400 ft (see Valerie's)

HISTORY: Ran to extent indicated in February 1980.
Endangers Snowbird facilities adjacent to Snowbird Entry 4, including Top Station of Chickadee Chairlift.
Destroyed road closure gate in February 1998.

METHOD OF CONTROL:

PRIMARY: Artillery

SECONDARY: Helicopter

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Hilton **MILEPOST:** 10.6

SIZE CLASSIFICATION: Significant

RETURN INTERVAL: Frequent

VERTICAL FALL: 960 ft

DISTANCE TO HIGHWAY: 1,800 ft **ALPHA ANGLE:**

STARTING ZONE:

ELEVATION: 9,280 ft (ASL)

ASPECT: S-SE

INCLINE: 37

ACREAGE: 5

TOPOGRAPHY: Steep hanging snowfield.

TRACK:

INCLINE: 22

TOPOGRAPHY: Semi-confined gully.

RUNOUT ZONE:

INCLINE: 14

TOPOGRAPHY: Open slope directly above highway.

ACREAGE: 17 (see Valerie's)

LENGTH OF HIGHWAY AFFECTED: 1400 ft (see Valerie's)

HISTORY: Ran to extent indicated in January, 1982.

Combined with Superior in January, 1965.

Endangers SR -210 and Alta Bypass Road. Snowbird Employee Housing Bldg., Snowbird Fire Station, and Cliff Lodge.

METHOD OF CONTROL:

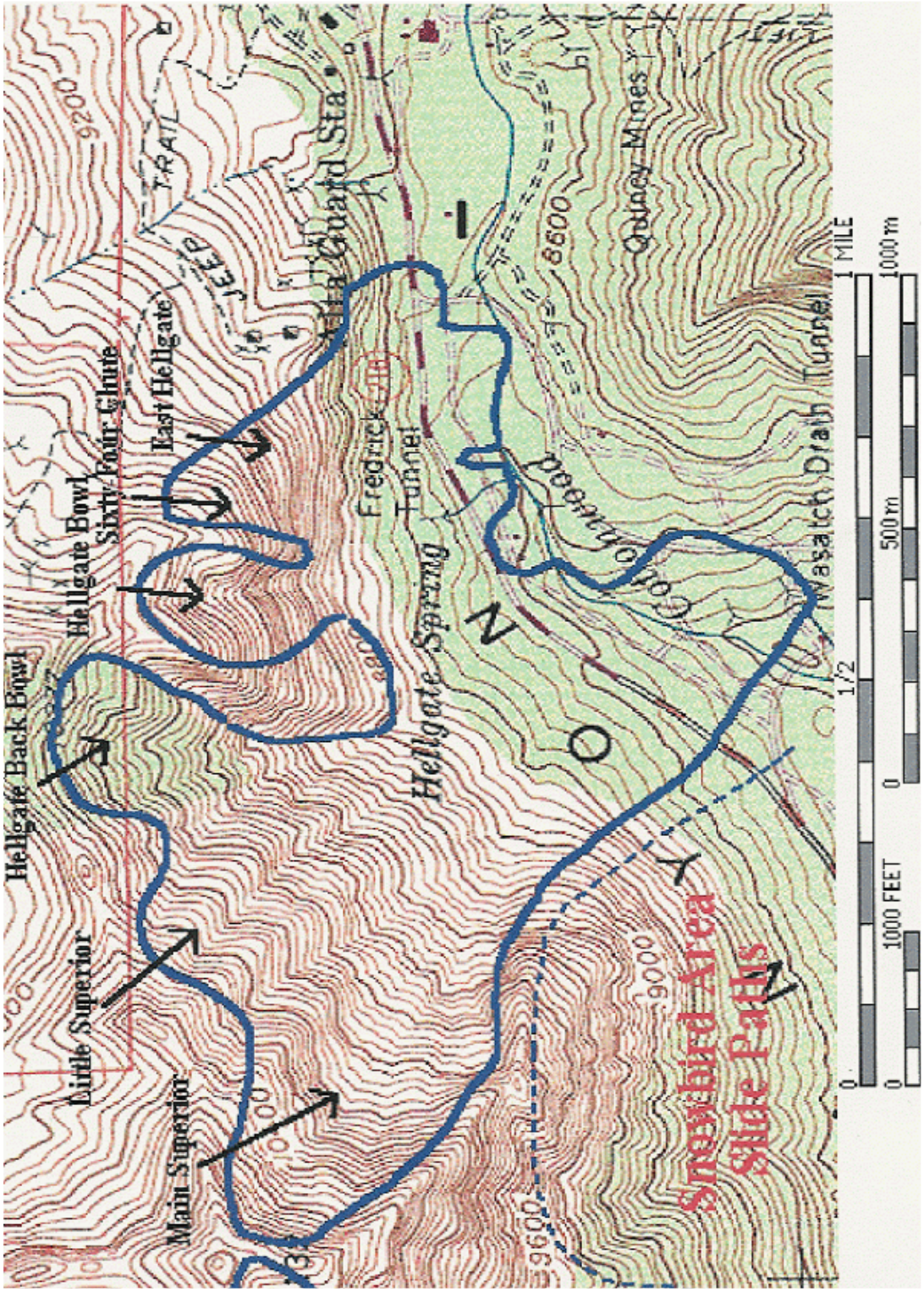
PRIMARY: Gaz-ex Exploder

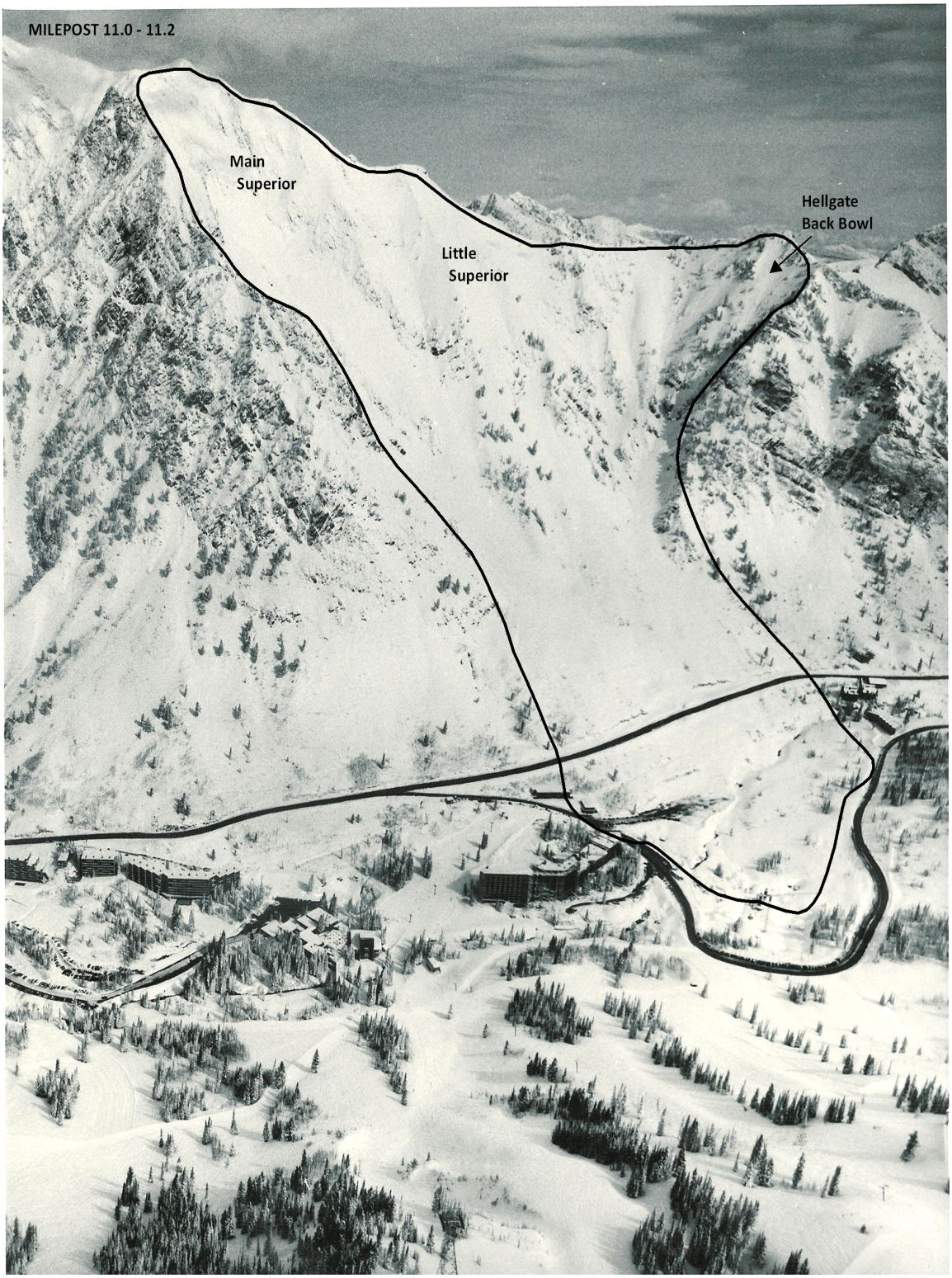
SECONDARY: Helicopter

Hellgate/Superior Area

Avalanche Path	Mile Marker
Main Superior	**11.0**
Little Superior	**11.2**
Hellgate Backbowl	**11.2**
Hellgate Bowl	**11.3**
Sixty-Four Chute	**11.4**
East Hellgate	**11.5**

Hellgate/Superior Topographical Map




MILEPOST 11.0 - 11.2
Main
Superior
Little
Superior
Hellgate
Back Bowl

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Main Superior **MILEPOST:** 11.0

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Frequent

VERTICAL FALL: 2,760 ft

DISTANCE TO HIGHWAY: 5,000 ft **ALPHA ANGLE:** 30.6°

STARTING ZONE:

ELEVATION: 10,960 ft (ASL)

ASPECT: SE-S-SW

INCLINE: 37

ACREAGE: 93

TOPOGRAPHY: Open slope, rocky ribs, and talus.

TRACK:

INCLINE: 28

TOPOGRAPHY: Open, unconfined talus.

RUNOUT ZONE:

INCLINE: 17

ACERAGE: 42

TOPOGRAPHY: Open, no obstructions, some mountain brush.

LENGTH OF HIGHWAY AFFECTED: 1950 ft (includes through Hellgate Back Bowl)

HISTORY:

-Ran to extent indicated in January, 1969. Overran historical **G**un mount on Bypass road. Hit NE corner of Cliff Lodge in April 2010.
-Main Superior can release as several smaller individual avalanche paths, or all at once producing a very large avalanche.
-Usually crosses highway 2 to 3 times in a normal winter.
-Endangers SR-210, Snowbird Employee Housing Building,, Snowbird Fire Station, Bypass Road, Snowbird parking areas on north and south sides of creek, portion of Cliff Lodge.

METHOD OF CONTROL:

PRIMARY: Artillery
SECONDARY: Helicopter

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Little Superior **MILEPOST:** 11.2

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Frequent

VERTICAL FALL: 2,000 ft

DISTANCE TO HIGHWAY: 3,700 ft **ALPHA ANGLE:** 29.9°

STARTING ZONE:

ELEVATION: 10,200 ft (ASL)

ASPECT: SE-S-SW

INCLINE: 36

ACREAGE: 93 (combined with Main Superior and Hellgate Back Bowl)

TOPOGRAPHY: Open slope, talus, and grass.

TRACK:

INCLINE: 29

TOPOGRAPHY: Some funneling at lower west prow of Hellgate cliffs, otherwise unconfined.

RUNOUT ZONE:

INCLINE: 17

TOPOGRAPHY: Open slope, mountain brush.

ACREAGE: 42 (combined with Main Superior)

LENGTH OF HIGHWAY AFFECTED: 1950 ft (see Main Superior)

HISTORY:

-Ran to extent indicated in January 1969.
-Can combine with Main Superior and Hellgate Back Bowl in a massive avalanche.
-Usually crosses highway 2 to 3 times in a normal winter.
-Endangers private residencies on south side of the creek, and Snowbird parking areas on north and south side of creek.

METHOD OF CONTROL:

PRIMARY: Artillery

SECONDARY: Helicopter

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Hellgate Back Bowl **MILEPOST:** 11.2

SIZE CLASSIFICATION: Significant

RETURN INTERVAL: Occasional

VERTICAL FALL: 1,594 ft

DISTANCE TO HIGHWAY: 3,450 ft **ALPHA ANGLE:** 27.9°

STARTING ZONE:

ELEVATION: 10,015 ft (ASL)

ASPECT: S-SW

INCLINE: 34

ACREAGE: 93 (combined with Main Superior and Little Superior)

TOPOGRAPHY: Open slope, talus, and grass.

TRACK:

INCLINE: 29

TOPOGRAPHY: Confined rocky gullies and cliffs.

RUNOUT ZONE:

INCLINE: 17

TOPOGRAPHY: Open slope, mountain brush.

ACREAGE: 42 (combined with Main Superior and Little Superior)

LENGTH OF HIGHWAY AFFECTED: 1950 ft (see main Superior)

HISTORY: Ran to extent indicated in January, 1969.

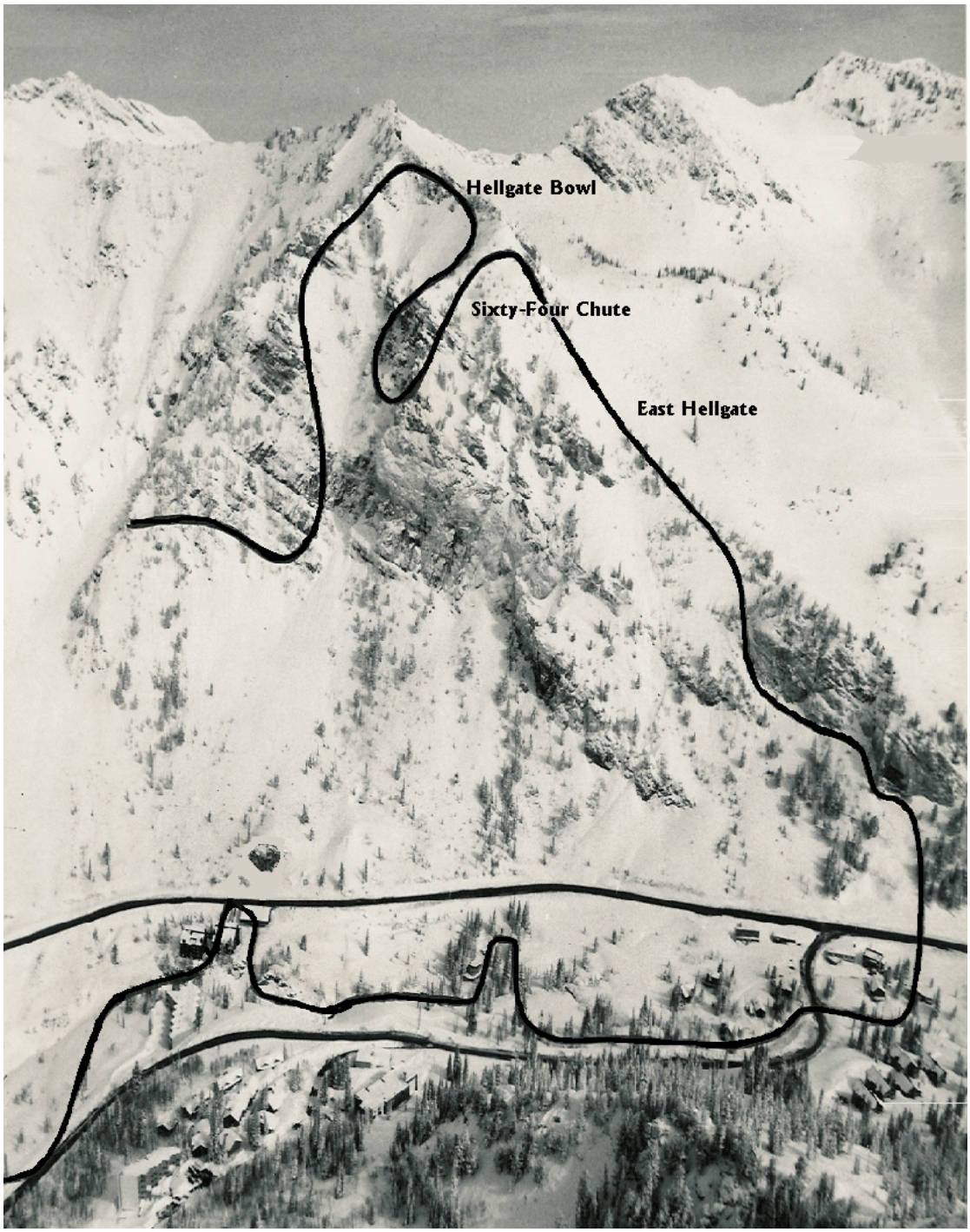
Can combine with Main Superior and Little Superior in a massive avalanche.

Endangers private residencies on north and south side of the creek.

METHOD OF CONTROL:

PRIMARY: Artillery

SECONDARY: Helicopter


Hellgate Bowl
Sixty-Four Chute
East Hellgate

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Hellgate Bowl **MILEPOST:** 11.3

SIZE CLASSIFICATION: Significant

RETURN INTERVAL: Frequent

VERTICAL FALL: 1,450 ft

DISTANCE TO HIGHWAY: 2,500 ft **ALPHA ANGLE:** 35.0°

STARTING ZONE:

ELEVATION: 9,880 ft (ASL)

ASPECT: S-SW

INCLINE: 35

ACREAGE: 10

TOPOGRAPHY: Scree, grass, and hardpan dirt slope.

TRACK:

INCLINE: 50

TOPOGRAPHY: Limestone Cliff. Plunging Avalanche, becomes airborne over cliffs in Track.

RUNOUT ZONE:

INCLINE: 18

TOPOGRAPHY: Unconfined, with mountain brush, and small fir trees.

ACREAGE: 8

LENGTH OF HIGHWAY AFFECTED: 1900 ft (includes through East Hellgate)

HISTORY: Ran to extent indicated in January, 1965.

Historically, a large event from this path usually occurred every three years. Can initiate secondary release below cliffs. Can combine with Little Superior and Hellgate Back Bowl..

Endangers Hellgate condominiums, and private residencies on south side of creek.

METHOD OF CONTROL:

PRIMARY: Artillery
SECONDARY: Helicopter/ Avalauncher

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Sixty-Four Chute **MILEPOST:** 11.4

SIZE CLASSIFICATION: Significant

RETURN INTERVAL: Frequent

VERTICAL FALL: 1,300 ft

DISTANCE TO HIGHWAY: 2,000 ft **ALPHA ANGLE:** 41.6°

STARTING ZONE:

ELEVATION: 9,760 ft (ASL)

ASPECT: S

INCLINE: 38

ACREAGE: 4

TOPOGRAPHY: Confined chutes, grass, and limestone.

TRACK:

INCLINE: 43

TOPOGRAPHY: cliffs, small vegetation. Plunging avalanche becoming airborne over cliffs in Track.

RUNOUT ZONE:

INCLINE: 22

TOPOGRAPHY: Unconfined, with mountain brush, and small fir and aspen trees.

ACREAGE: 10

LENGTH OF HIGHWAY AFFECTED: 1900 ft (see Hellgate Bowl)

HISTORY: Ran to extent indicated in January, 1965 and December, 1973.

Reaches highway several times in a normal winter. Historically, has produced a large avalanche once every 3 years.

Endangers private residences on north side of creek.

METHOD OF CONTROL:

PRIMARY: Artillery
SECONDARY: Helicopter/Avalauncher

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: East Hellgate **MILEPOST:** 11.5

SIZE CLASSIFICATION: Significant

RETURN INTERVAL: Frequent

VERTICAL FALL: 1,300 ft

DISTANCE TO HIGHWAY: 2,000 ft **ALPHA ANGLE:** 40.0°

STARTING ZONE:

ELEVATION: 9,760 ft (ASL)

ASPECT: S-SE

INCLINE: 36

ACREAGE: 8

TOPOGRAPHY: Hanging snowfield, mixed grass, and limestone.

TRACK:

INCLINE: 41

TOPOGRAPHY: Open cliffs, small vegetation.

RUNOUT ZONE:

INCLINE: 15

TOPOGRAPHY: Unconfined, with mountain brush, and small fir trees.

ACREAGE: 13.5

LENGTH OF HIGHWAY AFFECTED: 1900 ft (see Hellgate Bowl)

HISTORY: Ran to extent indicated in January 1965, and February, 1973.

Reaches highway several times in a normal winter. Highway located at bottom of Track, allowing even small avalanches to reach road.

Endangers private residences on north side of creek.

METHOD OF CONTROL:

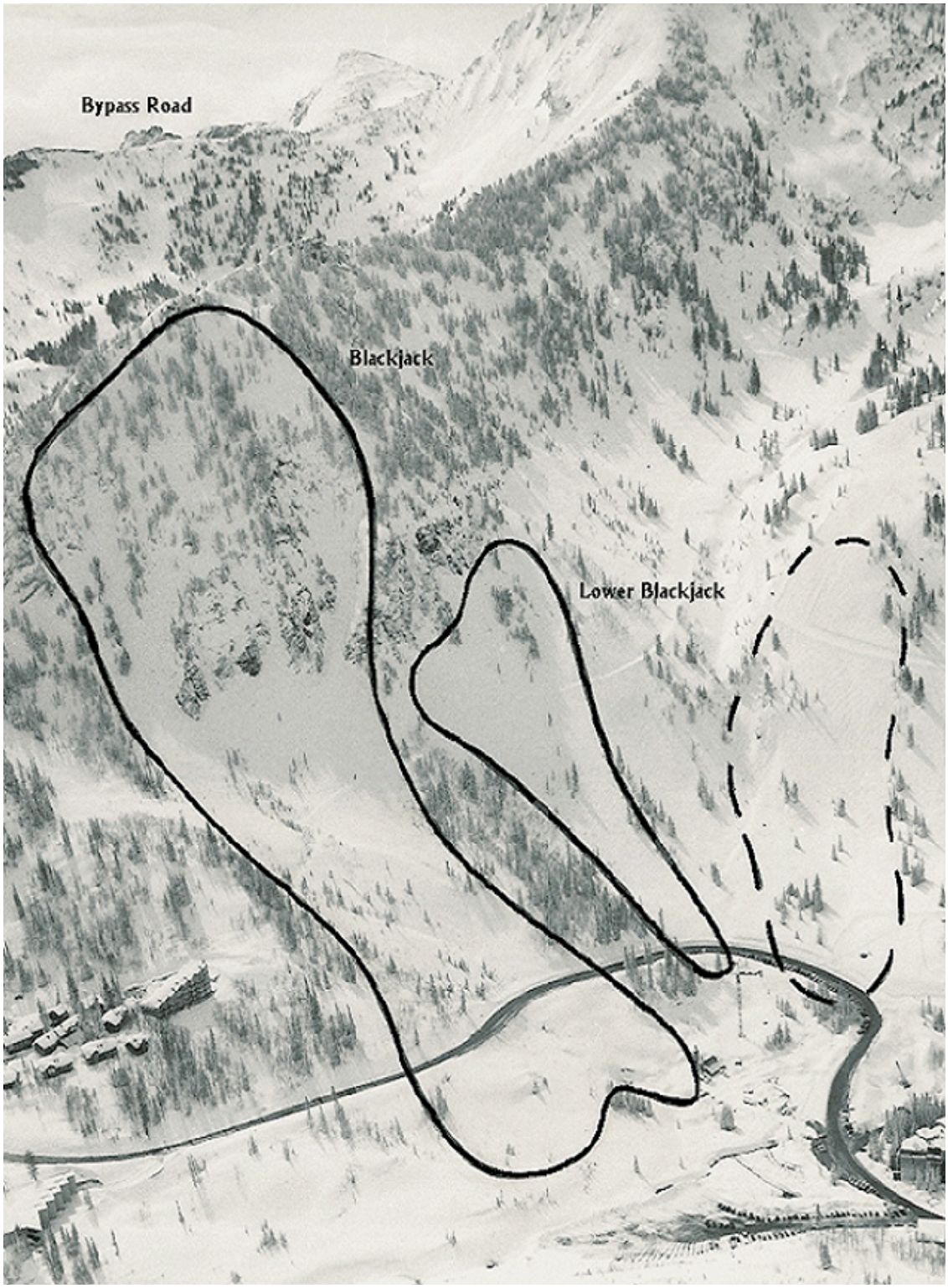
PRIMARY: Artillery

SECONDARY: Helicopter/Avalauncher

Blackjack Area

Blackjack
- **Comma Chute**
- **Blackjack Bowl**
- **White Cliffs**

Lower Blackjack
- **Lightening Tree Gully**
- **Lightening Tree Hill**
- **Car Alarm Slide**


Bypass Road
Blackjack
Lower Blackjack

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Blackjack **MILEPOST:** Bypass Road
(Comma Chute, Blackjack Bowl, White Cliffs)

SIZE CLASSIFICATION: Significant

RETURN INTERVAL: Occasional

VERTICAL FALL: 1,400 ft

DISTANCE TO HIGHWAY: 2,300 ft **ALPHA ANGLE:** 32.0°

STARTING ZONE:

ELEVATION: 9,600 ft (ASL)

ASPECT: NW

INCLINE: 42

ACREAGE: 21

TOPOGRAPHY: Hanging snowfields, and rocky chutes.

TRACK:

INCLINE: 24

TOPOGRAPHY: Confined chutes, or airborne over cliffs.

RUNOUT ZONE:

INCLINE: 13

TOPOGRAPHY: Open slope, sparse damaged fir trees. Blackjack Ski Run, Snowbird Ski Area

ACREAGE: 19

LENGTH OF HIGHWAY AFFECTED: 450 ft

HISTORY: Ran to extent indicated in January, 1965. Combined with avalanche debris from Main Superior.
Runs close to highway once in five years on average.

Endangers Bypass Road, Snowbird Cliff Lodge Parking Structure, and Snowbird parking areas.

METHOD OF CONTROL:

PRIMARY: Hand Charge Route
SECONDARY: N/A

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Lower Blackjack **MILEPOST:** Bypass Road
(Lightening Tree Gully, Lightening Tree Hill, Car Alarm Slide)

SIZE CLASSIFICATION: Minor

RETURN INTERVAL: Occasional

VERTICAL FALL: 560 ft

DISTANCE TO HIGHWAY: 1,150 ft **ALPHA ANGLE:** 26.0°

STARTING ZONE:

ELEVATION: 8,775 ft (ASL)

ASPECT: NW

INCLINE: 39

ACREAGE: 3

TOPOGRAPHY: Open slope, and gully below cliff face. Starting Zone, Track, and Runout Zone all part of Snowbird Resort terrain

TRACK:

INCLINE: 25

TOPOGRAPHY: Unconfined.

RUNOUT ZONE:

INCLINE: 14

TOPOGRAPHY: Open slope.

ACREAGE: 1.5

LENGTH OF HIGHWAY AFFECTED: 150 ft

HISTORY:
-Regular skier compaction has decreased frequency of avalanches reaching road.
-Endangers Bypass Road, Snowbird Cliff Lodge Parking Structure, and parking areas.

METHOD OF CONTROL:

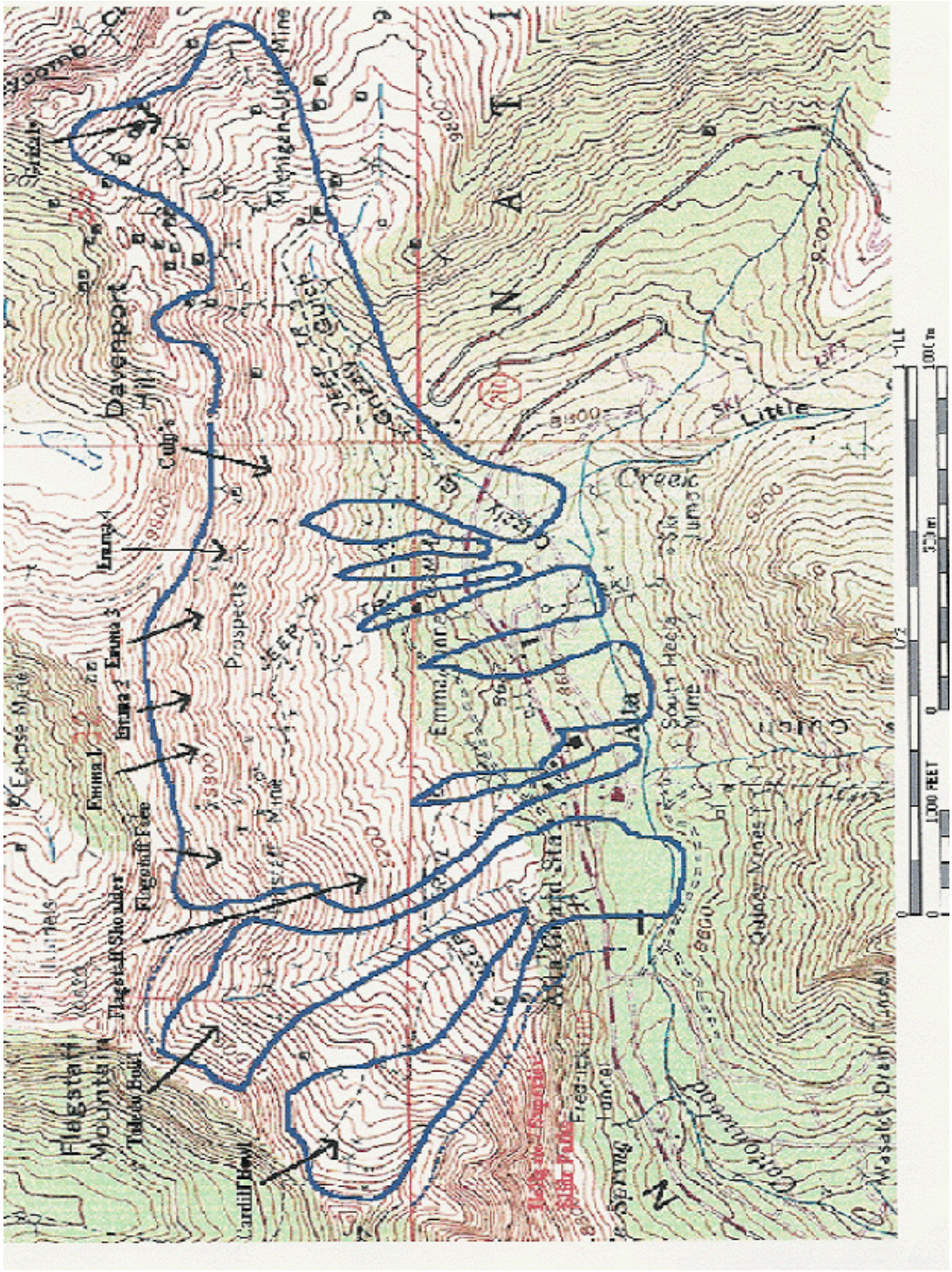
PRIMARY: Hand Charge Route

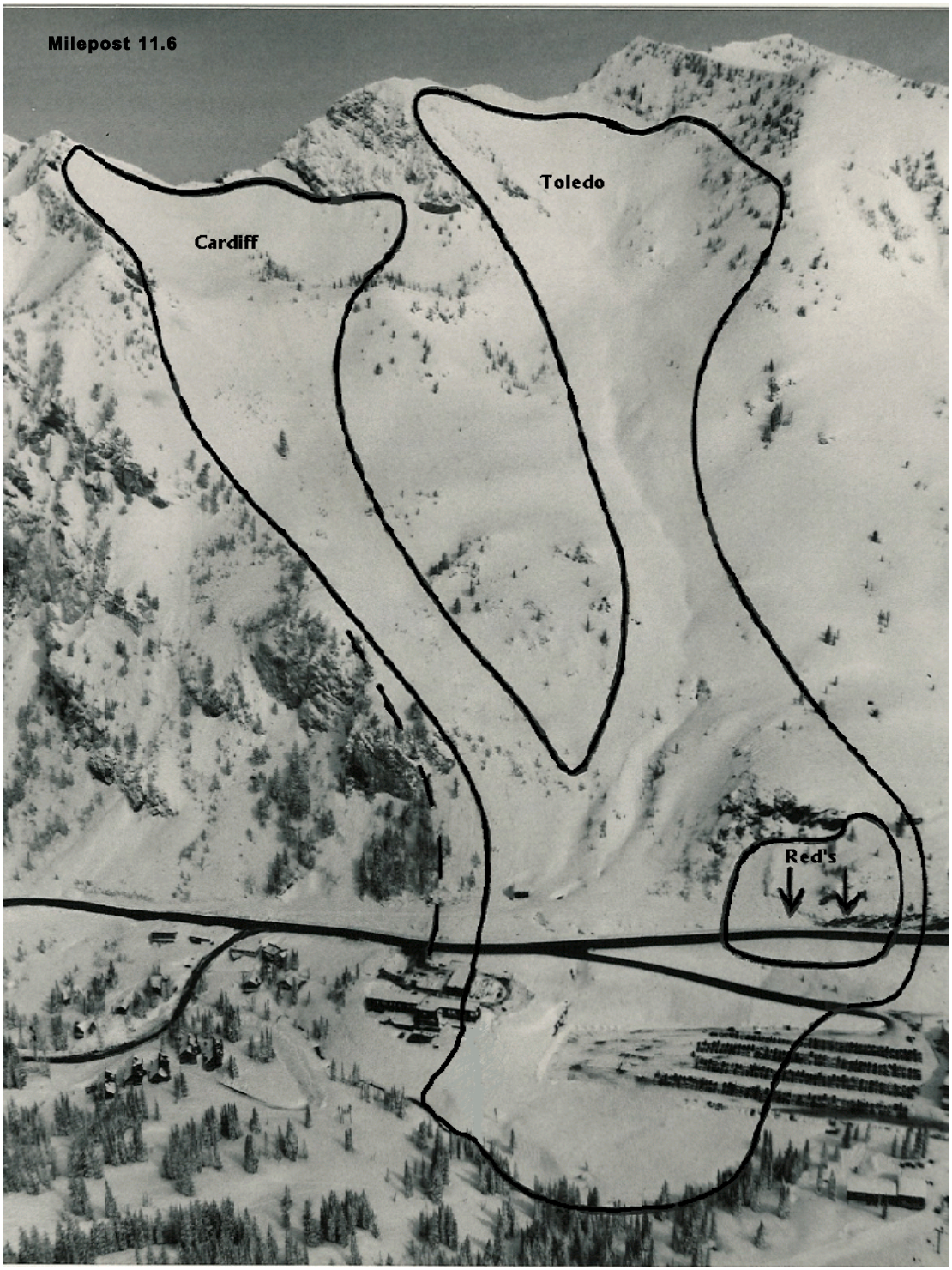
SECONDARY: Avalauncher

Town of Alta

Avalanche Path	Mile Marker
Cardiff	**11.6**
Toledo	**11.6**
Red's	**11.9**
Flagstaff Shoulder	**12.02**
Flagstaff Face	**12.04**
Emma 1, Emma 2	**12.1**
Emma 3, Emma 4	**12.3**
Culp's	**12.6**
Grizzly	**12.61**

Town of Alta Area Topographical Map




Milepost 11.6
Toledo
Cardiff
Red's

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Cardiff **MILEPOST:** 11.6

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Infrequent

VERTICAL FALL: 1,550 ft

DISTANCE TO HIGHWAY: 4,100 ft **ALPHA ANGLE:** 22.2°

STARTING ZONE:

ELEVATION: 10,080 ft (ASL)

ASPECT: SE

INCLINE: 37

ACREAGE: 14

TOPOGRAPHY: Mixed grass and talus, very open.

TRACK:

INCLINE: 22

TOPOGRAPHY: Unconfined, some small fir trees.

RUNOUT ZONE:

INCLINE: 14

TOPOGRAPHY: Somewhat confined by East Hellgate cliffs.

ACREAGE: 22

LENGTH OF HIGHWAY AFFECTED: 1000 ft

HISTORY: Ran to extent indicated in December, 1973.

Can combine with Toledo in a massive release.

-Historically, has reached highway usually once every 4 to 5 years.
-Has not run to highway in at least 20 years prior to this publication.
- When combined with Toledo, endangers Wildcat Parking Lot, Peruvian Lodge, and private residencies on south side of creek.

METHOD OF CONTROL:

PRIMARY: Artillery
SECONDARY: Helicopter

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Toledo **Milepost:** 11.6
(Includes Toledo Chute, Face, and Bowl)

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Occasional

VERTICAL FALL: 1,700 ft

DISTANCE TO HIGHWAY: 4,200 ft

STARTING ZONE:

ELEVATION: 10,260 ft (ASL)

ASPECT: S/SE-S-SW

INCLINE: 35

ACERAGE: 23

TOPOGRAPHY: Rocky talus and scree, open slope (Toledo Chute, confined steep gully)

TRACK:

INCLINE: 18

TOPOGRAPHY: Open slope with a few small damaged trees leading into gully.

RUNOUT ZONE:

INCLINE: 13

TOPOGRAPHY: Open, unconfined, includes Wildcat Parking lot.

ACERAGE: 22 (Combined with Cardiff)

LENGTH OF HIGHWAY AFFECTED: 1000ft

HISTORY:
-Ran to extent indicated in January 1964.
-Historically has combined with Cardiff to create a very large avalanche.
-Historically reaches highway once every four to five years.
-Has not crossed highway since 2002, when it hit and damaged Peruvian Lodge and numerous vehicles.
-Endangers SR-210, Peruvian Lodge, Wildcat Parking Lot, private residences on south side of creek, Telephone Relay facility.

METHOD OF CONTROL:
PRIMARY: Artillery
SECONDARY: Helicopter

UTAH 210 AVALANCHE PATH SUMMARY

NAME: Red's **MILEPOST:** 11.6

SIZE CLASSIFICATION: Minor

RETURN INTERVAL: Frequent

VERTICAL FALL: 100 ft

DISTANCE TO HIGHWAY: 250 ft **ALPHA ANGLE:** 25.9°

STARTING ZONE:

ELEVATION: 8,725 ft (ASL)

ASPECT: S

INCLINE: 36

ACREAGE: 1

TOPOGRAPHY: Talus, scree, grass, and open slope.

TRACK:

INCLINE: 32

TOPOGRAPHY: Unconfined open slope

RUNOUT ZONE:

INCLINE: Highway

TOPOGRAPHY: Open and unconfined

ACREAGE: .5

LENGTH OF HIGHWAY AFFECTED: 250

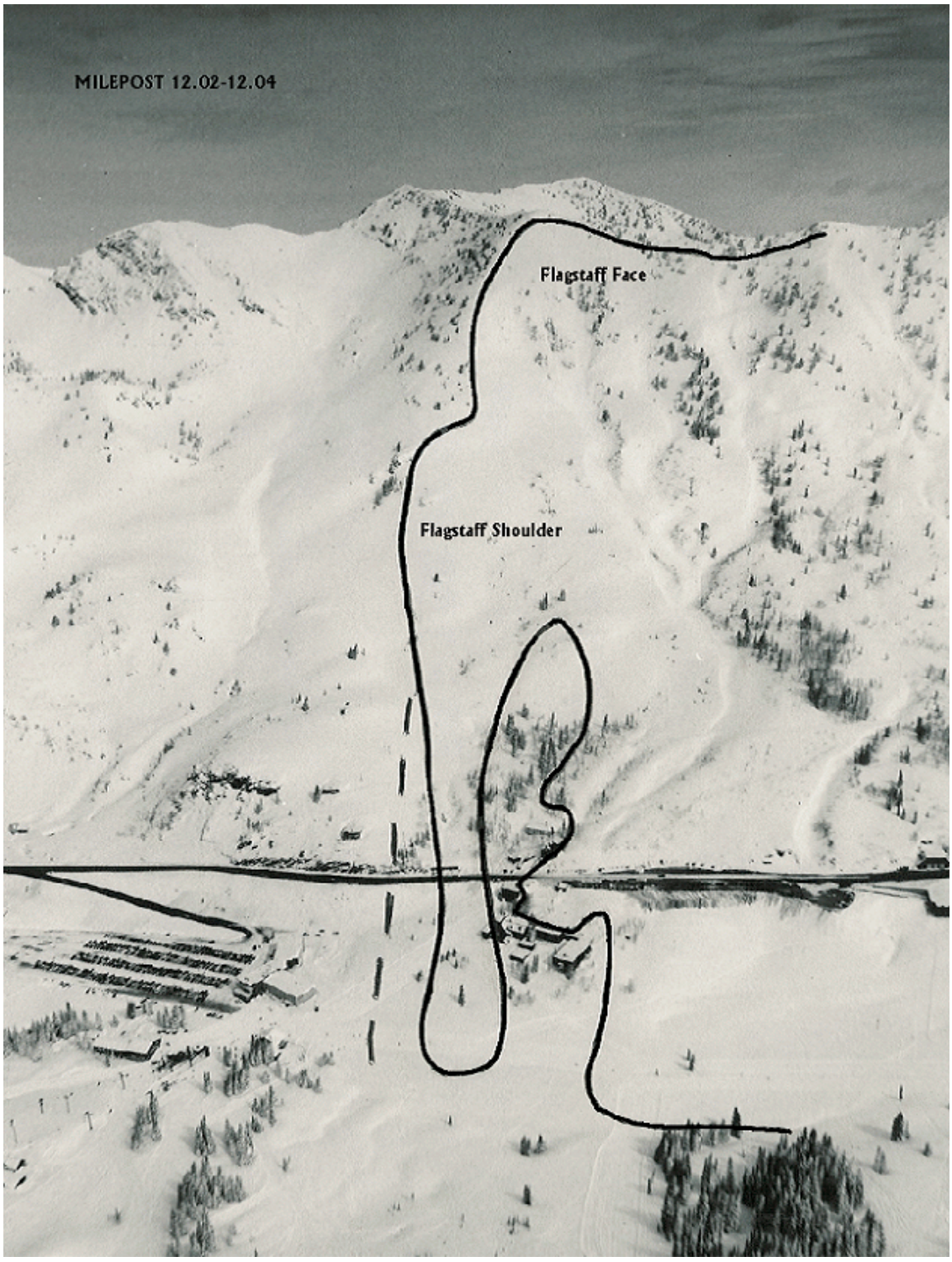
HISTORY: Usually crosses downhill lane as a small bankslide.

Larger releases have swept cars off road and into Wildcat Parking Lot.

METHOD OF CONTROL:

PRIMARY: Hand Charge

SECONDARY: None


MILEPOST 12.02-12.04
Flagstaff Face
Flagstaff Shoulder

UTAH 210 AVALANCHE PATH SUMMARY

NAME: Flagstaff Shoulder **MILEPOST:** 12.02

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Occasional

VERTICAL FALL: 1,050 ft

DISTANCE TO HIGHWAY: 2,500 ft **ALPHA ANGLE:** 20.1°

STARTING ZONE:

ELEVATION: 9,600 ft (ASL)

ASPECT: S-SW

INCLINE: 34

ACREAGE: 8

TOPOGRAPHY: Open grassy slope.

TRACK:

INCLINE: 17

TOPOGRAPHY: Both unconfined grassy slope, and some channeling in Flagstaff gully.

RUNOUT ZONE:

INCLINE: 11

TOPOGRAPHY: Both unconfined, and some channeling in lower gully, sparse aspen.

ACREAGE: 5

LENGTH OF HIGHWAY AFFECTED: 175 ft

HISTORY:

-Ran to extent indicated in January, 1953.
-Historically ran to road more frequently than during past 20 years.
- Can combine with Flagstaff Face in a massive avalanche.
-Poses a significant threat to The Alta Lodge, USFS Garage, Our Lady of Snows Center, Deep Powder House, Photo House, and east end of Alta Central Building.

METHOD OF CONTROL:

PRIMARY: Artillery

SECONDARY: Helicopter

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Flagstaff Face **MILEPOST:** 12.04

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Occasional

VERTICAL FALL: 1,650 ft

DISTANCE TO HIGHWAY: 3,800 ft **ALPHA ANGLE:** 23.6°

STARTING ZONE:

ELEVATION: 10,200 ft (ASL)

ASPECT: SE-S

INCLINE: 35

ACREAGE: 39

TOPOGRAPHY: Open slope, mix of grass, low shrubs, and scree rock.

TRACK:

INCLINE: 17

TOPOGRAPHY: Open slope up high, then confined by gully.

RUNOUT ZONE:

INCLINE: 12

TOPOGRAPHY: Open, with some small firs and aspen.

ACREAGE: 22 (includes Emma 1)

LENGTH OF HIGHWAY AFFECTED: 900 ft (includes Emma 1)

HISTORY:

-Ran to extent indicated in January, 1973, causing extensive damage to The Alta Lodge and the Chapel.
-Can combine with Flagstaff Shoulder and all the Emma's as one massive avalanche. This occurred in January, 1964 and a similar event in December, 1973.
-Released in May, 1983 as Wet Slab avalanche, damaging Photo House and destroying chapel.
-Historically reached highway every 4 to 5 years.

METHOD OF CONTROL:

PRIMARY: Artillery
SECONDARY: Helicopter


MILEPOST 12.1-12.5
Emma 1
Emma 2
Emma 3
Emma 4

UTAH 210 AVALANCHE PATH SUMMARY

NAME: Emma 1, Emma 2 **MILEPOST:** 12.1-12.3

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Occasional

VERTICAL FALL: 1,475 ft

DISTANCE TO HIGHWAY: 3,300 ft **ALPHA ANGLE (1,2):** 23.1°, 24.9°

STARTING ZONE:

ELEVATION: 10,040 ft (ASL)

ASPECT: SE-S-SW

INCLINE: 36

ACREAGE: 66

TOPOGRAPHY: Open slopes with minor ridges, low shrubs, and scree.

TRACK:

INCLINE: 20

TOPOGRAPHY: Series of semi-confined gullies and open ridges.

RUNOUT ZONE:

INCLINE: 10

TOPOGRAPHY: Open, unconfined, scattered aspen and fir trees.

ACREAGE: 16

LENGTH OF HIGHWAY AFFECTED: Emma 1 - 900 ft (includes Flagstaff Face), Emma 2 - 500 ft

HISTORY:

-Ran to extent indicated in December 1973.
-Two large, Wet Slab avalanches reached highway in May, 1983. Flagstaff Face / Emma 1, and the other from Emma 2.
-The post office from the early mining days was located where the new addition to the Rustler lodge is today, and was the only old mining era building in Alta that had not been destroyed by avalanches.
-Endangers Snowpine Lodge, and Alta Water Supply pump station.

METHOD OF CONTROL:

PRIMARY: Artillery
SECONDARY: Helicopter

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Emma 3, Emma 4 **MILEPOST:** 12.3-12.5

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Frequent

VERTICAL FALL: 1,100 ft

DISTANCE TO HIGHWAY: 2,500 ft **ALPHA ANGLE (3,4):** 25.3°, 26.9°

STARTING ZONE:

ELEVATION: 9,800 ft (ASL)

ASPECT: SE-S-SW

INCLINE: 36

ACREAGE: 66 (includes Emma 1 and 2)

TOPOGRAPHY: Open slopes with gentle ridges, grass, and scree.

TRACK:

INCLINE: 20

TOPOGRAPHY: Series of semi-confined gullies and open ridges.

RUNOUT ZONE:

INCLINE: 10

TOPOGRAPHY: Open, unconfined, with scattered aspen and fir trees.

ACREAGE: 16 (Includes Emma 1 and 2)

LENGTH OF HIGHWAY AFFECTED: Emma 3 - 125 ft, Emma 4 - 150 ft

HISTORY: Ran to extent indicated in December, 1973.

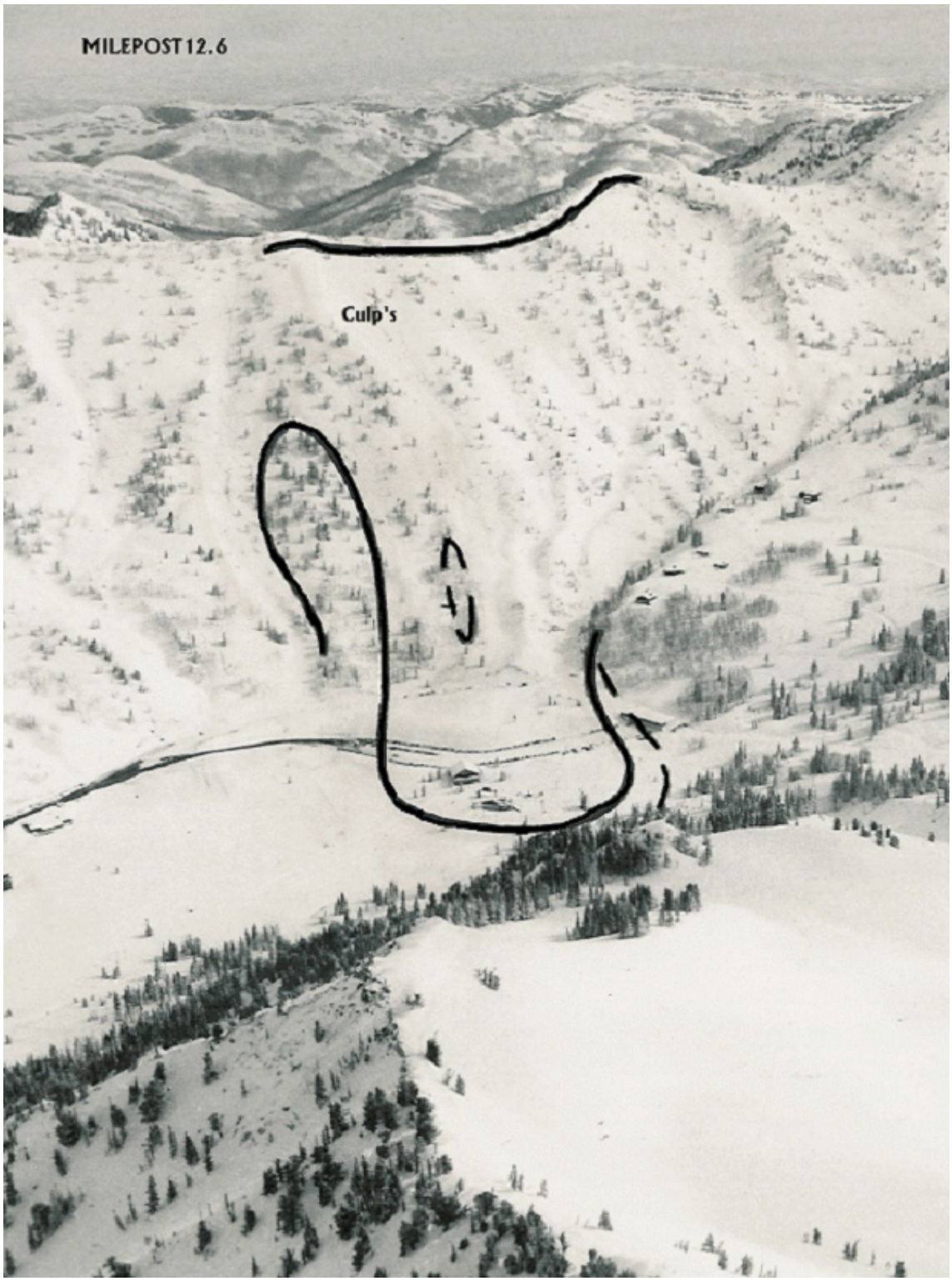
Reaches highway every 4 to 5 years. Emma 3 and 4 are typically more active than Emma 1 and 2.

Endangers the Albion parking lot.

METHOD OF CONTROL:

PRIMARY: Artillery

SECONDARY: Helicopter


MILEPOST 12.6
Culp's

UTAH 210 AVALANCHE PATH SUMMARY

NAME: Culp's **MILEPOST:** 12.6

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Occasional to Frequent

VERTICAL FALL: 1,050 ft

DISTANCE TO HIGHWAY: 2,400 ft **ALPHA ANGLE:** 26.4°

STARTING ZONE:

ELEVATION: 9,800 ft (ASL)

ASPECT: SE

INCLINE: 36

ACREAGE: 14

TOPOGRAPHY: Open grassy slope, some talus.

TRACK:

INCLINE: 25

TOPOGRAPHY: Confined to gullies.

RUNOUT ZONE:

INCLINE: 13

TOPOGRAPHY: Unconfined, with some damaged aspen and spruce.

ACREAGE: 13

LENGTH OF HIGHWAY AFFECTED: 625 (includes Grizzly)

HISTORY: Ran to extent indicated in January,1964. Overran old howitzer position located about 100 feet up Albion road from Grizzly Gulch.

Can combine with Grizzly in a massive avalanche.

Reaches highway every four to five years.

Endangers the Albion Parking lot, Day Lodge, and ticket office.

METHOD OF CONTROL:

PRIMARY: Artillery
SECONDARY: Helicopter


Milepost 12.61
Grizzly

UTAH SR-210 AVALANCHE PATH SUMMARY

NAME: Grizzly **MILEPOST:** 12.61

SIZE CLASSIFICATION: Major

RETURN INTERVAL: Occasional

VERTICAL FALL: 1,250 ft

DISTANCE TO HIGHWAY: 3,200 ft **ALPHA ANGLE:** 16.2°

STARTING ZONE:

ELEVATION: 9,880 ft (ASL)

ASPECT: SW

INCLINE: 37

ACREAGE: 79

TOPOGRAPHY: Open grassy slope, scree, and some talus.

TRACK:

INCLINE: 13

TOPOGRAPHY: Confined to gully

RUNOUT ZONE:

INCLINE: 13

TOPOGRAPHY: Unconfined, with some damaged aspen and spruce.

ACREAGE: 13

LENGTH OF HIGHWAY AFFECTED: 625 (Includes Culp's)

HISTORY: Ran to extent indicated in February, 1968.

Can combine with Culp's in a massive avalanche.

Endangers the Albion Parking lot, Day Lodge, and ticket office

METHOD OF CONTROL:

PRIMARY: Artillery

SECONDARY: Helicopter

SECONDARY AVALANCHE AREAS

There is no record or any significant evidence of these avalanche paths affecting the canyon road.

The first group of avalanche paths is located on the north side of the canyon and extends from the Lower Canyon to the Snowbird Village. It may be possible for one or more of these paths to reach the road under the right combination of snowpack and weather conditions.

Acorn	Significant	Ran to extent indicated in 1983.
Oak Ridge	Minor	Ran to extent indicated in 1984
Goat Slide	Significant	Ran to extent indicated in 1983.
Elbert's Slide	Significant	No significant activity observed. Historical anecdotal account of destroying stable and corral.
Lodge Corner	Minor	Small events have run close to road in past.

The following avalanche paths are located on the south side of the canyon from the Lower Canyon to the Snowbird Resort. There is no evidence that any of them have reached the Canyon Road.

Waterfall	Significant	No significant activity observed.
Coalpit Gulch	Major	No major activity observed.
Un-named	Minor	Ran to extent indicated in 1985.
Y - Not	Significant	Very active path. Ran to extent indicated in 1985.

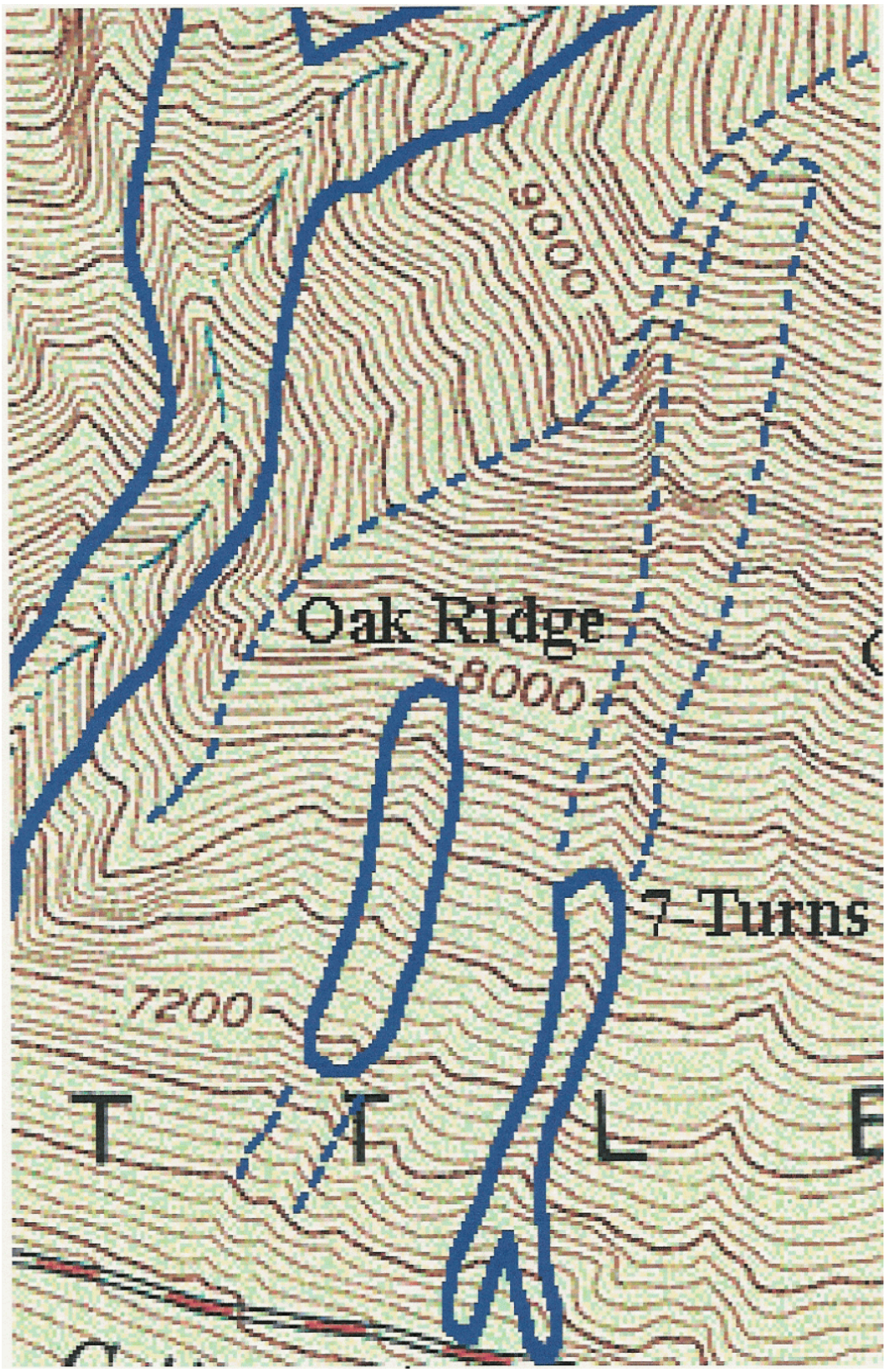
Y - Couloir	Significant	Very active path. Ran to extent indicated in 1985.
Un-named	Minor	Ran to extent indicated in 1985.
Un-named	Minor	No significant activity observed.
Red Pine Chute	Minor	Ran to extent indicated in 1985.
Display Ridge	Minor	No significant activity observed.
Scotty's Notch	Significant	Ran to extent indicated in 1980.
Scotty's Bowl	Major	Large avalanche in January 2005 destroyed major stand of large trees and ran past creek. An event of that same size in the future could possibly threaten road.
Coffin Chutes	Significant	Ran to extent indicated in 1985.
Thunder Face	Significant	Ran to extent indicated in 1980.
Thunder Bowl	Major	Ran to extent indicated in 2005 damaging Baby Thunder Chairlift

North Side Secondary Avalanche Areas

Acorn
Oak Ridge
Goat
Elbert's
Lodge Corner

South Side North Side

Acorn


9000
Oak Ridge
8000
7-Turns
7200
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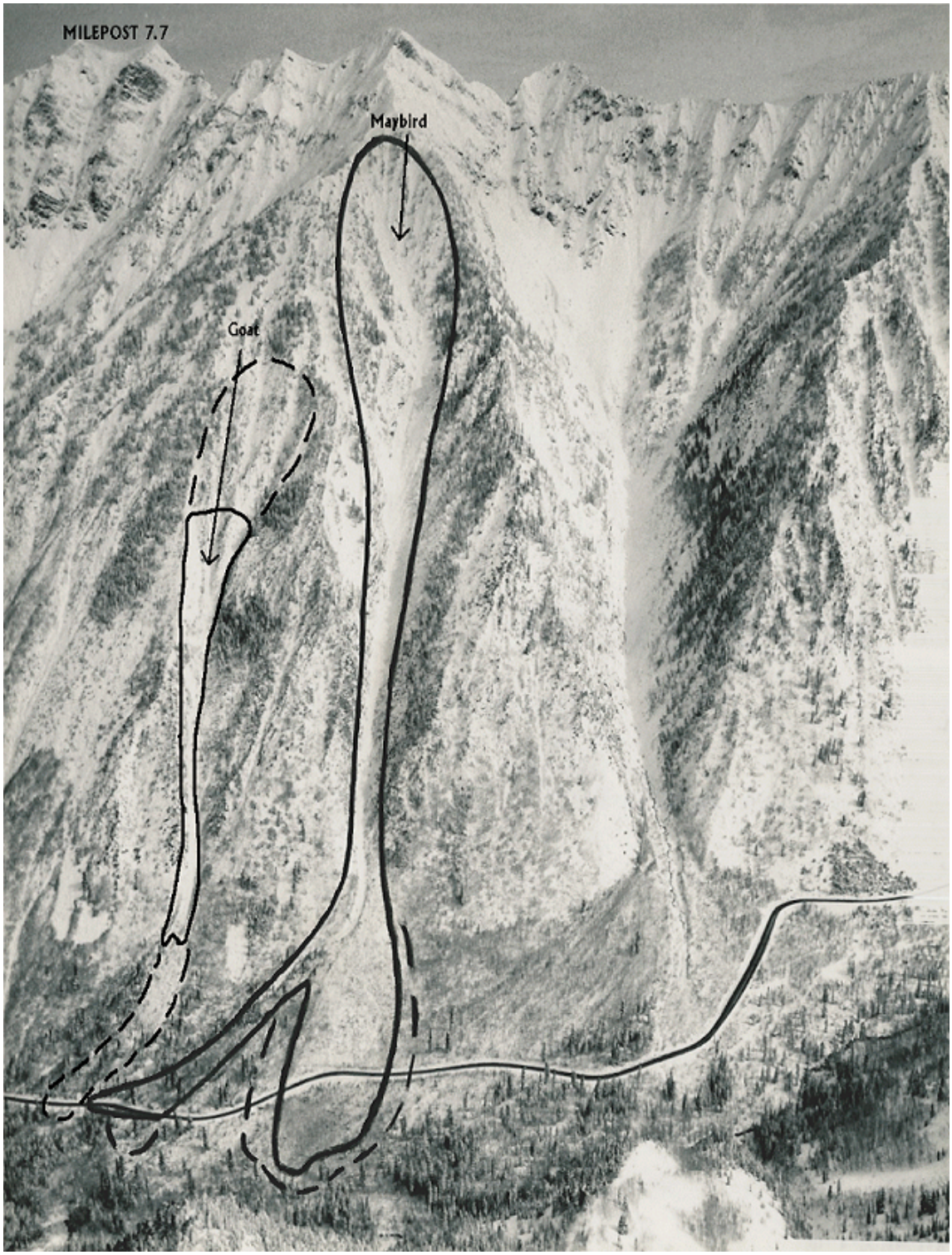
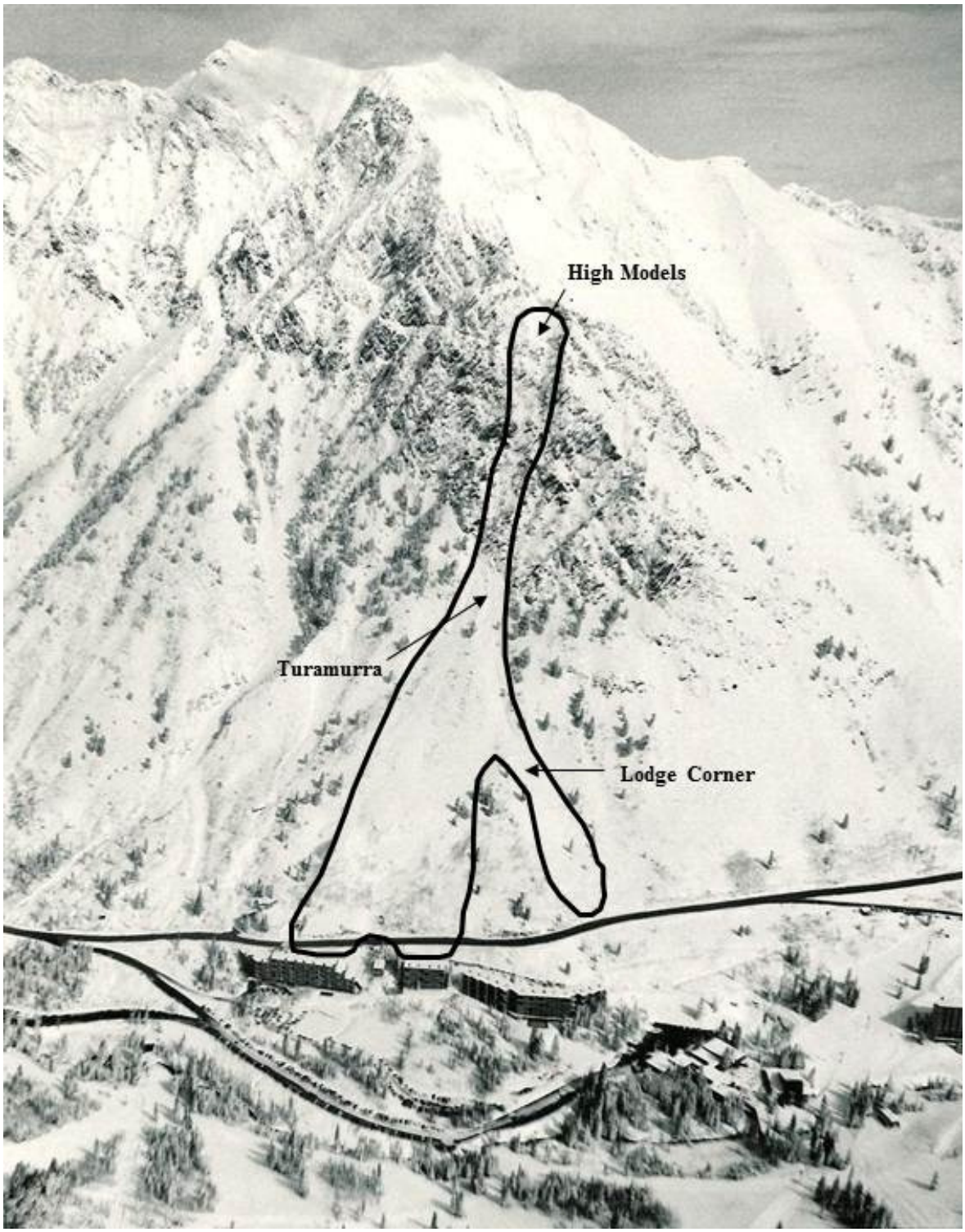
Goat



Elbert's

Lodge Corner



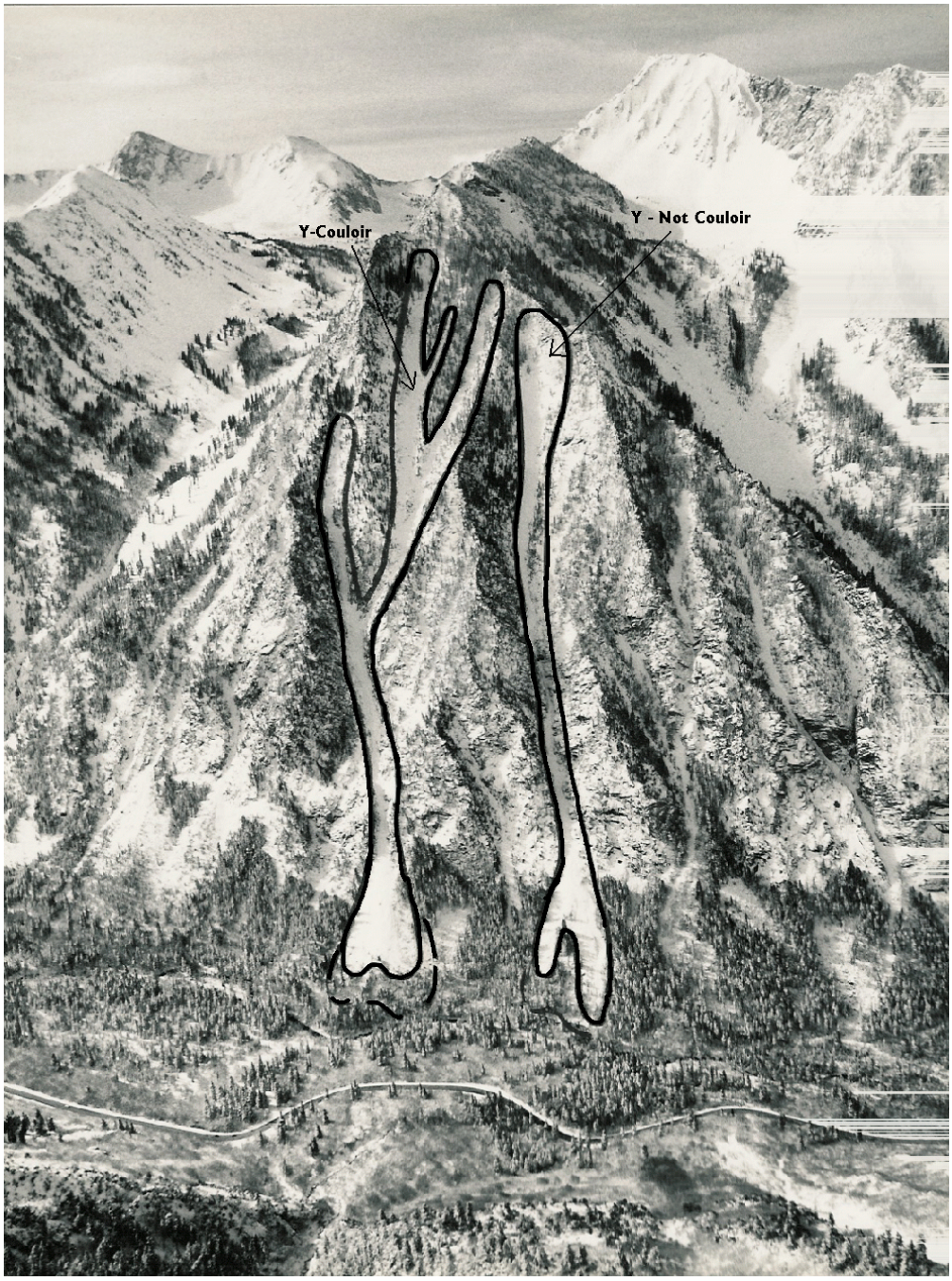
South Side Secondary Avalanche Areas

Y-NotCouloir
Y Couloir
Red Pine Chute
Display Ridge
Scotty's Notch
Scotty's Bowl
Coffin Chutes
Thunder Face
Thunder Bowl

South Side
/

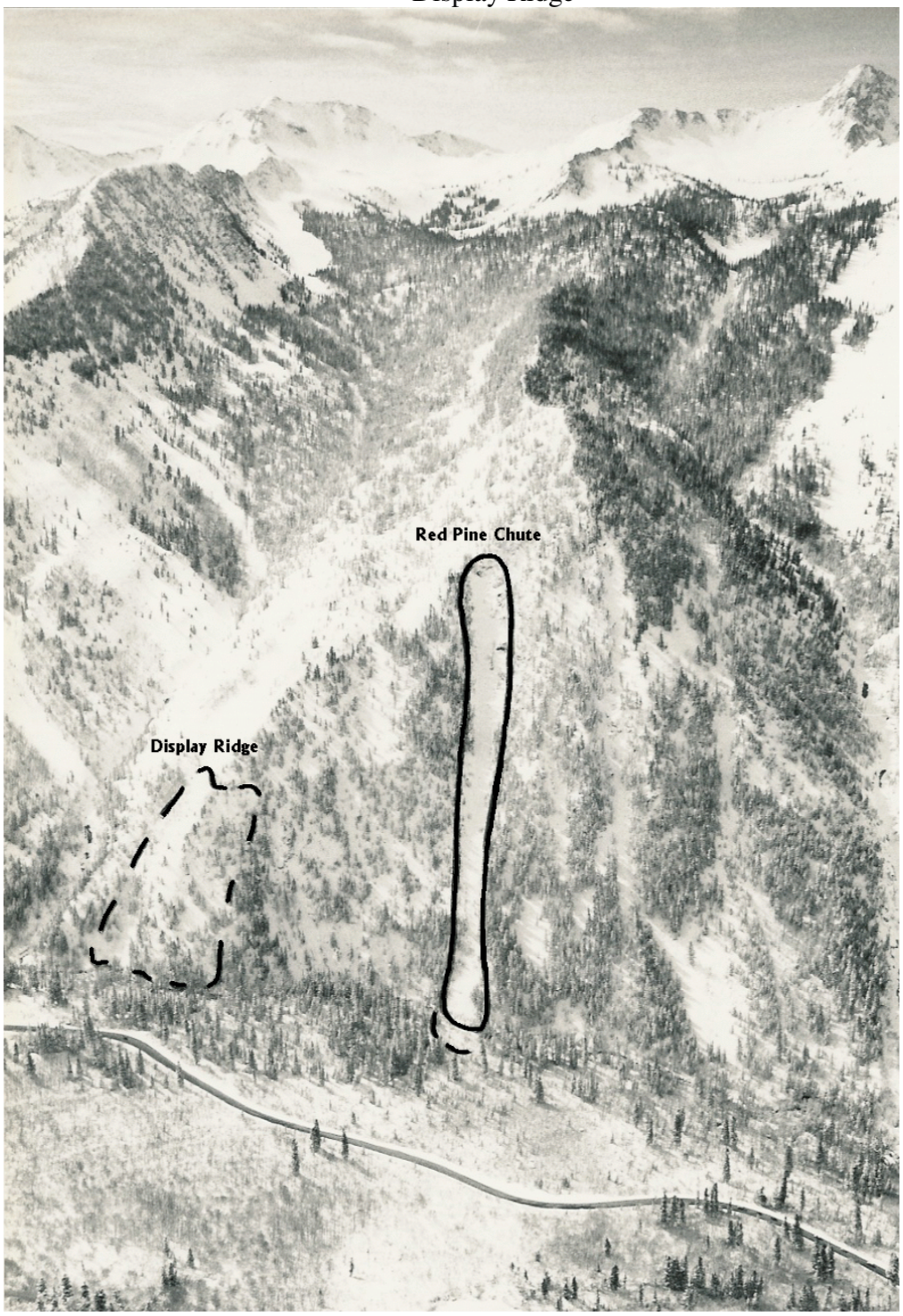
North Side
\

Y-Not Coulior
Y Couloir

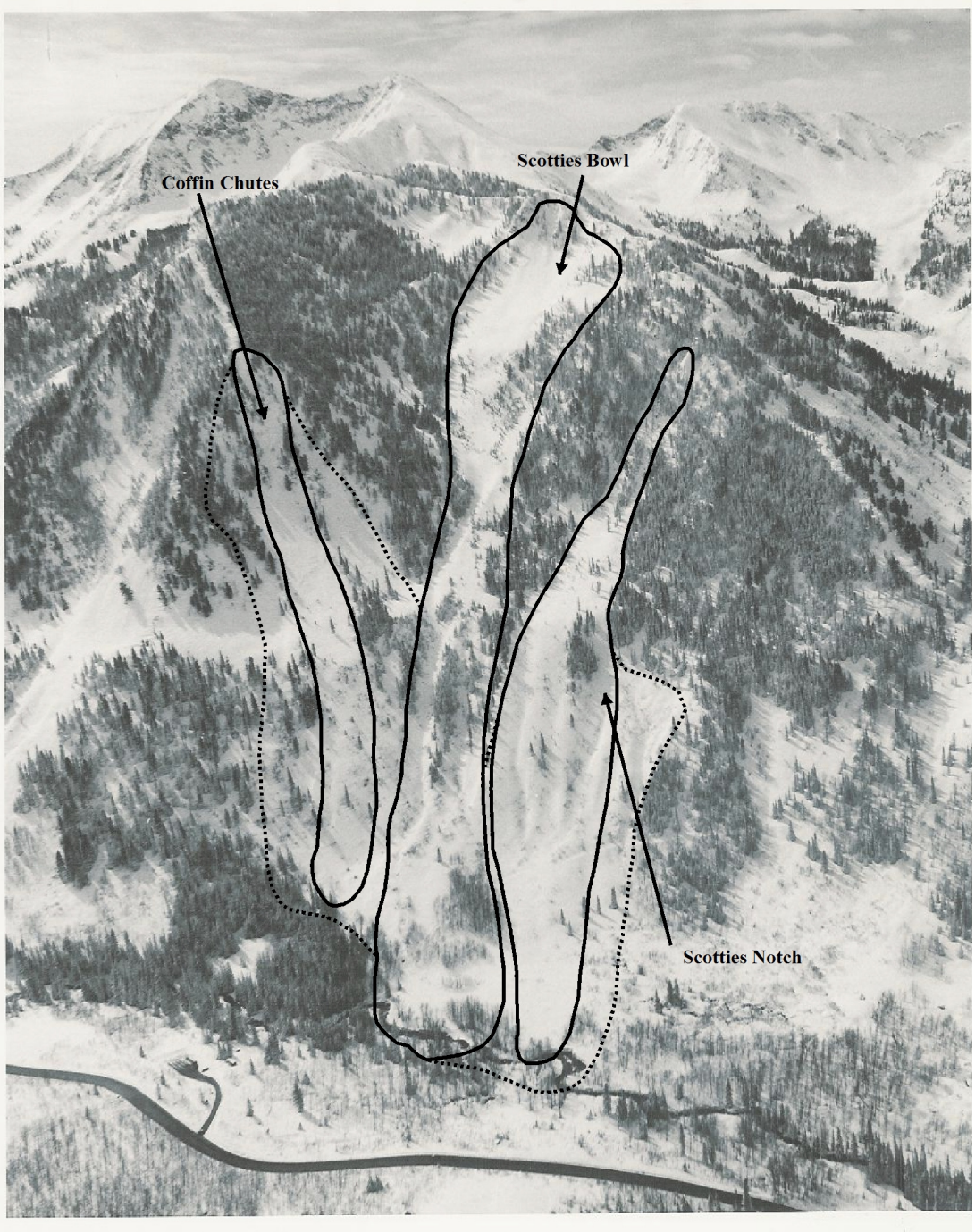


Red Pine Chute

Display Ridge



Scotty's Notch
Scotty's Bowl
Coffin Chutes



Thunder Face
Thunder Bowl

VOLUME II- HIGHWAY OPERATIONS DATA

I- ANNUAL SNOWFALL TOTALS, GUARD STATION STUDY PLOT ALTA, UTAH – COMPARED WITH:

-NUMBER OF ARTILLERY ROUNDS USED FOR HIGHWAY AVALANCHE CONTROL WORK IN LT. COTTONWOOD CANYON

YEAR	SNOWFALL AMOUNT (“) Nov 1- April 30	NUMBER OF ARTILLERY ROUNDS FIRED
1992-93	659”	918
1993-94	490”	317
1994-95	790”[9]	663
1995-96	563”	575
1996-97	599”	456
1997-98	575”	746
1998-99	436”	516
1999-00	446”	476
2000-01	433”	154
2001-02	494”	735
2002-03	349”	117
2003-04	527”	651
2004-05	491”	712
2005-06	566”	678
2006-07	356”	187
2007-08	601”	809
2008-09	578”	786
2009-10	430”	504
2010-11	553”	824
2011-12	330”	492
20 yr. Ave 1992-2012	514”	561
10 yr. Ave 2002-2012	478”	594

9 Snowfall totals measured differently this year.

- NUMBER OF DAYS WITH ROAD CLOSURES IN LT. COTTONWOOD CANYON

Year	Snowfall Amount (“) Nov1 – April 30	Days With Closures **All Canyon**/Hellgate-Superior only	Total Days With Closures
1992-93	659”	**15**/18	33
1993-94	490”	*/*	*
1994-95	790”[10]	**22**/31	53
1995-96	563”	**19**/24	43
1996-97	599”	**17**/25	42
1997-98	575”	**19**/22	41
1998-99	436”	**4**/9	13
1999-00	446”	**7**/10	17
2000-01	433”	**4**/6	10
2001-02	494”	**14**/17	31
2002-03	349”	**0**/8	8
2003-04	527”	**17**/11	28
2004-05	491”	**11**/17	28
2005-06	566”	**18**/14	32
2006-07	356”	**7**/13	20
2007-08	601”	**22**/10	32
2008-09	578”	**22**/14	36
2009-10	430”	**15**/14	29
2010-11	553”	**25**/26	51
2011-12	330”	**10**/7	17
20 yr. Ave 1992-2012	514”	**19**/16	35
10 yr. Ave 2002-2012	478”	**15**/13	28

*Indicates data missing for this year.

10 Snowfall measured differently this year

-NUMBER OF AVALANCHE EVENTS TO REACH ROAD IN LT. COTTONWOOD CANYON

Year	Snowfall Amount (") Nov 1 – April 30	Avalanches to Reach Road **Natural**/Artificial	Total Avalanches To Reach Road
1992-93	659"	**1**/29	30
1993-94	490"	**0**/0	0
1994-95	790"[11]	**7**/16	23
1995-96	563"	**2**/16	18
1996-97	599"	**4**/13	17
1997-98	575"	**8**/24	32
1998-99	436"	**0**/11	11
1999-00	446"	**2**/2	4
2000-01	433"	**0**/0	0
2001-02	494"	**4**/18	22
2002-03	349"	**0**/0	0
2003-04	527"	**9**/5	14
2004-05	491"	**7**/22	29
2005-06	566"	**6**/19	25
2006-07	356"	**0**/3	3
2007-08	601"	**11**/13	24
2008-09	578"	**2**/26	28
2009-10	430"	**2**/13	15
2010-11	553"	**8**/10	18
2011-12	330"	**5**/7	12
20 yr. Ave 1992-2012	514"	**4**/11	15
10 yr. Ave 2002-2012	478"	**5***/12	17
(1982-83	*637"*	***17/90***	*107)*

* Since 2002-03 there have been a total of 18 Natural avalanches to reach the road while it was open, An average of 1.8/year.

11 Snowfall totals measured differently this year.

II- ROAD CLOSURES FOR AVALANCHE CONTROL WORK BY YEAR
SR-190, BIG COTTONWOOD CANYON

YEAR	TOTAL HOURS OF CLOSURE
2002-03	.3
2003-04	9.5
2004-05	21.5
2005-06	7.25
2006-07	1.25
2007-08	24.3
2008-09	5.0
2009-10	2.5
2010-11	5.0
2011-12	7.75
Average number of hours of closure per year for the past 10 years-	8.50

Average snowfall at the Spruces Snow Study Plot
in Big Cottonwood Canyon 2002-2012 = 298”

III- Daily Traffic Count, SR-210, Lt. Cottonwood Canyon, for March 4, 2012
(A typical "Busy" day for skier visits, and traffic on the canyon road)

Station Name: SR 210 Mouth of Little Cottonwood Canyon, SLC M.P. 4.166
Station Num:000000000317
Start Date/Time:03-04-2012 00:00
End Date/Time:03-04-2012 23:59

	Lane 1 (East)	Lane 2 (West)	All Lanes
00:00	11	29	40
01:00	11	15	26
02:00	2	5	7
03:00	8	4	12
04:00	12	5	17
05:00	46	9	55
06:00	131	32	163
07:00	368	30	398
08:00	1,248	57	1,305
09:00	1,180	97	1,277
10:00	792	105	897
11:00	433	194	627
12:00	8	14	22
13:00	7	5	12
14:00	5	10	15
15:00	4	6	10
16:00	316	1,046	1,362
17:00	85	1,174	1,259
18:00	68	1,029	1,097
19:00	34	719	753
20:00	17	152	169
21:00	40	101	141
22:00	29	72	101
23:00	13	58	71
Total	4,868	4,968	9,836
Percentages	49.49%	50.51%	100.00%

IV- AVALANCHE HAZARD INDEX RATING, SR-210 Lt. Cottonwood Canyon Road

The initial study to determine the Avalanche Hazard Index (AHI) Rating for SR-210 in Lt. Cottonwood Canyon was carried out in 1987, by Duain Bowles, and Bengt Sandahl, both UDOT Avalanche Forecasters at that time. A second study was carried out in 2006 by Chris Stethem and Associates as part of the *Little Cottonwood Canyon SR-210 Transportation Study*, published by Fehr & Peers Associates, August 2006. The Index Rating values of 1,439 (for average vehicle speed of 5 mph) and 722 (for average vehicle speed of 30 mph) in the Bowles-Sandahl Study, are considerably different from the values of 1,045 (without current avalanche mitigation practices) and 104 (with the current program in place) in the Stethem report. The differences could be the result of the data that was used, or perhaps a difference in the way the values are derived. A portion of the Bowles-Sandahl Study is included in this document. The data used to compute the final values used in that study can be found in the previous addition of the *Highway Avalanche Safety Plan for* SR-190, and SR-210, or are on file at the UDOT Avalanche Forecast Office in Lt. *Cottonwood Canyon*. Reference to the study by Chris Stethem & Associates and be found in the Little Cottonwood Canyon, SR 210 Transportation Study, which can be accessed using the following link,
http://www.udot.utah.gov/main/f?p=100:pg:0:::1:T,V:1720

Category of AHI Rating (source: P. Schaerer, 1989)

Very Low	<1
Low	1 – 10
Moderate	10 – 40
High	40 – 150
Very High	> 150

In both studies, the Hazard Index Rating for SR-210 is either High, to Very High, to “off-the chart”. The options included in the Future of the Highway Avalanche Safety Program section of this document, could significantly lower the overall AHI value.

ROUGH DRAFT 19 Nov 87

AVALANCHE HAZARD INDEX FOR HIGHWAY 210
LITTLE COTTONWOOD CANYON
MILE 5.4 TO MILE 13.1

by

Duain Bowles and Binx Sandahl
Utah Department of Transportation
Highway Avalanche Forecasters

Introduction. The calculation of the avalanche hazard has found wide acceptance both in Europe and North America as a method to evaluate a relative hazard index and as a criteria for selecting various safety and control measures. Recent work by (Lev,1987) on the Little Cottonwood Canyon Avalanche Atlas has provided a primary source of data and the impetus for using the avalanche index approach. Highway avalanche indices have been worked out for many highways in Canada and Europe and have provided guidance for control programs, highway location, and defense structure location.

Highway U-210 follows the grade of the old railroad from Granite Park to Alta. The old rails and ties can still be found under the present asphalt surface of the highway. The location of the road is far from ideal from the avalanche point of view since the avalanche activity is far more severe and concentrated on the north side. The average slope of paths on the north side start at the ridge line at about 37 to 40 degrees and continue at 35 degrees to the slope transition just above the road. Avalanche run outs typically extend across the valley to the south slope. Early mining rapidly cleared most of the slopes of what little timber existed and probably increased the avalanche activity. Bowman (2) estimates that there were at least 200 avalanche fatalities from the onset of mining in 1865 to 1985. The only avalanche defense structure in the canyon,appropriately named the Chinese Wall, was built on the White Pine avalanche run out in the late 1800s and still serves to keep many early season slides from reaching the road. Highway avalanche control and traffic restriction started in 1950 or about the same time that the last highway avalanche death occurred. Avalanche control activity and highway traffic restrictions have increased with the increasing traffic load and area development. During the early 50s avalanche control consisted primarily of road closure until natural snowpack stabilization had occurred. However, today road closures are of much shorter duration and are usually only long enough to permit artillery control to test snow pack sensitivity and possibly effect stabilization.

The U.S.Forest Service has collected almost 35 years of weather

and avalanche occurence data for the Little Cottonwood Canyon Highway. However, there has been limited analysis of the data base to define highway avalanche characteristics. This index analysis is based upon a smaller subset of data from the period 1973 to 1985. This shorter time span may be influenced by more extreme events which occurred with maximum snow falls in winters such as 83 and 84. A large body of data exists on magnetic tape which would be expected to yield more statistically relevant numbers for calculating the highway avalanche index. However, the time and resources are not presently available to do such a large statistical evaluation. We do feel that the limited set of data will yield meaningful, but conservative results. For this reason the results should be considered provisional and are subject to change when a more complete analysis of the larger data base is accomplished.

Methodology

The index calculations use a method developed by(Schaerer,1974) and require the calculation of the probability of an avalanche encounter with a moving vehicle (PM) and the probability of waiting vehicles (PW) being hit by another slide. Studies by Schaerer and (Armstrong,1981) indicate waiting vehicles are 3 to 6 times more likely to be struck than moving vehicles. The method developed by Schaerer assumes uninpeded traffic flow during avalanche periods. This is not the case on U-210, however, the technique is used here for comparison purposed. The two probabilities are then added and multiplied by a weighting factor (W) which takes into account the damage which could be expected by the average slide.

Avalanches which reach the road travel beyond the road because of the steepness of the terrain on both side of the road. An exception would be slides from Cardiff or Flagstaff which are restricted by lodges in the Town of Alta section. Highway snow removal usually keeps the shoulder berm pushed off thus helping to reduce the damming effect during avalanche flow. The R3 with a weighting factor of 4 and the R4 at 10 seem to best define damage potential for the hazard calculation. Calculation of the moving probability (PM) is of the form

$$PM=.000008(ADT/V)(L+D)(F)$$

Where

ADT= the average daily traffic for the period December through March
V= the average vehicle velocity under winter driving conditions
L= the average length of debris on the highway centerline
D= the vehicle stopping distance
F= the Frequency of avalanche occurance. For example 0.5 would be one avalanche every two years.

And the probability of a waiting vehicle being hit by a second slide is

$$PW=Ps(N)(F)$$

Where

Ps= the probability of a second or adjacent avalanche occurring. The Schaerer calculation uses an average value of 0.15. This value of Ps gives the index value used for comparison purposes.

N=L/45 the number of vehicles which could wait in the avalanche path assuming 45 feet per vehicle.

The Average Daily Total traffic counts were taken from UDOT traffic counter data at the mouth of Little Cottonwood canyon. Since the canyon is a dead end the ADT represents the average of two-way traffic for the 1986-87 season. Peaks during this period reached over 10,000 vehicle trips on every month of the index period. The average ADT was 6960. The ADT was reduced along the highway to represent the effect of distributed parking. Calculations for the Blackjack Bypass and the theoretical Lower Road Bypass used the ADT value assigned to the highway section for which the bypass is used. The ADT for Little Cottonwood Canyon U210 may be compared with an ADT of 675 for the Silverton/Red Mountain U.S.Highway 550 or the ADT of 1020 for the Rogers Pass Transcontinental Highway in Canada.

Values for avalanche frequency(F) were obtained from the 1973-85 period. Frequencies of longer period slides were estimated on the basis of tree trim lines and growth patterns. The average length of debris on the highway(L) and depth of debris from were obtained by averaging known data or by assuming half of the known maximum. Further analysis is needed since very little is known about size distribution relative to terrain factors or the effect avalanche control has on slide size and occurance (Armstrong). Analysis of some of the data from Tanners(Tann) suggests that using half of the maximum slide center line length and debris depth may yield values on the conservative side. The Tanners data suggests that the avalanche size distribution is not normally distributed but skewed towards the small size. Over 90% of the Tanners slides were natural occurences. This result is unexpected since our view has been that Tanners "runs big". This view that control results in more but smaller avalanches is one that is generally held by avalanche control persons (Armstrong). Further study is needed on this issue because of the obvious implications for control programs.

The Hazard Index (HI) is calculated by multiplying the sum of the probabilities, PM+PW, by a Weighting Factor (W). Selection of the weighting factor depends upon the effect avalanches would have on traffic. Schaerer uses four classes in the calculation of the hazard index. The four classes are:

R1 Snow Dust: Snow dust or wind blast only; no significant deposit of snow on the road. The conditions would be similar to that in a blizzard, where drivers could lose control.

R2 Sluffing: Frequent small bank avalanches or sluffing; the snow deposit would be across the width of the highway at the maximum. The individual avalanches would be small, but many of them could occur during and avalanche cycle, and, in time, a car could be buried.

R3 Light: Avalanches go beyond the highway, and deposit snow, usually dry, between 1 to 4 feet deep; cars could be pushed over the highway, but not buried. Heavy trucks would be buried with their wheels covered, but usually not damaged or moved.

R4 Deep Snow: Avalanches would deposit snow averaging deeper than 4 feet on the highway; vehicles could be buried or swept off the highway and damaged when falling over a steep slope (Schaerer, 1974)

Since Highway U-210 runs across the upper part of the avalanche transition zone and the snow volumes are high the majority of avalanches are in the last two classes R3 and R4. Damage to buildings and cars along the highway amply verifies the accuracy of the classification. Weights used by Schaerer for R3 and R4 are 4 and 10 respectively.

Estimates of vehicle velocities range from 5 mph under severe conditions to 20mph for normal winter driving on snowpack. The Hazard Index was calculated using three velocities 5, 20,and 30 mph with a stopping distances for dry pavement and slick snowpack. The values,computed by the Utah Highway Patrol Daily(4), for up and downhill traffic on a 9% grade are as follows:

VEHICLE STOPPING DISTANCE (FEET)
VELOCITY (MPH)

ROAD CONDITION	DOWNHILL 5	DOWNHILL 20	DOWNHILL 30	UPHILL 5	UPHILL 20	UPHILL 30
DRY	7	55	97	7	40	88
SNOWPACK	15	154	333	13	87	183

Computation of the highway index was made on a DEC Rainbow 100 using a Basic program Each section of the Highway 210 was treated separately with all sections summed to arrive at a total highway hazard index. An index was also computed for a theoretical highway section,called Lower Road Bypass. The Lower Road Bypass was assumed to leave the Entry 1 parking lot on the south side of the valley and follow the south side of the canyon to a point opposite the west edge of the Maybird(MAYB) slide path. All identified slide paths described by Lev were evaluated. Paths which run together or discharge into the same run out are listed as one path. White Pine Chutes, Blackjack, Emma, and

Gulps are all composed of several other distinct paths but, generally avalanche together. Most of the paths along Highway U-210 have several start zones which discharge into one run out zone. Follow up avalanches and avalanches which override the first are the rule rather than the exception. The computed hazard indices are in Appendix A.

Discussion

Several aspects of the data selected for this analysis bear additional discussion: 1) The ADT for the Little Cottonwood Canyon (U210) exceeds by far the ADT for any other mountain road previously examined. An ADT of 675 for Colorado U.S.550 and an ADT of 1020 for the Rogers Pass in Canada are the most notable reported. 2) The number of avalanche paths crossing the highway is extreme, with 42 paths in seven miles, or an average of six paths per mile with about 57% of the road distance in an avalanche run out. This means that over half the vehicles are under some level of exposure at any given time. Road blockages for any reason are sure to develop massive traffic jams in all lanes involving hundreds of cars. 3) Vehicle velocities are very low especially under high ADT and snowpack conditions. Under ideal conditions velocities reach 20 MPH on snowpack but realisticly 5 MPH is more nearly realized. During the March 13, 1987 storm, vehicle speeds were stop and go at 2 to 5 MPH. All of these factors have a major effect on the computed ADT. 4) The 1964-65 slide cycle involved the entire canyon from Hellgate to Lisa Falls (LISA). Avalanche debris covered almost the entire length of the highway. This suggests that the maximum slide size may be actually larger and the "Safety Zones", which are used for planned evacuation have limited use. Safe evacuation routes, if they exist, are reasonable only on the south side of the canyon. Highway U210 is perhaps one of the most tightly traffic controlled highway in the country with blocking gates on all entrances and sections of the highway. Total closure and sweeping of the road takes about two hours although under gridlock conditions of the March 13 storm this would not have been possible.(Becker-Alta Central Traffic Report 87550)
Under high avalanche hazard conditions it would be necessary to evacuate stalled motorists to previously selected "Safety Zones" by snowcat. This has been necessary in the past. During the March 13 storm approximately 1000 vehicles were trapped in a total jam for several hours. Evacuation of this many people under avalanche conditions would be almost impossible. It should be noted that the gridlock occurred on a relatively low traffic day with an ADT of 3670, a snowfall rate of three inches per-hour which was decreasing, and good snowpack stability. A fortuitous condition which shouldn't be counted upon. This type of situation can be counted on occurring at least three times per winter and will inevitably result in a truly spectacular avalanche disaster of monumental proportions.

The total highway avalanche index computed at 20 mph downhill on snowpack (Appendix A, page 6) is 766. This may be compared to

126 calculated for U.S. Highway 550 in Colorado by Armstrong which puts U.S. 550 in a category requiring full control and closure. During the 28 years selected for the study by Armstrong from 1950 there were five avalanche fatalities. During roughly the same period there has been only one fatality on U210 with about seven times the hazard index. This suggests that the closure and control policy used on U210 was effective. How effective that policy will remain should be examined by further study. The hazard index on Rogers Pass on the TransCanadian highway is 174 although it would be 335 if many of the paths were not passively controlled by snow sheds (Schaerer,1974).

Examination of the results of this study indicates that the use of the Blackjack Bypass reduces the overall hazard index from 766 to 266 by eliminating the Superior/Hellgate section. If we had the option of using a Lower Road Bypass the overall hazard index would drop to 65 of which a HI of 2 would be contributed by the Lower Road. It should be remembered that the Snowbird Section of Highway U210 still presents a Hazard Index of 36 and that Ten Springs would run into the supposed intersection of the assumed Lower Road Bypass. The Lower Road Bypass is assumed to run from the Snowbird parking lot at Entry 1 along the south side of Little Cottonwood Canyon to a point of intersection with the present Lower Road below the Maybird slide path.

Vehicle velocity has a decided effect on the overall highway hazard index. At five miles per hour on snowpack the overall hazard index becomes 1439 while at 30 MPH the hazard index is 722. This points out the importance of maintaining high vehicle speeds. While major highway realignment, lane widening, increasing lanes, and traffic control devices would help to accomplish this goal of higher speeds. A major improvement in overall vehicle speed, on the present road could be achieved with strict enforcement of tire/chain laws.

The Hazard Index calculations used in the above discussion are based upon an assumed average probability of a follow-up avalanche using Schaerer's average value of 0.15. For comparison purposes this may be appropriate. Actual values are likely higher for Little Cottonwood Canyon Highway U-210. Preliminary calculations with the limited data base indicates values of .175 for the Alta Town Road, .30 or higher for the Superior Hellgate Section and .175 or higher on the Snowbird and Lower highway. These values seem reasonable considering the closeness of the avalanche paths, the size of the path start zones, and the position of the highway relative to the path slope transition The the high traffic density and the high probability of serious traffic jams occurring makes the high values of encounter probability (PW), suggested by the calculations, for waiting vehicles seem reasonable. The the procedure used by Schaerer and Armstrong was to eliminate values (PW) of over one from there calculation. Our experience, as exemplified by the March 13, 1987 scenario, is to keep the calculated values as totally realistic. Again further study is needed on this point.

One calculation was performed using a Ps value of 0.30 for Superior/Hellgate section. This increased the hazard index for the Superior/Hellgate section about 75%. The increase suggests the direction the overall hazard index will go with additional analysis of follow-up or second avalanche data. The actual avalanche hazard index for the Little Cottonwood Canyon is higher than the calculations used for the comparison index based upon the average waiting probability of 0.15 suggested by Schaerer.

The Avalanche Hazard Index of Highway U-210 is high and it doesn't seem to be a statistical aberation but, rather a true reflection of the danger present to people using the highway. Schaerer uses the hazard index as an indicator to determine the kind of control action necessary. The relatinship is as follows:

HAZARD	HAZARD INDEX	CONSEQUENCE FOR AVALANCHE CONTROL
very low	less than 1	no action necessary
low	1 to 10	avalanche warning and occasional closure
moderate	10 to 100	avalanche control at selected sites, closure
high	greater than 100	full control

The hazard index for U-210 is likely 10 times the high catagory. An index of 335 on the Rogers Pass road apparently prompted the Canadian government to plan and install snow sheds. Certainly index values in this range suggest effort should be made to address the problem. Does our present system safely handle the suggested danger or are we on the edge of some catastrophic accident, as has been previously suggested?

Repeated jamming of the highway by massive traffic flows and some of the more recent near misses under high traffic conditions are a few of the indicators of a serious problem. This brief examination of limited data suggests a much broader and more in depth study should be made.

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Appendix A

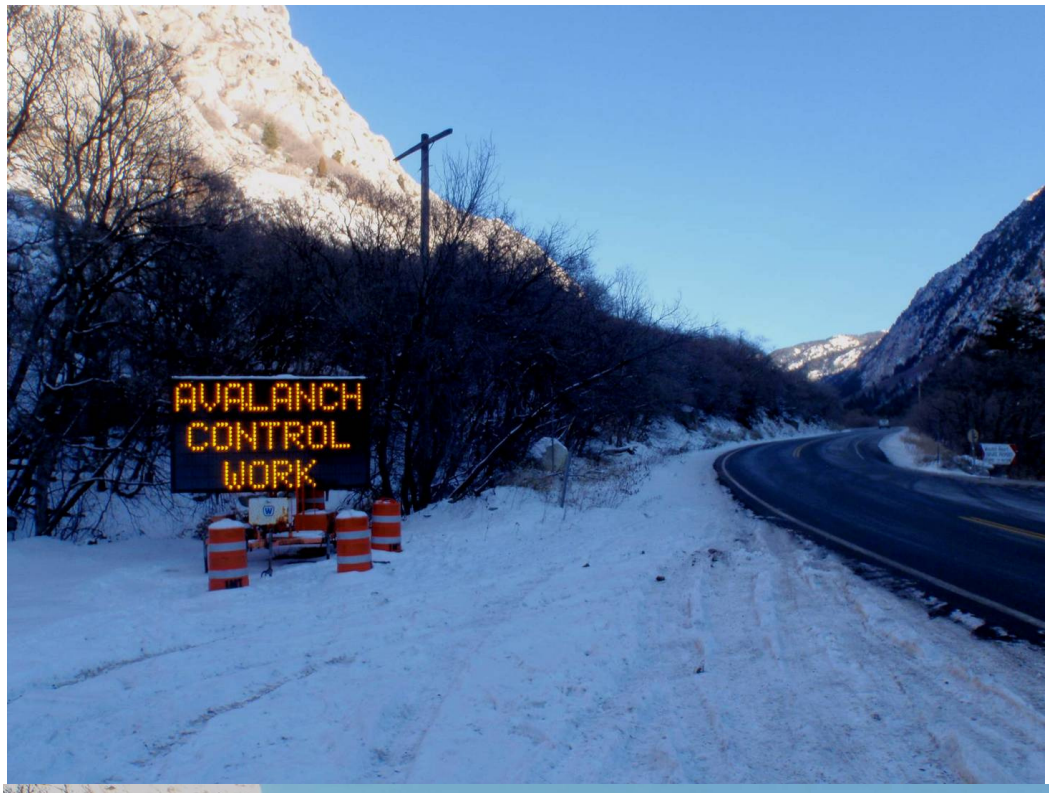
Examples of Signage Pertaining to the UDOT Highway Avalanche Safety Program

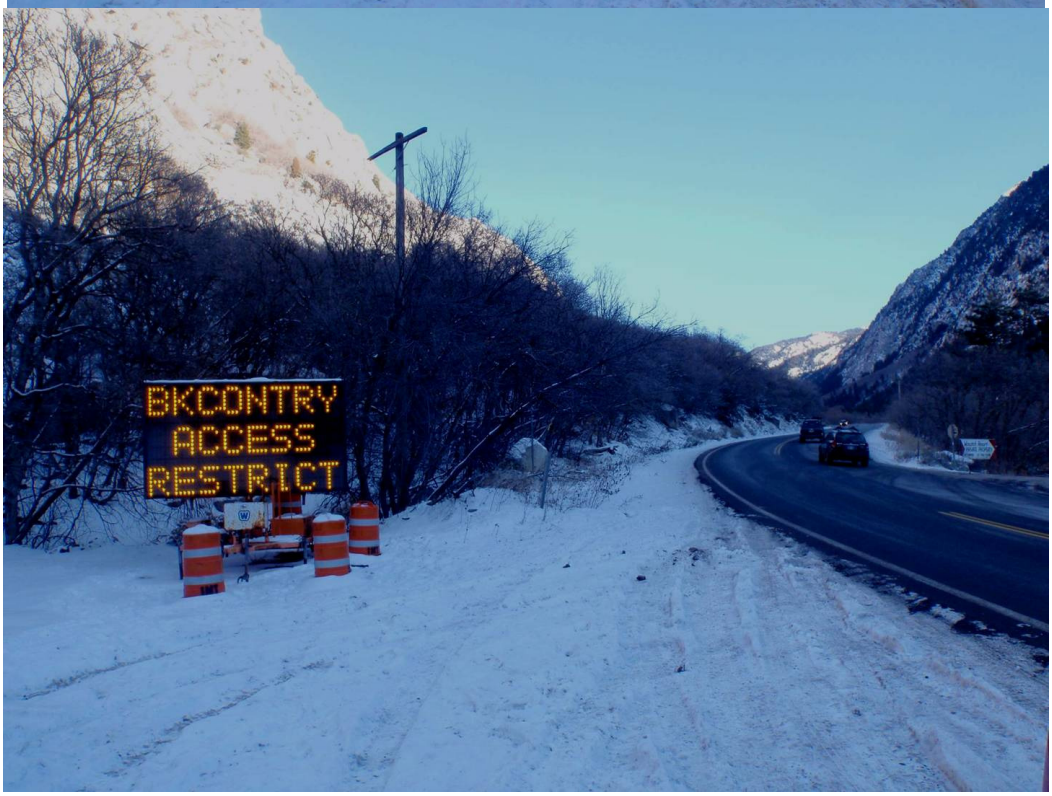
-Snow Avalanche Area Signs

-4x4 or Chains and AM Radio 530 Signs

-Trailhead Signs-

- Roadside VMS





-Un-exploded Ordinance/Avalauncher/ Hand Charge, Warning Signs