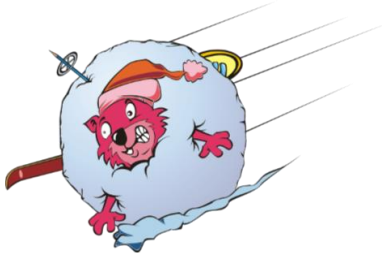
Big POW Mountain
Avalanche Safety Plan



Presented By: Gabi Benel, Tara Vessella, Rich Rogers, Andy Wenberg, Nolan Van Harte

Table of Contents **Page**

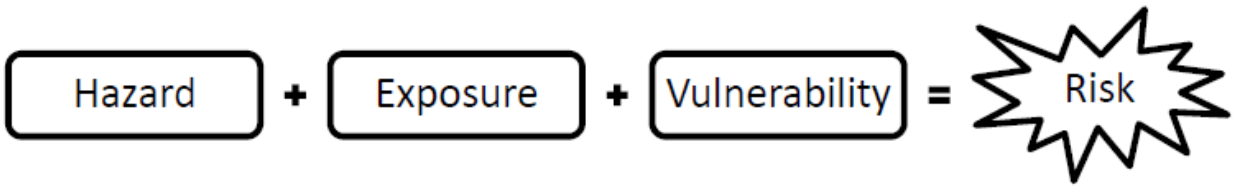
Other Information
Emergency Response Plan

A.GEOGRAPHICAL DESCRIPTION

Big Pow Mountain is located on the eastern side of the Continental Divide within the southern Sawatch Range of Colorado. The ski area presents with the characteristic shallow continental snowpack found throughout the central Rocky Mountains. Ski area elevations range from 12,000 feet to 10,970 feet at the base with 1,200 ft vertical feet of skiing terrain. Big Pow Mountain has a total of 800 acres of terrain with 700 acres being lift accessible, 100 acres classified as hiking accessed terrain, and more than 1,600 acres of guided terrain. The majority of the terrain within the ski area boundary consists of cut ski runs within forested terrain, while hike-to terrain is primary above treeline and contains sporadic tree cover throughout bowls, chutes, and natural avalanche paths. With the majority of the terrain being on easterly aspects, Big Pow Mountain benefits from morning sunshine and leeward wind deposited snow throughout the ski area. Big Pow Mountain sees an average annual snowfall total of 350 inches between November and April, with the area being void of any snowmaking infrastructure within the ski boundary. Annual temperatures range between -2 degrees Fahrenheit and 40 degrees Fahrenheit during the six month winter operating season.

B. OPERATIONAL GOALS AND OBJECTIVES

The goal of the Big Pow Mountain Snow Safety Program is to reduce the risk and likelihood of avalanche hazard to both guests and employees of the ski area. It is recognized that access to avalanche prone terrain is desired by ski area guests and there are inherent risks in allowing access. Big Pow Mountain recognizes that avalanche risk cannot be entirely eliminated on steep avalanche prone to avalanche and strides for a balance between access and safety within the ski area boundary.

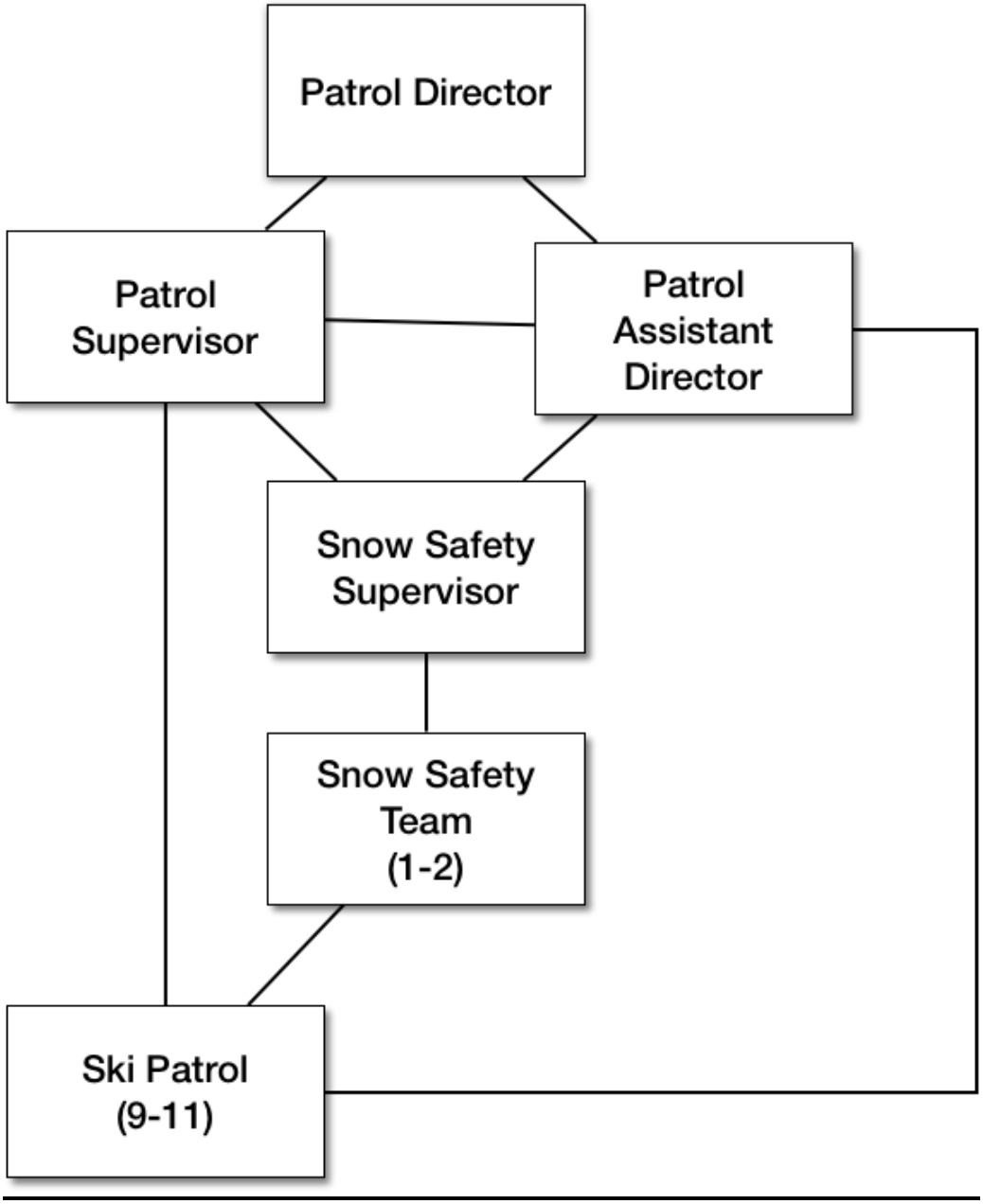


Objectives

- Implement avalanche mitigation and safety plans that reduce avalanche risk within the ski area by mitigating hazard, controlling exposure, and decreasing vulnerability.
- Commitment to continuing education opportunities for all snow safety team members.
- Maintain operational capacity to respond to avalanche incidents within the the ski area boundary and within the Sawatch Zone.
- Communicate routinely with other members of the avalanche community.
- Abide by the regulations of agencies that oversee components of the Big Pow Mountain Snow Safety Program.

C. STAFF ROLES AND SUPERVISION

1.Organizational Chart



2.Roles

Ski Patrol Director (PD)- Oversees ski patrol operations and delegates to branches within the ski patrol organization chart.

Assistant Ski Patrol Director (AD)- Jointly oversees ski patrol operations with the Ski Patrol Director and/or in the absence of the Director. Coordinates with Ski Patrol Supervisor on priority of projects, medical quality assurance, training, continuing education, Assists with snow safety missions.

Ski Patrol Supervisor- Assists PD and AD with daily patrol operations. Supervises and follows up with frontline patrol to ensure completion of projects, medical quality assurance, trainings and continuing education. Assists with snow safety missions.

Snow Safety Supervisor- Coordinates and leads all snow safety operations and documentation as required. Directly supervises members of the Snow Safety Team. Duties include coordinating and/or completing snow and weather observations daily, analyzing snow and weather observations, creating and implementing daily mitigations plans, and accountability of all explosives use/training. Communicates plans and objectives to PD and AD daily.

Snow Safety Team- Collaborates with team members to carry out daily mitigation plans delivered by the Snow Safety Supervisor. Complete daily forecasts, weather and snow observations as delegated by the Snow Safety Supervisor. Ensure documentation of all mitigation actions and respond to all avalanche accidents/ incidents within the ski area boundary. Coordinates avalanche rescue.

Ski Patrol- Provides medical care to injured guests, completes daily tasks and projects assigned to each duty station by Patrol Supervisor, marking of hazards on slopes, maintain all rope boundaries or closures, tower pads, and chair lift clearance. Any snow safety concerns are passed on to snow safety team, snow safety supervisor and patrol management.

D. STAFFING REQUIREMENTS

1.Essential Positions

Prior to terrain expansion, daily patrol operations roster, depending on proposed skier visits and snow safety needs, falls between 9-11 members total.

2.Additional Positions

With the proposed terrain expansion an additional 3-6 ski patrol members will be required to ensure proper coverage during high skier visit days that align with high snowfall and snow safety needs.

3. Qualifications

The Patrol Director, Assistant Director, Patrol Supervisor, Snow Safety Supervisor and Snow Safety Team are all required to hold a Pro 1(minimum) or Pro 2 (preferred) avalanche certifications supplemented with Mountain Weather forecasting course. 2-3 members of the Snow Safety Team will also be certified in avalanche rescue dog training through C-RAD (Colorado Rapid Avalanche Deployment). A team consists of a certified dog, certified handler, Avalanche technician. Federal, state background checks and fingerprint checks are required for all potential employees who will or could be in possession of explosives. A type 1 Blasters permit is required for all route leaders.

E. TRAINING

1.Initial Training Objectives

Patrol members must be 21 years or older, expert skiing ability, Recreation Level 1 or 2 avalanche training (ski patrol members), and WFR, EMT or higher qualification. All Patrol members will be required to go through the National Ski Patrol Outdoor Emergency Care (OEC) training to ensure employment standards and professional organizational requirements are met. Pro 1 Level avalanche training is required for patrol member to be considered for the Snow Safety Team.

Blasters-in-Training are required to attend 8 hours of classroom training, complete a state administered written test, and simulate a component construction. Prospective blaster will need to observe 20 shots, assist with deploying 20 shots, and deploy 20 shots under supervision of route leader(Blaster-in-Charge) prior to qualification. Supervised shots must be a combination of hand charges and ANFO. The ignition of 5 uncapped fuse, simulation of 5 misfires of uncapped fuse, and ignition and deployment of 5 pre-assembled capped fuse is performed annually as part of refresher for both long-time and new patrol members.

2. Continuing Education Objectives

An annual ski patrol refresher will occur prior to the operational season and consist of a total of 4-5 days of training. This includes the following trainings:

2 days of medical related topics
1 day of lift evacuation techniques
1 day to include Explosives Regs./Explosives Use/Explosives Intro.
1 day of Terrain Orientation
½ day Accident Investigation

Topics covered during the one day explosives training will include; explosives handling safety, demonstration of shot construction, throwing techniques, example routes with shot placement. The day will also cover mitigation related topics to include: AM terrain-based weather and forecasting processes, documentation of shot placement/results, explosives use report, simulated misfire protocols, ending with an explosives demonstration.

F. EQUIPMENT & INFRASTRUCTURE REQUIREMENTS

1. Snow and Weather

A variety infrastructure will be utilized to observe both weather and snow parameters at Big Pow Mountain. Infrasture will consist of 2 automated weather stations with one located just off the top of the Short & Sweet ski run and the other located on the ridgeline above Tomichi Bowl. One manual snow study site will be located at the top of the PreMadonna zone with an additional precipitation bucket location on the Short & Sweet weather station. Additional information related to snow and weather infrasture can be found in Section G. Operational Procedures of the Avalanche Safety Plan and in Section A. Snow, Weather, and Avalanche Observations in the Forecasting Plan.

Tomchi Bowl automated weather station

2. Communications

Strong communication is a key component to operating safely and mitigating risk in avalanche terrain. The team at Pow Mountain will be equipped with two-way radios and also carry cell phones for back up. A repeater is located at the top of the mountain.

A central dispatcher will direct calls and mountain personnel to the needs of the mountain and guests. Transmission of messages should be clear, concise, timely, relevant, and acknowledged. Verizon and AT&T are both strong strong mobile signals in the expansion area.

3. Avalanche Mitigation

A well rounded avalanche mitigation plan begins before the area is open for operations and runs the full length of the operating season. At Big Pow Mountain a combination of bootpacking, ski packing, ski cuts, hand thrown explosives, (3) tram delivery systems and a disruption roller will be used at various times through the season. In the early ⅓ of the season the snow safety team will use human packing techniques as well as the disruption roller to compact early season layers. Bootpacking and ski packing will take place in all 3 of major expansion zones.

Bootpacking the early season snowpack.

A roller compacts and disrupts the snowpack in Tomichi Bowl.

During the heart of the operating season ski cuts and explosives will be the main forms of mitigation. Ski cuts are very effective for mitigating storm and wind slab problems and are cost effective. Ski cuts will be used in Tomichi Bowl, PreMadonna and Madonna Ridge and routes are outlined on the mitigation map. Ski cuts will be concentrated in starting zones and smaller terrain features throughout the expansion terrain.

A combination of hand thrown explosives and airblast tram explosives will be used to mitigate large storm and wind events, and persistent problems that rest deeper in the snowpack. Routes, shot placements and tram lines are outlined on the mitigation map.

Hand thrown explosives and ski cuts are both used to mitigate terrain in the expansion area.

4. Explosives

Explosives Types

In order to reduce the risk of injury to all involved with the use and operation of the area due to avalanches, the ski patrol will employ various types and sizes of high and low explosives extensively.

Explosives are used to intentionally trigger avalanches when terrain features or avalanche characteristics preclude other techniques. Additionally, explosives may be used to “test” snowpack strength or to create mechanical compaction of snow layers that cannot be boot packed, ski packed, or skier compacted. Whenever using explosives, it is important to have clear expectations of the predicted results and to carefully consider the cause of any deviation from these expectations. Poor explosive placement, explosives that are too small, and explosives that are spaced too far apart may all lead to a false sense of snow stability.

Samples of the explosives to be used are shown below

Cast Boosters:

Pre-made emulsions:

ANFO ((Ammonium Nitrate/Fuel Oil):

Explosive Tramways

Explosive tramways (trams) suspend explosives above the snow surface and facilitate accurate location of explosives, and an effective air blast above the snow surface. Hand charges and ANFO charges can both be used on explosive tramways.

Explosive Transportation

Explosive deliveries are generally transported to storage magazines by truck, utility cat, or snowmobile. Restocking of satellite magazine throughout the winter is typically done using snowmobiles and chairlifts. Explosives should not be left unattended at any point during transportation. Before moving explosives between magazines, ensure quantities are within weight and size constraints of the receiving magazine.

Explosive Transportation on Lifts

Explosives are generally transported on lifts only when the line is clear of public. A ski patroller should ride with the explosives. Before loading, ensure that both top and bottom lift operators are aware that the line should remain clear of public until all explosives are unloaded. If explosives must be transported on a lift during operating hours, consult with the acting Mountain Manager to determine an acceptable plan. Clearing the lift of public is one option. If transporting explosives up a lift with public is determined to be necessary, consult the State of Colorado Explosives Regulations Article 7, Section 7-5 (C) for requirements.

Explosives Storage

Photo: Bradley Metals Co, Inc

5. **Signs & Physical Barriers**

A large hinged metal gate will be present at the main entrance to the terrain expansion area on the timber archway. A large red sign will be permanently fixed to the center of the gate. This sign will have interchangeable messages to indicate the closure of the area during mitigation actions. The two magnetic options messages will state. “Area Closed for your safety” and “Area Closed. DANGER. Explosives in Use.” The main gate will act as the primary physical boundary and control point for access to the terrain expansion area.

A large sign kiosk will be permanently installed just beyond the main entrance gate that informs the public of the risks and hazards of the terrain. This sign will define the potential hazards, suggest preparedness measures (to include avalanche safety gear) and express self reliance and decision making in this type of terrain. It will present terrain difficulty ratings and zone names depicted in a visual map format. A self-checking avalanche transceiver device will be installed on the side of this large sign. See example photos below.

Large sign posted just beyond main entrance gate

Transceiver checking device on large sign

Zone ropelines serve to separate mitigation zones within the terrain expansion area. A total of three zone ropelines are present. Ropelines and gates will be constructed with orange/black bamboo and flagged orange rope in all areas and it is recommended these are installed during the early season. The main goal of ropelines is to allow for mitigations actions to occur in zones independent of each other for the safety of both guests and snow safety teams, They define the expansion are based on aspects and terrain features. Gates made of rope are present between the zones and should be used as the primary entrance to each zone. Gates should be closed at the end of each day on sweeps to prepare for the next day's mitigation plan.

An additional rope line will be necessary to mark the large closed portion of terrain on the downhill side of the hiking route between the main entrance gate and the top of Tomichi Bowl. This area is permanently closed to the public as it is not covered within the Special Use Permit area. A red

rope line with small red square sign stating " Closed Area. No Access" will be attached to the rope line every 50 feet.

A physical red rope boundary will be constructed beginning on the uphill side of the main entrance to the terrain expansion area. This boundary will run the full distance of the perimeter of the area all the way down to the Make-up Room area. A small red square sign stating "ski area boundary" will be attached to the rope line every 50 feet to ensure guests are aware of the significance of this boundary. At the base of the Madonna zone a gate in the rope line will be created for backcountry user access as defined in the Special Use Permit with the USFS. This will be a physical gate that will need to be opened by a human hand with a caution sign posted on it. A large sign stating the backcountry access purpose and release of responsibility will be posted to all users here next to the gate.

6. **Vehicles**

Big Pow Mountain will operate a small fleet of vehicles for use in both early season and daily mountain operations. Four wheel drive pickup trucks will be used during early season operations when snow cover is not present on the lower mountain elevations. When snow is present at both lower and upper elevations snowmobiles will be the main means of transport. Hiking will be required from designated snowmobiles parking locations for staff safety. Snow cats with winching capabilities will be used for early season rolling operations, grooming of ingress and egress areas and transport of staff for mitigation when conditions are safe.

7. **Personal Protective Equipment (PPE)**

When entering new expansion terrain, each patroller will be required to carry personal protective equipment. Basic PPE consists of standard medical gear, helmet, and releasable ski set-up or snowboard release cord. The avalanche equipment required consists of an avalanche airbag with fully charged battery or full canister, beacon, probe no shorter than 300cm, and a shovel.

When on avalanche mitigation routes in the new expansion terrain, patrollers will be required to deploy double-capped explosives, to reduce the probability of a misfire. Additionally, each patroller on mitigation routes is required to have a quick-access knife to prevent rope entanglement.

G. OPERATIONAL PROCEDURES

1. **Weather, Snowpack and Avalanche Mitigation Data Collection**

Weather Data

Collecting and documenting pertinent weather data is essential to the success of the Snow Safety Program at Big Pow Mountain. This data will be collected daily to support the snow safety program in the mitigation of avalanche risk within the permitted area. Daily weather is collected at 5am and 5pm, using one snow study site and two automated weather station within the ski area boundary. Two regional automated weather stations also contribute to the daily weather documentation and provide information related to the spatial variability of weather events. All weather data is documented daily in both the AM Weather Form and the

PM Reporting Form as delegated by the Snow Safety Supervisor. The National Weather Service's weather forecast for 11,000 ft in elevation, is documented daily within the Forecast Form which is utilized to support the ski area forecast and avalanche mitigation plan. The Snow Safety Supervisor routinely monitors weather data during daily ski area operations and documents a summary of findings in the PM Summary daily.

Snowpack Data

Snowpack will be assessed within select zones inside of the ski area boundary. These zones make up the hike-to terrain of Big Pow Mountain and include the Ingress Zone, Closed Area Zone, Tomichi Bowl Zone, Pre Madonna Zone, and Madonna Zone. Early season snowpack operations in the zones with skiing terrain, will include monitoring, snow profiles, and compaction rolling by snowcat winch. The assessment of the early season snowpack within these zones is essential to safety of the area for the duration of the season. Snow profiles should be completed weekly while terrain is closed to the public in the early winter season to ensure a snowpack history is logged in the ski area database.

Once this terrain is open to the public, snowpack in these zones will be visually assessed when skiing the terrain on daily patrols and during daily morning/evening sweeps. A snow profile should be completed in each of the four zones with skiing terrain, 1-2 days prior to all forecasted precipitation events greater than 6 inches. A minimum of one test snow profile will be completed and recorded by a member of the snow safety team in the predetermined area of each zone, using the North American Snow Weather, and Avalanche Guidelines (SWAG). Snow profile areas have been chosen in areas that represent the mean aspect and slope angle of the zone. Standard snow profile data should include snow layer depths, snow hardness rating, total height of snow, and both grain type and size of each layer using SWAG standards. All snowpack tests at each profile area will include a minimum of 2 compression tests (small column test) and one extended column test (large column test) per visit. If propagation occurs during any large column tests a propagation saw test should be considered to confirm or deny the reactiveness of the weak layer present in the snowpack. All data from snowpack profiles will be collected in the ski patrollers field notebook and be entered into the Big Pow Mountain Snow Pilot private account by the end of each day. Other snowpack tests include use of explosive shots and completing ski cutting routes. Snowpack results from these mitigations will be logged daily in the PM Summary. In the event of no results after explosives mitigation in this terrain, a snow profile in the area should be utilized in the area (only if safe) or in a representative area with the same aspect and elevation, to further assess the snowpack.

Avalanche Mitigation Data

Both avalanche mitigation and avalanche occurrences are important data sets relevant to snow safety operations at Big Pow Mountain. Avalanche mitigation will include skier compaction, completion of ski cutting routes, roller based compaction, reduction of cornices, and deployment of explosives within the terrain. An avalanche occurrence is defined as any single event resulting in the release of cohesive snow cover, either intentional or unintentional, that can be rated using the R and D avalanche rating scales found within the North American Snow, Weather, and Avalanche Guidelines (SWAG). All avalanche occurrences from

avalanche mitigation operations will be logged daily in the PM Summary Form by each route leader.

Five mitigation zones have been determined for the safety of operations. Each zone consists of designated ski cutting routes, named shot placements (Shot ID's), designated safe zones for staff, and general avalanche start zones. Route identifiers generally follow a skier's right to left orientation when standing at the top of the terrain. All routes and shot placements are based on best practices and historical data. Bomb trams and hand shots are the two preferred methods of avalanche mitigation within the five zone and may be used independently or in conjunction with each other. Some weather events and locations in the terrain may require additional mitigation actions (ski cuts and/or shot locations) on case by case basis to ensure safety of both ski patrol staff and the public.

Each route leader will be required to report mitigation results daily to include: the type of route, the number of shots used, the trigger type, avalanche size (both R & D scales), avalanche type(s) and provide a narrative of any additional mitigation needs. Mitigation results are reported in the PM Summary Form immediately following completion of routes.

In the event of no results occur after explosives mitigation in this terrain, the miss-fire protocol will be followed by the route leader and team members. Route leaders will be required to complete a narrative of the mis-fire event in the PM Summary Form for each occurence. A snow profile should occur in the area (only if safe) or in a representative area nearby with the same aspect and elevation, to further assess the snowpack and determine any further mitigation needs.

2. Risk Mitigations

Exposure of staff during mitigation activities will be reduced by only utilizing the minimum staff necessary to accomplish the tasks planned. Staff will travel one at a time while in avalanche terrain to and from pre determined safe zones. Hazards within the terrain will be determined and discussed prior to entering the terrain in during the morning briefing, with the Snow Safety Supervisor when assigned, and amongst the smaller snow safety teams prior to entering terrain. If a team member raises concern during the briefing process all tasks with stop until a mitigation can be agreed upon by the team. It is encouraged that risk assessment tools/templates are used to aid in the decision making and risk rating process.

The goal of mitigation actions at Big Pow Mountain is to reduce the avalanche size and frequency to tolerable events, with the top tier goal of zero events annually. Due to the nature of the extreme terrain located within the terrain expansion, we look to accept no more than 2 avalanche events per terrain zone per year with a size no larger than R2 D1.5.

All staff participating in mitigation actions will be required to utilize all personal protective equipment (PPE) daily during actions and complete regular proficiency checks with equipment by the Snow Safety Supervisor.

Explosives Misfire Procedures:

In case of a misfire,

1. Maintain security around the blast site
2. Mark location of misfire
3. Radio Dispatcher to mark the time
4. Wait at least one hour before attempting recovery of the misfired charge
5. Dispose of explosive with another explosive
6. If a misfire is unable to be recovered, ensure that details are recorded in order to facilitate a later search

3.Communications

All staff are required to carry a digital two-way radio and utilize for clear communication during mitigation routes. Communication between multiple teams is crucial so that teams are aware of each others location, ski cut timing, shot timing, and results. Members of mitigations teams relay ski cut locations, explosives shot locations and size of shot to dispatch prior to deployment.

During avalanche mitigation work, snow safety teams will check in with dispatch before and after routes using issued two-way radios. Terrain openings will be reported via radio communication upon completion of mitigation routes.

4. Event Reporting

Report all staff emergencies immediately to the Snow Safety Supervisor by radio. The Snow Safety Supervisor will inform the Ski Patrol Director as soon as possible. Emergencies include any injury, illness, or avalanche accident occurring during employment hours while carrying out assigned position duties. In the event of a serious accident or employee fatality, ensure the accident scene is preserved to the best or your ability and prohibited access. An investigation will occur within 24hrs and involve the County Sheriff's Office in conjunction with Big Pow Mountain management staff.

All incidents that do not result in an injury or accident response will be defined as a “near miss” incident. Near miss incidents can occur anytime during employment hours duties and should be reported the same day. All near miss reporting is highly recommended as it allows for the operations to learn and revisit new operational procedures. No disciplinary actions will occur from near miss incidents work duties performed are within operational policy guidelines. Communicate all near miss reporting to your immediate supervisor in a timely manner.

6. Sharing of Information

A daily briefing will occur each morning with all Ski Patrol staff at the base area patrol room. Weather, forecasting, and mitigation planning details will be presented to staff prior to beginning ski area operations. Information pertinent to daily operations will be shared via database printouts/postings and person-to person communication. It is the responsibility of each ski patrol/snow safety member to report all information from the daily operations by the end of each day via database entry

7. Public/Professional Information

Public Information- Ingress/Egress Plan to New Terrain Area

Access to the Tomichi Bowl and Madonna areas of Big Pow Mountain can be gained by riding to the top of the Breezeway Lift. When exiting the chairlift stay straight off the ramp towards the large timber archway. This timber archway is the main entrance to all of the hike-to terrain. Always enter through the main gate located under the timber archway and ensure the area is open for public use by checking for green “open” sign at the gate. Please read and respect all signage at and beyond the gate during travel in this terrain to ensure your safety. A flat groomed cat track will take you in a northerly direction toward the base of the hike to the ridge line of Tomichi Bowl. This hike requires carrying your equipment with no assistance provided by staff of Big Pow Mountain. You will gain 290 vertical feet during the hike over a quarter mile in distance. Average hiking time from the top of Breezeway Lift to the ridgeline above Tomichi Bowl ranges between 10-20 minutes depending on your fitness level. Terrain in this area is above 11,000 ft therefore high altitude may effect you physical and cognitive abilities during the hike. Take frequent breaks and whenever possible hike with a partner.

After descending either of the three areas, you will arrive at a flat basin in the bottom of the drainage. A groomed cat track marked with a rope line along the downhill side, starts here and returns you to the base of the Breezeway Lift if followed. Be sure to stay uphill of the the rope line as snow safety mitigation and skier services are significantly delayed beyond the rope line. When exiting the ski area boundary it should occur through a well marked gate with signage allowing for departure to backcountry areas.

Staff Information- Ingress/Egress Plan to New Terrain Area

There are a variety of options for Ski Patrol and management staff of Big Pow Mountain to access terrain within the newly expanded hike to areas of the mountain. Access can be gained to both the ridgelines above the three different terrain areas as well as a common area at the base of the terrain.

The ridgelines can be accessed by either a chairlift or snowmobile ride to the top of the Breezeway Lift. A large timber archway contains the main entrance gate for this terrain and ridgeline

access with snowmobile, snow cat, and hiking are the three methods of access to this location. Using a snowmobile allows for the fastest access to the ridgeline but is limited to no more than 3 people per trip and should be used on a limited basis when the area is open to the public to reduce potential conflicts. Consider snow depths and the status of overhead safety (cornice, etc) when using a snowmobile for accessing the ridgeline in this area. Hiking is the slowest but most common method of access. If time and hazards are not a factor to hiking up the ridgeline this option will allow for staff to engage with the public and monitor conditions. The use of a snowcat to gain the ridgeline is possible when a large number of people may need to be transported at one time and when increased efficiency is desired. The timing for the use of this equipment is important to ensure efficient use and should be coordinated ahead of use. Snow cat use may be beneficial when significant weather events (ie, heavy drifting, deep snow etc.) occur making visibility and travel along the cat track to the ridgeline difficult by other motorized or human powered methods.

Access to the bottom of the terrain can be gained by motorized equipment (snowmobile or snow cat) from the bottom of the Breezeway Lift. The groomed skier egress will be the primary route used for uphill travel with motorized equipment. When the ski area is open to public use, use conservative speeds and be mindful as skier traffic will be coming towards you as you ascend. Your ascent with motorized equipment terminates at the flat basin at the end of the groomed cat track where all three terrain zones meet. Motorized equipment should be parked in a location visible to downhill skiers and not in the center of main travel routes. Audible cues and lights are preferred on all motorized equipment during operation to ensure visibility and reduce potential conflict.

8. Documentation

Documentation will be required for all mitigation actions performed daily, including both ski cuta and/or explosives use. The PM Summary form is the source for all reporting and is the responsibility of all route leaders to complete prior the end of their day. This form can be accessed electronically through all Big Pow Mountain computer stations. Size, location and mitigation ID numbers/names are required with all reporting. All documentation will be stored in an electronic database used to analyse mitigation statistics and review operational efficiency on a regular basis.

9. Emergency Response Plan

Helicopter Use

Within the new expansion terrain, there will be one additional helicopter landing zone. Depending on visibility and weather conditions, a helicopter will be able to land on the ridge of Tomichi Bowl at the top of the groomed ingress road. This will allow for a top down approach for an avalanche deployment team, for example. Also, a helicopter may land here if there is a medical emergency along the ridge of Tomichi or Madonna. Before landing a helicopter at this LZ, the gates for the hike in to Tomichi Bowl will be

closed to public, and any remaining public along the ridge will be swept away from the area.

Additional landing zones pertinent to the new expansion terrain are some of the pre-existing LZ's of Big Pow Mountain. These LZ's are the Entrance LZ, located at the entrance of the resort off the highway, and the Dirt Lot LZ, located in the upper dirt parking lot near the explosive make-up room. The Dirt Lot LZ will be the main LZ for medical emergencies within the expansion terrain, while the Entrance LZ is a last-resort LZ in case the other LZ's are occupied and cannot be cleared. Both the Dirt Lot and Entrance LZ will require ski patrol to clear and close the area of public before a helicopter can land. Using the Entrance LZ would also restrict vehicle traffic from entering or exiting the ski area, making this the last-case LZ.

Personal Protective Equipment (PPE)

Patrollers at Big Pow Mountain performing snow safety work within the new expansion terrain will be required to carry a set of PPE with them at all times. This PPE consists of an avalanche airbag, 3-antenna beacon, probe equal to or greater than 300cm, and metal avalanche shovel. Other items include a quick-access knife to prevent rope entanglements, basic medical gear, and a partner.

Ear plugs are not required, but are recommended when performing explosive control work. Explosives are required to be in an anti-static bag when transporting, and must be kept separate from pull-wire igniters.

Rescue Equipment

With the new expansion terrain, new rescue equipment and placements are being considered. At the top of Tomichi Bowl along the ridge, there will be an Akja and toboggan stashed at all times. There will also be a toboggan located at the top of Madonna Ridge at all times. Both the akja and toboggans will be equipped with loop holes and suited for any high angle rescue/belaying that may be necessary. Within the toboggans and akja, there will be a blanket, leg splint, and pillow, all within a waterproof bag.

Additional rescue equipment will be located at the nearest patrol hut, next to the Tomichi gate. This equipment consists of a medical code pack (drugs and ALS equipment), high angle rope rescue kit, heat packs, KTD, pelvis binder, oxygen and nebulizer packs, AED, long spine board and scoop, zoll monitor, and additional BLS medical equipment.

To access this terrain and bring in medical/rescue equipment quickly, a snowmobile will be ready at all times and will be located at the patrol hut near the Tomichi Gate. The snowmobile will be able to tow patrollers and rescue equipment into the area via the

ingress and egress roads. Both of these roads will be groomed each night, with the ingress being groomed from the Tomichi gate to the top of Tomichi Bowl and around to the top of Modanna Ridge, and the egress groomed from the pre-existing ski run all the way up into Tomichi drainage. Also, any medical emergencies in the area will utilize a snowmobile tow out the groomed egress, providing an easier and faster transport to the Big Pow Mountain Clinic or the Dirt Lot or Entrance LZ.

Enhancing Emergency Operations

With our early season bootpacking program, each bootpacker will be required to carry a beacon, probe, and shovel, and will also be required to be accompanied by a patroller. Bootpackers will be trained on how to perform a beacon search, and how to properly probe and dig for a buried victim.

Patrollers will take part in weekly training exercises, when time allows. Training will consist of steep rig runs, medical scenarios, avalanche scenarios, and mock explosive/ski cut routes. This continue training will ensure that patrollers in this terrain are ready and can handle taking on more expansion terrain.

Appendices

I.Avalanche Terrain Atlas & Maps

II.Terrain Zoning

III.Risk Assessment(s)

IV. Mitigation Plan: Avalanche Mitigation Atlas & Explosives Budget

V. Equipment, Materials inventories / Cache(s)

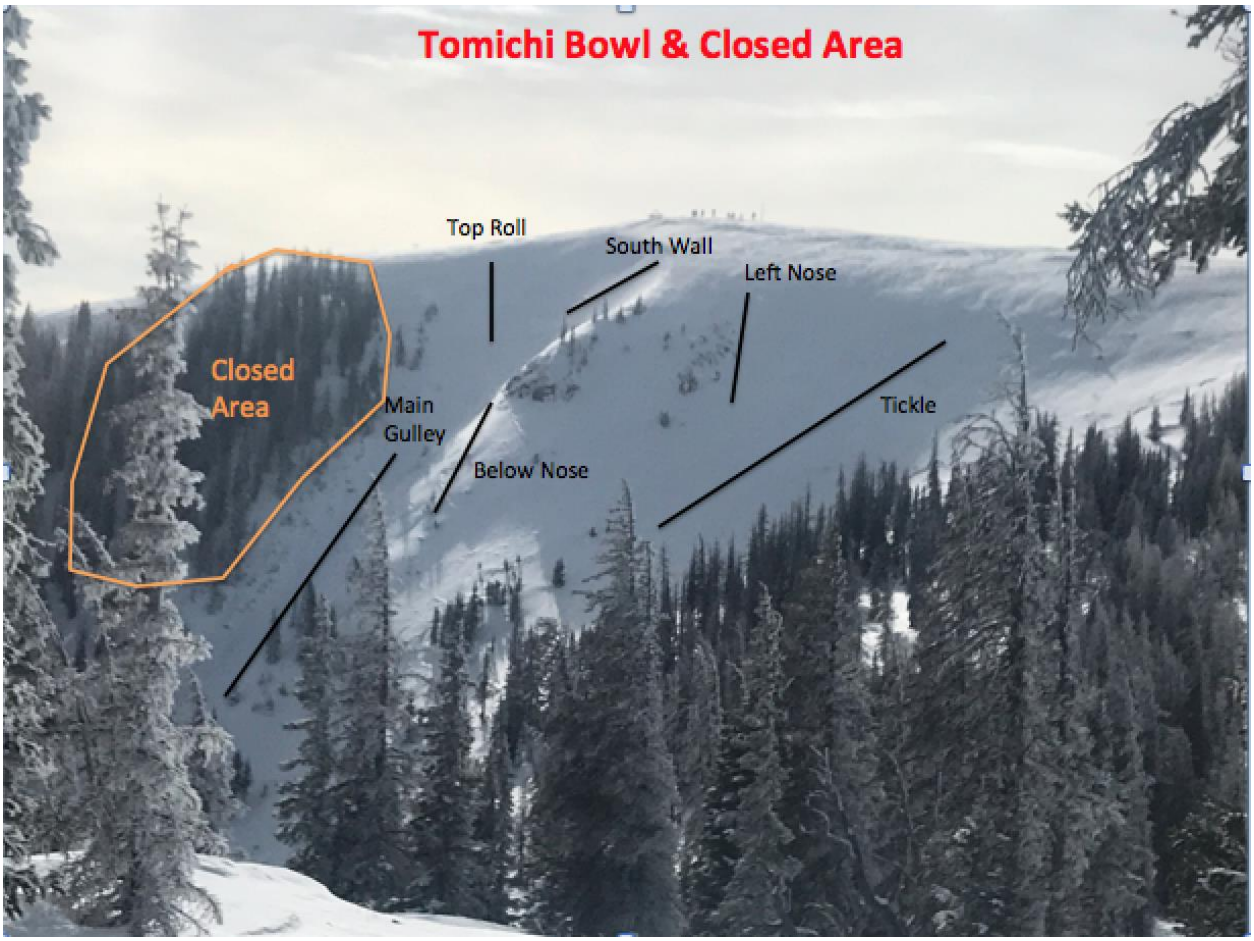
APPENDIX- I: Avalanche Terrain Atlas & Maps

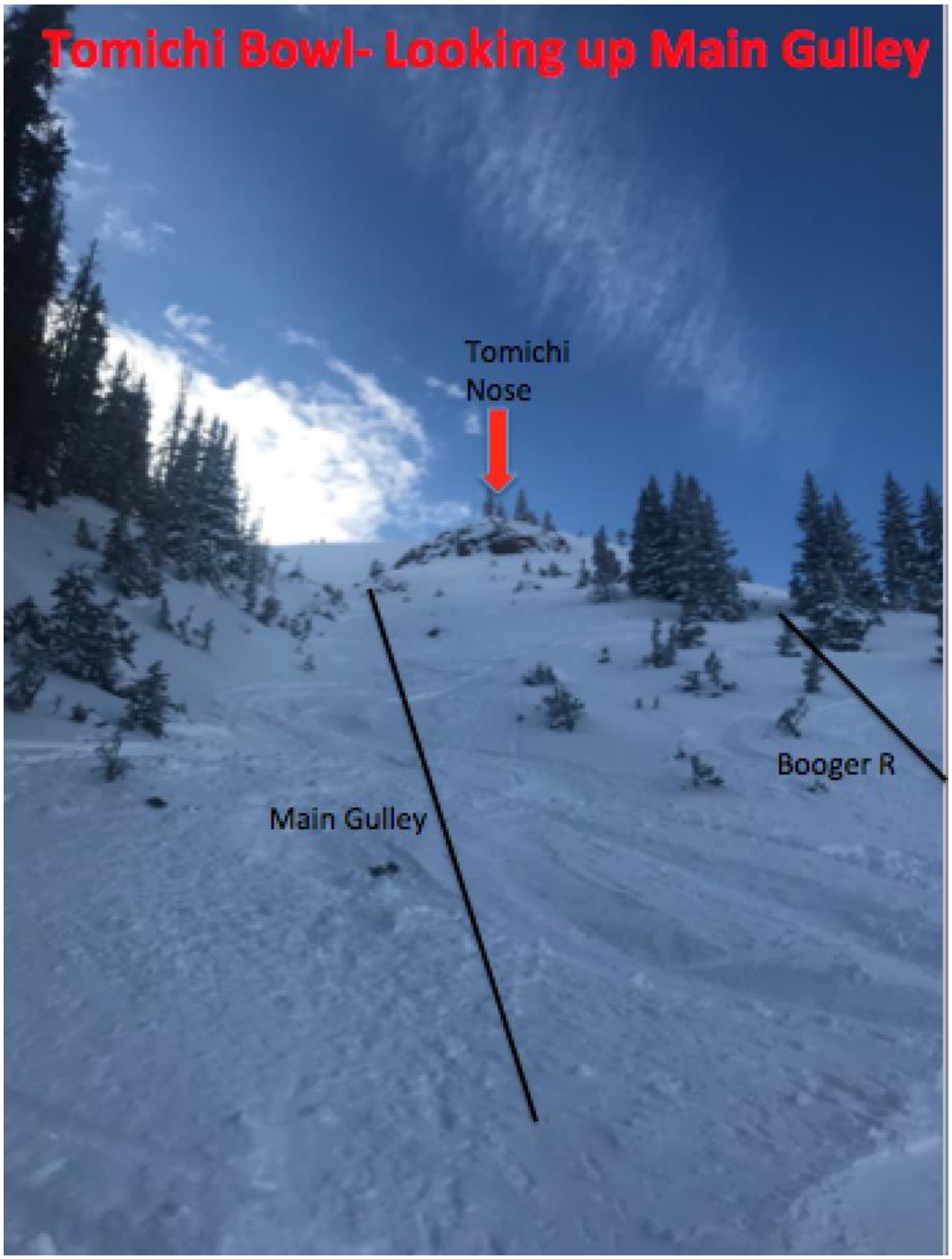
Expansion Map

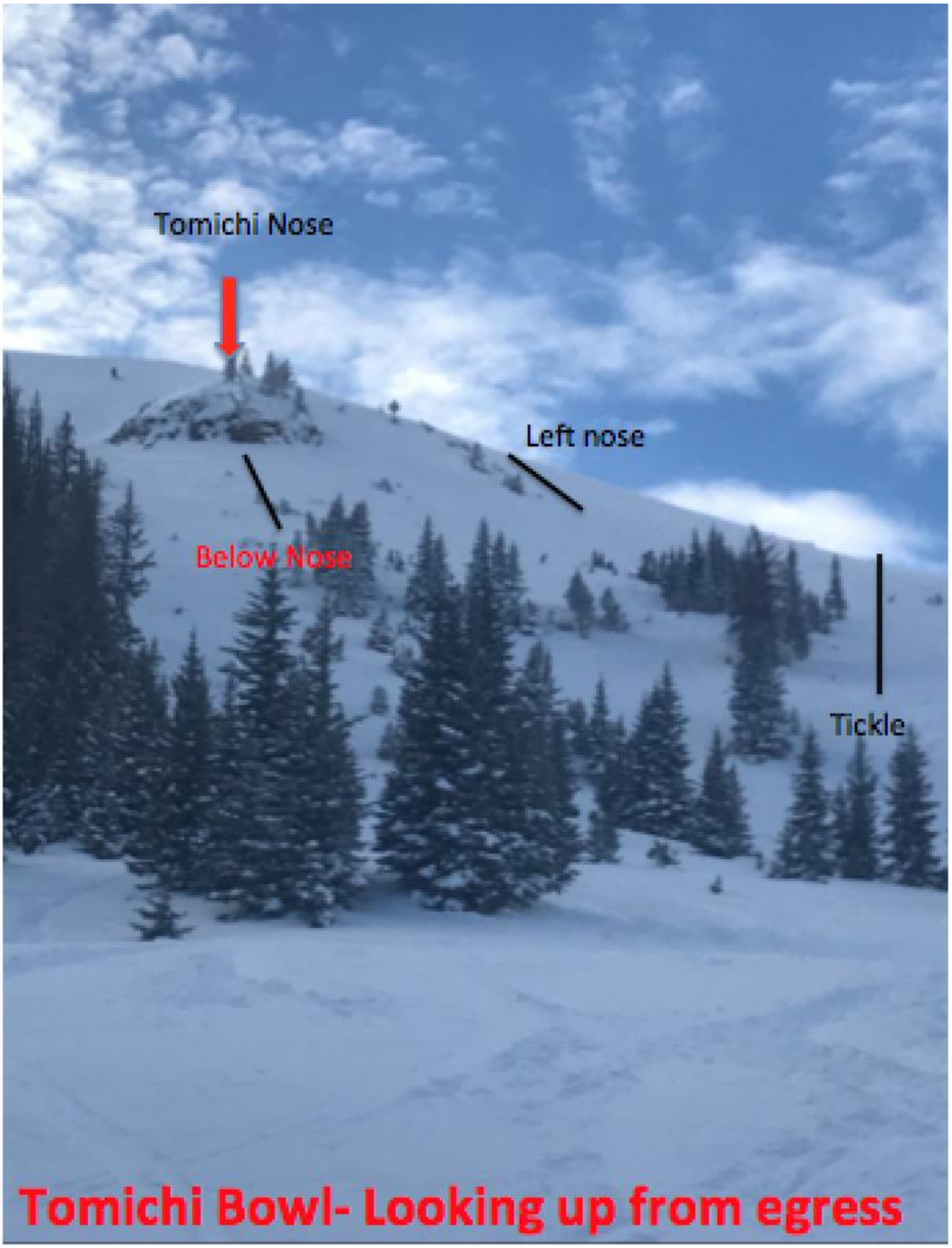
-Full view of hike-to terrain
-Landing Zones
-Wx Stations
-Snowprofile Locations
-Snow Study Sites
-Explosives Magazine & Make Up Area(s)
-Patrol Hut
-Closed Terrain
-Ropelines w/ gates
https://caltopo.com/m/CG4V
Password: monarch

Run Atlas

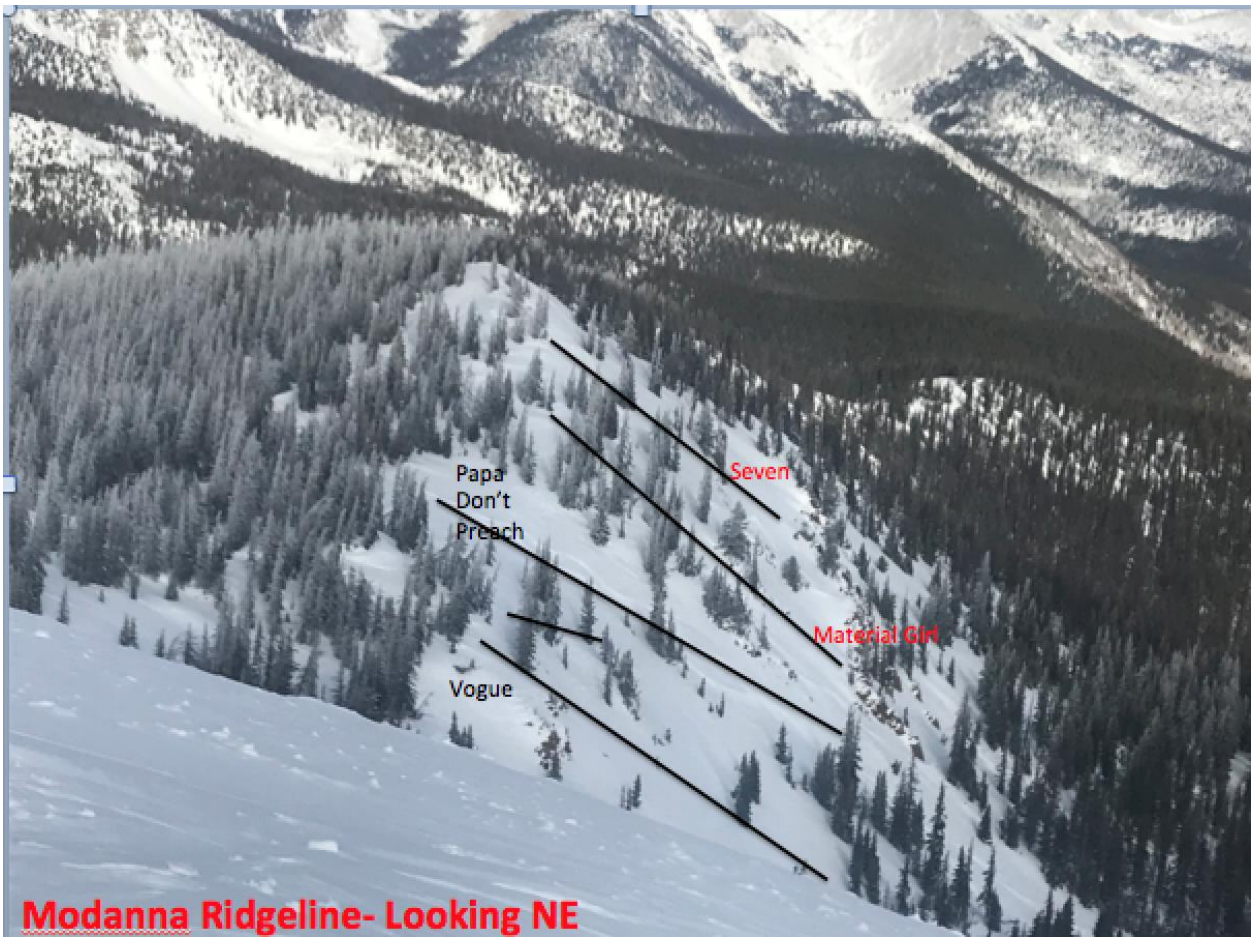
-Zones (w/ ropelines)
Tomichi
Pre Madonna
Madonna
-Run Names
https://caltopo.com/m/P0BF
Password: monarch

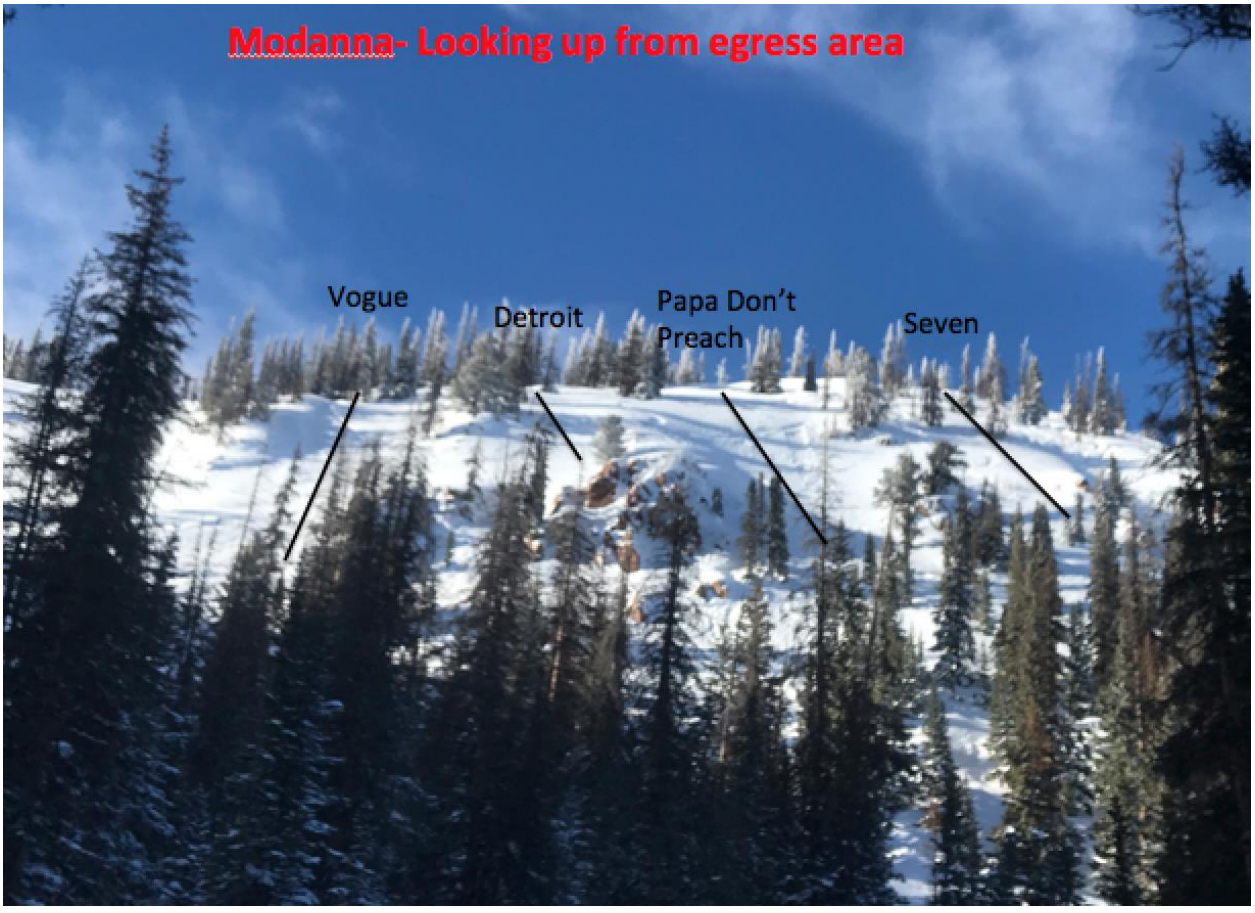

Tomichi Bowl & Closed Area
Top Roll
South Wall
Left Nose
Closed Area
Main Gulley
Below Nose
Tickle


Tomichi Bowl- Looking up Main Gulley
Tomichi
Nose
Booger R
Main Gulley


Tomichi Nose
Left nose
Below Nose
Tickle
Tomichi Bowl- Looking up from egress


Pre Modanna – Looking NE
Don't Tell Me
The Edge
Detroit


Papa
Don't
Preach
Seven
Material Girl
Vogue
Modanna Ridgeline- Looking NE


Modanna- Looking up from egress area
Vogue
Detroit
Papa Don't
Preach
Seven

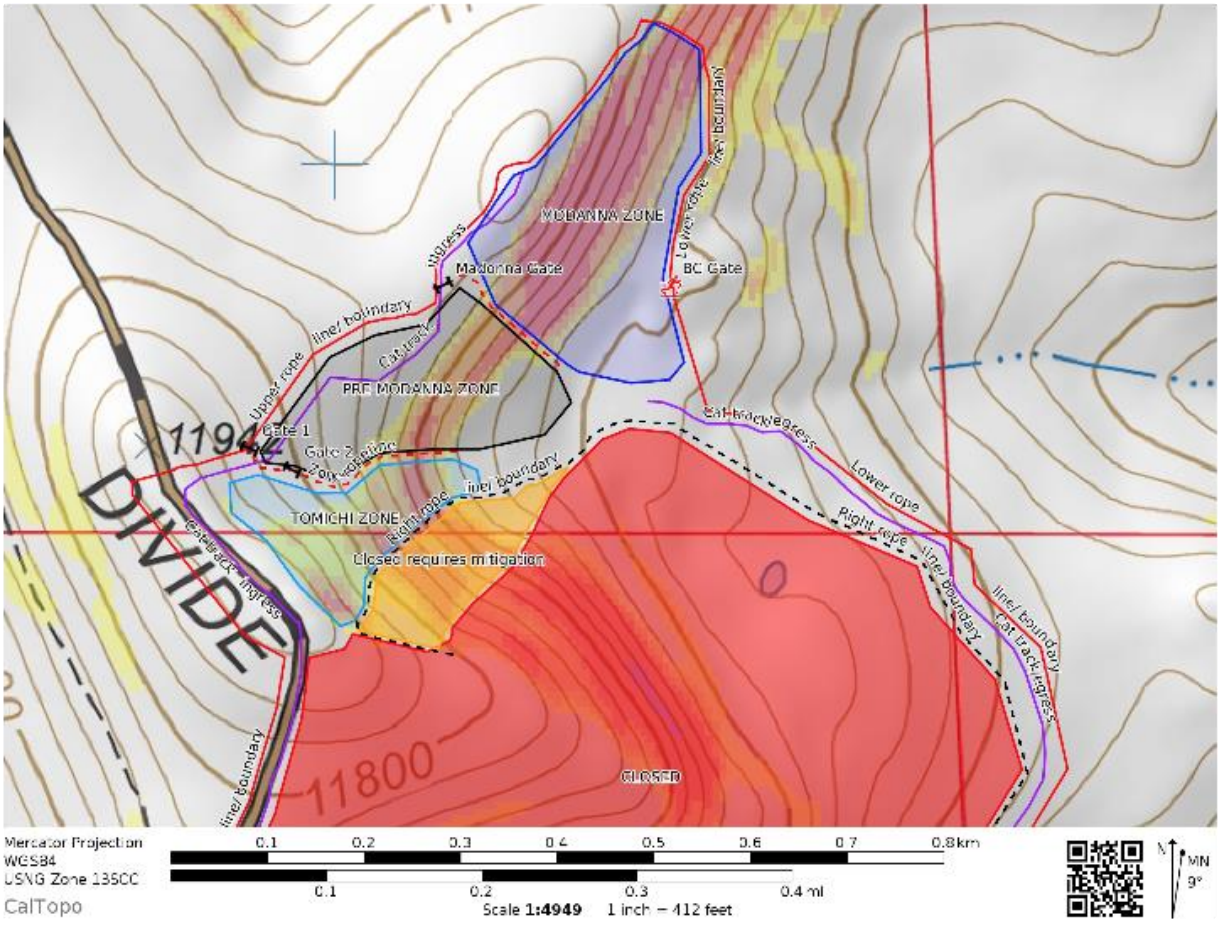
APPENDIX - II: Terrain Zoning

- *See Run Atlas Map or Mitigation map for more details*

Zones:

Ingress Zone
Closed Area Zone (orange area north of red CLOSED polygon)
Tomichi Zone
Pre Madonna Zone
Madonna Zone

All terrain located within the above stated zones are rated as double-black diamond by the North American Terrain Rating Scale for ski area operations.



APPENDIX - III: Risk Assessments

Risk assessments are an important tool in helping Big Pow Mountain staff to better understand the level of risk they are exposed to during daily employment activities. These are tool to engage teams in discussions about their exposure and mitigations that can be taken to reduce overall or areas or inherently risky activities. The risk assessment matrix below is the format utilized by Big Pow Mountain staff prior to all mitigation activities. Each team will complete a risk assessment and assign a total score to the planned activity as a group. All numerical ratings higher than a 5 will required a planned mitigation for that subject area prior to engaging in the activity.

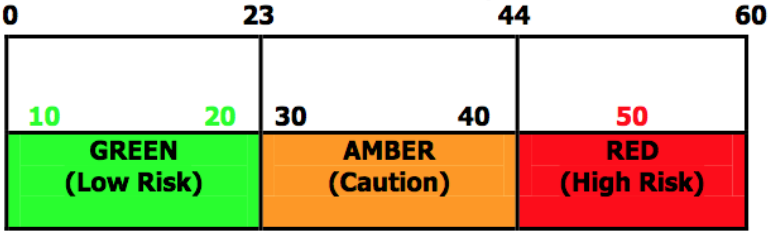
GAR IS BASED ON A TEAM DISCUSSION TO UNDERSTAND AND EVALUATE THE RISKS ATTENDANT TO A MISSION AND HOW THEY WILL BE MANAGED.
RISK MANAGEMENT IS WHAT IS IMPORTANT; NOT THE ABILITY TO ASSIGN NUMERICAL VALUES OR COLORS TO RISK ELEMENTS.

Assign a risk code of 0 (For No Risk) through 10 (For Maximum Risk) to each of the six elements below. The discussion should start with the junior (least experienced) members first on each category.

Supervision -qualifications / experience / communications	
Planning – details / clarity / vessel selection and condition	
Team Selection – qualifications / experience	
Team Fitness – physical / mental state	
Environment - seas / visibility / wind / current / temperatures	
Event/Evolution Complexity –details / tasks	

Total Risk Score	

GAR Evaluation Scale - Color Coding the Level Of Risk



If the total falls in the green zone, risk is at a minimum. If the total falls in the amber zone, risk is moderate and you should consider adopting procedures to minimize risk.

IF THE TOTAL FALLS IN THE RED ZONE, YOU NEED TO IMPLEMENT MEASURES TO REDUCE THE RISK PRIOR TO STARTING THE EVENT/EVOLUTION.

APPENDIX - IV: Mitigation Plan & Avalanche Mitigation Atlas

Mitigation Plan Map

-Start Zones
-Run names
-Shot placements
-Safe Zones
-Ski cutting routes
-Explosives route
-Explosives Trams
-Zone ropelines
https://caltopo.com/m/81BE
Password: monarch

Avalanche Hazard Mitigation & Tools

The goal of avalanche mitigation is to decrease the likelihood of triggering an avalanche and/or decrease the potential size of avalanches. Physical manipulation of snowpack layers and intentional exploitation of weaknesses serve to increase snow stability and diminish the continuity of failure planes. Common avalanche mitigation techniques include:

Boot packing and ski packing: This early season tactic mechanically compacts the snowpack layers that will form the base of the seasonal snowpack. Mechanical compaction increases the strength of these layers and helps to mitigate the effects of high temperature gradients through the early winter. Boot packing and ski packing also improve early season ski conditions and allow terrain to be opened sooner than otherwise possible.

Skier compaction: Compaction of snow layers throughout the season increases snowpack strength and reduces the opportunity for continuous failure planes to form across terrain. Skier compaction must stay ahead of snowfall rates, the effects of wind loading, and snowpack settlement in order to remain effective. This is one of the most efficient ways to mitigate avalanche hazard.

Ski cuts: Ski cutting involves intentionally triggering predictable avalanches. Ski cuts should be restricted to terrain features and avalanche characteristics with relatively low consequence. Ski cuts are best utilized for loose snow avalanches or small and shallow soft slab avalanches.

Explosives: Explosives can be used in many different ways to mitigate avalanche hazard. Most commonly, explosives are used to intentionally trigger avalanches when terrain features or avalanche characteristics preclude other techniques. Additionally, explosives may be used to “test” snowpack strength or to create mechanical compaction of snow layers that cannot be boot packed, ski packed, or skier compacted. Whenever using explosives, it is important to have clear expectations of the predicted results and to carefully consider the cause of any deviation from these expectations. Poor explosive placement, explosives that are too small, and explosives that are spaced too far apart may all lead to a false sense of snow stability.

Mitigation Plan by Zone

Ingress Zone Mitigation-

The Ingress zone begins at the main entrance gate located under the timber archway and continues to the top of Tomichi Bowl where hiking access terminates. This area is roughly one-quarter mile in length and 150 feet wide at its largest section. Not all of the zone requires mitigation work as it lacks terrain features in the upper two-thirds of the zone where it is regularly maintained by snow cat as a flat groomed track on a flat ridgeline. Terrain aspects containing slope angles greater than 30 degrees in this area are primary east-facing, while the cat track/hiking route is primarily southeast facing and consists of slope angles in the mid-twenties, as it climbs to the top of Tomich Bowl. All terrain features of this zone are located above treeline and contain few trees leaving terrain exposed during weather events and solar radiation.

The Ingress Zone is closed to the public for the first portion of each winter season as the access it provides is dependent on a significant amount of natural snowfall cover prior to opening for public use. During the first 2-3 months of each season operations for mitigation in this zone should include regular grooming of the ingress cat track after each snowfall event equal to or greater than six inches. Grooming to the

ridgeline along the hiking route will aid in retaining snow cover and allow for snowcat access to the ridgeline above Tomichi Bowl, Pre Madonna, and Madonna to carry out early season terrain compaction activities as planned. Mitigation of cornices on the east aspects just beyond the gate are necessary for safe travel of staff to/from terrain above the area to carry out early season mitigation operations. Cornices will form above the Ingress entrance gate during snowfall events that include moderate to strong westerly winds or during moderate to strong wind events where snowfall is present on westerly aspects and therefore available for transport onto easterly aspects. Mitigations early season cornice problems include cornice drops/cuts and in some cases use of explosives when size exceeds effectiveness of staff ability to do so in a safe manner.

Ingress Zone- catrack and hike to the top of Tomichi Bowl

Once the hike-to terrain is open for daily public access during the mid-winter season regular mitigation activities will occur to ensure safe access for staff and the public to the terrain this area accesses. Each morning the status of this zone will be determined by the Snow Safety Supervisor by the use of the AM Weather and Forecast Form. Ski Patrol staff should maintain the main entrance gate to the Ingress zone based on the determination by the Snow Safety Supervisor. When the area is closed for mitigation operations staff should plan for ski cutting and/or explosives use within the zone. This zone contains one ski cut route and two shot placement locations for explosives use. The objectives for both ski cut and explosives use in his zone include management of cornice size, soft slab posting below the cornice and above the cat track, and start zone management on leeward aspects.

The primary ski cut route in this zone should be completed daily prior to public opening during mid-winter operations as the area receives no public ski traffic. This will allow for the tension within the snow in the start zone on a leeward aspect to be released daily and any slab formation to be broken down in size. Daily ski cuts will ensure safe access in all conditions and weather events. Two ski patrollers should be used to perform this task to ensure safety and multiple ski cuts on the terrain. Prior to ski cuts cornice size and reactiveness should be assessed by ski patrol staff above the area. Cornice drop kicks should be performed from a safe distance behind the center of the cornice and a safe runout area below is ensured. If cornices are reactive and small in size after mitigation actions, ski cuts can proceed below the cornice area. Large cornices should be managed with explosives to ensure safety of all staff and ski cut should not proceed until mitigation actions occur. Record all daily mitigation actions and results, both ski cuts and explosives use, in the PM Summary Form.

The use of explosives in the zone may be necessary to mitigate and manage continued large cornice formation along the east facing ridgeline above the main entrance gate. Weather events that promote cornice formation in this area include moderate to strong westerly winds (SW, W, NW), new snowfall combined with moderate to strong westerly winds, or moderate to strong westerly winds when snow is available for transport on west aspects adjacent to this ridgeline. The Snow Safety Supervisor will determined when explosives use is necessary and share this information daily through the Forecast Form. Two shot placements are assigned to this area near the top of the east facing ridge to manage large cornices and leeward snow load as needed. These shots are identified as I1 and I2 and easily determined by a skier's right to left direction when standing on top of the ridgeline. Ensure the main entrance gate is closed prior to all explosives use and the area below is clear of all staff. One or two separate charges can be used here as needed based on how conditions present. Two pound or five pound double capped cast boosters used in either an airblast or lowered over the cornice edge are preferred as they are the most effective method for cornice removal.
Air shots can be taped to bamboo, stuck into the middle of the cornice and ignited or tied to a rope, ignited, lowered over the edge, and anchored for use. After deploying explosives ski patrollers will move back to their safe zone, as indicated on the Mitigation Map, and await discharge. This area provides a safe location behind ridgeline to ensure staff a wide berth when the cornice fails. The main objective with cornices is to reduce the size of formation on a regular and recurring basis. When cornices remain small they are easier to manage and reduce accidents/injury to staff. By maintaining small cornice size throughout the season, workload during warming events in the spring months will be infrequent and temperatures will be less likely a trigger for these problems. Log all shot deployments and results by their ID number in the PM Summary Form after all mitigation actions.

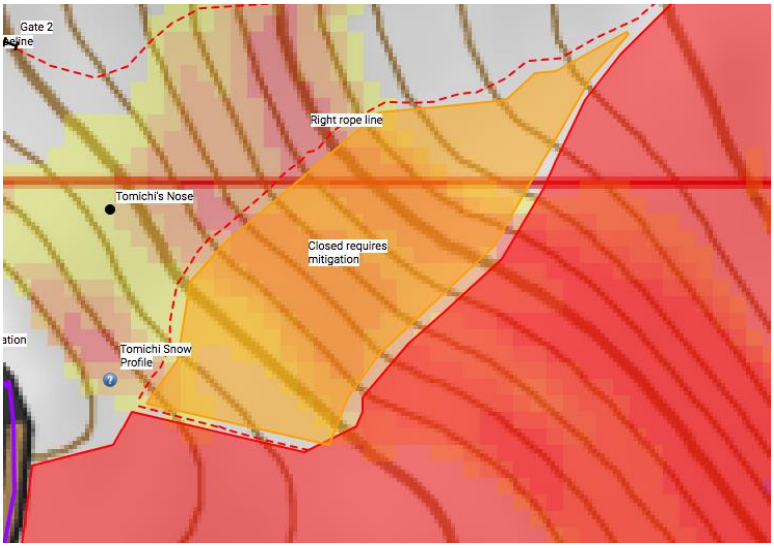
Ingress Knoll- primary mitigation area within zone

INGRESS ZONE - MAXIMUM MITIGATION REQUIREMENTS SUMMARY

Area	**Hand Charges (max)**	**Ski Cut Routes**
Ingress knoll	2	1
TOTAL	***2***	***1***

Closed Area Zone Mitigation

The Closed Zone is adjacent to Tomichi Bowl and is closed to the skiing public at all times. However, this zone will be closely monitored throughout the operating season, as the small, isolated paths have the potential to cross into the open terrain of Tomichi Bowl. The Closed Zone is a NE aspect that consists of isolated terrain features. This zone starts at an elevation of 11,800 ft and runs down to 11,400 ft.



Closed Zone is the orange polygon.

Mitigation Routes in the Closed Zone - Overview

When needed, mitigation in the Closed Zone will be able to take place simultaneously with mitigation efforts in Tomichi Bowl. Storm events greater than 10” of snow and Westerly wind events will need to be closely monitored. Generally snow is deposited in the mid-slope starting zones of this area. Early season ANFO shots will help to disrupt the potential persistent slab problem, along with an isolated bootpacking and skipacking program. During the operating season the Closed Zone will be mitigated using ski packing and hand thrown explosives. Snow safety teams will travel through the Closed Zone on regular basis to promote compaction and to break up layers.

Snow safety teams are able to enter the terrain from the top corner of Tomichi Bowl. All teams will use a designated entrance point to limit ski tracks that may lure guests into this terrain.

The mitigation plan for the Closed Zone must address the following needs:

1. Large storm events and loading by prevailing winds
2. Mitigation of isolated terrain features and steeper pockets
3. Potential for avalanches/terrain features in Closed Zone to impact open terrain in Tomichi Bowl

Travel Path of the Snow Safety Team in Closed Zone

The mitigation plan for the Closed Zone is designed to work simultaneously with mitigation efforts in Tomichi Bowl. The snow safety team will always enter through the skier’s right flank of the zone at around 11,700ft. The entrance for mitigation work will be out of site from the general public to avoid luring skiers into the terrain.

All mitigation will take place in the orange box outlined in the mitigation map. Snow safety teams start at C1, then C2, and progress to C3 and C4. Explosives will be used during times of higher hazard

and boot packing and ski packing used in between larger weather events in effort to continue to break up problematic layers.

CLOSED ZONE MITIGATION NEEDS

	Early Season	**Persistent Slab Problem**	**Storm Slab**	**Wind Slab, or Storm Slab with loading Wind**
Number of patrollers	2-10. Bootpacking or Skipacking	2-3	2	2
Number of hand charges		Large (25-50lb) ANFO shots	4 (2lb) - C1, C2, C3, C4	4 (2lb) C1, C2, C3, C4
Number of tram charges	N/A	N/A	N/A	N/A
Number/details of ski cut locations	Four small starting zones	no	C1, C2, C3, C4	C1, C2, C3, C4
Other notes			Follow Up work as necessary with more ski cuts and protective skiing	Follow Up work as necessary with more ski cuts and protective skiing

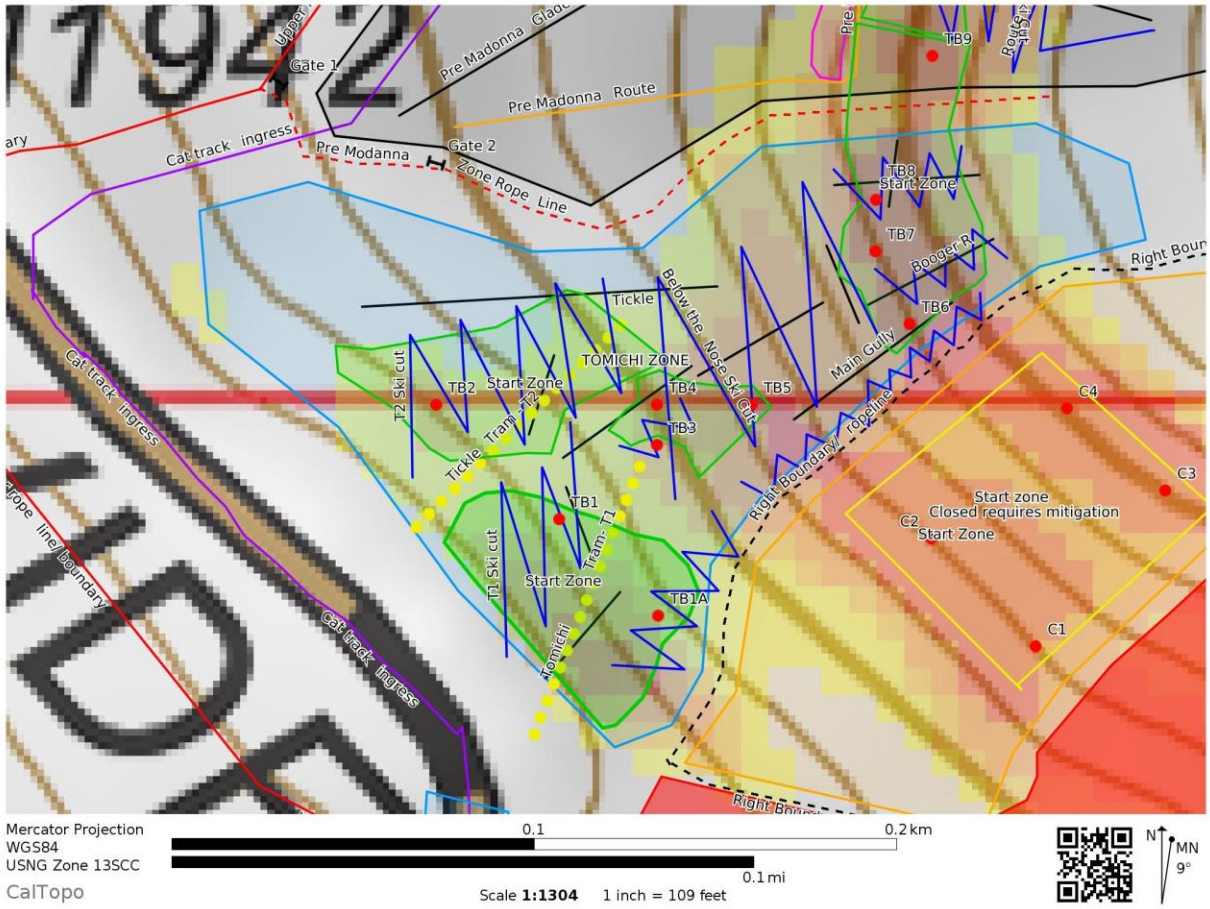
CLOSED ZONE - MAXIMUM MITIGATION REQUIREMENTS SUMMARY

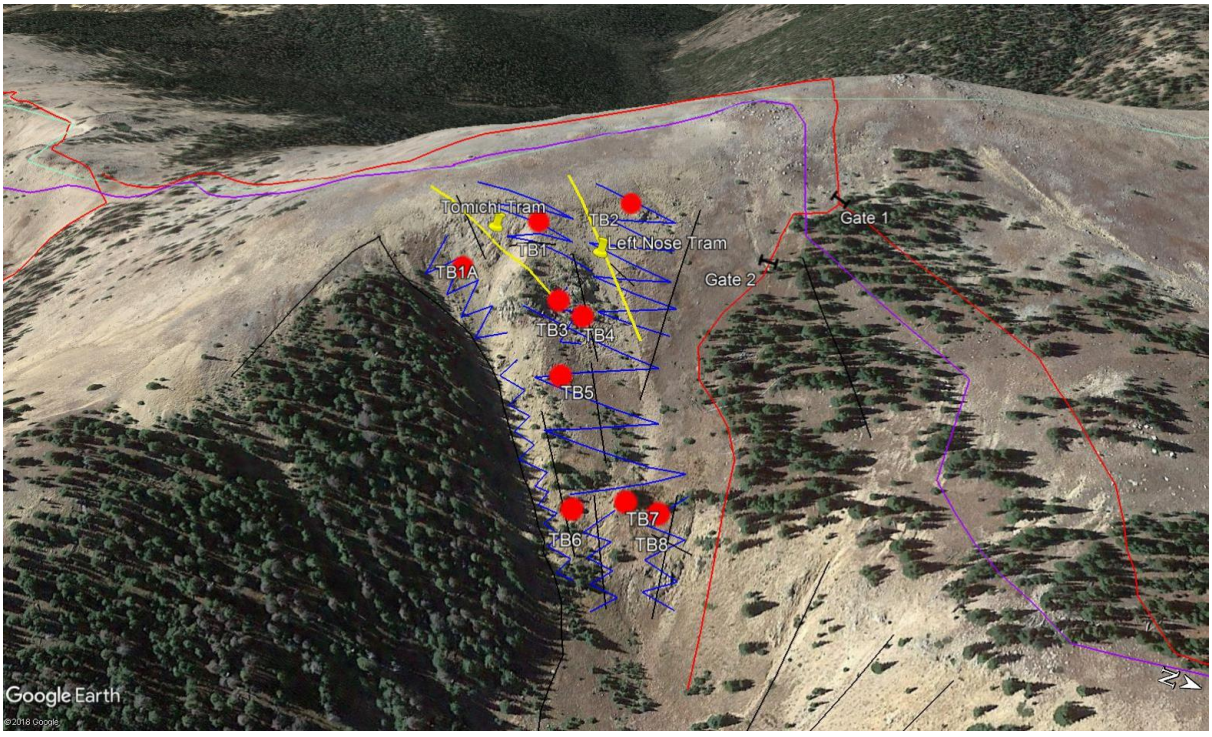
Area	**Hand Charges (max)**	**Tram Charges (max)**	**Ski Cut Routes**
Closed Zone Total	4	0	2

Tomichi Bowl Zone Mitigation

The Tomichi Zone is the first area encountered by the public after completing the hike through the ingress zone. It is a mostly East and North East facing aspect that begins at 11,700 ft.

Ground cover in the Tomichi Zone is fairly smooth in the upper parts of the paths. Mid path there is one significant terrain feature, the Tomichi Nose, that makes up a small cliff band. Lower in the zone there are more features, including small to medium sized trees and a gully on skier’s right.





Two main avalanche paths are located in the Tomichi Path as well as multiple smaller paths and start zones that must be monitored and mitigated.

Controlling Skier Access to the Tomichi Zone

Access to the Tomichi Zone is controlled via the main gate at the ingress entrance. There is no separate method for controlling skier access to this zone, so patrollers must diligently understand and check the morning plan distributed by the snow safety team for mitigation efforts in the gated terrain area. Once the main gate is open, Tomichi Bowl is open to the public.

Early Season Mitigation Considerations in the Tomichi Zone - Bootpacking and Avalanche Roller Use

A significant factor in the mitigation plan for the Tomichi Zone is early season work using both bootpacking and the avalanche roller to break up early season basal layers. The primary goal of the early season work is to minimize the persistent slab problem that could carry through the whole winter if not addressed early.
Another goal of the early season compaction is also to improve early season conditions enough so that skier compaction can begin as soon as possible.

Mitigation Routes in the Tomichi Zone - Overview

The Tomichi zone is the first zone to access in the terrain area after crossing through the Ingress zone. It is advantageous for the mitigation plan to be as efficient as possible for this zone so that the other (Premadonna and Madonna) zones can be opened in a timely manner. Some of the avalanche paths in the Tomichi Zone can run into the exit areas of the other zones, and thus some work in the Tomichi Zone may need to be completed before some areas in the other zones can be accessed safely by ski patrol.

The mitigation plan for the Tomichi Zone must address the following needs:

4. Frequent loading by prevailing winds
5. Possibility of hard slabs due to aspect and wind direction
6. A large, prominent main path that could produce large avalanches
7. Specific areas in the zone that have steeper pitches and different aspects that need addressing.
8. Steep convexities below trigger points at rocks and cliffs
9. A gully feature
10. Cornice formation

Travel Path of the Snow Safety Team in Tomichi Bowl

The mitigation plan for the Tomichi Zone is designed to allow for efficient and safe travel of the mitigation team through the zone. The team only enters an area after the appropriate mitigation methods have been applied to that piece of terrain.

The team will travel as follows after reaching the top of the zone through the ingress area:

1. Top of Tomichi / Tomichi Entrance
    a. The team can access the first explosives tram here and throw hand shots from the top of the ridge
    b. Cornice control work may need to be done here
2. Top of Tickle / Left Nose
    a. The team can access the second explosives tram here and throw hand shots from the top of the ridge
3. Tomichi Nose / Below Tomichi Nose
    a. The team traverses to the top of this feature
    b. From this point the team can direct mitigation efforts (hand charges or cuts) for below the cliff band safely.
    c. The team can then access Below Tomichi Nose
    d. The team can also access the gully below the main Tomichi Bowl if necessary from here
4. Booger
    a. There are various safe zones at the convexity of this area that allow for mitigation operations

Mitigation Plan - Top of Tomichi / Tomichi Entrance

The top of the Tomichi Bowl features a large, N/NE facing bowl that is the start zone for the main avalanche path in the zone. This area is made up of the following named runs on the Mitigation Map:

- "Top Roll"
- "South Wall"
- The top of "Tomichi Nose"

The top of Tomichi Bowl is also a common spot for the formation of cornices. These would need to be controlled either via explosives or ski cutting methods.

Explosives Tram at the top of Tomichi Bowl

A tram at the top of Tomichi Bowl (across "Top Roll") provides the capability for an efficient air blast over the top of the bowl. A hanging explosive from this tram will affect the entire top of the bowl and it's flanks. It will allow for safe and efficient movement of the control team at the top of this area.

TOP OF TOMICHI BOWL MITIGATION NEEDS ("TOP ROLL", "SOUTH WALL", TOP OF "TOMICHI NOSE")

	Early Season	**Persistent Slab Problem**	**Storm Slab**	**Wind Slab, or Storm Slab with loading Wind**
Number of patrollers	2-10. Either Avalanche	3-4	3-4	3-4

	compression roller or bootpacking.			
Number of hand charges		Large (25-50lb) ANFO shots	4 (2lb) - T1, TB1,TB1A, TB3	3 (2lb) TB1, TB1A, TB3
Number of tram charges	Consider large tram shots after compaction efforts. Possibly ANFO air blasts.	Large shots. ANFO shots from tram in addition to 5-10lb tram shots	Depends on quantity of snow.	1 (5lb) - T1
Number/details of ski cut locations	Early ski tracks if safe	no	Top Roll, South Wall, Top of Tomichi Nose	Follow Up after tram shots with Top Roll, South Wall, Top of Tomichi Nose
Other notes			Follow Up work as necessary with more ski cuts and protective skiing	Follow Up work as necessary with more ski cuts and protective skiing

Mitigation Plan - Left Side of Top of Tomichi / Top of Tickle / Left Nose

The skier's left side top of the Tomichi Bowl features a broad, N/NE facing slope that has a lower slope angle than the skier's right side described in the previous section. The right flank of this area, though, has a steep slope angle and is loaded frequently by wind and storms. This area is made up of the following named runs on the Mitigation Map:

- "Tickle"
- "Left Nose"

Explosives Tram at the skier's right side of Tickle ("Left Nose")

A tram at the top of Tickle (across "Left Nose") provides the capability for an efficient air blast over the "Left Nose". A hanging explosive from this tram will affect this steep area. It will allow for safe and efficient movement of the control team at the top of this area.

TOP OF TICKLE MITIGATION NEEDS ("TICKLE", "LEFT NOSE")

	Early Season	**Persistent Slab Problem**	**Storm Slab**	**Wind Slab, or Storm Slab with loading Wind**
Number of patrollers	2-10. Either Avalanche compression	2-4	2	2

	roller or bootpacking.			
Number of hand charges		Large (25-50lb) ANFO shots	2 (2lb) - T2, TB2	1 (2lb) - TB2
Number of tram charges	Consider large tram shots after compaction efforts. Possibly ANFO air blasts.	Large shots. ANFO shots from tram in addition to 5-10lb tram shots	Depends on quantity of snow.	1 (5lb) - T2
Number/details of ski cut locations	Early ski tracks if safe	no	Top of Tickle, Left Nose	Follow Up after tram shots with Top of Tickle, Left Nose
Other notes			Follow Up work as necessary with more ski cuts and protective skiing	Follow Up work as necessary with more ski cuts and protective skiing

Mitigation Plan - Tomichi Nose

Tomichi Nose is the prominent rock feature / cliff band that connects the right side, Tomichi Bowl, with the skiers left side, Tickle. This area is both a trigger point for slopes below due to thin snow cover near the rocks, and also provides a safe point for patrollers to stand to perform mitigation operations on the steep slopes below Tomichi Nose.

There are several small paths at and below Tomichi Nose that require accurate placement of explosive charges.

TOMICHI NOSE MITIGATION NEEDS ("TOMICHI NOSE", "BELOW THE NOSE")

	Early Season	**Persistent Slab Problem**	**Storm Slab**	**Wind Slab, or Storm Slab with loading wind**
Number of patrollers	2-10. Either Avalanche compression roller or bootpacking below Tomichi Nose	2-4	2	2
Number of hand		Large (25-50lb)	2 (2lb) - TB4, TB5	2 (2lb) - TB4, TB5

charges		ANFO shots		
Number of tram charges	N/A	N/A	N/A	N/A
Number/details of ski cut locations	Early ski tracks if safe	no	Below the Nose. Gully ski cut on skier's right as necessary	Follow Up after explosives
Other notes			Follow Up work as necessary with more ski cuts and protective skiing	Follow Up work as necessary with more ski cuts and protective skiing

Mitigation Plan - Booger

Booger is the more densely treed area below "Below Tomichi Nose" that has some steep, convex rollovers. It is a wider area so will require patrollers to spread out and may require extra manpower if it is deemed necessary to cover the entire bottom of this area (Left, Right and Air for an Old Man).

Safety zones are harder to identify in this area so patrollers must familiarize themselves with designated islands of safety in this area.

BOOGER MITIGATION NEEDS ("BOOGER RIGHT", "BOOGER LEFT", "STEEP FOR AN OLD MAN")

	Early Season	**Persistent Slab Problem**	**Storm Slab**	**Wind Slab, or Storm Slab with loading Wind**
Number of patrollers	8-10. Bootpacking only in this area (no roller) because of denser trees.	2-4	2-3 (extra manpower needed if necessary to cover entire area)	2-3 (extra manpower needed if necessary to cover entire area)
Number of hand charges		Large (25-50lb) ANFO shots	Up to 3 (2lb) - TB6, TB7, TB8 as deemed needed	3 (2lb) - TB6, TB7, TB8.
Number of tram charges	N/A	N/A	N/A	N/A
Number/details of ski cut locations	Early ski tracks if safe	no	Booger R and Booger L ski cuts	Follow Up after explosives
Other notes			Follow Up work	Follow Up work

			as necessary with more ski cuts and protective skiing	as necessary with more ski cuts and protective skiing. Pay attention to rock band “Air For an Old Man”

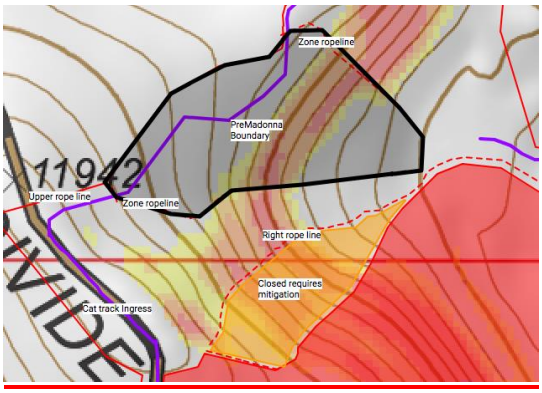
TOMICHI ZONE - MAXIMUM MITIGATION REQUIREMENTS SUMMARY

Area	**Hand Charges (max)**	**Tram Charges (max)**	**Ski Cut Routes**
Top Of Tomichi	3	1	2
Tickle / Left Nose	1	1	1
Tomichi Nose / Below the Nose	2	0	3
Booger	3	0	2
TOTAL	***9***	***2***	***8***

PreMadonna Zone Mitigation

The PreMadonna Zone (PMZ) sits to the north of Tomichi Bowl and features east and southeast facing terrain. The PreMadonna Glades are the highest point in zone at an elevation of 11,800ft. The zone provides 400 feet of vertical terrain for the Big Pow Mountain guests. The terrain features steep, convex and concave rollovers, rock outcroppings and tree clusters.

The PreMadonna Zone consists of smaller avalanche paths and terrain features that will need to be mitigated to ensure safe recreating for the Big Pow Mountain guests.



Controlling Skier Access to the PreMadonna Zone

A strategic rope line in between the Tomichi and PreMadonna zones is used to control skier traffic entering the PreMadonna Zone. Skier traffic is prohibited from crossing under this rope and must enter the PreMadonna Zone through Gate 1, or Gate 2. These gates will give snow safety teams the ability to open the Tomichi Zone while keeping other areas closed as they work through their mitigation plan.

Early Season Mitigation Considerations in the PreMadonna Zone - Bootpacking

One key component in the mitigation plan for the PreMadonna Zone (PMZ) will be an early season bootpacking program. Given the short vertical of the PMZ, boot packing will be an effective technique used to disrupt weak, early season basal layers. This program will begin in late October/early November and will minimize a persistent slab avalanche problem, that can linger throughout an entire operating season. The bootpacking program will also help to consolidate early season snow, creating a base for early season skier compaction.

Mitigation Routes in the PreMadonna Zone – Overview

In most cases, the PMZ will open following the Tomichi Zone opening. This will allow for teams to clear paths in the Tomichi Zone that have the potential to impact the Pre Madonna Zone. Once the areas in Tomichi Zone have been cleared, the snow safety team will be allowed to proceed into the PMZ. The shorter avalanche paths of the PreMadonna Zone do not impact the Tomichi or Madonna Zones.

Mitigation plans for the PreMadonna Zone must address the following needs:

1. Numerous steep isolated terrain features
2. Rock outcroppings
3. Soft slab and wind slab instabilities
4. Efficient use of patrol resources
5. Limited safe zones while traveling through terrain

Travel Path of the Snow Safety Team(s) in PreMadonna Zone

The mitigation plan for the PreMadonna Zone prioritizes worker and guest safety. The plan is designed to provide safe working and skiing conditions, through a systematic avalanche mitigation strategy. The following route and travel recommendations are designed to limit the risk to workers while allowing for a timely opening of the PreMadonna Zone terrain.

The snow safety team will follow the travel routes outlined below:

1. Don't Tell Me/Detroit
    a. Team will enter through Gate 2 and travel to TB9 to begin explosive mitigation.
    b. Team will ski cut any small terrain features along way
    c. Shot locations- TB9, PM1 and PM2 will impact Don't Tell Me and Detroit runs
    d. Once control work has been completed in these locations the team will move to PM3

2. The Edge/M&M
    a. Team will continue along designated path to PM3, the M&M Tram (T3) and then PM4.
    b. This work will mitigate The Edge and M&M ski runs.
    c. Once control has been completed at PM4 the team will move onto PM5

3. Last Chance
    a. Team will travel to PM5 to begin explosive work in the Last Chance ski run.
    b. Following PM5 control work, team will travel to lower safe zone.

Mitigation Plan – Don't Tell Me/Detroit

This area is accessed by entering through Gate 1, or Gate 2 and features east facing terrain, steep features, and small rock features. The main terrain of concern is near 11,600ft and runs down to 11,400ft.

Don't Tell Me/Detroit will be mitigated using early season bootpacking, explosives and ski cuts during the operating season.

Don't Tell Me/Detroit Mitigation Needs

	Early Season	**Persistent Slab Problem**	**Storm Slab**	**Wind Slab, or Storm Slab with loading Wind**

Number of patrollers	5-10 Boot Packers.	2-3	2	2
Number of hand charges		Large (25-50lb) ANFO shots	3 (2lb) – TB9, PM1,PM2	3 (2lb) TB9, PM1,PM2
Number of tram charges	N/A	N/A	N/A	N/A
Number/details of ski cut locations	Early ski tracks if safe	no	DTM Ski Cut Route, Detroit Ski Cut Route	Follow explosives with ski cuts where applicable
Other notes			Continue to monitor and ski cut as needed.	Continue to monitor and ski cut as needed.

Mitigation Plan – The Edge/M&M

The Edge and M&M ski runs are adjacent to the ski run named Detroit and contain the steepest terrain in the PreMadonna zone. These runs feature steep, open terrain and small terrain features that must be closely monitored. Located below treeline, this terrain is not as exposed to wind loading and snow transport when compared to Tomichi Bowl. Snow profiles showed a snowpack composed of facets, ranging in slab hardness of fist hard to four finger hardness, resting on top of well developed depth hoar.

The Edge/M&M will be mitigated using early season bootpacking, hand charges, the M&M tram and ski cuts during the operating season.

Explosives Tram on the skier's right side of M&M

A tram running the length and fall line of the starting zone in M&M provides the capability for an efficient air blast over a steep section of terrain. The tram will allow for safe travel from PM6 to PM4

The Edge/M&M MITIGATION NEEDS

	Early Season	Persistent Slab Problem	Storm Slab	Wind Slab, or Storm Slab with loading Wind
Number of patrollers	5-10. Bootpackers.	2-3	2	2
Number of hand charges		Large (25-50lb) ANFO shots	2 (2lb) – PM3, PM4	2 (2lb) – PM3, PM4
Number of tram charges		Large shots. ANFO shots from tram in addition to 5-10 lb tram shots	Depends on quantity of snow.	2 (2lb) – PM3, PM4
Number/details of ski cut locations	Early ski tracks if safe	no	Edge/M&M ski cut route	Follow up after explosive work using outlined ski cut route
Other notes			Continue to monitor and ski cut as needed.	Continue to monitor and ski cut as needed.

Mitigation Plan – Last Chance

The Last Chance area is at the north east end of the PreMadonna Zone, adjacent to Madonna Ridge. This terrain features steep rollovers, scattered trees and ground covering made up of alpine vegetation and rocks. Last Chance is an east- southeast aspect and the main terrain of concern is from 11,650 ft – 11,460 ft in elevation.

Last Chance MITIGATION NEEDS

	Early Season	Persistent Slab Problem	Storm Slab	Wind Slab, or Storm Slab with loading Wind
Number of patrollers	5-10. Bootpackers.	2-3	2	2

Number of hand charges		Large (25-50lb) ANFO shots	2 (2lb) – PM5, PM6	2 (2lb) – PM5, PM6
Number of tram charges	N/A	N/A	N/A	N/A
Number/details of ski cut locations	Early ski tracks if safe	no	Last Chance ski cut route	Follow up after explosive work using outlined ski cut route
Other notes			Continue to monitor and ski cut as needed.	Continue to monitor and ski cut as needed.

PREMADONNA ZONE MAXIMUM MITIGATION REQUIREMENTS SUMMARY

Area	**Hand Charges (max)**	**Tram Charges (max)**	**Ski Cut Routes**
Don't Tell Me/Detroit	3	0	2
The Edge/M&M	1	2	1
Last Chance	2	0	1
TOTAL	**6**	**2**	**4**

<u>Madonna Zone Mitigation</u>

Madonna Ridge extends out to the northeast of the Premadonna Zone with the highest point reaching 11,750 feet. This is the farthest hike-to terrain in the new expansion plan. This zone is predominantly a ESE aspect with NE and S micro aspects within the terrain features. Terrain features within the zone are convex rolls, chutes, rock-bands and cliffs, and gladed trees.

Controlling Skier Access to the Madonna Zone

Skier traffic in the Madonna Zone will be controlled by the permanent boundary rope line and the vertical Madonna Zone ropeline, with access to this area through the Madonna Gate. The vertical rope line will also be marked with signs stating ‘Enter Through Gates Only’, and will prevent public from accessing this area while control work is being conducted. The Madonna Gate is the only way for public to enter this zone, and will open after mitigation is complete and conditions are safe.

Early Season Mitigation Considerations in the Madonna Zone - Bootpacking

Big Pow Mountain’s bootpacking program will also enter the Madonna Zone. Ideally, we will have bootpackers in the area once snow consistently begins to accumulate in early October to disrupt early season weak layers, and to create a harder base layer for the rest of the season. Bootpacking in this zone will end once we have artificially packed in the early season snow, and when the snow reaches depths of one meter. The Madonna Zone is too heavily forested and rocky for an avalanche roller to enter the area.

Mitigation Routes in the Madonna Zone – Overview

Mitigation in the Madonna Zone will be the last priority, after both Tomichi Bowl and PreMadonna have been opened to public. All slide paths in this zone do not affect the egress, nor will affect skier traversing with the installment of the Madonna Zone Rope Line. The backcountry access gate cannot be accessed by skier traffic until this zone has been mitigated.

Mitigation plans for the Madonna Zone must address the following needs:

1. Numerous steep isolated terrain features
2. Rock outcroppings
3. Soft slab and wind slab instabilities
4. Efficient use of patrol resources
5. Limited safe zones while traveling through terrain

Travel Path of the Snow Safety Team(s) in Madonna Zone

The following route and travel recommendations are designed to limit the risk to workers while allowing for a timely opening of the Madonna Zone terrain. Depending on the conditions, patrol will perform an explosives route, ski cut route, or both.

The snow safety team will follow the travel routes outlined below:

1. Madonna Route 1
    a. Patrol will begin at the top of Madonna Ridge and move south towards the start zone of Vogue, placing shots along the way at the top of Material Girl (M4), Papa Don't Preach (M3), and Vogue (M1).
    b. Long toss of shot into mid path of Vogue (M8) will be considered
    c. Teams will then move skiers left towards Kabbalah shot placement high (M2) and low (M9), Lower Papa Don't Preach (M10) and, Lower material Girl (M11) and Left Material Girl (M12)
    d. Up-slope or cross-slope shot into Grumpy's (M13)
    e. Shot placement locations are not mandatory and will be evaluated depending on snow conditions
    f. Team will exit terrain

2. Madonna Route 2
    a. Patrol will move northeast along boundary into Canary Silence Paths
    b. Cover shot will be thrown into upper Grumpy's (M5)
    c. Shot placement in start zone of canary Silence Near (M6), and working towards Canary Silence Mid shot placement (M7)
    d. Team will descend into lower Canary Silence Mid (M15), finishing will cross-slope shot placement in lower Canary Silence Near (M14)

e. Shot placement locations are not mandatory and will be evaluated depending on snow conditions
f. Team will exit terrain

3. Madonna Ski Cut Route 1
    a. Cutting route will allow for patrollers to work different terrain individually
    b. 1a will ski cut into Vogue and kabbalah
    c. 1b will ski cut into Papa Don't Preach and Material Girl
    d. Cut route may be incorporated into explosive route
4. Madonna Ski Cut Route 2
    a. Cutting route will allow for patrollers to work different terrain individually
    b. 2a will ski cut into the canary Silence areas
    c. 2b will ski cut into Grump's and Like a Prayer
    d. Cut route may be incorporated into explosive route

Mitigation Plan – Vogue/Kabbalah

Early season, we will send our bootpacking crews through the main fall line of Vogue and Kabbalah. Vogue's start zone is a dish protected by trees that will likely become evenly loaded throughout a storm event. Lower Vogue maintains a steady pitch throughout, and will also see an even amount of loading. Both of these zones may require a hand charge during a storm event. Kabbalah's start zone is sheltered within the trees, with it's runout entering a choke through some rocks. Mid path may see some cross loading, and also may require a hand charge.

Vogue/Kabbalah MITIGATION NEEDS

	Early Season	**Persistent Slab Problem**	**Storm Slab**	**Wind Slab, or Storm Slab with loading Wind**
Number of patrollers	Bootpack	2-3	2	2
Number of hand charges	2	2 (7-15lb ANFO)	4	4
Number of tram charges	N/A	N/A	N/A	N/A
Number/details of ski cut locations	1a	No	1a	1a if soft slab

Other notes	Bootpack	Deep layer of concern	Continue to monitor and ski cut as needed.	Continue to monitor and ski cut as needed.

Mitigation Plan – Papa Don't Preach/Material Girl

Both Papa Don't Preach and Material Girl will require early season bootpacking. The start zone of PDP is sheltered, while mid path consists of a choke through rocks. The upper zone will most likely see an even amount of loading and may require a shot, while mid path may become cross loaded and will almost always need a shot. Material Girl is very similar to PDP, requiring a shot in the sheltered start zone and the cross loaded mid path choke.

Papa Don't Preach/Material Girl MITIGATION NEEDS

	Early Season	**Persistent Slab Problem**	**Storm Slab**	**Wind Slab, or Storm Slab with loading Wind**
Number of patrollers	Bootpack	2-3	2	2
Number of hand charges	2	2 (7-15lb ANFO)	4	4
Number of tram charges	N/A	N/A	N/A	N/A
Number/details of ski cut locations	1b	No	1b	1b if soft slab
Other notes	Bootpack	Deep layer of concern	Continue to monitor and ski cut as needed.	Continue to monitor and ski cut as needed.

Mitigation Plan – Grumpy's/Like a Prayer

Bootpack early season to disrupt faceting process. Grumpy's and Like a Prayer have a convexity at the top start zone, and mostly consisting of gladed trees throughout the paths. Grumpy's may require a cover shot up high, while both paths may need a hand charge mid path.

Grumpy's/Like a Prayer MITIGATION NEEDS

	Early Season	**Persistent Slab Problem**	**Storm Slab**	**Wind Slab, or Storm Slab with loading Wind**
Number of patrollers	Bootpack	2-3	2	2
Number of hand charges	3	2 (7-15lb ANFO)	3	3
Number of tram charges	N/A	N/A	N/A	N/A
Number/details of ski cut locations	2b	No	2b	2b

Mitigation Plan – Canary Silence Near/Mid/Far

These paths are shorter and less steep than the rest of the Madonna Zone. Bootpacking early season is preferred. Being that these paths are in the glades, they may end up seeing lower slab quality than the rest of the paths in the zone. The Canary Silence paths may also end up seeing less skier traffic, as this is the farthest terrain to access. With less skier traffic we will want to test and texture the snow with up to 4 hand charges; 2 high, 2 low.

Canary Silence Near/Mid/Far MITIGATION NEEDS

	Early Season	**Persistent Slab Problem**	**Storm Slab**	**Wind Slab, or Storm Slab with loading Wind**
Number of patrollers	Bootpack	2-3	2	2
Number of hand charges	4	2 (7-15lb ANFO)	4	4

Number of tram charges	N/A	N/A	N/A	N/A
Number/details of ski cut locations	2a	No	2a	2a
Other notes	Texture as much as possible	Post slab	Continue to monitor and ski cut as needed.	Continue to monitor and ski cut as needed.

MODANNA - Mitigation SUMMARY

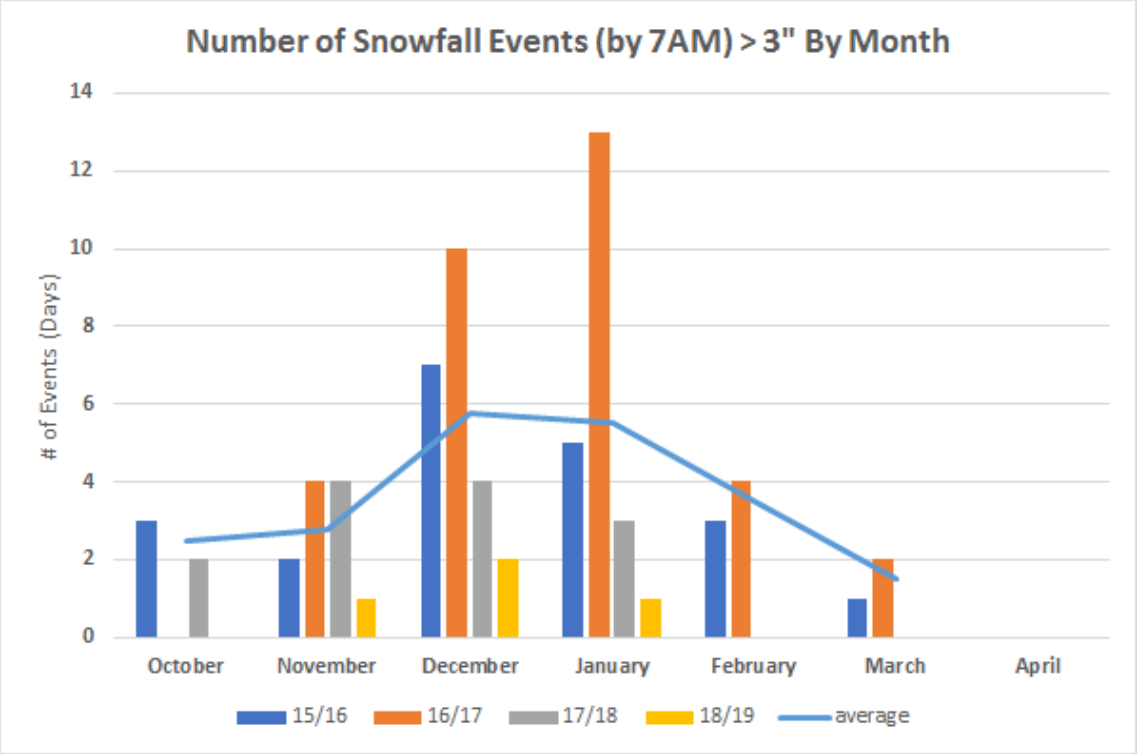
Area	**Hand Charges (max)**	**Ski Cut Routes**
Vogue	2	1
Kabbalah	2	1
Papa Don't Preach	2	1
Material Girl	2	1
Grumpy's	2	1
Like A Prayer	1	1
Canary Silence (Near/Mid/Far)	4	1
TOTAL	15	4

Mitigation Budget

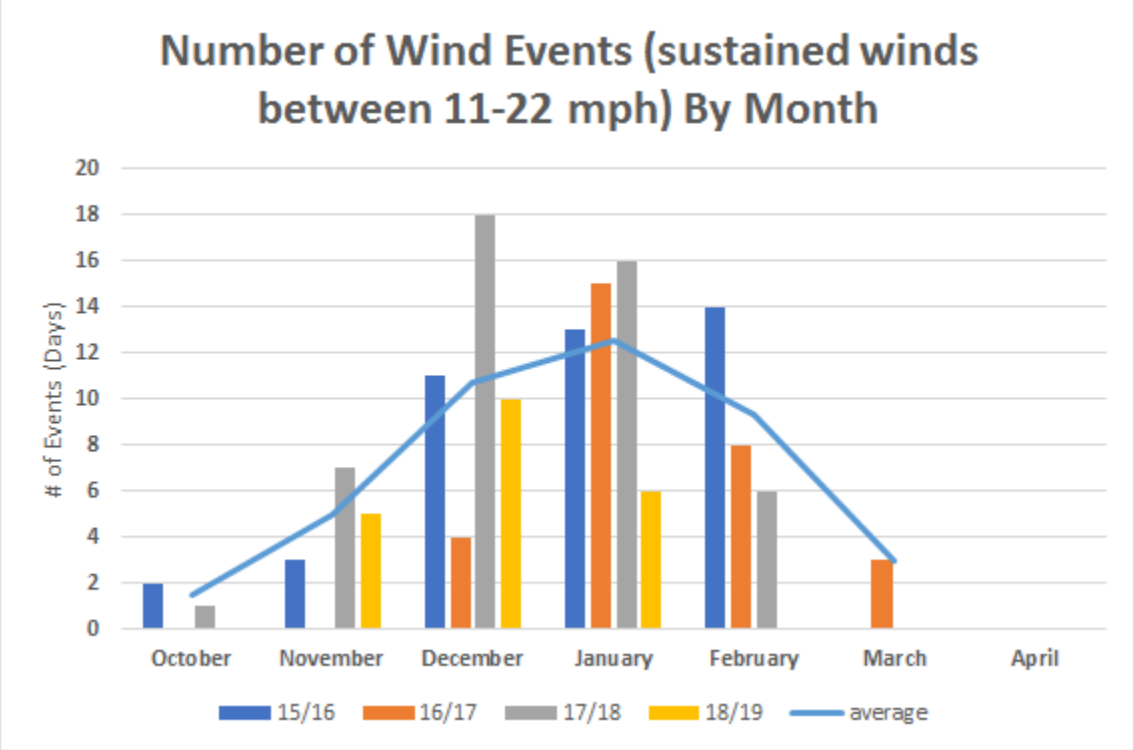
Determining the mitigation budget:

To determine the number of events that may require the use of explosives, data from the last 4 seasons were analyzed. Criteria were as follows:

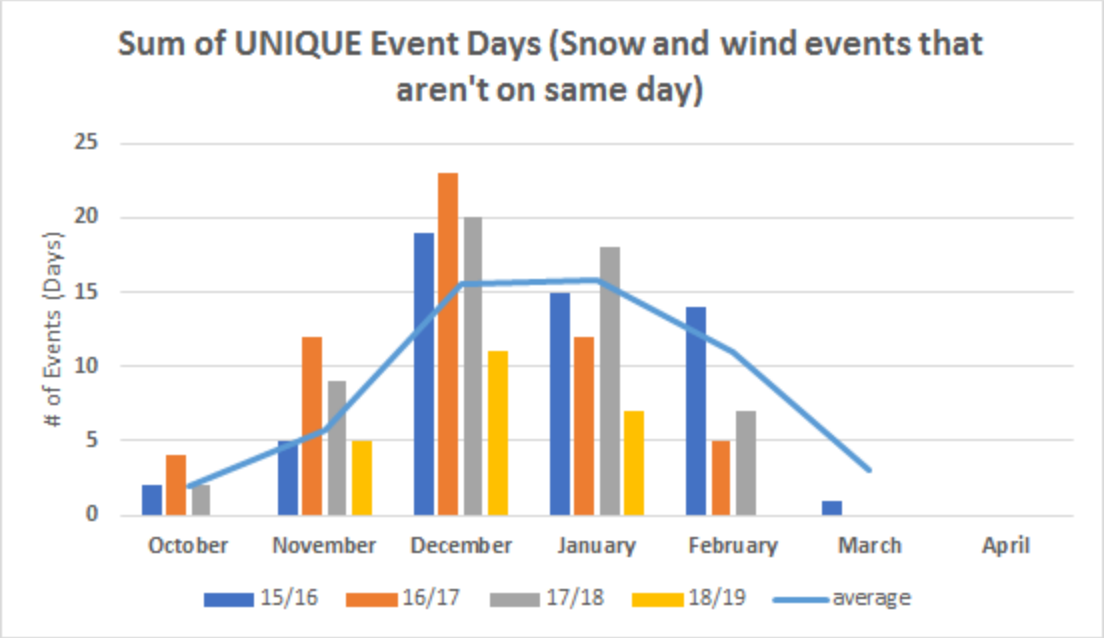
- Number of snow events per month, defined as >3" measured by 7AM
- Number of wind events per month, defined as sustained winds between 11-22 mph.
- The sum of *unique* event days, i.e. a day with both snow greater than 3" as well as sustained moderate winds counts as 1 day.



Total average event days due to snow (given data provided): 22 days



Total average event days due to wind (given data provided): 42 days



Total average unique event days (given data provided): 53 event days

For the events below, a slightly lower number is used because not all events will require action in all zones.

INGRESS ZONE

Explosives Type	Quantity per Month	Price per unit	Months per season	Total per season
2lb Cast Booster	4	$16.75 ea.	5	$335.00
5lb Cast Booster	4	$36.00 ea.	5	$720.00
CIL/Orion Mildet 1 meter cap and fuse	16	$10.00 ea.	5	$800.00
Pull wire igniters	16	$340.00 per (100 case)	5	$340.00
			Annual Total:	$2,195.00

TOMICHI ZONE

Explosives Type	Quantity per event (max)	Price per unit	Events (avg)	Total per season
2lb Cast Booster	9	$16.75 ea.	45	$6,784
5lb Cast Booster	2	$36.00 ea.	20	$1,440

(will use these as tram shots)				
ANFO	**50 lb**	**$85 per 100 lb**	**4**	**$170**
2lb Cast Booster for ANFO shots	**4**	**$16.75**	**1 cast booster for each ANFO shot**	**$67**
CIL/Orion Mildet 1 meter cap and fuse (double)		**$10.00 ea.**	**TOTAL FOR ALL SEASON: 810 (2lb) + 80 (5lb) + 8 (ANFO) = 898**	**$8,980**
Pull wire igniters (double)		**$340.00 per 100**	**898**	**$3,053**
			Annual Total:	**$20,494**

PREMADONNA ZONE

Explosives Type	Quantity per event (avg)	Price per unit	Events (avg)	Total per season
2lb Cast Booster	**6**	**$16.75 ea.**	**35**	**$3,517**
5lb Cast Booster (will use these as tram shots)	**2**	**$36.00 ea.**	**20**	**$1440**
ANFO	**50 lb**	**$85 per 100 lb**	**4**	**$170**
2lb Cast Booster for ANFO shots	**4**	**$16.75**	**1 cast booster for each ANFO shot**	**$67**
CIL/Orion Mildet 1 meter cap and fuse	**26**	**$10.00 ea.**	**20**	**$5,200**
Pull wire igniters	**26**	**$340.00 per 100**	**20**	**$1768**
			Annual Total:	**$12,162**

MADONNA ZONE

Explosives Type	Quantity per event (avg)	Price per unit	Events (avg)	Total per season
2lb Cast Booster	15	$16.75 ea.	35	$8,793.75
5lb Cast Booster (will use these as tram shots)	0	$36.00 ea.	20	N/A
ANFO	50lbs	$85 per 100 lb	4	$170
2lb Cast Booster for ANFO shots	4	$16.75	4	$268.00
CIL/Orion Mildet 1 meter cap and fuse	19	$10.00 ea	39	$7,410.00
Pull wire igniters	19	$340.00 per 100	39	$2,728.00
			Annual Total:	$19,369.75

TOTAL MITIGATION BUDGET

Explosives Type	Quantity per event (avg)	Price per unit	Events (avg)	Total per season
2lb Cast Booster	34	$16.75 ea.	45	$19,429.75
5lb Cast Booster (will use these as tram shots)	8	$36.00 ea.	20	$3,600
ANFO	150lb	$85 per 100 lb	4	$510
2lb Cast Booster for ANFO shots	12	$16.75	4	$402
CIL/Orion Mildet 1 meter cap and fuse	76	$10.00 ea.	45	$22,390

Pull wire igniters	**76**	**$340.00 per 100**	**45**	**$7,889**
			Annual Total:	**$54,220.75**

Terrain Features Table

- Avalanche size references the maximum size of each path prior to terrain expansion with backcountry snowpack present/no mitigation efforts.

Name	Start Zone Elevation	Aspect	Slope Angles	Maximum avalanche size	Notes:
INGRESS					
Start Zone	11,700 ft	E	30-35	D2	Top of ridgeline above patrol hut and just after main entrance gate for hiking route. Large cornice(s) build here and create overhead hazard
TOMICHI BOWL					
Top Roll	11,900 ft	NNE	35	D3	First prominent rollover below main timber sign. Wind load here or cross loading here as well as cornice formation
South Wall	11,860 ft	S	40	D2.5	Steep wall of the south side (skiers right side of tomichi's nose)
Below Tomichi Nose	11,790 ft	ENE	32	D2.5	Planar slope below tomichi's nose, continues all the way to next convex rollover below

Main gully	11,700 ft	ENE	33	D2	Manage with ski cuts. Wall with NW facing aspect along skiers right side.
Steep Rock Rollover	11,660 ft	ENE	35-37	D2	Convex roll over starts below the Below Tomichi Nose area. HS 150cm average
Tomichi's Nose	11,790 ft	ENE	32	D2	Pillow below rock band S and E facing was HS 125- 170cm
Steep for an old man	11,612 ft	E	35	D2	Rocky roll over at the end of the Tomichi & Pre Modanna rope line. Wind pillow here and a rock band that rolls over steep
PREMADONNA					
Don't Tell Me	11,657ft	ESE	36 at start zone, avg 34	D2	First gully in Pre-Madonna zone.

Detroit	11,647ft	SE	34	D2	Second gully in Pre-Madonna Zone. Snow loads deeply at the top of this area. Need to sidestep uphill when coming from Don't Tell Me when doing mitigation in order to stay in safe zone
The Edge	11,634ft	SE	34	D2	Third run feature in Pre-Madonna Zone. Snow loads deeply at the top of this area.
M&M	11,634ft	SE	Avg 35 with steeper sections of 38 and some cliffs.	D2	Larger open area in Pre-Madonna zone. Has numerous cliffs where snow is thinner. Many trigger points. Steeper roll mid-lower slope that need to be considered.
Last Chance	11,640ft	SE	Avg 34 with steeper sections of 37	D2	Open area adjacent to Madonna Zone rope line.

MADONNA					
Vogue	11,644 ft	SE	34	D3	Nearest run to PreModanna and vertical ropeline. Dish feature start-zone
Kabbalah	11,653 ft	SE	34	D2	Convex roll start zone with chute through rocks mid path
Papa Don't Preach	11,697 ft	SE	35	D3	Third run to east; Convex roll start zone with rocks skiers right mid path
Material Girl	11,690 ft	SE	37	D3	Fourth run to east; Convex roll start zone with dish-like mid path through rocks
Grumpy's	11,630 ft	SE	36	D3	Steady convex roll with sparse gladed trees
Like a Prayer	11,730 ft	SE	34	D3	Gladed start zone, convex roll mid path with sparse trees and some rocks
Canary Silence (Near/Mid/ Far)	11,605 ft	SE	35	D3	Farthest east terrain; Gladed trees with some small rock features and opening down low