

ASPEN SNOWMASS NORDIC TRAIL SYSTEM MANAGEMENT PLAN APPENDICES

Summer 2026





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APPENDIX A: EXISTING TRAIL SYSTEM

EXISTING TRAIL DESCRIPTIONS

Aspen Golf Course & Cross Country Center

The Aspen Cross-Country Center is located at the Aspen Golf Course, 1 mile west of downtown Aspen off Highway 82. The Center offers ski lessons, tours, retail shop, rentals, a lounge, lockers, snacks, and videos. **Difficulty:** Beginner. **Length:** 5 km. **Access:** RFTA bus service available. Moore, Marolt and High School trails are all easily accessible from the golf course trails.

Bernese Boulevard

Located on the Aspen Golf Course, the Bernese Boulevard provides dog owners and their pets a scenic route around the perimeter of the golf course. Please keep your pet under control at all times. **Difficulty:** Beginner. **Length:** 3.2 km.

High School Trails

The High School tracks offer excellent skiing on varied terrain, and in warmer weather have better snow conditions because of the higher elevation and exposure. A shorter 3 km loop omits the steeper hills, and a longer 5 km loop negotiates hillier terrain. **Difficulty:** Intermediate/Advanced. **Length:** 5 km.

James E. Moore Trail

The James E. Moore Trail has a short loop and a connecting trail to the High School, Iselin and Owl Creek trails. Both the flat connecting trail and loop wind through open sage areas that are home to deer; fox and other wildlife. **Difficulty:** Beginner and Intermediate. **Length:** 3.2 km. **Access:** The safest access is via the roundabout pedestrian underpass. Or, from the parking lot at the Aspen Golf Course, cross under Highway 82 on foot and go 200 feet to the left (east). RFTA bus service available.

Marolt Property Trails

These tracks are used primarily as an access route between the west end of Aspen and the Aspen Golf Course and the High School tracks. Dogs are allowed on designated routes only. **Difficulty:** Beginner. **Length:** 2.4 km. **Access:** From Aspen via the Marolt Trail, by foot, take Hopkins west to 7th Street and go left, then turn right at the Marolt Pedestrian Bridge.

Maroon Creek Club Trails

These tracks are accessed from the Tiehack Nordic Bridge, the old Highway 82 Bridge from the Aspen Nordic center, or from the Buttermilk base area. **Difficulty:** Intermediate. **Length:** 3.2 km on and around the golf course. **Access:** Pick up the tracks beyond the Panda Peak lift at the Buttermilk Base area. RFTA bus service available.

Snowmass Golf Course

The Snowmass Golf Course trail system is the western hub of the Aspen/Snowmass Nordic Trail System. The Cross-Country Center, located on the golf course, has a retail shop, snack bar, restaurant, lessons, rentals and tours. **Difficulty:** Beginner through Intermediate. **Length:** 8 km. **Access:** By car from Aspen or Snowmass, take Brush Creek Road and turn left onto Club House Drive. By bus, take the free skier shuttle to Snowmass Village, and get off at Town Park Station

Labrador Lane

Labrador Lane is a dog friendly trail at the Snowmass Cross-Country Center. **Length:** 3.2 km. **Access:** Follow instructions for Snowmass Cross-Country Center listed above.

Village Way

Village Way is a multi-use access route between Snowmass Village and the Snowmass Golf Course tracks. The trail is fairly steep and not generally groomed for cross country skiing, making the route challenging in either direction. Dogs are allowed. **Difficulty:** Intermediate **Access:** From Snowmass Village, this is best reached from the bottom of the Assay Hill Lift. From the golf course, follow the same direction as the Owl Creek Trail but turn right after Owl Creek Road.

Terminator

The Terminator trail, which loops around the Two Creeks development, is an exciting trail for advanced cross-country skiers. This loop can also be used to access the Owl Creek Trail. **Difficulty:** Advanced. **Length:** 5 km for the loop. **Access:** Follow the same direction as the Owl Creek Trail but continue straight uphill after crossing Owl Creek Road.

Owl Creek Trail

This popular and scenic trail connects Aspen and Snowmass Village, hugging the south side of the Brush Creek and Owl Creek valleys. The easiest and most popular stretch of trail runs from the West Buttermilk Road to the Snowmass Cross-Country Center. Another popular option from West Buttermilk Road is to ski to Glendale Divide and back. The Terral Wade (Tiehack) Bridge allows skiers seamless access to the Owl Creek Trail from the Aspen Cross-Country Center. Follow the green disks to stay on course when crossing the Buttermilk Ski Area. Be aware and yield to downhill skiers. **Difficulty:** Intermediate; most of the trail is good for beginners, but the occasional hills add some difficulty. **Length:** 14.5 km from the Aspen Golf Course to the Snowmass Cross-Country Center. **Access:** *Snowmass Village:* Village Way Trail or Snowmass Cross-Country Center. Follow signs. *West Buttermilk Road:* Drive west on Owl Creek Road from Highway 82 to West Buttermilk Road, turn left. The Owl Creek Trail crosses 1.4 miles up the road, by a small parking area on the right. *Tiehack:* Experienced skiers can ski from the base of Tiehack up along the right side of the alpine trail to the Oregon Trail towards and across Main Buttermilk. Follow the green disks. *Aspen Golf Course:* **Access** Tiehack via the James E. Moore Trail and the Terral Wade Bridge.

Rio Grande Trail

A popular walking, skiing and snowshoeing trail, the Rio Grande follows the old Denver and Rio Grande Railroad bed along the Roaring Fork River. The trail gently meanders through the quiet woods and open sage areas. Note: the snow can deteriorate quickly on this trail. The Rio Grande is a dog friendly trail. Dog owners are required to keep their companion on a leash and to pick up after their pet. **Difficulty:** Beginner **Length:** Up to 32 km one way, from Aspen to Basalt: **Access:** The eastern end starts behind the Aspen Post Office. Numerous additional access points exist between Aspen and Basalt. RFTA bus service available.

Maroon Creek Road

The county road to Maroon Lake is not plowed in the winter due to USFS winter closure. T-Lazy 7 operates snowmobile tours to the lake and grooms the road to the lake. There are no classic tracks, but it is a gentle climb with nice scenery. Check Colorado Avalanche Information Center (<http://avalanche.state.co.us>) for information on backcountry conditions. Respect closed signs. Share the trail with other users. **Difficulty:** Beginner/intermediate. **Length:** 10 k to Maroon Lake. **Access:** Drive 3.5 miles up Maroon Creek Road until the road is closed. Park in the lot across from the stables. Dogs are allowed.

North Star Nature Preserve Loop

The Preserve is 175 acres of land east of Aspen that has been preserved to allow its natural ecology to continue with a minimum of human impact. Cross-country skiing and snowshoeing are one of the few uses permitted on the flat, open meadows close to the Roaring Fork River. Please stay on marked trails and respect the wildlife. **Difficulty:** Beginner. **Length:** A little over 2.4 km. **Access:** Go 1.5 miles east of Aspen on Highway 82 and look for the small parking area on the right.

Benedict Trail

This section of trail serves as a connection from the East end of Aspen to the North Star Nature Preserve. It is narrow, winding and mostly in the trees. A small portion of the trail is subject to avalanche danger. **Difficulty:** Intermediate. Not suitable for skating. **Length:** 2.5 km from Ute Avenue to North Star Nature Preserve. **Access:** Follow Ute Avenue to the Ute Trail parking lot, then up a public access 100 yards to where the trail crosses. RFTA bus service available.

Independence Pass Road

This road is not plowed in the winter. Check Colorado Avalanche Information Center (<http://avalanche.state.co.us>) for information on backcountry conditions. Share the trail with other users. **Difficulty:** Beginner through Intermediate. **Length:** Up to 25 km one way. **Access:** Drive 5 miles east of Aspen on Hwy 82 until the road is closed. Dogs are allowed.

EXISTING TRAIL MAPS

Aspen Area Trails

TRAIL RULES & ETIQUETTE



HAVE FUN, BE SAFE Remember sunscreen, water and in case of emergency, call 911 from a cell phone.



DOGS are only allowed on the dashed trails depicted on this map. Please keep your dog under control, and remember to pick up after your dog. Also, we ask that you keep dogs leashed around the Nordic Center.



BIKES Fat tire bikes are not permitted on the Nordic ski trail system, with the exception of the Rio Grande Trail and the Marolt Trails, or other marked routes.



SNOWSHOEING & WALKING Walkers are only allowed on the dashed trails depicted on this map. Otherwise we ask that you have skis on your feet! Snowshoeing is allowed on our groomed trails, but please do not walk on the classic ski tracks and stay to the edge of the trail, especially in soft conditions.



MOTORIZED VEHICLES No motorized vehicles are allowed on the trail system.



PRIVATE PROPERTY Many of our trails cross private property, and we are grateful for the support of local land owners. Skiing off trail jeopardizes our access so please stay on the groomed trail, especially on the Owl Creek Trail.

SIGNAGE SYSTEM



You'll notice that each trail has a number. The numbers ending in zeros (10, 20, 30, etc.) are considered main loops. The spur trails and connectors off of the main loops are numbered sequentially (11, 12, 21, etc.) Collectively, this numbering system will help you find your way around each area as well as help you connect from trail to trail.



Every trail is color coded according to the difficulty level of the terrain – green is easiest, blue is intermediate and black is advanced.



When in doubt, look for trail maps posted at major intersections.



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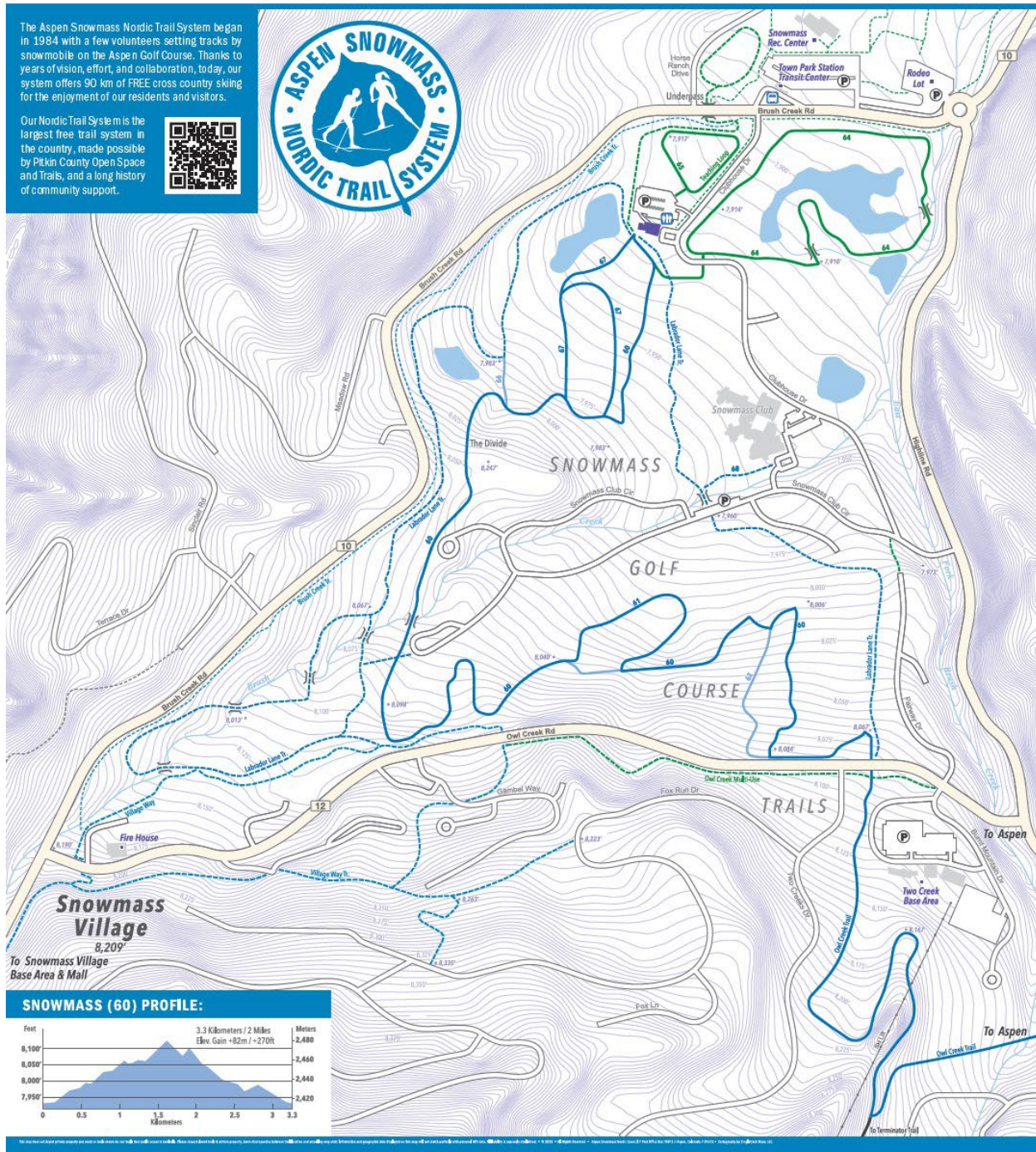
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The Aspen Snowmass Nordic Trail System began in 1984 with a few volunteers setting tracks by snowmobile on the Aspen Golf Course. Thanks to years of vision, effort, and collaboration, today, our system offers 90 km of FREE cross country skiing for the enjoyment of our residents and visitors.

Our Nordic Trail System is the largest free trail system in the country, made possible by Pitkin County Open Space and Trails, and a long history of community support.



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Every trail is color coded according to the difficulty level of the terrain – green is easiest, blue is intermediate and black is advanced.

When in doubt, look for trail maps posted at major intersections.



TRAIL RULES & ETIQUETTE

HAVE FUN, BE SAFE Remember to bring sunscreen and water. In case of emergency, call 911 from a cell phone.

NO DOGS allowed on the Owl Creek Trail or the Terminator Trail.

NO MOTORIZED VEHICLES No vehicles are allowed anywhere on the trail system.



SNOWSHOEING & WALKING Walkers are only allowed on dashed trails. Snowshoeing is allowed on groomed trails, but please do not walk on the classic ski tracks and stay to the edge of the trail, especially in soft conditions.

BIKES Fat tire bikes are not permitted with the exception of the Rio Grande Trail and the Marolt Open Space, or other marked routes.



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LEGEND

Nordic Ski Trail (Skiing Only, See Difficulty Below) 

Multi-Use Trail (Walking, Snowshoes & Dogs Allowed) 

Plowed Trail (Multi-Use) 

Non-maintained Trail (Backcountry Trail - Use Caution) 

Trail Number or Name	Trail Number or Name
Non-maintained Trail (Backcountry Trail - Use Caution)	1017

Parking -----

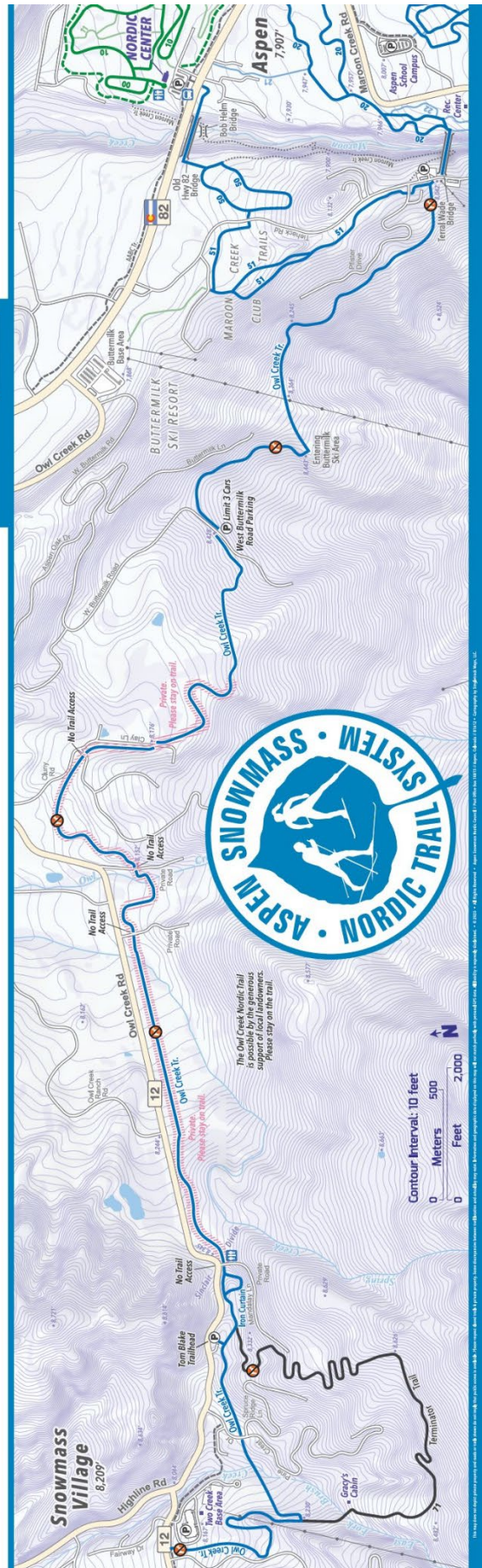
Restrooms 

Bus Stop

Trail Difficulty (Skiing)

Easiest.....

Intermediate **Difficult**

[illegible]

Rio Grande Trail

SIGNAGE SYSTEM



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Every trail is color coded according to the difficulty level of the terrain – green is easiest, blue is intermediate and black is advanced.



When in doubt, look for trail maps posted at major intersections.

TRAIL RULES & ETIQUETTE



HAVE FUN, BE SAFE Remember to bring sunscreen and water. In case of an emergency, call 911 from a cell phone.



DOGS are only allowed on dashed trails and must be leashed on the Rio Grande Trail. No dogs allowed MM 26-28. Please keep your dog under control, and remember to pick up after your dog.



BIKES Fat tire bikes are not permitted with the exception of the Rio Grande Trail and the Marolt Open Space, or other marked routes.



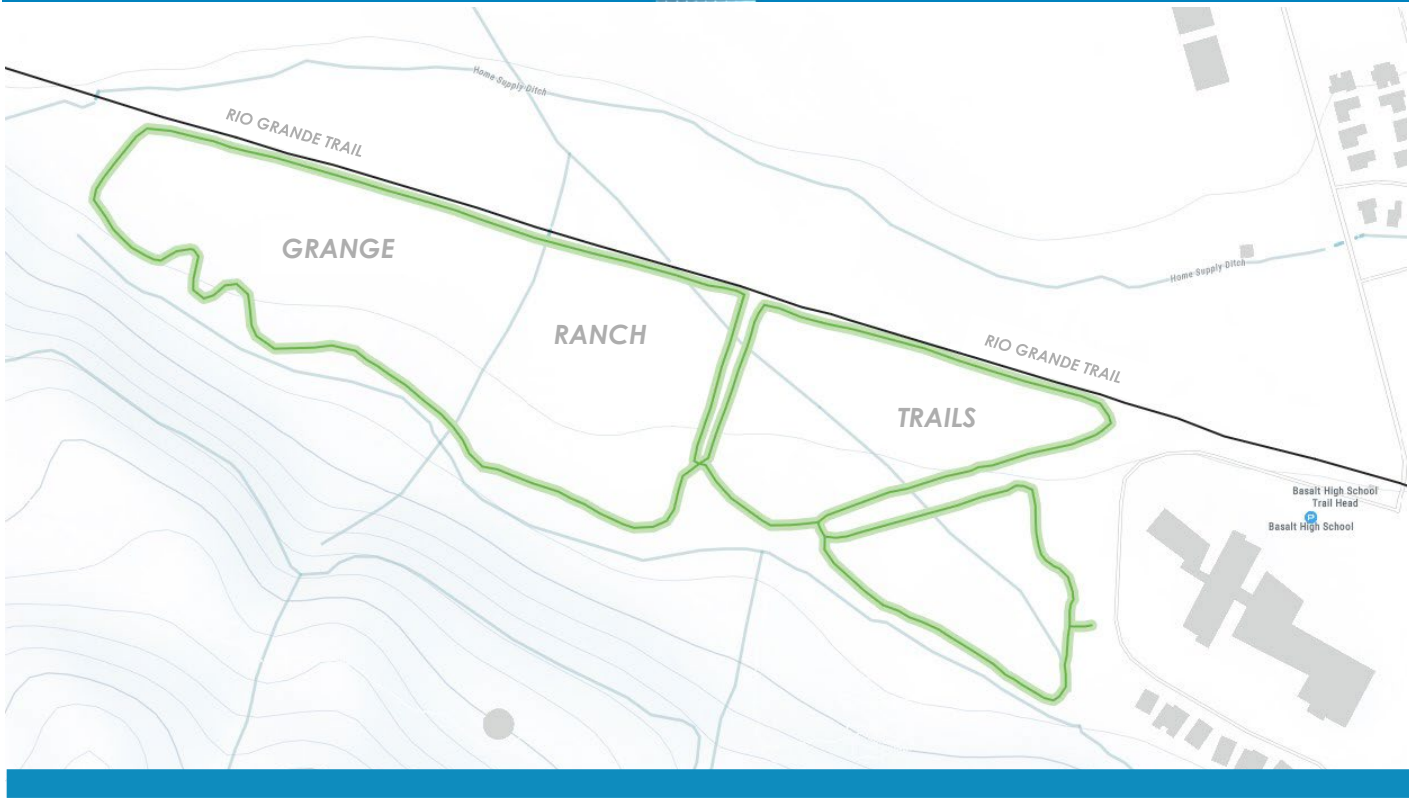
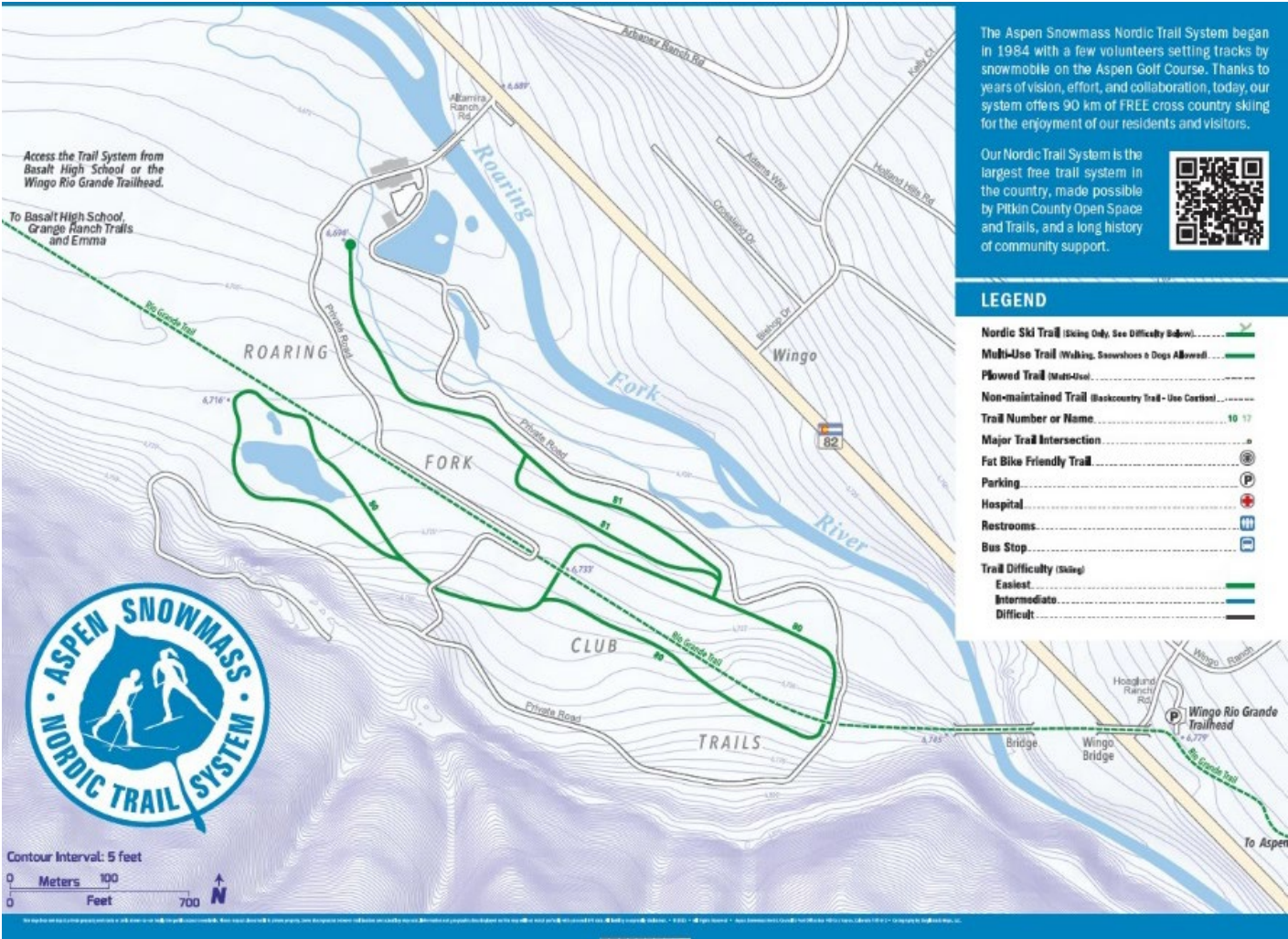
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MOTORIZED VEHICLES No motorized vehicles are allowed anywhere on the trail system.



Roaring Fork Club and Grange Ranch



APPENDIX B: NEW TRAIL DESIGN AND SCREENING

Expansion Background

As the Nordic Trail System continues to gain use, improve, and grow, the Nordic Council has developed guiding principles to focus any efforts towards improvements and expansion. Concurrently, it is important growth does not exceed the need for and appropriate use of trails or the Pitkin County Open Space and Trails' ability to properly maintain these trails. A primary consideration is ensuring high-quality grooming of existing trails along with the ability to groom trails in new areas.

Guiding Principles for New Trail Design and System Expansion

The **first priority** is to maintain the quality and integrity of the existing Nordic Trail System and strive towards the best user experience:

- **Secure existing endangered trails** where formal long-term easements do not exist, or to reroute trails to better/more secure alignments. This is specifically identified as a management action under goal 2 of this document.
- **Resolve critical road crossings** so that skis do not need to be removed to cross roads allowing a seamless skiing experience.
- **Create high quality skiing platforms** for all groomed trails. Improve sections of trails that do not meet the guidelines of a high-quality skiing experience. Examples include trails that have not been graded properly, are very steep, or trails that have problems with snow coverage due to aspect (sun exposure) or their rocky nature.
- **Focus on the amount of use** as more use warrants more effort. Trails close to urban areas will require more facilities, wider trails, variety of use, terrain and signage.

The **second priority** is to expand and enhance the Nordic Trail System, in particular to anticipate future development and climate variations, using the following design considerations:

- **Ensure the ability** to maintain and groom the trails.
 - It is strongly preferred that trails are not groomed on top of hard surface summer trails, such as asphalt and concrete.
 - Consider areas of snowier microclimate, greater shade, ideal aspect, or higher altitudes.
 - Consider opportunities for snowmaking or the use of manmade snow.
- **Provide a variety** of terrain and skiing experiences from easy to difficult, from core to rural.
 - Identify opportunities for groomed classic-only ski trails
- **Integrate adjacent trails** that may be less used trails, currently un-groomed trails, or potential high-quality trails. This may be achieved by additional grooming, signage, or easements.

- **Identify linkages** where trails are needed to connect existing trails and to create connections to community centers e.g. downtown Aspen, the Airport Business Center, or Burlingame Housing.
- **Consider parking** needs.
- **Ensure useable public** transportation connections.
- **Trail Resilience:** New trails must consider climate variations and have good snow holding ability, e.g. north facing, at high elevation, or shaded by vegetation.
- **Resolve multi-use conflicts** through signage, designate trails appropriately, conversion of plowed trails to groomed trails, ranger enforcement, and identifying new trails.

It **must be noted**; the above vision principles rely greatly on the following:

- Landowner cooperation and public support
- Collaboration with jurisdictions
- Review and input on land use applications for affected properties

New Trail Screening

The following set of questions should be analyzed and answered during the planning process for future trail developments. While value is not placed on any specific question, this is a starting point for discussion of expansion (or contraction) or changes. Consideration should also be given to the preceding guiding principles.

- Does this expansion connect seamlessly with current trail system?
- Does this expansion meet the goals of Nordic Trails Design guidelines (variety of terrain)?
- Does this expansion address climate resilient skiing considerations?
- What are the increased operational costs or savings?
 - Does this expansion trigger additional equipment needs or staff time?
 - Prepare cost benefit analysis comparing proposed changes
- Would we eliminate existing trail segments in exchange for this expansion opportunity?
 - Outreach the idea for reduction of service with adjacent communities or impacted parties
- If Nordic Council resolves to recommend expansion beyond the scope of current budget or projected budget, the following are steps to implement the changes:
 - Nordic council submits recommendations to either City of Aspen Open Space and Trails Board, Pitkin County Open Space and Trails Board, Basalt Parks Open Space and Trails, or Town of Snowmass Village Trails committee, based on appropriate jurisdiction.
 - Or seeks other funding opportunities.
- What kind of public scoping and process will be needed?
- Is the land public, private, or based on an easement? What will be the planning, zoning, or other land-use implications?
- Are there impacts to wildlife, including critical winter habitat zones?
 - Review expansion with existing wildlife studies and/or Colorado Parks and Wildlife.
- If expansion opportunity exists apart from current trail system, special attention should be paid to increased operational costs, and to how the expansion addresses the goals of the 2026 Nordic Trails Plan revision, as stated in Goal 3.

APPENDIX C: POTENTIAL TRAIL OPPORTUNITIES

The following tables depict both vital trail connections and easements, as well as potential large scale trail developments and opportunities. The tables also identify several areas where people currently enjoy skiing on non-maintained winter trails, and further improvements could be made such as improved wayfinding, route clearing, access improvements, or easements. All the following opportunities require the design and screening process listed in Appendix B before implementation.

Aspen Vicinity Nordic Trails Opportunities

The following trail descriptions are organized from east to west starting at Independence Pass. First, there are the trails already in the Aspen Snowmass Nordic Trail System which have been identified for enhancements. These trails may lack permanent easements, may require improved road crossings, or may be improved by re-routing the trail onto a different alignment. Trail alignments that may be at risk in the future are identified. Second, are areas currently used informally for Nordic skiing, or are summer activity areas, identified as potential alignments providing high-quality additions to the trail system.

TRAIL CONNECTOR	CHARACTERISTICS VALUE	RISK NEEDS	PROPOSED ENHANCEMENT
A1: James H. Smith Open Space	Expansion of North Star skiing with beginner and tranquil terrain on the north side of the river.	Currently not groomed.	TO BE UPDATED: North Star Management Plan updated in 2015 providing authorization to expand skiing. Study and design connection to existing trails on North Star.
A2: East of Aspen Trail	Could provide a seamless East of Aspen Trail from North Star Trail to Difficult Campground.	Additional parking at North Star; road crossings. Improve Benedict Trail to North Star route. Private and public land access.	Provide larger parking area. Improve trail connections.
A3: Midland Trail (Shadow Mountain)	Direct connection to downtown from Marolt pedestrian bridge.	Sidewalk currently plowed in winter.	Obtain alignment at base of Shadow Mountain between 5 th and 7 th Streets.
A4: Aspen High School Trails Meadowood Subdivision (critical)	Varied terrain, great racing venue close to town.	Current Meadowood Subdivision agreement is short term.	Obtain long-term easement with Meadowood Subdivision.
A5: Aspen High School Trails AVSC to ARC	Important seamless ski linkage between High School Trails and Moore Open Space.	Need to remove skis crossing plowed entrance to the H.S. parking lot near the AVSC clubhouse.	Overpass needed to eliminate ski removal.
A6: Moore Open Space Crowne Parcel (critical)	Critical connectivity for Aspen trails. Rolling terrain, historically used.	Easement is short term.	Secure long-term easement.

A7: Haleakala Connection	Connects High School Trails to Moore Open Space directly. Offers more loops and seamless skiing.	Large scale construction required, easement review and land use required.	Widen easement and build bridge over Maroon Creek rd.
A8: Aspen Golf Course (important)	Highly utilized, maintained, facilities, multi-use.	Continue to enhance facilities and opportunities. Need for snow to hold longer.	Continue to enhance facilities. Add snowmaking.
A9: Maroon Creek Golf Course Trails	Varied terrain, close to town.	Multiple rd crossings. Potential to provide trail on northern area of Maroon Crk Club, currently "private".	Install grade-separated crossings.
A10: Burlingame via Maroon Creek Golf Course and Double Bar X Ranch	Potential trail connection of Burlingame and Double Bar X Ranch.	Additional area could be groomed per PUD. Need connection through underpass and easement on Double Bar X to connect to Burlingame	Coordinate with Maroon Creek Club, Double Bar X.
A11: Owl Creek Trail W. Buttermilk Connection (important)	Offers an alternative improved route.	Currently steep trail crosses driveway.	Obtain easement for new alignment that would be gentler with less crossings.
A12: Difficult Campground*	Summer road, good snow coverage in winter. Scenic, secluded skiing. Early and late season grooming.	Currently not part of Nordic Trail System.	Would require special use permit or agreement with USFS to groom. Possible multi-use.
A13: Richmond Ridge*	High elevation, good snow coverage, great early and late season use, ski lift access, spectacular views, rolling terrain, near facilities.	Currently not used for Nordic trails. Need access. Possible multi-use. High altitude advantages and challenges.	Partner with Aspen Skiing Company and USFS for use, access and facilities.
A14 Castle Creek Valley Alignment (Aspen to Ashcroft)	Could provide a viable connection in Castle Creek valley.	Options need to be studied. Very large scale project; feasibility.	Coordinate with stakeholders.
A15: Five Trees and Water Plant Trails:	Connects to Aspen High School Trails. Advanced racing terrain. North facing and wooded.	No easements exist.	Coordinate with City of Aspen for long-term use agreement.
A16: Maroon Creek Valley*	Scenic, good snow, gentle terrain.	Currently road is groomed by private special use permittee, ski future not guaranteed.	Secure guarantee of long-term use at appropriate time. Nice terrain, avalanche hazard.
A17: Ashcroft*/** (important)	Scenic, good snow, rolling wooded terrain. Excellent skiing at cross-country area. Restaurant.	Currently area is groomed by private operator.	Secure guarantee of long-term use at appropriate time. Restaurant operation.

* Potential addition to Aspen Snowmass Nordic Trail System

** Separate from Aspen Snowmass Nordic Trail System

Potential Trail Opportunity Maps can be found in Appendix D.

Snowmass Village Vicinity Nordic Trails Opportunities

Interests of Snowmass Village residents focused on the immediate vicinity in and around the Town of Snowmass Village. There is a desire for more, easy dog-friendly ski trails. Owl Creek Trail is popular, however users would like to see fewer road crossings where skis need to be removed. There are several recommendations for new trails including Brush Creek Trail.



View of Sam's Knob in Snowmass

TRAIL CONNECTOR	CHARACTERISTICS VALUE	RISK NEEDS	PROPOSED ENHANCEMENT
S1: Owl Creek Road Straight Away (critical)	Critical scenic link in Aspen to Snowmass trail system.	Optimize alignment. Current license agreement is short term. Many road crossings.	Reinstate "Twister" alignment and other historic alignments. Obtain permanent winter easements. Resolve crossings through realignments.
S2: Glendale Drive	Potential alignment has good snow retention, is an easier route. Would provide better access to Owl Creek Trail. Parking at Tom Blake TH.	Need an alternative to steep "Berlin Wall" section.	A potential trail from Glendale Divide to Terminator Trail on a high contour should be explored. An easement exists for portions of alignment.
S3: The Pines	This new alignment would potentially provide improved skiing and fewer road crossings.	The Pines HOA will realign a trail section to an alpine easement to reduce road crossings and provide a wider trail.	Secure long-term easement for new trail that is to be created. Possibly a PUD agreement through Town of Snowmass Village (TOSV).
S4: Snowmass Golf Course (important)	Hub of Nordic skiing, provides great groomed trails and facilities.	Need connection to the recreation center across Brush Creek Road. Separate conflict areas with pedestrians and dog walking users.	Existing underpass too low. Install at-grade or grade separated crossings. Study enhancing facilities.
S5: Town Connector – Village Way Trail	Section of Village Way is being relocated for development.	New alignment may be inconvenient with road crossings.	Possible grade separated crossing at Owl Creek and Brush Creek road intersection
S6: Brush Creek Trail*	Summer trail could be used in winter linking the Brush Creek intercept lot at Highway 82 to Snowmass Golf Course trails.	Current wildlife closure during winter on Pitkin County section. Possible multi-use needs. Requires snow cover.	With TOSV and Pitkin County, explore possibility of Nordic use in winter.

*Potential addition to Aspen Snowmass Nordic Trail System
Potential Trail Opportunity Maps can be found in Appendix D.

Mid-Valley Vicinity Nordic Trails Opportunities

During the 2014 planning and review process, existing and future use trends were studied including what needs are not currently met and estimating the potential demands and uses in the future. With the addition of community support, it became apparent that there is the need for the Nordic Trail System to continue to grow, especially into the wider geographic area of the Roaring Forks' Mid Valley.

During the community meetings, the mid-valley area was perceived as being suitable for the expansion of the Nordic Trail System. In the 2000-teens, The Nordic Council acted as the default mid-valley Nordic ski advocacy agency for the Basalt community, and more specifically, the Roaring Fork Club trails and the lower Rio Grande trail connections. The Nordic Council membership includes residents and elected officials of the Town of Basalt.

TRAIL CONNECTOR	CHARACTERISTICS VALUE	RISK NEEDS	PROPOSED ENHANCEMENT
M1: Rio Grande Trail	Major trail connector through valley. RFTA has maintained Carbondale to Catherine Store section.	Multi-use coordination. Road crossing issues. Near Aspen underpasses need more snow.	Use signage. Possibly move ski trail to previous track alignment. Continue to coordinate with RFTA for grooming.
M2: Roaring Fork Club	Close to Basalt and Rio Grande Trail. North facing, good snow. PUD approval requires grooming of Nordic trails for public.	Trails seldom skied. Public access difficult.	Improve trail connections to transit. Possible new trailhead near bus stop. Coordinate with Roaring Fork Club provide better skier access.
M3: Basalt High School*	Central location, highly popular when groomed, provides growth for the sport. Possible use of adjacent properties.	Conflicts with sledding hill and school activities behind school. Land use approval for additions to North of Grange Ranch.	Study options and coordinate with landowners and town, including recreation department to expand Basalt High School Nordic Trail hub.
M4: Capitol Creek Valley*	Scenic, varied terrain, historic Nordic use, possible valley wide links, annual event occurred.	Maintenance. Need for arrangements with landowners. Traffic and parking.	Nordic Council to coordinate with landowners. Could be part of larger valley system.
M5: Spring Gulch** (important)	Existing cross-country trail system maintained by Mt. Sopris Nordic Council with 28k of groomed trails and is partially funded by Pitkin County OST (20% of operational costs).	Spring Gulch and Mt. Sopris Nordic Councils to remain independent of the Aspen Snowmass Nordic Council, but continue as a strong partner.	Continue to communicate with Mt. Sopris Nordic Council.
M6: Crown Mountain Park	Small trail system surrounded by mid-valley homes.	Independently groomed by Eagle County parks staff.	Nordic council available for collaboration.

*Potential addition to Aspen Snowmass Nordic Trail System

** Separate from Aspen Snowmass Nordic Trail System

Potential Trail Opportunity Maps can be found in Appendix D.

Un-Groomed Valley-Wide Nordic Skiing Opportunities

The following Nordic areas provide a unique experience that the Nordic council has identified as vital to the Nordic trail system in the upper Roaring Fork valley. Most of these areas are not suitable for machine grooming in their current state, and if the community or the Nordic Council identify these as future priorities, a recommendation using the expansion screen must be presented to Pitkin County Open Space and Trails Board.

TRAIL CONNECTOR	CHARACTERISTICS VALUE	RISK NEEDS	PROPOSED ENHANCEMENT
UG1: Hay Park Trail	"Down Valley Government Trail" to remain unmaintained. Link to valley system. Parking available. Possible multi-use.	Steep access from public parking on Capitol side.	Add signage. Coordinate with and discuss alternative access with private landowners. Consider Dinkle Lake Rd access and possible winter gate for closure.
UG2: Northeast facing hillside – Light Hill	Good snow holding. Ditch alignment.	Identify public access locations.	Study options and coordinate with stakeholders, including recreation department and BLM.
UG3: Tom Blake Trail and Stark Trail	To remain ungroomed. Potential connectors between Government Trail and Owl Creek Trail at Two Creeks.	Stark Trail is steep.	Study options.
UG4: Highline Trail from Maintenance Center	To remain un-groomed. Potential connector from Owl Creek Trail to Brush Creek potential trail.	Most of Sky Mountain Park area closed in winter; winter elk range.	Study winter connection and wildlife recommendations.
UG5: Divide Ditch Trail to East Snowmass Creek	More remote style skiing. Gentle terrain. Multi-use.	Parking and access needs. Resolve multi-use conflicts and long-term use.	Resolve parking, access, and long-term use. To remain un-groomed. Repair or replace failed foot bridge.
UG6: Government Trail (important)	To remain un-groomed. Currently a more remote ski experience, scenic, wooded terrain. Potential to loop with Owl Creek Trail.	Improve trail access from Two Creeks side. Improve ski connectivity on both sides.	Work with Aspen Skiing Company on access from Two Creeks via lift or gondola. Explore possibilities on West Buttermilk side. Better winter route marking.
UG7: Hunter Creek Valley	Scenic, gentle terrain, near town.	Access and parking limitations, steep entry.	Discuss access and parking with area stakeholders.
UG8: Windstar Valley Ranch	Scenic terrain in the Old Snowmass area.	Parking and access.	Secure long-term parking and consider designation of non-maintained ski routes.

Potential Trail Opportunity Maps can be found in Appendix D.

Long-term Trails Opportunities

The following areas are identified as having Nordic skiing potential. Due to circumstances such as property ownership, distance from population centers and access, the Nordic Council has pursued these options to date, although there was mention of these areas during the 2008 public meetings. Therefore, these locations should be considered as possibilities only. The trail alignments and easements could initially be acquired as summer trails. Backcountry trails, including the 10th Mountain and other overnight Hut Systems will remain separate from the Aspen Snowmass Nordic Trail System.

- In the **Aspen Snowmass** area, the land near the Rio Grande in the vicinity of **W/J Ranch** may offer gentle terrain with access to the Rio Grande Trail.
- Cozy Point Ranch Nordic opportunities include expanded use of horse trails, and use of fields for biathlon and skijoring.
- Long-term, a trail connection from Brush Creek Road to **Aspen Village** can provide a useful link. In addition, trail opportunities may exist in the Watson Divide area.
- In the **mid-valley** area potential Nordic skiing areas may include the Spring Park Reservoir vicinity on **Missouri Heights**.
- The Crown area near **Emma** provides summer hiking and biking trails that may be considered for un-groomed winter use providing there is sufficient snow coverage and BLM permission.
- Near downtown **Carbondale**, Prince Creek Road and trails could provide a short, but easily accessed trail for residents of Carbondale.
- The **Crystal River Valley** and **Redstone** have Nordic skiing opportunities in the coke ovens vicinity, as well as further up Coal Basin. The potential trails would reflect the Nordic Trails Plan continued interest in more remote and rustic trails and could provide down valley residents with an alternative to Spring Gulch. The Crystal River Valley is also known to hold snow well, and partnerships with the community of Redstone or the US Forest Service could be explored if funding becomes available. If a regional trail were developed in the **Crystal River Valley**, it could have potential for Nordic use as well.



Photo Credit: Nordic Program Staff

Snowy meadow in Crystal River Valley

APPENDIX D: POTENTIAL TRAIL OPPORTUNITY MAPS

Aspen Vicinity Trail Opportunities Map

Coming Soon

Snowmass Vicinity Trail Opportunities Map

Coming Soon

Mid-valley Vicinity Trail Opportunities Map

Coming Soon

APPENDIX E: EXAMPLE NORDIC EVENT CALENDAR

Example Event Calendar from 2025-2026 Season

Nordic events requiring special planning, grooming, and changes in routine operations

Thurs Nov 27	Opening Day Aspen Cross Country Center (snow dependent)	
Sun Dec 14	Ute Series – High School Get The Lead Out	Mass F
Sun Jan 4	Ute Series – Snowmass Slip 'n Slide	Mass C
Fri Jan 9	CHSAA Race – Aspen High School	Classic
Sun Jan 11	Nordic Extravaganza - AXCC	
Sun Jan 18	Ute Series – Owl Creek Chase	Mass C/F
Wed Jan 21	Ute Series – XC Games Night (X-Games Jan 23-25)	Team Sprint
Sun Feb 1	Ute Series – Rat Race – Spring Gulch	Mass F
Sat Feb 7	Art Cart Derby – Aspen Rec Center	
Sun Feb 8	Ski For Sisu – Spring Gulch	
Sat Feb 14	Nordic Bonfire Dinner – Aspen AXCC	
Sun Feb 15	Ute Series – Ski for the Pass	Mass C
Sat Feb 21	JNQ/RMISA – Aspen High School	Mass C
Sun Feb 22	JNQ/RMISA – Aspen High School	Mass F
Sun Mar 8	Ute Series – Silverboom	Mass F/C
Wed Mar 18	AVSC End of Season Fun Course - Ballfields	
Sun Mar 22	Closing Day Aspen Cross Country Center (snow dependent)	

APPENDIX F: SNOWMAKING FEASIBILITY STUDY

SNOWMAKING DESIGN

FOR THE ASPEN SNOWMASS NORDIC TRAIL SYSTEM



Photo Credit: Aspen Ski Company

Task 3 (Final) Deliverable: Design Development and Cost Refinement

JUNE 2025

Prepared for:



Prepared by:

SE GROUP



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APPENDICES

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Appendix B. Site Planning and Grading
Appendix C. Climate Change Analysis
Appendix D. Above Ground Infrastructure & Automation
Appendix E. HKD Snowmaking Gun Performance
Appendix F. City of Aspen and Pitkin County Zoning Analysis

INTRODUCTION & EXECUTIVE SUMMARY

SE Group, in partnership with Sno.matic Controls & Engineering, was retained by the City of Aspen to evaluate the feasibility, design requirements, and implementation considerations for adding snowmaking to key portions of the Aspen Snowmass Nordic Trail System. This effort also included analysis of trail improvements necessary to meet current FIS (International Ski and Snowboard Federation) homologation¹ standards for Nordic competition.

The scope of work was structured in three tasks: 1: Feasibility Assessment, 2: Schematic Design and Cost Estimation, and 3: Design Development and Cost Refinement. SE Group led the multidisciplinary team, which included input from Morton Trails and HKD Snowmakers. The team assessed snowmaking suitability across two priority areas—the Aspen High School (HS) trails and the Golf Course (GC) trail network—considering physical, environmental, and economic feasibility alongside climate trends and user needs.

This document summarizes the findings of **Task 3: Design Development and Cost Refinement**. It includes:

- A refined layout for both trail networks and associated infrastructure improvements;
- An assessment of climate data and water resources, including detailed recommendations for snowmaking coverage and timing;
- A preferred snowmaking system layout, including system sizing, equipment recommendations, and water source strategies;
- Capital and operating cost estimates, as well as operational staffing recommendations;
- A summary of potential environmental impacts and permitting considerations.

At the **High School**, the recommended snowmaking system prioritizes early-season coverage of the 3.3 kilometer (km) race loop. The system layout includes below-grade hydrant vaults and a new pumphouse with pump and compressor automation. Water would be drawn from the City's Raw water system with a proposed bypass, which may provide the Nordic operation with limited water pumping abilities before December 1, while Aspen Highlands is making snow. The Nordic operation is expected to have full access to Raw water once Aspen Highlands finishes making snow, which typically occurs around or before December 1. *The system would be sized for a design capacity of 800 gpm (gallons per minute – water) and 1,410 cfm (cubic feet (ft) per minute – compressed air),* with 34 stick guns and 4 shared fan guns to achieve coverage goals efficiently while minimizing infrastructure impacts.

The estimated capital cost for the High School system is \$4.30 million, with annual operating and maintenance costs totaling approximately \$129,000. These operating costs reflect anticipated water, electric, and labor expenses, with a maintenance allocation equivalent to 25% of operating costs. *Labor requirements are estimated at 684 hours over the course of the season.*

At the **Golf Course**, a similar system is recommended to serve the site's 2.2 km layout. Snowmaking coverage would rely on 18 portable stick guns and the same set of shared fan guns, with below-grade hydrants to preserve visual character and avoid conflicts with golf operations. A new on-site reservoir would store approximately 2.4 million gallons, filled seasonally via the Marolt Ditch. *The system would be sized at 400 gpm and 1,000 cfm,* with infrastructure concentrated around the driving range.

The estimated capital cost for the Golf Course system is \$3.33 million, with annual operating and maintenance costs totaling approximately \$51,000. These costs follow the same methodology used for the High School, reflecting electric usage, labor, and a maintenance allocation. *Labor needs are estimated at 380 hours per season.* A fully automated option has been evaluated for the driving range portion of the Golf Course, which would add an estimated \$330,000 to capital costs, bringing total capital costs for the Golf Course to \$3.66 million.

¹ FIS process for review, approval, and registration of a racecourse for sanctioned competition.

For **both systems**, *the total capital cost would be approximately \$7.62 million*. If full automation is pursued for the driving range portion of the Golf Course, total capital costs for both venues would amount to \$7.95 million. *Total seasonal labor requirements are estimated at 1,064 hours, and combined operating and maintenance costs would be approximately \$180,000 annually*, which includes water, electric, labor, and maintenance costs.

Collectively, these improvements are expected to enhance the reliability and longevity of Aspen's Nordic skiing product, support early-season training goals, and provide a durable foundation for future homologation and competitive event hosting.

1. TRAIL DESIGN

SE Group, with input from Morton Trails, was retained to review existing trail layouts at both the High School and Golf Course venues and recommend refinements to enhance skier experience, ensure operational compatibility with snowmaking, and support the potential for FIS homologation at the High School. The City of Aspen team played a critical role in this process by test-skiing proposed alignments, suggesting adjustments, and guiding key decisions.

A. SITE VISIT OBSERVATIONS

Upon project initiation, team members from SE Group, Sno.matic, Morton Trails, and the City of Aspen conducted a joint site visit on July 31, 2024. This visit was timed during summer so that the project team could observe terrain features typically hidden under snow in winter. The team walked both the High School and Golf Course Nordic areas, using GPS files to identify the locations of existing winter trail alignments, which were not visible in the summer landscape. This fieldwork allowed the team to evaluate trail topography in context, identify design opportunities and constraints, and assess potential locations for water storage. A full site visit summary is included in **Appendix A**.

B. EXISTING TRAIL AND TERRAIN ANALYSIS

Differences in terrain, microclimate, and user function informed design approaches for the Golf Course and High School. Presently, trails at both venues are groomed on natural snow, shifting based on operational discretion from the Aspen Snowmass Nordic Trail System. Formalizing alignments is necessary for trails receiving snowmaking.

GOLF COURSE

The Golf Course trail system is used primarily by beginner and intermediate skiers, including tourists, first-time users, and families. It serves as the main public-facing venue for Nordic skiing and is less frequented by advanced or competitive skiers. This trail network typically opens later and closes earlier than the High School Nordic system, with Golf Course trails usually opening by December 1 and closing around the third weekend in March to accommodate the transition to spring golf operations. During the ski season, the Golf Course Pro Shop serves as the Aspen Cross Country Center, offering demos, rentals, lessons, and ski tuning and repair services. The Golf Course has approximately 12 km of groomed trails at full grooming capacity.

Within the Golf Course trail system, the project team was asked to focus on two distinct functional zones: a beginner- focused loop around the driving range, referred to as the Teaching Loop and Advanced Teaching Loop (approximately 1.0 km total) and a broader recreational loop, referred to as Golf Course East and the multiuse trail Bernese Boulevard, designed for general use (approximately 1.1 km and 1.0 km respectively). These trails range from an elevation of 7,850 ft to 7,870 ft, and users typically experience the terrain as flat with more milder climbs on the teaching loops. Certain sections of trail, including areas near conifers and on slopes with a south or west aspect, tend to melt out easily. These “hot spots” require patching during low-snow years. As a result, the user experience can be compromised when natural snowfall is insufficient.

HIGH SCHOOL

The High School trail network is primarily used by Aspen Valley Ski and Snowboard Club (AVSC) athletes, local competitive skiers, and advanced recreational users. It serves as a high-performance venue, supporting daily training needs and occasional events. This area typically opens earlier and closes later than the Golf Course Nordic system, with the High School trails usually opening by early November—earlier if conditions allow—and remaining in use through early to mid-April.



Photo Credit: City of Aspen
“Hot spots” at the Golf Course

The High School system sits slightly higher, ranging from 8,000 to 8,150 ft. It benefits from relatively cooler temperatures and north-facing slopes that help retain snow. The existing groomed loop totals 5.9 km and more formal race loops, such as 1.2 and 2.5 km loops, are frequently created for training and events that share a common footprint. This layout supports flexible programming for training and competition. The nearby baseball fields serve as start/finish areas for races and offer excellent viewing opportunities for spectators.

C. PROPOSED TRAIL ANALYSIS

The proposed trail layouts reflect each site's unique topographic and operational characteristics. Unlike the existing trails, which shift year-to-year as grooming differs slightly, the proposed trail layouts are “formal” and would need to be the same year-to-year, since they require grading and permanent snowmaking infrastructure to be installed. Developed by the Aspen Snowmass Nordic Trail System staff, the designs optimize snow retention, skier circulation, and alignment with future infrastructure. At both venues, terrain grading would be a key enabling action, ensuring the trail surfaces are consistent, the drainage is effective, and the snowmaking system can operate efficiently.

GOLF COURSE

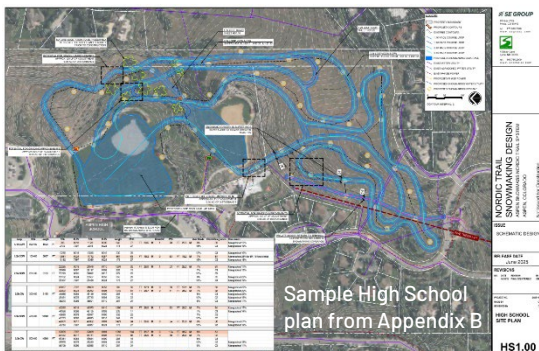
Snowmaking is proposed on the full length of the Teaching and Advanced Teaching Loops (1.0 km total), 1.1 km of the Golf Course East loop, and approximately 0.2 km of the Bernese Boulevard trail in front of the parking lot. While only a short segment of Bernese Boulevard would receive snowmaking, approximately 1.0 km of its alignment would be shifted to improve layout and functionality.

The Teaching and Golf Course East loops would be graded to 24 ft in width; the Bernese segment would be 14 ft wide. Grading would occur across roughly 2.5 acres and is designed to create a more challenging teaching environment—introducing moderate climbs and downhill—while preserving the landscaped character of the Golf Course. During the design process, careful alignment avoided impacts to tee boxes, greens, cart paths, and mature vegetation to the greatest extent possible.

This project also presents an opportunity to coordinate trail grading and infrastructure improvements with Golf Course operations to identify solutions that benefit both summer and winter use. Shared improvements could enhance site efficiency, preserve aesthetics, and reduce long-term maintenance needs.

HIGH SCHOOL

Proposed trails at the High School feature formal loop designs that share a common footprint. *The two longer loops can both be skied in both directions, creating two 2.5 km and two 3.3 km potentially homologatable course configurations. In addition, a 1.1 and 1.2 km “sprint course” has been planned, which may be homologatable as well.* This yields 6 total potentially homologatable courses, supporting flexible programming for training and competition. The surrounding baseball fields serve as logical start/finish areas and offer excellent viewing opportunities for spectators.



At the High School, there are areas of recommended grading to improve grooming consistency and enhance the race experience. This total area to be regraded is 0.25 to 0.5 acres. The disturbance required to achieve this regrading is discussed in **Section 6**. The recommended grading design would support snow retention while minimizing the need for deep snowpack buildup.

Detailed grading extents and proposed methods are illustrated in the schematic site plans included in **Appendix B**. The snowmaking feasibility assessment that follows in this report is based on these accepted trail layouts.

D. PROPOSED MODIFICATIONS TO MEET FIS HOMOLOGATION CRITERIA

Evaluation of the proposed High School race loops for FIS homologation was based on the recommendations and requirements set by the *FIS Cross-County Course and Venue Design Guidelines*, Spring 2023 edition.² The City and design teams also considered desirable components that, although not required for homologation, contribute to a successful facility and exciting, enjoyable competition experience. The final 6 race loop alignments reflect the desire to meet FIS homologation requirements while giving the City and participating competition planners the flexibility to plan successful and enjoyable events.

REQUIREMENTS

Below are some of the requirements considered during design and required for a cross-country race course and homologation certificate. IBU (International Biathlon Union) approval for a biathlon venue was not considered as part of this process.

- Specific distances of loops: Ideally 2.5 km, 3.3 km, or 3.75 km with options for cut-offs and multiple laps. The proposed 1.1 km and 1.2 km loops are intended to meet homologation standards through inclusion of multiple laps during competition or as a sprint course.
- Required climbs per loop: A climb is a course segment that has an average grade between 6% and 14% and is categorized into climb classes based on the Partial Total Climb (PTC), the total elevation gain of an ascent. An "A" Climb is defined as a course segment with at least 30 meters (m) (approximately 98 ft) total ascent. A "B" climb has between 10 m and 29 m of ascent (between 33 ft and 95 ft). A "C" climb has an average grade greater than 6% but is less than a 10 m (33 ft) ascent. FIS recommends 0-to-1 A climbs and 1-to-3 or 2-to-3 B climbs for 2.5 km and 3.3 km courses respectively. The proposed 2.5 km and 3.3 km courses reflect that climb distribution.
- Maximum climbing grade: FIS states that climbing segments should be no greater than 18% where feasible but these steeper sections of 18% gradient are preferred for sprint courses in particular. There are multiple sections of each loop that are greater than 18% but are not sustained climbs greater than 15 ft ascent and are still considered within the acceptable A and B climb average gradient changes.



Together, these physical requirements establish the technical foundation for homologation. In addition to meeting these criteria, the design team aimed to incorporate other features that would enhance the functionality and experience of the venue for racers, spectators, and operations teams.

DESIRED COMPONENTS

Below are some of the components that contribute to a successful Nordic competition venue that were considered during the design process even though they are not required for homologation.

- Spectator visibility: Each loop is configured so that the athletes are within sight of the start/finish area and spectators, teammates, and coaching staff are able to see athletes multiple times. There are also multiple easily accessible, sunny locations in which spectators can watch.
- Elevation efficiency: A start/finish roughly at the mid-point of the available elevation eliminates the need for trails which generally either descend, or climb from the far point, all the way back to the finish.

² <https://www.fis-ski.com/cross-country/documents>

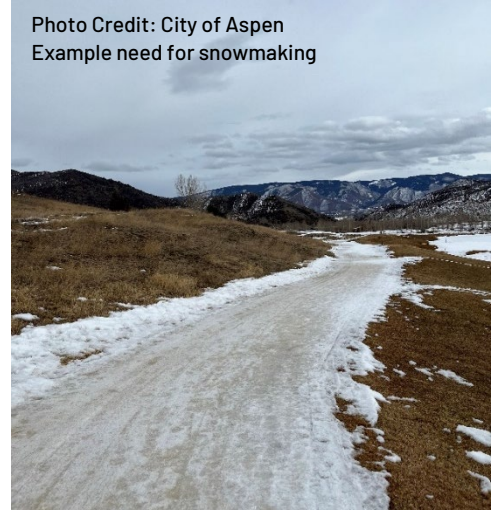
- Ease of grooming and maintenance: Overlapping sections of race course loops help minimize the need for additional grooming and snowmaking coverage. The proposed loops largely overlap each other and use cut-offs to define specific length loops. These alignments also give flexibility for different total race lengths using the 1.1 km, 1.2 km, 2.5 km, and 3.3 km loops as varying lap distances. The loops also make use of existing dirt roads, hills, and natural variations in the slope that require minimal, if any, grading to create a viable race experience.

The proposed High School trail design not only meets the technical requirements for FIS homologation but also integrates enhancements that support a more dynamic and enjoyable race environment. With a layout that prioritizes visibility, operational efficiency, and minimal maintenance effort, the resulting loops are well-suited to host a wide range of successful, spectator-friendly events in the years ahead. As detailed, planning and design effort carefully considered all FIS homologation requirements in order to allow the City to subsequently seek formal homologation through FIS. This evaluation was intended to seek/achieve homologation at this time.

2. THE NEED FOR SNOWMAKING

The City of Aspen is pursuing snowmaking on its Nordic trail systems to improve the reliability and quality of winter operations. Although both the High School and Golf Course venues currently receive adequate natural snowfall during a typical year, conditions during the early season and in dry years are unpredictable. This variability makes it difficult to schedule programming, support consistent training, and ensure high-quality public access. Key users and staff repeatedly identified the lack of early-season dependability as a significant operational challenge. Climate trends suggest that these uncertainties will increase in the coming years.

Photo Credit: City of Aspen
Example need for snowmaking



A. CLIMATE CHANGE ANALYSIS

To understand how future conditions may affect the need for snowmaking in Aspen, SE Group conducted a climate change and temperature analysis.

The Climate by Forest tool was used to model changes in temperature and precipitation. This tool utilizes specific Representative Concentration Pathway (RCP) scenarios that model different concentrations of greenhouse gases (GHGs). The two RCPs that were used are RCP 4.5 and RCP 8.5. For more information on the specifics of these RCP scenarios, please refer to the full Climate Change Analysis in **Appendix C**.

According to the model outputs, average daily minimum temperatures in Aspen are projected to rise by approximately 2.2°F (under RCP 4.5) to 3.9°F (under RCP 8.5) by 2090, depending on GHG emissions.³ Average maximum temperatures are projected to increase by 1.8°F (under RCP 4.5) to 3.6°F (under RCP 8.5) over the same period.⁴

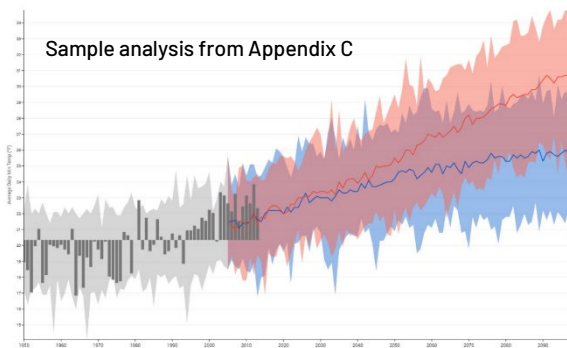


Exhibit 1. Average Daily Minimum Temperature Under Climate Change in Aspen, CO

Note: Grey shading indicates observed temperature history. Blue shading and blue trend line represent RCP 4.5. Red shading and red trend line represent RCP 8.5.

A different model from the Rocky Mountain Research Station was used to understand how snow water equivalent (SWE) and snow residence time (SRT) (the duration of time that snow stays on the ground) would change in the future.

In Aspen's ecoregion, snow water equivalent (SWE) is projected to decline by 65–80%, and snow residence time (SRT) by 40–50%, by 2090 under the RCP 8.5 scenario—relative to average conditions from 1975 to 2005.⁵

Early-season snowmaking will depend on the continued availability of cold weather windows. The following section assesses how often those conditions actually occur—and how climate change may affect them.

B. HISTORICAL AND PROJECTED TEMPERATURES

To determine whether a future snowmaking system may reliably cover Aspen Nordic trails by key early-season dates, SE Group completed an analysis of wet bulb temperatures using 10 years of recent hourly data (2013 to 2024).

³ USDA Forest Service 2024a

⁴ USDA Forest Service 2024b

⁵ Luce et al. 2023a

WET BULB TEMPERATURE

Wet bulb temperature is a calculated index that combines temperature and humidity readings to account for the effects of both conductive and evaporative cooling of the water droplets that are sprayed in the air during snowmaking operations. A higher temperature with low humidity has an equivalent wet bulb temperature to a colder temperature with high humidity. While it is possible to make snow up to approximately 28°F wet bulb, snowmaking becomes far more productive and efficient below 25 to 26°F wet bulb.

For this analysis, 25°F wet bulb was used as the operational threshold, with a conservative assumption that snowmaking operations would only begin after 8 consecutive hours below that threshold.

RECENT CONDITIONS (10-YEAR AVERAGE)

Table 1 shows the multi-year average number of hours at or below 25°F wet bulb, using the 10 years of historical record, segmented by date milestones (e.g., November 1, November 15, etc.). The data indicates there are approximately 605 hours available for snowmaking by mid-December in a typical year. Nearly two thirds of these hours fall below 20°F wet bulb. This figure indicates that based on the historical record, there are an ample number of snowmaking hours available to meet system needs.

Table 1. Average Observed Snowmaking (Wet Bulb) Hours from 2013-2024

Date	Hours <20°F	Hours Between 20°F and 25°F	Total Hours <25°F
By 11/1	41	15	56
By 11/16	107	54	161
By 12/1	299	107	407
By 12/15	460	145	605
By 12/25	815	199	1,013

RECENT RELIABLE CONDITIONS

Table 2 refines this analysis by showing the number of hours that occurred in at least 8 out of 10 years. This 80% reliability threshold enables realistic planning for most years without overbuilding for outliers. Even under this more conservative approach, 567 hours are available by mid-December—enough to fully cover both the Golf Course and High School trail systems.

Table 2. Observed Reliable Snowmaking (Wet Bulb) Hours from 2013-2024

Date	Hours <20°F	Hours Between 20°F and 25°F	Total Hours <25°F
By 11/1	2	6	8
By 11/16	25	26	51
By 12/1	191	62	253
By 12/15	402	118	567
By 12/25	589	147	816

PROJECTED CONDITIONS – LOWER EMISSIONS SCENARIO (RCP 4.5)

Tables 3 and 4 assess snowmaking conditions around year 2090 under a lower emissions future, under which temperature data was adjusted upward by 2.1°F to reflect projected warming under the RCP 4.5 scenario.

- Table 3 shows average available hours under these adjusted conditions. By mid-December, 465 hours remain available, down from the historical average but still adequate.
- Table 4 applies the 8-in-10-year filter to the RCP 4.5 data, showing 426 reliably available hours by mid-December—still enough to meet system coverage goals in most seasons.

Table 3. 10-Year Average Wet Bulb Hours with +2.1°F Adjustment

Date	Hours <20°F	Hours Between 20°F and 25°F	Total Hours <25°F
By 11/1	32	11	43
By 11/16	77	36	113
By 12/1	221	86	307
By 12/15	341	124	465
By 12/25	626	178	805

Table 4. 8/10-Year Wet Bulb Hour Reliability with +2.1°F Adjustment

Date	Hours <20°F	Hours Between 20°F and 25°F	Total Hours <25°F
By 11/1	0	0	4
By 11/16	10	17	27
By 12/1	135	73	208
By 12/15	284	116	426
By 12/25	422	155	619

PROJECTED CONDITIONS – HIGHER EMISSIONS SCENARIO (RCP 8.5)

Tables 5 and 6 present projected snowmaking hours around year 2090 under the RCP 8.5 scenario, which assumes greater warming (+3.5°F) and reflects a high-emissions future.

- Table 5 captures average available hours under RCP 8.5, with 397 hours below 25°F by mid-December. This pushes the system closer to its minimum required window but still offers operational feasibility.
- Table 6 filters this data for reliability (8 out of 10 years), showing 348 consistent snowmaking hours—still enough to meet target coverage needs, but with less margin.

Table 5. 10-Year Average Wet Bulb Hours with +3.5°F Adjustment

Date	Hours <20°F	Hours Between 20°F and 25°F	Total Hours <25°F
By 11/1	27	10	37
By 11/16	60	36	96
By 12/1	180	81	261
By 12/15	278	119	397
By 12/25	522	175	697

Table 6. 8/10-Year Wet Bulb Hour Reliability with +3.5°F Adjustment

Date	Hours <20°F	Hours Between 20°F and 25°F	Total Hours <25°F
By 11/1	0	0	0
By 11/16	4	8	9
By 12/1	103	52	155
By 12/15	218	96	348
By 12/25	322	136	496

The tables above demonstrate that *despite projected climatic warming, snowmaking hours are expected to remain sufficient in most years to meet coverage goals at both Nordic venues around year 2090*. Over time, snowmaking windows will become shorter, requiring more efficient and responsive operations. Automation and strategic crew scheduling may help maximize productivity. The design recommendations in this report respond to these realities.

C. COVERAGE REQUIREMENTS AND SYSTEM CAPACITIES

While climate projections indicate narrowing windows for snowmaking, the conditions modeled show that sufficient cold-weather hours are likely to still exist to support early-season snowmaking operations around year 2090. In practice, this translates to a high likelihood of achieving coverage by mid-November in 8 out of 10 years. Raw water delivery limitations at the High School during October and November may delay coverage into December, when Aspen Highlands is done making snow. At the Golf Course, having reliable early season snow coverage would enable a consistent public experience and support early-season programming. At the High School, it would provide the operational certainty needed to schedule/host events and support athlete training.

To meet operational goals and snow coverage expectations at both trail systems, the team evaluated pumping capacities, snowmaking durations, and trail coverage areas based on conservative early-season temperature conditions.

The **Golf Course** would require approximately *4.1 acres* of snowmaking coverage across priority teaching and recreational loops. To have consistent early season snow coverage in 8 out of 10 years, *the required water pumping capacity would be approximately 375 gpm, assuming 110 hours of system runtime* (requiring 380 total labor hours). To allow for faster coverage in tighter temperature windows, a capacity of 400 gpm is recommended.

The **High School** system would require approximately *9.6 acres* of snowmaking coverage, with an additional 0.5 acres to cover the alpine egress. The goal would be to cover 1.0 to 1.5 km of trail by November 15, and the remainder by December 1. Due to a shared water line with Aspen Highlands (see **Section 3**), water pumping capacity before December 1 would be limited to 300 gpm. After that date, full pumping capacity would become available. Using these assumptions, *an average pumping capacity of 600 gpm and roughly 132 hours of system runtime* (requiring 684 total labor hours) would be sufficient to meet coverage goals in most years. To ensure operational flexibility and reduce snowmaking duration, a total pumping capacity of 800 gpm is recommended.

Together, these system design assumptions support a two-phase operating model: snowmaking would begin at the Golf Course when temperature conditions allow, then transition to the High School as water availability improves. These recommendations reflect realistic timing goals, climate-adjusted temperature projections, and the operational constraints identified.

3. WATER RESOURCES

While cold temperatures are critical, snowmaking performance also depends on reliable, cost-effective water delivery. This section outlines estimated water requirements and recommends an approach for each site.

A. WATER REQUIREMENTS

The Nordic trails would require a snowmaking coverage width of 25 ft, except for a small segment of the Golf Course, which would only need 14 ft of coverage (Bernese Boulevard). This totals approximately 4.1 acres of coverage on the Golf Course and 9.6 acres for the High School. Based on an assumed application rate of 600,000 gallons per acre, which would yield approximately 2.5 to 3 ft of machine-produced snow on the Nordic trails, *the Golf Course would require roughly 2.40 million gallons of water and the High School would require roughly 5.76 million gallons.*

Table 7. Water Requirements Based on Site Location

Site Location	Acres of Coverage	Gallons/Acre	Total Gallons
Golf Course	4.1	600,000	2,400,000
High School	9.6	600,000	5,760,000

B. WATER SUPPLY OPTIONS

Several different (non-exclusive) options were investigated for water supply at both the Golf Course and High School:

- City of Aspen Raw Water: Raw water is available near the High School and typically charged at a rate of \$5.73 per 1,000 gallons. Although there is sufficient supply, this Raw water also supplies the Aspen Highlands snowmaking system, and Aspen Highlands utilizes all available water when operating at full capacity. This would result in Raw water not being guaranteed to supply the High School until Aspen Highlands has finished making snow, which normally occurs around or prior to December 1. In **Table 8** (High School), **Options 1, 2, and 5** use Raw water.
- City of Aspen Potable Water: Potable water is available at both the Golf Course and High School sites; however, it is the least preferred option by the City of Aspen Utilities Department. In addition to carrying a substantial tap fee and high usage rates, potable water is treated with chlorine, which is not ideal for snowmaking. Due to these limitations and preferences, potable water is considered a fallback option. In **Table 8** (High School), **Options 4 and 5** include potable water. In **Table 9** (Golf Course), potable water is used in **Options 2 and 3**.
- 30" Concrete Line from Hydro Plant to Thomas Reservoir: Water could potentially be diverted from this 30" pipeline near the High School. However, the City uses this hydroelectric generation to help broker electricity rates on a quarterly basis. The value of this power is tied to how much renewable energy is produced and how much electricity the City expects to use, making the financial implications of diverting water highly variable and difficult to predict. As a result, it would be challenging for Aspen Nordic to establish a clear or consistent reimbursement rate for lost hydropower revenue. This option is reflected in **Table 8** (High School) as **Option 3**.
- New Intake on Maroon Creek: This would be very expensive as it requires a new intake constructed in the river, a long delivery pipeline, and a remote pumphouse. In addition, water may be insufficient to satisfy snowmaking demands above minimum creek flow requirements. This is captured by **Option 6** in **Table 8** (High School).
- On-Site Storage: Tanks or a reservoir could be used at the Golf Course. At the High School there is no practical location for a storage reservoir, and a tank would be expensive and/or unsightly. This (reservoir) is captured under **Option 1** in **Table 9** (Golf Course).
- Bear Pond: This pond could serve the Golf Course system, as it has an existing irrigation water pipe to the Golf Course. However, this irrigation pond is typically drained in winter and there is no recharge of Bear Pond after mid-October. This was also connected to **Option 1** in **Table 9** (Golf Course); however, it was disregarded in favor of using water from the Marolt Ditch instead.

Table 8. High School Water Supply Options

Option	Water Source	Pros	Cons	Estimated Annual Water Cost	One-Time Tap Fee	Estimated Pipeline Costs	Estimated Cost of Getting Water to Pumphouse
1	Raw water line near the High School building	Easy connection into existing line Plenty of capacity except when Aspen Highlands is operating Raw water is cheaper	No operation when Aspen Highlands is operating at full capacity Primary power extension 400' to proposed pumphouse	\$33,005	None of the existing tap for Aspen Highlands can be utilized	305 ft 8" HDPE pipe \$40/ft material \$50/ft install <u>Net \$27,450</u>	\$27,450
2	12" Raw water parallel line to improve capacity by 2-300 gpm	Low cost Nordic could benefit via realization of high pipeline capacity	Requires coordination and agreement with Aspen Highlands Requires controls to not overdraw Raw water City may not allow for more water flow, so water may not always be available for Nordic	\$33,005	\$0	250 ft 8" HDPE pipe \$40/ft material \$50/ft install 2x\$10,000 connections <u>Net \$42,500</u>	\$42,500
3	30" concrete Raw water feed line tap ¹	Not a long connection Very close to primary power (approx. 60') vs. further extension required at alternate pumphouse	Uncertain tap fee for concrete pipeline Water availability subject to minimum flows in Maroon Creek Pumphouse may need to be benched into the road bank for screening	\$33,005 + Reimbursement for Lost Hydropower Revenue (Highly Variable and Difficult to Predict)	Assume \$0	1,000 ft 8" HDPE pipe plus concrete pipe tab \$40/ft material \$50/ft install \$25,000 tap <u>Net \$115,000</u> Assumes pumphouse at upper site	\$115,000
4	Potable Water, tap near parking lot ²	Adequate supply based on hydrant tests	Requires municipal water tap fee Requires Snomax More expensive Requires backflow preventer or air gap Primary power extension 400' to proposed pumphouse The City of Aspen Utilities Dept least prefers potable water	\$87,119	\$410,560	305 ft 8" HDPE pipe \$40/ft material \$50/ft install \$7,500 backflow preventer <u>Net \$34,950</u>	\$445,510

Option	Water Source	Pros	Cons	Estimated Annual Water Cost	One-Time Tap Fee	Estimated Pipeline Costs	Estimated Cost of Getting Water to Pumphouse
5	8"/6" Raw water tap blended with potable water as required, tap near High School parking lot	Adequate water Ability to use cheaper Raw water when available Expensive potable water when it isn't	Requires municipal water tap fee Requires Snomax More expensive Requires controls to not overdraw Raw water Primary power extension 400' to proposed pumphouse The City of Aspen Utilities Dept least prefers potable water	Estimate \$73,000 if 50% Raw, 50% potable water	\$410,560	305 ft 2x8" HDPE pipe 2x\$40/ft material \$50/ft install \$7,500 backflow preventer <u>Net \$62,400</u>	\$472,960
6	New Intake in Maroon Creek for 1 CFS (448gpm)	No water cost	Very expensive due to intake and long pipeline Water availability subject to minimum flows in Maroon Creek	\$0	\$0	6,500 ft HDPE pipe \$300/ft estimated material + install \$350,000 estimated intake \$650,000 estimated pumphouse <u>Net \$3,000,000</u>	\$3,000,000

¹ The concrete tap alternative would likely require the Parks Department to reimburse the Hydro plant for lost revenue during snowmaking operations. If the Hydro Plant averages 125 kW and is turned off entirely for a month, a total of 90,000 kWh would be lost. At \$0.25/kWh this amounts to \$22,000 per year. However, the snowmaking system would likely be operated about 25% of this time which would drop the lost revenue to about \$6,000 per year if the Hydro Plan can be turned on when snowmaking is not running.

² Because of incoming pressure, potable water at 100 psi would save 6,770 kWh for 7 million gallons. At \$0.25/kWh this is a \$1,700 per year savings in power costs.

Of the options evaluated for the High School, **Options 1 and 2** were selected as the most practical and cost-effective solution. This approach leverages existing infrastructure while enhancing early-season delivery capacity without requiring major permitting hurdles or long construction timelines. Although this option does not provide full water use abilities when Aspen Highlands is drawing at full capacity, it does allow the Nordic system to operate at a limited rate during October and November and reach full pumping capacity after Aspen Highlands concludes snowmaking operations. This sequencing aligns well with operational goals and seasonal system demands.

Table 9. Golf Course Water Supply Options

Option	Water Source	Pros	Cons	Estimated Annual Water Cost	One-Time Tap Fee	Estimated Pipeline Costs	Estimated Cost of Getting Water to Pumphouse
1	Expanded Clubhouse pond to provide 2.4 million gallons	Inexpensive water sourced from the Marolt Ditch in the summer All water on-site	Requires new reservoir close to the clubhouse Does not provide the full 3 million gallon max estimate	\$0	\$0	None – pumphouse adjacent to proposed expanded pond Pond estimated at \$400,000 by City of Aspen (construction in house)	\$400,000
2	Potable water, 4" tap connection ¹	Adequate water for the required system	Requires municipal water tap fee Requires Snomax More expensive Requires backflow preventer or air gap Primary power extension 400' to proposed pumphouse The City of Aspen Utilities Dept least prefers potable water	\$36,300	\$410,560	Minimal connection piping (60')	\$410,560
3	Potable water, 2" tap connection	No need to construct storage	Low capacity – estimated 200 gpm max at 20'/sec limit Reduced system size = longer coverage time Requires Snomax Requires backflow preventer Max capacity estimated at 200 gpm vs. approximately 400 gpm planned The City of Aspen Utilities Dept least prefers potable water	\$36,300	\$164,224	Minimal connection piping (60')	\$164,224

¹ At the Golf Course, savings would be 2,320 kWh which works out to \$580 per year in power costs. However, this savings would not be realized if an air gap is required.

At the Golf Course, **Option 1**—construction of a new on-site pond filled by the Marolt Ditch—was selected. This option provides a reliable, gravity-fed water source near the Clubhouse, minimizing infrastructure needs and allowing for seamless integration into the snowmaking system. The pond would be filled during the summer and fall months, storing sufficient volume for snowmaking and reducing demand on the City's water infrastructure during the winter. It also avoids the capital cost and operational complexity associated with potable water taps, storage tanks, and pumping systems.

C. WATER SOURCE SELECTION

The selection of water sources was a critical component of the overall system design. City engineering staff, utility representatives, and operational leadership were engaged throughout the evaluation process to ensure that the proposed approach would be acceptable to key stakeholders and administrators. Each option was evaluated not only for capacity and cost, but also for long-term sustainability, compatibility with existing infrastructure, and its ability to minimize disruption to other City operations. Importantly, legal considerations—including water rights and the allowable uses of each source—were also factored into the selection process. The resulting strategies reflect the most balanced and feasible solutions given the unique constraints at each location.

4. SNOWMAKING SYSTEM DESIGN

With water supply strategies identified, the next step in the planning process was to design a snowmaking system that fits the scale, operational goals, and environmental context of each Nordic venue. The following section outlines the primary components of the proposed snowmaking system, beginning with an overview of snowmaking equipment options and proceeding through layout, performance assumptions, and site-specific design recommendations.

A. SNOWGUN OPTIONS

There are three main types of snowmaking “guns”. Each type varies in terms of size, power requirements, snow output, and suitability for different trail configurations.

- **Traditional “air/water” snowguns:** These snowguns mix compressed air and water inside a nozzle and let it expand, creating a rapidly moving spray plume. These snowguns are loud, energy-intensive, and not recommended for the Aspen Nordic trail systems.
- **“Stick” or “lance” snowguns:** These snowguns inject a small amount of compressed air into a water spray formed by a series of pressurized nozzles. This mixing occurs outside the snowgun, with the air providing small ice nucleants to promote freezing. These snowguns can either be mounted on tall posts (typically 30 ft) or on small posts (typically 8 to 10 ft) that are towed around on small sleds. The nozzles can be configured to create a spray that is fairly linear, so they are often used in narrow areas like Nordic trails. These snowguns require both compressed air and water at each hydrant to operate (two separate pipelines), but do not require power. Typical stick guns cost in the range of \$5,000 to \$7,000.
- **Fan snowguns:** These snowguns use a ducted fan to blow a spray of water emanating from multiple nozzles located around the perimeter of the fan. These fan snowguns also typically have a small air compressor to create a stream of ice nucleants that help promote freezing in the snow plume. Fan snowguns work well in marginal temperatures and have a long “throw,” so they are ideal for wider areas like Nordic stadiums. Fan snowguns are larger and heavier than ‘stick’ snowguns. While portable, they typically require a four-wheeler or Snowcat for relocation, and movement is generally limited to periods with sufficient snow cover. Typical fan snowguns cost in the range of \$35,000 to \$50,000.

Photo Credit: Ratnik Industries
“Air/water” snowgun



Photo Credit: HKD
“Stick” snowgun

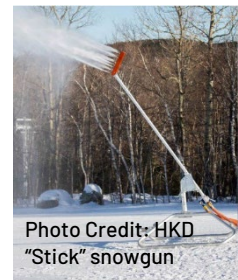


Photo Credit: HKD
Fan snowgun



Overall, “stick” snowguns and fans use approximately the same amount of energy to both pump the water and to convert water into snow. In the case of “stick” snowguns, additional energy is required to operate a central air compressor. In the case of a fan snowgun, additional energy is required to operate the fan and the on-board air compressor at the snowgun. These separate energy requirements largely balance out between the two.

Some specific factors for consideration on the Aspen Nordic trail systems are:

- Fan snowguns require power at each snowgun location, so that power needs to be installed in the trench with the water pipeline. “Stick” snowguns require air piping to be added to the trench. For the most part, the cost of power infrastructure and air piping is equivalent.
- Fan snowguns require an electric pedestal at each snowgun location for the snowgun power feed. While it is technically possible to install these pedestals in a buried vault, this is not advised for safety/integrity reasons. Therefore, in most cases, pedestals must be installed in a permanent, above-ground configuration. On the other hand, air and water hydrants for “stick” snowguns can be installed in the small below-ground vaults where there are visibility or obstruction concerns.

- The incremental cost to automate fan snowguns is fairly low since there is already power at the snowgun location. “Stick” snowguns are more expensive to automate both because there are more snowguns (lower production volume per snowgun than fans) and there is not already power at the snowgun location.
- “Stick” snowguns require a central air compressor. This increases the footprint requirement at the pumphouse to accommodate air compressors, as well as potential noise impacts. The noise impact can be mitigated by locating air inlets and vents away from noise-sensitive areas.

B. RECOMMENDED SYSTEM TYPE AND DETAILS

A preferred system configuration was identified based on site needs and equipment tradeoffs.



Photo Credit: City of Aspen
Example of portable “stick” snowguns

SYSTEM TYPE

The City of Aspen aims to minimize fixed, above-ground permanent structures like electrical pedestals and tower snowguns due to their visual impact. This eliminates most use of fan snowguns or on-board compressor variants of ‘stick’ snowguns. However, a few screened locations—where utility access and aesthetic impacts are less of a concern—may be suitable for such installations. Therefore, the majority of terrain on the trail systems is planned to be covered by portable “stick” snowguns. The stadium at the High School and open areas where electrical pedestals can be integrated into existing features would be serviced by fan snowguns.

Both the “stick” and fan snowgun equipment can be shared between the two venues providing that production timelines align. It is recommended that each location have a baseline number of dedicated snowguns so that snowmaking can progress at both sites simultaneously if desired, with additional snowguns transported between the sites as priorities dictate.

It is recommended that the City of Aspen purchase 4 fan snowguns to be shared between both sites, along with 34 “stick” snowguns (30 Phazer and 4 Impulse R5, if using HKD) for the High School. Of these, 18 stick snowguns could also be used at the Golf Course as needed. A recommended distribution layout is provided for both locations in **Appendix B**.

COMPRESSED AIR OPTIONS

Compressed air supply is a key design factor for systems relying on ‘stick’ snowguns. The following options reflect different strategies for meeting the required air delivery without overcommitting capital or maintenance resources.

It is assumed that each of the locations would have the capacity to operate 4 fan snowguns. While fan snowguns can operate up to 125+ gpm, a typical throughput with temperatures in the low 20s is around 60 gpm. This would then consume up to 240 gpm of the pumping capacity. A “stick” snowgun operating at 20°F wet bulb would generally produce 19 gpm using 47 cfm of air. This suggests that the required air capacity for the High School is 1,410 cfm and the required air capacity for the Golf Course is 1,000 cfm.⁶

Given this, there are several options for compressed air supply:

- Rent compressors: Given the limited hours that snowmaking would be running, the most economical alternative is to rent air compressors for 1 to 2 months. It is most cost-effective to rent diesel compressors, though rented electric compressors are quieter and more suitable for the two locations. It is assumed that if compressors were rented, space would be provided in the pumphouse buildings to roll the compressor inside, connect power and an air discharge lines. The advantages of renting compressors is that the initial capital cost would be significantly reduced, the City of Aspen would not be responsible for maintenance costs, and the compressor could potentially be shared between the two locations, especially if two compressors were rented.⁷

⁶ This allows full use of the proposed Golf Course water capacity if all fans are initially located at the High School.

⁷ A typical electrical compressor rental rate for 1,600 cfm is \$17,000 (+\$3,000 cabling) per month.

- **Purchase compressors:** This option has the advantage of not requiring an annual expenditure of the rental option. While more expensive, an oil free rotary screw compressor can be purchased which is highly reliable, simple to operate, and would require very little maintenance given the few hours it would operate.

Overall, a preliminary budget price to purchase oil-free air compressors is \$546,000 for the two required at the High School and \$273,000 for the one at the Golf Course, or \$819,000 total. This includes an allowance for tariffs and is likely a conservative estimate providing a starting point for evaluation. In 2024, the rental rate for electric compressors was approximately \$12.50 per cfm per month, which would equate to a comparable rental rate of approximately \$30,000 per month, or \$60,000 for 2 months. That provides a straight-line payback of about 14 years if the compressors are rented for 2 months per year.



Photo Credit: Sno.matic
Example of a compressor

For the purposes of this analysis, it is assumed that electric compressors would be purchased. However, from an economic standpoint, it makes sense to consider renting part of the air capacity for a 1-month period (mid-November to mid-December) and shuttling it between the two venues.

ABOVE GROUND STRUCTURES

A conventional snowmaking system has hydrant standpipes protruding above the ground along the trail corridor, typically being spaced 100 to 125 ft apart on Nordic trail systems. A hose is connected between these hydrants and the snowgun to provide water flow. In a “stick” snowgun system, there are 2 hydrants at each location (air and water). In a fan system, there is only a water hydrant, but every 2 to 3 hydrants (roughly 250 to 300’ spacing) are equipped with an electrical pedestal.



Photo Credit: Sno.matic
Example electrical pedestal



Photo Credit: Sno.matic
Example hydrant vault

Both the Golf Course and High School Nordic trail systems have aesthetic and multi-use constraints that restrict permanent snowmaking structures to screened locations. As a result, below-ground hydrant vaults are recommended for the majority of locations. These vaults consist of a 3 to 4 ft diameter vertical culvert with a lid (galvanized or plastic). To eliminate the potential for confined space entrapment, gravel is added up to 18 to 24” from the ground surface, and a 45° fitting is installed on the outlet of the hydrant to make it easier to attach hoses. A vault can hold a single or double set of hydrants. One drawback of below-grade vaults is that fresh snowfall can require crews to dig out hydrants mid-operation. However, since snowmaking typically occurs early in the season, this risk is limited. At the 2 venues, snowmaking would primarily occur early in the winter season and run times would be relatively short. In locations where hydrants or fan snowgun pedestals could be screened, they could be installed above ground.

FACILITY RECOMMENDATIONS

For the **High School**, the snowmaking pumphouse would be located near the upper ball field, close to both power and Raw water connections. *This pumphouse would house two 400 gpm water pumps, each with a 100 HP motor. These pumps would draw water directly from the Raw water system, which would provide approximately 100 psi of pressure at the point of connection.* A central compressor (or compressors)—recommended to be an oil-free rotary screw compressor—would also be located within the pumphouse. This compressor could either be rented or purchased. There would be provisions to operate up to 4 fan snowguns, using pedestals shown in the site plans in **Appendix B**. There would also be one valve distribution vault, allowing piping legs to be isolated in the event of a pipe or hydrant malfunction.

For the **Golf Course**, the pumphouse may be located near a tree island between the driving range and the proposed snowmaking pond. *This pumphouse would house one 400 gpm water pump that has a 100 HP motor.* The pumphouse would also include space for a purchased or rented electric compressor. There would also be provisions to operate up to 4 fan snowguns that would be shared with the High School.

This layout ensures both sites can operate independently during peak snowmaking periods and makes efficient use of shared equipment where feasible.



Photo Credit: Sno.matic
Example of pumps for a snowmaking system

C. AUTOMATION

Snowgun automation is an attractive option for facilities with labor constraints. It also improves efficiency by optimizing the snowgun setting (flow) as temperatures change. However, several considerations should be weighed:

- **Portable vs. fixed snowguns:** Almost all automated “stick” snowguns use fixed, permanent snowgun towers located next to the hydrant set. The ability to remotely start-up and shutdown a snowgun is a great benefit of automation, and this is difficult with a portable sled-mounted snowgun. It is possible to install fixed snowgun towers on flanges or pipe mounts that can be removed after the snowmaking season, but fixed snowguns cannot be relocated to optimize snow deposition during windy conditions. In addition, it is unusual to move fixed snowguns during the operating season, so 1 snowgun would need to be purchased for each hydrant location. Sufficient portable sled snowguns could be purchased to run one-third to half the hydrants, then moved when snow coverage has been completed at 1 hydrant location.
- **Fan snowgun automation tradeoffs:** Fan snowguns can be installed as fully automatic fixed snowguns, which start-up/shutdown automatically, or as semi-automatic snowguns which are started manually but self-adjust as temperatures change. For fully automatic operation, the fan snowgun should be permanently mounted (just like the automatic “stick” snowgun option above). Given the limited hours the fan needs to run at each location and the high cost of the fans, permanent fans are difficult to justify at a Nordic facility like Aspen. There is typically a relatively small incremental cost to upgrade from a manual to a semi-automatic fan. However, for a hybrid system with a few semi-auto fans and numerous manual “stick” snowguns, there is a risk that when a semi-auto snowgun increases its flow setting (as temperatures get colder), it would outdraw the capacity of the pumps.
- **Labor needs for on-site adjustments:** With Nordic trails, it is critical that operations personnel are at or near the snowgun when it starts to adjust the orientation of the nozzle based on wind direction. On a Nordic trail (excluding stadiums and double track areas), the snow needs to land within a narrow 25 to 30 ft wide corridor, so properly aiming the snowgun is critical. In addition, personnel need to be at the snowgun location to disconnect and drain hoses during shutdown (assuming snowguns are mobile).

- Automation efficiency: In a Nordic facility, the snowguns are generally connected to the hydrants and pre-set to a prescribed snowgun stage prior to system start-up. This makes the start-up and shutdown of snowguns very quick, with most of the time spent rotating or moving a mobile snowgun to optimize deposition. This reduces many of the benefits of snowgun automation in Nordic facilities as opposed to alpine facilities, where the distances and slopes make it much harder for crews to get to the snowguns.

Automation is recommended for pump and compressor systems to allow remote monitoring by crews operating the snowguns. Fan snowguns may be equipped with semi-automatic capability to enable early-season use at either venue with minimal on-site staffing. The automation of “stick” snowguns at the High School is not recommended due to:

- Permanent snowgun infrastructure (hydrants or snowgun towers) cannot be installed above ground due to aesthetic and conservation impacts.
- The need to focus snow on the narrow Nordic track requires personnel to be at the snowgun during startup to aim the snowgun, so some of the benefits of full automation are eliminated.

At the Golf Course, two layouts have been prepared: one assuming manual operations of all “stick” snowguns, and an alternate configuration for an automated system in the area around the driving range. The automatic option requires fixed guns and hydrants to be installed along the trail corridor. The tower guns could be removed during the summer, but typically vaults and brackets would extend above the surface slightly under this scenario.

The proposed snowmaking systems reflect the functional and physical constraints of the Aspen Nordic trail network. Design choices—such as using portable “stick” guns, limiting permanent infrastructure, and sharing equipment between venues—were selected to meet early-season goals while minimizing cost and site impacts. Compressor sizing, hydrant placement, and limited automation were tailored to Nordic-specific operational needs. Overall, the system has been designed to perform efficiently within the given seasonal windows and site parameters.

5. STAFFING REQUIREMENTS AND COST

A. STAFFING REQUIREMENTS

Snowmaking operations at Aspen Nordic are designed to be supported by a small, efficient team. Because the system relies on portable snowguns and buried infrastructure, the majority of labor would occur during system start-up and shutdown, with relatively low staffing needs while snowmaking is in progress.

Each snowmaking session would begin with towing and positioning the snowguns, laying out hoses, and connecting them to hydrants. This work would be done by a crew of 4 to 6 people. Start-up involves turning on the air compressor and water pump, which pressurizes the system within minutes due to the below-frost installation of the pipes. Shutdown at the end of each session involves turning off the systems, disconnecting and blowing out hoses, and storing equipment for the next use. These tasks would be repeated each session and would be the most labor-intensive parts of the operation.

While the system is running, staffing demands would be significantly lower. Monitoring typically requires only 2 to 3 people to shift the guns as winds change and make occasional nozzle adjustments.

The tables below summarize the estimated labor hours required for both venues, based on total snowmaking hours, the number of sessions, average session length, and crew size assumptions. These estimates are based on Sno.matic's operational experience and are intentionally conservative to ensure they cover typical and slightly adverse conditions.

HIGH SCHOOL

At the High School, staffing needs reflect the longer trail network and more extensive snowmaking system than that of the Golf Course.

Table 10. Labor Hours Required for the High School

Snowmaking Session Time Assumptions	Quantity	Notes
Total Snowmaking Hours	180 hours	Based on system pumping capacity. Includes hours for start-up, runtime, and shutdown
Snowmaking Sessions	12 sessions	Based on industry experience
Average Session Duration	15 hours	180 hours ÷ 12 sessions
Start-up Time per Session	2 hours	-
Shutdown Time per Session	2 hours	-
Total Start-up/Shutdown Time	48 hours	12 sessions × (2 + 2)

Labor Hours Calculation	Time	Crew Size	Labor Hours	Notes
Start-up/Shutdown	48 hours	6 people	288	Most labor-intensive part of operation
Runtime	132 hours	3 people	396	180 total hours – 48 for start-up/shutdown
Total Labor Hours	-	-	684	-

At the High School, snowmaking would occur across 12 sessions with an average duration of 15 hours. Each session includes 2 hours for start-up and 2 hours for shutdown, totaling 48 hours. With a crew of 6 people, this results in 288 labor hours for system activation and closure. The remaining 132 hours of system runtime require 3 staff members to monitor operations, adding 396 labor hours. *In total, 684 labor hours are anticipated for the High School system.*

GOLF COURSE

Labor needs at the Golf Course would be slightly lower due to the smaller snowmaking coverage area and fewer snowmaking sessions.

Table 11. Labor Hours Required for the Golf Course

Snowmaking Session Time Assumptions	Quantity	Notes
Total Snowmaking Hours	150 hours	Based on system pumping capacity. Includes hours for start-up, runtime, and shutdown
Snowmaking Sessions	10 sessions	Based on industry experience
Average Session Duration	15 hours	150 hours ÷ 10 sessions
Start-up Time per Session	2 hours	-
Shutdown Time per Session	2 hours	-
Total Start-up/Shutdown Time	40 hours	10 sessions × (2 + 2)

Labor Hours Calculation	Time	Crew Size	Labor Hours	Notes
Start-up/Shutdown	40 hours	4 people	160	Most labor-intensive part of operation
Runtime	110 hours	2 people	220	150 total hours – 40 for start-up/shutdown
Total Labor Hours	-	-	380	-

At the Golf Course, 10 snowmaking sessions are expected. Each includes 4 hours of start-up and shutdown time, totaling 40 hours, with a crew of 4 people—resulting in 160 labor hours. The 110 hours of runtime require only 2 staff, contributing another 220 labor hours. *Altogether, the Golf Course system is projected to require 380 labor hours.*

Across both venues, these estimates reflect the operational pattern typical of Nordic snowmaking: brief periods of intensive set-up and shutdown work paired with relatively passive monitoring while the system runs. This model would enable the systems to function with modest labor resources. *Total combined labor across both systems amounts to an estimated 1,064 hours per season.* These figures support a lean, efficient staffing plan aligned with the scale and design of the Aspen Nordic snowmaking system.

B. CAPITAL, OPERATING, AND MAINTENANCE COSTS

While labor is a key component of the overall investment, capital infrastructure and other recurring operating expenses also play a critical role in evaluating project feasibility and long-term sustainability. This section outlines the associated infrastructure, utilities, maintenance, and labor costs for both the High School and Golf Course systems.

The following tables (**Tables 12** through **15**) provide estimated capital and operating costs for the High School and Golf Course snowmaking systems. Maintenance costs are also included, based on industry averages. Electric costs are based on current Holy Cross Energy rates. While the City of Aspen could alternatively purchase electricity through its municipal utility—offering 100% renewable power—this approach would involve higher rates and a 1-time ECI (Electric Capacity Infrastructure) charge estimated at \$200,000 per site.

HIGH SCHOOL

Tables 12 and **13** summarize the capital costs and operating and maintenance costs for the High School snowmaking system. These figures reflect a more extensive system footprint, higher total coverage area, and a more complex infrastructure—including 34 snowguns, 2 compressors, and greater piping requirements. The Raw water source incurs an ongoing per-gallon cost, contributing to higher annual operating expenses compared to the Golf Course.

Table 12. Capital Costs for the High School Snowmaking System

Snowmaking Infrastructure	Quantity	Price per	Total	Origination of Estimate
Piping Distribution				
Water Pipe - Supply/Weld/Install	7,220 LF	\$70 per ft	\$505,400	Towsley Estimate
Air Pipe - Supply/Fuse/Install	7,220 LF	\$30 per ft	\$216,600	Towsley Estimate
Pipeline excavation	7,220 LF	\$45 per ft	\$324,900	Towsley Estimate
Shading for Backfill	7,220 LF	\$15 per foot	\$104,690	Towsley Estimate
Laterals (2")	940 LF	\$50 per ft	\$47,000	Towsley Estimate
Raw Water Connection	300 LF	-	\$24,400	Sno.matic Estimate
Parallel Raw Water Piping	250 LF	-	\$62,500	Sno.matic Estimate
Hydrant vaults, hydrants - single	22 units	\$4,000 per unit	\$88,000	Towsley Estimate
Hydrant vaults, hydrants - double	25 units	\$3,000 per unit	\$75,000	Towsley Estimate
Electrical Wire - Supply/Install	2,150 LF	\$25	\$53,750	Towsley Estimate
Electrical Wire - Trench	2,150 LF	\$20	\$43,000	Towsley Estimate
Electrical Pedestals	6 units	\$3,000	\$18,000	Towsley Estimate
Pipeline Mobilization	1 unit	\$75,000	\$75,000	Towsley Estimate
Pumphouse Building				
Structure	1,000 sq ft	\$500 per sq ft	\$500,000	Towsley Estimate
Pump Skid	1 unit	\$187,500	\$187,500	TorrenSkid quote
Compressor	2 unit	\$273,000	\$546,000	Copco quote
Mechanical Install	1 unit	\$100,000	\$100,000	Sno.matic Estimate
Snowguns				
Stick Guns (Phazer)	30 unit	\$6,000	\$180,000	Based on HKD pricing
Fan Guns (auto)	4 unit	\$55,000	\$220,000	Based on HKD pricing
Electrical				
Transformers	Assumed provided by utility, requires 1000 kva XFRMR			-
Service Entrance	1 unit	\$100,000	\$100,000	-
Panel Board	1 unit	\$80,000	\$80,000	-
Electrical Install	1 unit	\$100,000	\$100,000	-
Instrumentation and Control				
Instrumentation and Control	1 unit	\$85,000	\$85,000	-
Subtotal Capital Costs				\$3,736,740
Contingency 15%				\$560,511
TOTAL CAPITAL COSTS				\$4,297,251

Table 13. Annual Operating & Maintenance Costs for the High School Snowmaking System

Snowmaking Infrastructure	Quantity	Total
Water		
Raw Water Cost	5.76 million gallons, \$5.73/kgal	\$33,005
Electric		
Electrical Demand Charges ¹ - Holy Cross	-	\$14,919
Electrical Energy Charges - Holy Cross	-	\$10,474
Labor		
Labor Estimation	684 total hours, \$65 per hour (with burden)	\$44,460
Maintenance		
Maintenance Allocation	Recommended = 25% of Water + Electric + Labor	\$25,714
TOTAL ANNUAL COSTS		\$128,572

¹ Demand charges may be higher for the first several years to pay for primary delivery.

GOLF COURSE

Tables 14 and **15** provide equivalent cost detail for the Golf Course. While this system is smaller in scale, it still includes robust infrastructure such as a dedicated pumphouse and 1 compressor. Because water would be coming from a new pond on the Golf Course fed by the Marolt Ditch, there are no anticipated charges for water use, contributing to comparatively lower annual operating costs.

Table 14. Capital Costs for the Golf Course Snowmaking System

Snowmaking Infrastructure	Quantity	Price per	Total	Origination of Estimate
Piping Distribution				
Water Pipe - Supply/Weld/Install	5820 LF	\$70 per ft	\$407,400	Towsley Estimate
Air Pipe - Supply/Fuse/Install	5820 LF	\$30 per ft	\$174,600	Towsley Estimate
Pipeline excavation	5820 LF	\$45 per ft	\$261,900	Towsley Estimate
Shading for Backfill	5820 LF	\$15 per foot	\$84,390	Towsley Estimate
Laterals (2")	700 LF	\$50 per ft	\$35,000	Towsley Estimate
Hydrant vaults, hydrants - single	23 units	\$4,000 per unit	\$92,000	Towsley Estimate
Hydrant vaults, hydrants - double	11 units	\$3,000 per unit	\$33,000	Towsley Estimate
Electrical Wire - Supply/Install	1600 LF	\$25	\$40,000	Towsley Estimate
Electrical Wire - Trench	1600 LF	\$20	\$32,000	Towsley Estimate
Electrical Pedestals	5 units	\$3,000	\$15,000	Towsley Estimate
Pipeline Mobilization	1 unit	\$50,000	\$50,000	Towsley Estimate
Pumphouse Building				
Structure	750 sq ft	\$500 per sq ft	\$375,000	Towsley Estimate
Pump Skid	1 unit	\$150,000	\$150,000	Estimated from HS Quote
Compressor	1 unit	\$273,000	\$273,000	Copco quote
Mechanical Install	1 unit	\$100,000	\$100,000	Sno.matic Estimate
Reservoir				
Reservoir	1 unit	-	\$400,000	Estimate for in-house construction
Snowguns				
Stick Guns (Phazer)	20 units	\$6,000	\$120,000	Based on HKD Pricing
Fan Guns (auto)	0 units	\$55,000	Included in High School Estimate	
Electrical				
Transformers	Assumed provided by utility, requires 500 Kva XFRMR			-
Service Entrance	1 unit	\$60,000	\$60,000	-
Panel Board	1 unit	\$50,000	\$50,000	-
Electrical Install	1 unit	\$75,000	\$75,000	-
Instrumentation and Control				
Instrumentation and Control	1 unit	\$65,000	\$65,000	-
Subtotal Capital Costs				\$2,893,290
Contingency 15%				\$433,994
TOTAL CAPITAL COSTS				\$3,327,284

Table 15. Annual Operating & Maintenance Costs for the Golf Course Snowmaking System

Snowmaking Infrastructure	Quantity	Total
Water		
Raw Water Cost	2.4 million gallons, \$0/kgal	\$0
Electric		
Electrical Demand Charges ¹ - Holy Cross	-	\$10,774
Electrical Energy Charges - Holy Cross	-	\$5,673
Labor		
Labor Estimation	380 total hours, \$65 per hour (with burden)	\$24,700
Maintenance		
Maintenance Allocation	Recommended = 25% of Water + Electric + Labor	\$10,287
TOTAL ANNUAL COSTS		\$51,434

¹ Demand charges may be higher for the first several years to pay for primary delivery.

These cost summaries show that the **High School** system would require a *larger capital investment—approximately \$4.30 million*—due to the longer trail network, higher pumping capacity, and larger number of snowguns (34 total, including 4 fan guns). Annual operating and maintenance costs are estimated at \$129,000, driven primarily by labor, followed by water costs (\$5.73/kgal for 5.76 million gallons), electrical usage, and a maintenance allocation.

By comparison, the **Golf Course** system's *capital costs are estimated at \$3.33 million*. This lower total reflects the smaller number of snowguns (20 stick guns). Annual operating and maintenance costs for the Golf Course are estimated at \$51,000, also driven primarily by labor, followed by electrical usage, and a maintenance allocation. There is no anticipated water cost for the Golf Course, since water would be coming from a new pond on the Golf Course fed by the Marolt Ditch. Automating snowmaking operations at the driving range portion of the Golf Course would add an estimated \$330,000 to capital costs.

For **both venues** together, *the total capital cost to implement snowmaking would be approximately \$7.62 million*, with total annual operating and maintenance costs estimated at \$180,000. If automation is included at the Golf Course, total capital costs amount to \$7.95 million. These figures reflect the full build-out scenario and include all primary infrastructure, utilities, and staffing assumptions for both the High School and Golf Course.

Cost efficiencies would be reinforced by shared equipment (e.g., fan guns) and the strategic use of gravity-fed infrastructure at the Golf Course. Additional savings could be explored in the future through the use of pre-fabricated structures.

It should be noted that permitting costs are not included in the above estimates. **Sections 6 and 7** outline anticipated environmental impacts and permitting requirements, respectively.

6. ENVIRONMENTAL IMPACTS

The proposed snowmaking system and related trail improvements are expected to result in relatively limited environmental impacts. Nonetheless, areas of disturbance should be managed with care to maintain existing site functions and comply with applicable regulations.

A. STORMWATER DRAINAGE AND INFRASTRUCTURE

No new stormwater infrastructure (e.g., culverts or ditches) is proposed at either site, both of which currently have minimal to none. All earthwork would follow local permitting requirements and best practices for restoration. Snowmaking installation is expected to have minimal long-term impact on drainage patterns, given the limited introduction of hardscape and the commitment to restoring grade and vegetation post-construction.

B. GROUND DISTURBANCE

The project would result in two types of ground disturbance at both the High School and the Golf Course:

1. Permanent disturbance from trail grading, which would modify the existing grade to support improved trail alignments, and from minimal surface equipment installation; and
2. Temporary disturbance associated with snowmaking system installation, including utility trenching and construction access, after which the existing grade would be restored.

All areas requiring earthwork would be considered “disturbed.”

PERMANENT DISTURBANCE

At the **High School**, *permanent disturbance may range from 0.25 to 0.50 acres*, depending on whether grading is pursued in addition to snowmaking installation.

At the **Golf Course**, trail improvements and limited surface equipment installation would *permanently disturb approximately 2.5 acres* of ground vegetation.

TEMPORARY DISTURBANCE

Snowmaking installation would require a temporary disturbance corridor up to 20 ft wide along the proposed pipe alignment, providing space for trenching (approximately 6 ft wide), staging, and equipment access. Soil excavation would be limited to the trench footprint where practicable. To support revegetation and soil stabilization, topsoil should be stripped and stockpiled separately, then replaced as the final lift during backfill. Temporary above-ground irrigation infrastructure should be considered to support native area restoration.

Based on current plans, *the project could result in up to 4 total acres of temporary ground disturbance.*

C. MATURE OAKS

Mature oak trees within the High School trail system contribute to the site’s ecological and visual character. The proposed trail alignment has been designed to avoid removal of these trees. Minor branch trimming may be necessary to maintain adequate clearance within the trail corridor, but no stump removal is anticipated.

7. LAND USE REQUIREMENTS

This section draws on the plats and covenants provided to assess whether snowmaking infrastructure is compatible with the designated recreational uses and open space goals at the High School and Golf Course. SE Group prepared a supplemental zoning review to evaluate applicable permitting pathways under both City of Aspen and Pitkin County codes, which can be found in **Appendix F**.

A. HIGH SCHOOL

The High School land property is owned and governed by the City of Aspen and the Moore Family PUD. Portions of the property are adjacent to, and governed by, easements and covenants tied to the Five Trees subdivision, including designated open space areas. As such, coordination with the Five Trees HOA may be required for any modifications to existing easements or new infrastructure proposed within those areas.

Plats and covenants outlining land use requirements for the High School include:

- Document 420462: PUD Plat – Lot Line Adjustment for Moore Family PUD
- Document 420463: Planned Unit Development Guide – Moore Family PUD
- Document 420493: Declaration of Covenants, Conditions and Restrictions – Moore Family Athletic Fields
- Document 420494: Assignment and Assumption of Declaration of Covenants – Moore Family Athletic Fields

A summary of the permitted use, permitted infrastructure, restrictions, and development review implications contained in these documents is provided below.

PERMITTED USE

Permitted use of the Moore Family Athletic Fields is designated for baseball, softball, and soccer and their associated infrastructure. A portion of the property separates the Moore Family Athletic Fields and the Meadowood Subdivision. This portion of the property is designated for open space uses and Nordic skiing; no physical infrastructure like swing sets, barbecue pits, or picnic tables shall be permitted. Special events may be hosted at the Moore Family Athletic Fields four times each year on Sundays from 9 a.m. to 5 p.m. Overall, the use of the property is designated for recreational purposes associated with using the fields.

PERMITTED INFRASTRUCTURE

Mentions of infrastructure within the Declaration Covenants is geared explicitly towards facilitating the use of the baseball/softball and soccer fields. The explicit mentions of infrastructure that is or is not allowed include:

- No lighting will be permitted for any of the fields. The parking lot lighting shall be restricted to the minimum level necessary for safety or legal standards.
- Restroom facilities shall be limited to portable and removable facilities located on the far western edge of the property. Restrooms shall also be removed during the winter season.
- Bleachers are not permitted on the fields
- Snow removal and maintenance on the Nordic trails is allowed
- The use of a sound system or loudspeaker is prohibited

Infrastructure such as snowmaking may be allowed as long as it is reviewed through proper land use and building permit processes. Physical infrastructure for the snowmaking system, like pumps, hydrants, pipelines, or electrical connections, would most likely need to be visually screened or placed in areas that would not impede the primary recreation or use of the fields.

RESTRICTIONS

The Moore Family Athletic Fields are limited to athletic fields, open space, and public recreation. The installation of snowmaking facilities on this property must be compatible with the designated recreational use, must not interfere with public access, and may require review or approval by Pitkin County or other interested parties before implementation.

DEVELOPMENT REVIEW IMPLICATIONS

The installation of snowmaking infrastructure would likely require a site plan review or amendment to the Planned Unit Development if new above-ground infrastructure, utility extensions, or water conveyance structures are proposed. Before implementation, a review of site plans and a potential amendment with Pitkin County and other interested parties shall occur.

ANTICIPATED TIMELINE

Permitting processes for the High School are expected to take 18 to 24 months, with some concurrent tasks listed below:

- Initiate land use application, retain Land Planner (2 months)
- Formal Pre-application conference with City of Aspen Community Development, Planning Office (1 month)
- Formal presentation, request, and conversation with Five Trees HOA and Metro District (2 months)
 - Determination of agreement that would authorize amendments, Five Trees Open Space (2-4 months)
 - Preparation of amended easements (3-5 months)
- Outreach with adjacent neighbors (3 months)
 - Five Trees
 - School District
 - Meadowood
 - Bus barn lane residents
- Development of PD amendment application (3-6 months)
- Establish Raw water agreements (3 months)
- PD amendment submittal and City Council Review and Ordinance (6-9 months)
- Landscape and Grading & Building Permit Submittal (6 months)

A Greenline review process may also be required for the High School. Further detail is provided in **Appendix F**.

B. GOLF COURSE

The Golf Course land property is owned by the City of Aspen and is managed as the Aspen Golf Course Subdivision. Plats and covenants outlining land use requirements for the Golf Course include:

- Document 269092 (1985 Plat): Subdivision Exemption Plat – Aspen Golf Course Subdivision
- Document 451795 (2001 Plat): Amended Plat – Aspen Golf Course Subdivision

A summary of the permitted use, permitted infrastructure, restrictions, and development review implications contained in these documents is provided below.

PERMITTED USE

Snowmaking infrastructure is understood to be generally allowed as long as below-ground elements do not impact landform or drainage, and above-ground elements do not conflict with the existing Golf Course layout. Above-ground elements would likely require review before installation to avoid impacting the property's fairways, greens, or irrigation systems.

PERMITTED INFRASTRUCTURE

Infrastructure such as snowmaking may be allowed as long as below-ground elements do not interfere with golf operations or permanently alter landform or drainage, and above-ground elements do not conflict with the existing Golf Course layout. Above-ground elements would likely require review before installation to avoid impacting the property's fairways, greens, or irrigation systems.

RESTRICTIONS

The Aspen Golf Course Subdivision identifies certain areas, like utility easements, drainage areas, and access routes, that need to remain unobstructed. The installation of snowmaking infrastructure for the Nordic trails must be sited to avoid these areas, or additional permitting must be obtained if they intersect or overlap with existing infrastructure.

DEVELOPMENT REVIEW IMPLICATIONS

Installation of snowmaking infrastructure at the Aspen Golf Course Subdivision would require coordination with the City of Aspen to confirm compatibility with summer operations. New permitting and design review through Pitkin County could also be necessary, specifically for trenching for water and utility lines, and for pumphouses that exist on school district property. It would also be essential to submit a site plan to ensure proper engineering, environmental, and zoning are considered. An engineering review would be needed to ensure adequate grading and drainage plans and erosion control measures are in place. An environmental review would ensure that adding this infrastructure or machine-produced snow would not impact nearby streams or wetlands. A zoning review would ensure utility corridors are correctly sited and snowmaking infrastructure installation is aligned with other uses on the property.

ANTICIPATED TIMELINE

Permitting processes for the Golf Course are also expected to take 18 to 24 months, with some concurrent tasks listed below:

- Initiate land use application, retain Land Planner (2 months)
- Formal Pre-application conference with City of Aspen Community Development, Planning Office (1 month)
- Formalize any water right documentation (6 months)
- Outreach with adjacent neighbors (3 months)
- Development of PD amendment application (3-6 months)
- Establish Raw water agreements (3 months)
- PD amendment submittal and City Council Review and Ordinance (6-9 months)
- Landscape and Grading & Building Permit Submittal (6 months)

CONCLUSION AND RECOMMENDED NEXT STEPS

The proposed snowmaking system would cover 3.3 km at the High School and 2.2 km at the Golf Course. At the High School, annual water use is projected at 5.76 million gallons. Water would be drawn from the City of Aspen's Raw water pipe system, potentially via a new bypass near the Aspen Highlands pump station. This bypass would allow for up to 300 gpm to be delivered while Aspen Highlands is operating at capacity, and full access would be available once Aspen Highlands completes snowmaking—typically by December 1.

At the Golf Course, an on-site storage pond would be constructed to hold 2.4 million gallons, matching the projected annual demand. The pond would be filled each summer using the existing irrigation system that draws from the Marolt Ditch.

A climate analysis indicates that Aspen receives sufficient cold weather to support snowmaking. In 8 out of 10 years, there are approximately 253 snowmaking hours before December 1 and 567 hours before December 15. Based on these conditions, *the recommended snowmaking capacity is 800 gpm of water and 1,400 cfm of compressed air for the High School, and 400 gpm of water and 1,000 cfm of compressed air for the Golf Course.*

The system would use primarily portable, low-energy stick guns, supplemented by 4 fan guns shared between the two sites. Hydrants would be installed in below-grade vaults in sensitive public areas, with permanent standpipes and electrical pedestals placed only where they can be visually screened. Due to the narrow trail width of Nordic tracks and the desire to remove equipment after snowmaking is complete, the system would be designed with automated pump and compressor controls, while snowguns would be operated manually, though an alternative option has been provided for snowgun automation on the Golf Course.

The estimated capital cost is \$4.30 million for the High School and \$3.33 million for the Golf Course, amounting to approximately \$7.62 million in total capital costs for both systems. If full automation is pursued for the driving range portion of the Golf Course, capital costs would increase by \$330,000, totaling \$3.66 million for the Golf Course and \$7.95 for both systems together. These estimates should be refined during final design, as they reflect current pricing and do not account for funding sources or repayment obligations related to the initial capital investment.

Annual operating and maintenance costs are estimated at approximately \$129,000 for the High School and \$51,000 for the Golf Course, reflecting water, electric, labor, and maintenance expenses. *Labor requirements are estimated at 684 hours for the High School and 380 hours for the Golf Course per season, totaling approximately 1,064 hours annually across both systems.*

When ready to initiate next steps, the City of Aspen Parks Department should evaluate funding feasibility for the proposed snowmaking systems. If funding appears viable, the next step would be to advance construction documentation. Once draft construction documents are developed, the City can engage in preliminary permitting discussions with relevant departments and agencies. These conversations may result in necessary revisions to the construction documents. Final approvals should then be secured based on the refined design, with opportunities to phase construction based on funding availability, site access, and operational needs.

REFERENCES

IN-TEXT CITATION	FULL REFERENCE
Luce et al. 2023a	Luce, C. et al. 2023. White River National Forest Snow Water Equivalent (April 1): Percent Change (1975-2005 vs. 2071-2090, RCP 8.5). Available at: https://usfs.maps.arcgis.com/apps/Cascade/index.html?appid=84d0b8b9388343149f5365de517a6689
USDA Forest Service 2024a	USDA Forest Service. 2024. Climate By Forest Average Daily Maximum Temperature. Available at: https://climate-by-forest.nemac.org/
USDA Forest Service 2024b	USDA Forest Service. 2024. Climate By Forest Average Daily Minimum Temperature. Available at: https://climate-by-forest.nemac.org/

APPENDIX G: ADOPTIONS

