BULKLEY VALLEY
NORDIC CENTRE

BULKLEY VALLEY NORDIC CENTRE COMPETITION TRAILS 2024 MASTER PLAN

BULKLEY VALLEY NORDIC CENTRE
COMPETITION AND TRAINING TRAILS 2024 MASTER PLAN
ADDITIONS AND MODIFICATIONS TO EXISTING TRAIL NETWORK

BULKLEY VALLEY CROSS COUNTRY SKI CLUB

SEPTEMBER 2024

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1.0 INTRODUCTION

This report presents a 'Competition and Training Trails Master Plan' for additions and modifications to the existing trail network to create new competition courses that meet the FIS homologation criteria. The Bulkley Valley Cross Country Ski Club (BVCCSC)) requires upgraded competition trails should it choose to apply to host inter-provincial or national level races in all seven race-types including classic and free-technique for individual start, mass start, relay, sprints, team sprints, pursuit, and skiathlon. The club also desires that any additional trails be built to also provide local athletes with graduated technical training terrain and to minimize grooming effort and maintenance.

A list of Club priorities related to competition and training trails is included in Appendix B.

2.0 BACKGROUND

The club currently operates two trail systems, the Pine Creek ski trails on the south side of the highway and the Chris Dahlie ski trails on the north side. The total trail network encompasses some xx km of groomed trails including:

- 10-15 km competition and training trails (Chris Dahlie trails)
- 13 km dog trails (part of Pine Creek trails)
- A total of 52.2 km trails (Pine Creek and Chris Dahlie trails)

The BV Nordic Centre (BVNC) also include a lodge, waxing hut, grooming equipment buildings, a caretaker's residence and a biathlon range. The ski area is located 15 minutes from Smithers at an elevation of about 900 m at the stadium.

BVCCSC has been operating since the 1980s using the Pine Creek trails. The Chris Dahlie trails were constructed in the 1990. BVCCSC is one of the largest and most active clubs in BC with jackrabbit, school, recreational, and racing programs, as well as biathlon.

3.0 SCOPE AND APPROACH

As mentioned above, the scope for this Master Plan is to identify options for upgrading the existing competition trails to accommodate all types of races for all age groups. The master plan provides preliminary designs based on desktop map assessment using lidar

mapping with 1 m contour interval and field reconnaissance by Roger McMillan and Reidar Zapf-Gilje (the author). This Competition and Training Trails Master Plan identifies the full potential in terms of suitable terrain and include proposed options for review and discussion and forms the basis for further planning and funding applications, Detailed design and construction would follow in subsequent stages and described below:

- Stage 2 - Detailed trail design and flagging of trails and other competition and training features.

- Stage 3 – Phased construction based on final designs of ski trails and features.

This Stage 1 Competition and Training Trails Master Plan field work involved identifying which part of the existing trails provide suitable challenges for the various distances and climbs for competition and training for all age groups; and where the existing network no longer meets homologation criteria to identify alternative layouts by incorporating additional terrain and trails connectors that also provide for grooming efficiencies. The result is a trail network that meet FIS homologation criteria with suitable cutoff options for young skiers and master skiers, that is also relatively efficient to groom and maintain.

Field measurements of distance and slope were made using a combination of GPS, clinometer and laser distance measurements. The measurements made are useful for preliminary design but not accurate enough for final design. The trails should be re-surveyed with high accuracy GPS or land surveying equipment in order to make necessary adjustment during final design to ensure that the homologation criteria are met.

The competition trails have been designed to provide smooth, rhythmical and interesting skiing for jackrabbits, junior skiers, senior skiers, and master skiers, while keeping within the recommended homologation criteria. General design considerations include:

- Providing skiing variety, appropriate hill climbs, and interesting views and scenery.

- Avoiding where possible areas with marginal snow cover on south facing sections.

- meeting the lower end (easier range) of the CSA/FIS homologation criteria for competition trails (see Appendix E).

- modifying sharp turns to provide safe runouts; and
- Including multiple trail connector trails to provide more choices for training.

Additionally, the design addresses the Club priorities which are described in more detail in the documents included in Appendix B. The Club priorities include the following:

- Grooming efficiency
- Sparing approach (don't build more than you need)
- Increase fun technical terrain
- Improve skier safety/reduce risk of collisions
- Groomability (eg. corners at least 11.5m radius)
- Minimize need for wide (9m) trail
- Minimize impact to recreational skiers' existing trail
- Provide new opportunities for recreational skiers
- Climate change resiliency
- Stewardship
- Major event readiness
- Maintain natural feel of trails (trail density, trees)
- Minimize skier confusion with 'maze'
- Maintain regular engagement with key club reps

4.0 STADIUM, TERRAIN PARK, PLAY AREAS

4.1 Stadium Layout

The existing stadium measures about 75 m wide by 150 m long. The many trails leading in and out of the stadium are wide and level and can serve as part of the start and finish chutes. These features allow for some flexibility when holding skiathlon and relay competitions. Options for sprint and individual start races as shown in Appendix C1.

4.2 Terrain Park

Next to the stadium is a flat area backing up against a hilly bank. The flat part of the area has some manmade bumps and banked trails. With some modification, this area is ideal for a Terrain Park with semi-permanent features such as obstacle courses, moguls, bicycle steps, jumps and many other features. Appendix F includes some ideas for a terrain park. A detailed design of the terrain park could be part of the next stage of trail and facility design.

4.3 Other Teaching and Play Areas – Including a Proposed location for a Downhill Slope

The stadium, warm-up loop and wax testing area, when not used for competitions provide a variety of level and slightly sloping terrain for teaching skate and classic technique, as well as fun play zones for jackrabbits and older kids alike.

A hill suitable for teaching downhill techniques for cross country skiers, as well as providing for fun play is important but often overlooked at cross country ski facilities. Downhill techniques are integral to cross country skiing and can be best taught if a hill is available near the stadium area. Such a hill would provide opportunities for holding CANSI instructor courses, as well as for the newly formed Nordique Canada Recreational Program.

A suitable location for a downhill slope is shown in Appendix C6. A detailed design of the downhill area could be part of the next stage of trail and facility design. The dimensions need to be at least 20m in width, by at least 50m long with room for at least five connected turns, and between 10% and 20% slope with a safe run-out at the bottom.

5.0 COMPETITION AND TRAINING TRAILS

5.1 Design considerations

The competition and training trails area follows the south facing slope of a ridge running east-west. The hill slope is varied with many benches and provides excellent options for modifying and adding to the existing trails to accommodate interesting and challenging competition and training courses which would meet the FIS homologation criteria. The proposed layout of the courses is shown in Appendix C and summarized in Table 1.

The proposed trail network includes a set of courses for regular competitions including Sprint, 1.5, 2.5, 3.3, 3.75 and 5 km. The courses are referred to as Main xx km courses.

To accommodate skiathlon, pursuit, and relays; a second set of paired courses including two separate loops for each of the 2.5 km and 3.75 km distances. These are referred to as Eastern and Western loops (Appendix C3 – Two-Course Race Trail Network). The benefits of paired courses rather than using the same course for both classic and skate legs include: grooming efficiency, race logistics, reduced trail width requirements, and competitor and spectator enjoyment of skiing on different terrain for the classic and skate leg of the race.

Two options for a 2.5 km trail suitable for sit-ski competitions has also been identified (see Appendix C4). Option A runs clockwise out Broadway and return on Northern Lights. Option B has two loops: The first loop takes the skiers around the Biathlon area, then return to the Stadium for the second loop out-and-back on Northern Lights. Both courses have slopes and climbs that meet the homologation standards (Table 1). It is important that sit-ski trails are safe and easy to navigate.

The proposed trail layouts include new trail segments while maximizing the use of existing trails. The preliminary design involves a recommendation to widen existing trails where needed, to increase the radius on some corners in particular at the exit of the curve, to reduce and distribute the hill climbs throughout the courses as recommended by the homologation criteria, and to add more undulating terrain with slopes of less than 4%.

The new trail segments were also located turn 3-way junctions into 4-way junctions to improve the grooming. A deliberate attempt was made to stay at the easy end of the range specified for hill climbs and downhill corners, as well as adding distance of

undulating terrain (less than plus/minus 4% slope) to make the competition and training courses skiable for the young and old racer.

The overall design allows for flexible competition courses using multiple laps or using a combination of the Eastern and Western loops. Using multiple laps provide grooming/snowmaking efficiency, and better media coverage and spectator viewing. Some examples include:

- 5 km: 2x2.5 (using the Main loop or using the Eastern and Western loops)
- 10 km: 4x2.5 (using the Main loop or using the Eastern and Western loops)
- 10 km: 3x3.3
- 10 km: 2x5
- 30 km skiathlon: 4x3.75 classic + 4x3.75 skate
- 30 km Skiathlon: 6x2.5 classic and 6x2.5 skate
- 4x5 km relay: 2 x 2.5 for each skier (using the Main loop or using the Eastern and Western loops)

All homologation measurements need to be confirmed by more detailed survey methods.

5.2 Staging of Construction

Most of the competition and training trails can be created with only moderate amount of new trail constructions and could easily be constructed in one summer season. Some of training trail connectors could be scheduled for construction at a later date, depending on funding.

A proposed phasing of construction of the new trail segments is described in 'BV Nordic Ski Club Homologation Proposal: Oct. 2024' which is included in Appendix B. Also described in this document, are layout and benefits that these new trail segments provide for the race trail network.

5.3 Warm-up and wax testing areas

A competition venue requires a warm-up and wax testing areas that do not interfere with the stadium and competition courses. The trails south and west of the stadium including the biathlon area, tunnel connector, and the recreational Broadway trail are suitable for this purpose. The trails are separated from the stadium and race trails, allowing for unimpeded access during competitions by racers warming up, support crew, and has space for additional waxing tents.

5.4 2.5 km Sit-Ski

Sit-ski competition trails require lower hill slopes and less elevation difference than regular competition trails. Course options are shown in Appendix C4 and Table 1.

5.5 Sprint Loops

BV Nordic Centre has hosted major sprint competitions (2006 Western Canadian Championships), however, sections of the sprint alignments used have revegetated or are no longer suitable.

Two separate sprint courses have been developed as shown in Appendix C5.

- One for classic races which runs clockwise and include a suitable incline for diagonal stride, as well as some challenging turns on the downhill into the stadium.

- The free technique course runs counterclockwise and starts with a climb and hairpin turn into a gentle downhill section that would separate skiers based on how well they can utilize the terrain to maximize glide. A second uphill breaks the speed, and levels off before the skier heads down towards the stadium. An interesting and spectator friendly finish include a small hill and some tight turns before reaching the stadium and the finish chute.

Both courses have several suitable climbs with undulating and downhill sections interspersed and include optional turnoffs for creating a shorter course for younger racers. Both courses are almost entirely visible from the stadium which will make the sprint competitions spectator friendly.

Alternate sprint courses for classic and free technique are shown in Appendix C5. These courses use much of the same trails but stay entirely within the view from the stadium.

5.6 1.5 km

The existing 1.5km loop has a very aggressive profile for young skiers, with an A climb of 30m, a very fast downhill and technical corner, with very little undulating terrain. It is recommended that this course be updated.

The new proposed 1.5 km course for younger racers is shown in Appendix C2 and Table 1. This course provides the appropriate level of climb, incline and difficulty for the age groups involved.

5.7 2.5 km

The 2.5km loop is a foundational distance for most competitions, so it is desirable to have a few options.

The existing 2.5km loop does not provide enough climb in the later sections of the course. Achieving the required Total Climb also relies on use of the Dip, which is sometimes excluded from competitions due to unsafe snow conditions.

There are several options for better 2.5 km alignments as shown in Appendix C2 and Table 1 (summary) and Appendix D (homologation measurements).

- Main 2.5 km (actual distance estimated at 2668 m): The main course runs counterclockwise and uses part of both the Eastern and Western trails and has one major A climb with several breaks in the first kilometer and a B climb in kilometer 2 also with some breaks, as well as several minor hills and distributed throughout. The amount of undulating terrain is approximately 1/3 of the total distance. All measurements need to be confirmed by more detailed survey methods.

- Eastern 2.5 km (actual distance estimated at 2557 m): The profile of this course is somewhat hillier than the Main course and the Western course with two A hills, one in kilometer 1 and the other in kilometer 2. The last kilometer is mainly downhill with some interspersed minor uphills and level areas.

- Western 2.5 km (actual distance estimated at 2491 m): This course is easier than the Eastern course with three B hills and no A hill. The B hills are distributed with two in kilometer 1 and the third near the end of kilometer 2. The course has several interspersed minor hills as well as at least 1/3 of the distance consisting of undulating terrain.

5.8 3.3 km

A 3.3 km course has been developed for the Main trail network only, as shown in Appendix C2, Table 1 and Appendix D. Options likely exist for also developing Eastern and Western loop courses but were not explored at this time.

- 3.3 km (actual distance estimated at 3357 m): The course is similar to the first half of the 2.5 km Main course with an added loop at the western end of the course. The course has one A hill and two B hills, all at the lower end of the homologation criteria. There are several minor hills interspersed throughout the course and the amount of undulating terrain meets the 1/3 recommended.

5.9 3.75 km

This is another foundational distance, and preferred to 2.5km loops for 7.5km races.

The existing '3.5km' loop is actually 3.75km. Similar to the existing 2.5km course, it does not provide enough climb in the later part of the course. In addition, the hilltop area, while undulating, is less suitable for mass-start competitions given the terrain is twisty and requires frequent technique adjustments (eg. it lacks flow).

There are several options for the 3.75 km as shown in Appendix C2, Table 1 and Appendix D.

- Main 3.75 km:
    - Option A (actual distance estimated at 3853 m): This course is hillier than the Option B Main course. It has one A hill in kilometer 1 and two B hills between 1.5 to 2.5 km. Minor hills are interspersed throughout and the amount of undulating terrain is estimated to be less than the recommended 1/3.

- Option B (actual distance estimated at 3807 m): This course will likely be the preferred course with its better distributed hills and less total climb than Option A. The proportion of undulating terrain is also greater than Option A and is estimated to meet the recommendation of about 1/3 of the total distance.

- Eastern 3.75 km (actual distance estimated at 3550 m): The course is at the higher end of the homologation criteria in terms of climb so being slightly short is good. The course has two A hills and one B hill. The first A hill is within kilometer 1 and is at the low end of the criteria with a total height difference of about 30 m. A B hill with a height difference of about 20 m runs from 1.25 to 1.5 km followed by an undulating break of just under 200 m before the start of the second A hill which runs from 1.65 to 2.75 km and has a height difference of about 30 m. The short break between the B and A hill makes adds up to a total climb of about 55 m, which makes the course demanding. The last kilometer is mostly downhill with interspersed minor climbs.

- Western 3.75 km (actual distance estimated at 3990 m): The Western course has a better overall profile than the Eastern course with only one A hill and one B hill, as well as many interspersed minor hills throughout and over 1/3 of undulating terrain. This course takes advantage of more of the new training terrain with a combination of rolling corner features and smooth transitions from downhills to uphills.

5.10 5 km

This is the longest foundational loop now common for competitions.

The existing 5km course has the same drawbacks as stated above for the 2.5km and 3.75km courses.

A homologated 5 km course has been developed for the Main trail network only, with two variants, as shown in Appendix C2, Table 1 and Appendix D. Two 5 km loops for the Eastern and Western trail networks are also mapped out, but while the course distances are acceptable, they do not meet homologation criteria due to the major climbs occurring in the first part of each course which does not meet the homologation criteria with

respect to the location of major hills. The stacked nature of the Eastern and Western 5km courses do achieve grooming efficiency, and may support local fun events.

- 5 km Option A (actual distance estimated at 5469 m): Option A is the more demanding of the two options. Both options have interspersed hills throughout the course, but Option A's climbs are longer. Option A has three hills that have about a 30 m elevation difference and may qualify at the low end of the range for A hills based on more detail measurements, or one or more may be at the maximum end of a B hill. The amount of undulating terrain is estimated to be less than the recommended 1/3.

- 5 km Option B (actual distance estimated at 5430 m): Option B will likely be the preferred course for most competitions with less total climb and more undulating terrain.

Table 1 – Cross Country Competition Trails

Trail	Max incline, %	Max hill Climb, m	Total Climb, m
2.5 km Sit-Ski	9	14	46
1.5 km Kids course	16	15	40
Skate Sprint: 1.2, 1, (and 0.7 km using cut-off)	15 (18)	17 (18)	32 (39)
Classic Sprint: Clockwise 1.3, 1.1, (and 0.6 km using cut-off)	18 (18)	14 (18)	32 (33)
2.5 km Main – Option A	18	30	77
2.5 km Main – Option B	18	30	79
2.5 km Eastern	18	30	82
2.5 km Western	18	25	83
3.3 km Main	18	30	99
3.75 km Main Option A	18	30	113
3.75 km Main Option B	18	30	116
3.75 km Eastern	18	30	118
3.75 Western	18	30	124
5 km Main Option A	18	35	168
5 km Main Option B	18	30	171

6.0 CONCLUSION

This Master Plan identifies additions and modifications to the existing trail network which will provide new competition courses that meet the FIS homologation criteria and allow the Club to host local, provincial, and national level races in all race-types including classic and free-technique for individual start, mass start, skiathlon and relay. The proposed trails will also provide local athletes with graduated technical training terrain and to minimize grooming effort and maintenance.

Next steps include the development of:

- Detailed design and centerline flagging of all new trail segments.
- Higher resolution field survey for homologation evaluation purposes.
- Construction schedule including preferred staging.
- Construction specification.

SIGNED BY:

Reidar Zapf-Gilje

ABOUT THE AUTHOR

Reidar Zapf-Gilje, Ph.D., P.Eng. is a civil/environmental engineer with over 40 years of consulting experience. He is a contaminated site expert but has also engineered roads, trails, parking, and drainage works for ski areas.

Reidar has been involved with ski area design and trail layout for over 30 years including the design of the legacy recreational trails at Callaghan Valley for the 2010 Olympics as well as ski facility design for many ski areas in BC. He is an avid skier competing in master skiing events as well a cross country ski instructor and coach (CANSI Level 4; CSA Level 3 - old system).

APPENDIX A – Existing Trail Networks

BULKLEY VALLEY NORDIC CENTRE

Hilltop Loop 1.8km
Goldeneye 0.6km
Games 0.3km
Down and Out 0.2km
NL 0.2km
NL 0.3km
NL 0.3km
NL 0.3km
0.1km
The Dip 0.2km
NL 0.4km
Broadway 0.8km
0.2km
0.2km
Berminator 0.4km
Northern Lights (NL) 0.5km
Biathlon Range
0.4km
Tunnel Connector 0.7km
The Way Home 0.5km
One Click Right 0.5km
Hudson-Bay-Mtn-Rd
Tunnel
Prairie-Rd
Valley View 0.6km
Valley View 1.6km
Upper Logging Trail 1.8km
Demo Forest (DF) 1.3km
Demo Forest (DF) 0.5km
Valley View 1.2km
Perimeter 1.2km
Down the Mountain 2.9km
Perimeter 1.5km
Goldeneye 0.6km
0.3km
Wetzin'kwa 1.3km
Wetzin'kwa 1.2km
Broadway 0.4km
Down and Out 0.5km
Broadway 0.5km
Goldeneye Lake
Goldeneye 0.6km
Perimeter 1.1km
0.3km
Perimeter 0.7km
West Connector 0.5km
Pine Creek Loop (PCL) 1.5km (CLOSED)
7.5 km Cut-Off 0.6km
PCL 0.4km
PCL 1km
5 km Cut-Off 0.6km
Pine Creek Loop 0.9km
Pine Creek Loop 2.8km
Pine Creek Loop 1.2km
Hound Heaven (HH) 0.8km
HH 0.3km
HH 0.4km
PP 0.7km
PP 0.7km
Hound Heaven (HH) 0.8km
Wild Dog 3.3km
Pooch Paradise (PP) 2.3km
The Pup 0.5km
Pooch Paradise (PP) 1km

0 100 200 300 m

0 250 500 750 1,000 m

Marked distances are measured between

N
W E
S

Legend

- Emergency Kit
- Toilets
- Parking
- View Point
- Lodge
- Dog Trails
- Lodge Area

Trails

- Lit Trails
- Easy
- Intermediate
- Advanced
- Dogs One Way

December 27, 2023
Download georeferenced PDF from bvnordic.ca/map
Bulkley Valley Nordic Centre is on Trailforks

BRITISH COLUMBIA | Recreation Sites and Trails BC

APPENDIX B – Homologation Trail Project Board Updates

Homologation Trail Project Board Update Jan. 15 2024

Club priorities:

Grooming efficiency (e.g. turning 3-way junctions into 4-way)

- Current proposal turns 6 junctions from 3 to 4 way
- Remaining odd-#'d junctions associated with 1.5km cutoff, Berminator, and Hilltop/NL
- Some inefficiency is needed if we want to regularly maintain some stretches of wider trail
- Ongoing dialogue with grooming staff (Kelsey)

Sparing approach to new trail

- New trail would deliver very high value per km
- Current proposal has 3km new build, and add 500m of existing logging rd
- Only 200m of new trail is race-specific (Skiathlon speed-catcher)

Increase FUN technical training terrain

- Corner analysis in progress to ensure technical options are graduated
- 4 new technical downhill alignments proposed, and renovating Berminator
- Would add up to 12 right-hand corners and renovate existing Berminator right corners
- Multi-position entrances (slower/faster) enhance training value of key features
- New wide hill useful for Rabbits training
- Sprint course can create opportunity to enhance the kids' area adjacent to stadium
- Ongoing engagement with coaches (Andrea, Ryan)

Skier Safety

- Keep speeds generally below 55km/h. Optional ski routes may go faster, but nothing as fast as the existing Dip
- Visibility- high-collision risk trails are in relative proximity so skiers would know others are around, and area between trails can be limbed
- Trails with particular blind features would be one-way
- Speed-catcher sections prior to external junctions
- Games Trail blind right-hand corner onto D&O would be replaced with safer alignment

Don't break the groomer

- Stadium calibration suggests 11m absolute minimum radius (centreline) for PB
    - Existing Berminator is 9m radius
    - 5km cutoff on Perimeter is 11m radius
    - Proposed new corners all at 14m radius except 2 (both at 13m)
    - Renovated Berminator would go from 9 to 11/12m radius
    - Other clubs (PG) have plenty of 14m corners, with some tighter
    - Re-calibration with Prinoth needed (April 2024?)
    - Ongoing engagement with grooming staff (Kelsey)

Minimize wide trails (9m width needed for some competitions)

- Current proposal is limited to a 5km Mass Start (skate) loop (9m wide uphills), which is the shortest distance that could support a major competition

    - Skiathlon, Pursuit, and Sprint trail width requirements would be almost entirely covered by the wide trail needed for the 5km Mass Start
- Use existing wide trails/cleared widths where possible (sections of Perimeter, Down&Out)
- Widening would be limited to Northern Lights area, short stretches of Perimeter, Hilltop, (a total of 2.5km of existing trail, much of which has already been widened to some extent)
- Trails would not all be groomed to 9m width regularly

<u>Minimize impact/provide opportunities to recreational skiers</u>

- New trails/adjustments focused in Northern Lights area, 5mins of skiing would take users beyond this area
- Alignments avoid Broadway, and no race loops currently proposed on Broadway.
- There is one potential junction with Broadway if of interest, but can remove it if not.

<u>Opportunities for recreational skiers</u>

- Recreational bypass through 'race maze' offers better connectivity to Hilltop area
- New Hilltop descent not overly technical, great view
- Alternate hill to the top of the Dip lower grade (<15%) and aesthetic

<u>Climate change mitigation</u>

- Stagger trails into junctions to avoid excess sun in one spot
- When needed, widen trails to North/east (don't cut the south/west facing trees)
- Reduce sideslopes with southern aspect
- Plant trees in key areas
- Reduce unevenness/rocks to ski on 6 inches of snow depth

<u>Stewardship</u>

- Using Hilltop area Logging road and cutblock area reduces net new disturbance
- Possibility of restoration of disturbance in Berminator area depending on final alignment
- Old trail in hilltop area could be replanted
- Focused trail density in this area reduces future 'expansionist' argument
- Although dense by our standards, this is not bad compared to PG

<u>Major Event Readiness</u>

- Current proposal contains:
    - Individual and Relay: two stacked courses each containing 1.5, 2.5, 3.3, 3.75, and 5k loops
    - Mass Start: 1.5, 2.5, 3.3, 3.75, 5k Skate loops, additional 7.5, 8.3k Mass Start Classic
    - Skiathlon: two stacked courses each containing 2.5, 3.3, 3.75k loops
    - Sprints: 200, 400, 600, 800, 1000, 1200m loops
    - New 1.5km option as alternative to existing route
    - Biathlon loops: 2, 2.5, 3, 3.5, 4k non-crossing loops
- Many many club-race loop options
- Engagement ongoing with Reidar Zapf-Gilje (consultant) to confirm/recommend feasibility

Homologation Trail Project Board Update Jan. 15 2024

Don't make trail network too dense, maintain woodsy feel

- Current proposal generally maintains visual buffers (~25m) from existing trails other than around junctions (3 locations have 10m buffers due to specific terrain features)
- For comparison:
    - Northern Lights and Broadway are 25m apart near the Dip exit
    - Perimeter and Logging Road are 10m apart at narrowest point
    - Perimeter and DTM are 25m apart
- Visual buffers would be smaller within the 'training maze', partly due to safety considerations (skiers should be able to see each other in complex terrain)
- There would be three locations on the existing trails with high density of junctions: top of Dip, top of Berminator, and along the 0.75km.
- There is still a big difference between this proposal and the PG trails

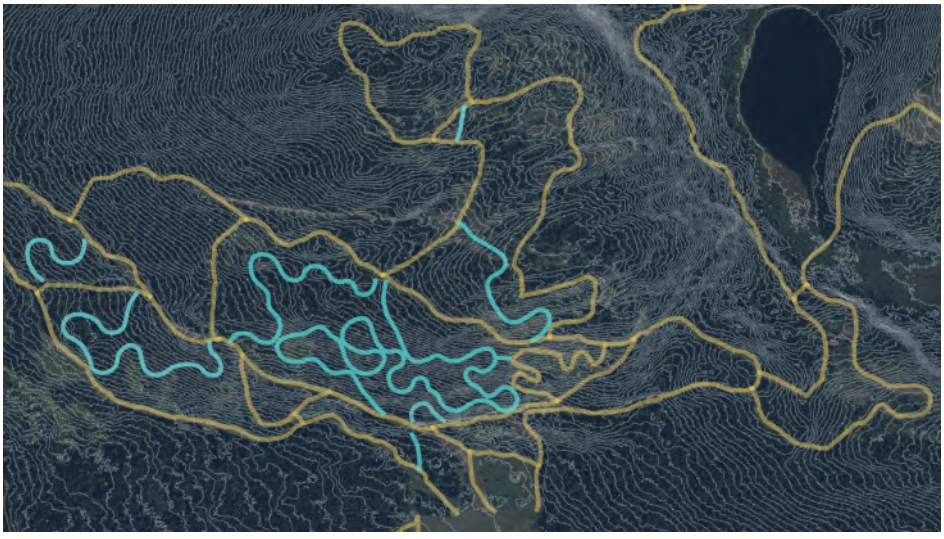
Minimize skier confusion with junctions/'training maze'

- At first impression, the map does look confusing, a bit messy, and curvier than the existing network
- Working with the above club priorities, constraints, and homologation trail specs, this may be difficult to address
- Trail complexity is a priority, and terrain features and existing junctions are where they are
- The map is not the territory, the ski experience will be different than looking at squiggles
- Junction alignments will get more specific as preferred training/race routes become clear
- Presentation material can be adjusted to provide more clarity

Club engagement

- Engagement to date with coaches, grooming staff, recently with biathlon rep (Peter)
- Need more engagement with Race staff (Stadium, timing), and GM (planned for Reidar visit)
- Berminator needs a group to recommend on specific fixes
- Working group/committee needed to support future Board consideration

Figure 1: Draft New Alignments in Blue



Race Course Updating and Homologation Proposal:

Alignment with Club priorities:

Grooming efficiency (e.g. turning 3-way junctions into 4-way)

- Proposal adds 3.8km of groomed trail at little/no extra grooming time
- Proposal turns 7 junctions from 3 to 4 way
- Remaining odd-#'d junctions associated with 1.5km cutoff, Berminator, and maintaining a 350m additional segment of wide trail which would be beneficial for training on hills in groups. The current wide trails are mostly flat, the one exception- the Interval Hill gets crowded and interferes with other skiers
- Feedback from groomers (Kelsey) is positive on benefits- particularly reducing areas where the machine is forced to reverse, or turn around and double back on trails.
- Overall, proposal including maintaining the wider section of trail is neutral on grooming

Sparing approach to new trail

- New trail would deliver very high value per km
- Current proposal has 3km new build, and add 350m of existing logging rd, and renovate Berminator to be able to regularly maintain it, to yield almost 4km of new ski trail

	Trail Distance	New Build
Upper Dip Connector	50	50
Hilltop descent	350	350
Berminator	525	40
Logging rd	330	50

XYS	225	225
Ear	570	570
Small Speedcatcher	85	85
Gully Trail	475	475
Main	630	630
New Corkscrew	450	450
Stadium Connector	60	60
Total:	**3750**	**2985**

Minimize Realignments to Existing Trails:

- Berminator would see a realignment of the exit to avoid risky crossing of the 1.5k downhill, replaced with a small adjustment to the intersection near the top of the 1.5k, corners re-shaped and widened, an existing skid-road regularly maintained, and connection formalized with NL
    - Goal is to preserve the main Berminator features, while making them more skiable and groomable, and to take advantage of the location to suit key race alignments
    - It will be important to leave brush above Berminator to provide shade for NL
    - Upper section of Berminator is lower priority to renovate, may not be needed

- Small adjustment needed to Goldeneye to allow for proper cornering if coming from Perimeter
    - Reduces the side-slope of a small hill if climbing, adds a bit of meander if descending
- Racer's corner should be modified to maintain constant radius (current alignment tightens)

Increase FUN training terrain

- Several new downhill corner alignments proposed, and renovating Berminator
- Technical corners are varied in terms of speed, difficulty, and degrees of turn
- Would add up to 12 active right-hand corners and renovate existing Berminator right corners
- Multi-position entrances (slower/faster) enhance training value of key features
- New wide hill useful for Rabbits training
- Sprint course can create opportunity to enhance the kids' area adjacent to stadium
- Design has been informed by engagement with coaches (Andrea, Ryan)

Skier Safety

- Keep speeds generally below 55km/h. Optional ski routes may go faster, but nothing as fast as the existing Dip
- Many high-speed corners and junctions have been removed from the revised proposal
- Junctions at the bottom of hills merge gradually with good visibility
- Trails with particular blind features would be one-way
- Speed-catcher sections prior to most external junctions
- Games Trail blind right-hand corner onto D&O would be replaced with safer alignment

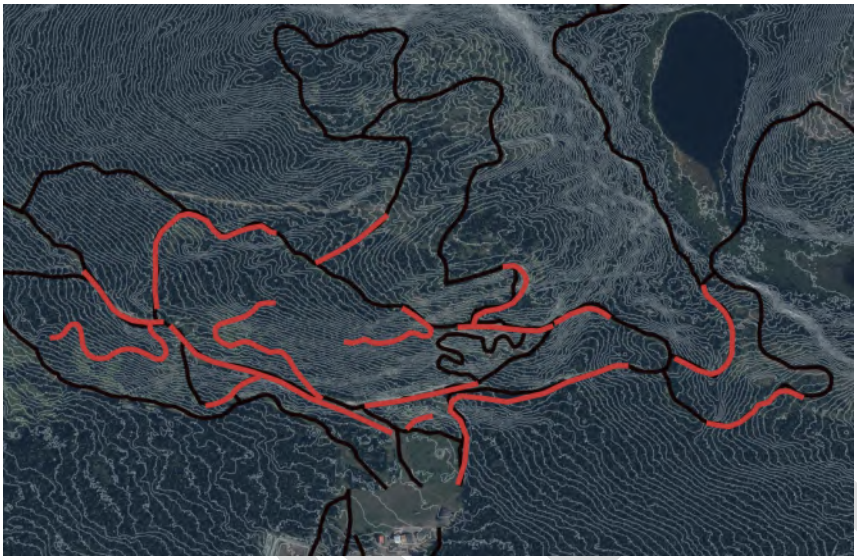
Don't break the groomer

- Stadium calibration suggests 11m absolute minimum radius (centreline) for PB. New machine may be able to go slightly tighter
    - Existing Berminator is 9m radius
    - Renovated Berminator would go from 9 to 11/12m radius
    - Existing 5km cutoff on Perimeter is 11m radius, would be widened to 12m radius
    - Proposed new corners all above 12.5m radius
    - Ongoing engagement with grooming staff (Kelsey/Jan)

Minimize wide trails (9m width needed for some competitions)

- Current proposal has limited wide trails to those needed for a 5km Mass Start (skate) loop (9m wide uphills), which is the shortest distance that could support a major competition
    - Skiathlon, Pursuit, and Sprint trail width requirements would be mostly covered by the wide trail needed for the 5km Mass Start

- Use existing wide trails/cleared widths where possible (sections of Perimeter, Down&Out)
- Widening would be limited to Northern Lights area, short stretches of Perimeter, Hilltop, (a total of 1km of additional existing trail).
- Wide-built (9m) trail segments below. Trails would not all be groomed to 9m width regularly:

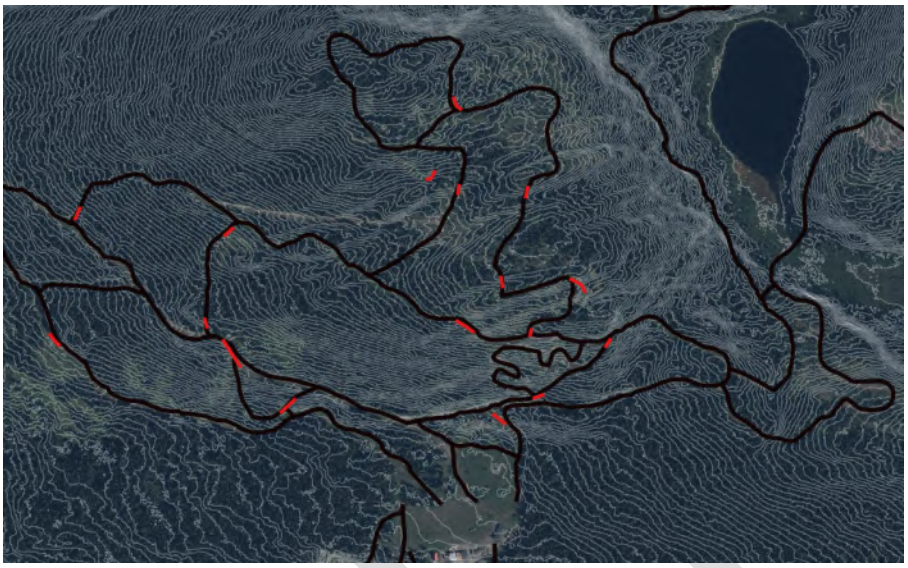


<u>Minimize impact/provide opportunities to recreational skiers</u>

- New trails/adjustments focused in Northern Lights area, 5mins of skiing would take users beyond this area
- Alignments avoid Broadway, and no race loops currently proposed on Broadway.
- Feedback from JoAnne Reed has been positive regarding the proposed trails being fun for young skiers, recreationalists, and racers
- Trails include better connectivity to Hilltop area
- New Hilltop descent has a great view
- Alternate hill to the top of the Dip lower grade (<15%) and aesthetic

<u>Climate change mitigation</u>

- Proposal provides an alternate, shaded route to top of dip, which is currently prone to early melt
- Stagger trails into junctions to avoid excess sun in one spot
- When needed, widen trails to North/East (don't cut the south/west facing trees)
- Reduce sideslopes with southern aspect
- Plant trees in key areas for shade
- Reduce unevenness/rocks to ski on 6 inches of snow depth
- Where possible, groom down south-facing hills rather than up them (pushes snow onto them rather than scouring it off)
- Have included identification of existing climate-change risk locations:



Stewardship

- Using Hilltop area Logging road and cutblock area reduces net new disturbance
- Possibility of restoration of disturbance in Berminator area depending on final alignment
- Old trail in hilltop area could be replanted
- Focused trail density in core area reduces future 'expansionist' argument
- Although this central area would be relatively dense by our standards, it is not a large area overall, and is not bad compared to PG
- **Initial high-density 'training maze' has been adjusted to a reduced trail density**

Major Event Readiness

- Current race network no longer meets Homologation criteria and is no longer appropriate for hosting large events
- Trail proposal would enable key race courses that meet Homologation criteria, per recommendations from consultant Reidar Zapf-Gilje
    - Main Loops- Individual/Mass Start: 1.5, 2.5, 3.3, 3.75, 5k
    - Skiathlon and Relay: two separate stacked courses each containing 2.5, and, 3.75k loops
    - Sprints: 1000, 1200, 1400m loops
- Biathlon loops: 1.5, 2, 2.5, 3, 3.5, 4k non-crossing loops
- Many other club-race loop options

Don't make trail network too dense, maintain woodsy feel

- Current proposal generally maintains ~20-25m visual buffers from existing trails other than around junctions, and 15m buffers between trails within the new network
- For comparison, on the existing network:
    - Northern Lights and Broadway are 25m apart near the Dip exit
    - Perimeter and Logging Road are 10m apart at narrowest point
    - Perimeter and DTM are 25m apart
- **Initial high-density 'training maze' has been adjusted to a reduced trail density**

- There would be three locations on the existing trails with high density of junctions: top of Dip, top of Berminator, and along the bottom of Northern Lights near the Stadium.
- Higher-density trail areas are within a relatively small area, and easily bypassed

Minimize skier confusion with junctions/'training maze'

- **Initial high-density 'training maze' has been adjusted to reduce trail density and number of internal junctions**
- Trail complexity is a priority, and terrain features and existing junctions are where they are
- The map is not the territory, the ski experience will be different than looking at squiggles on a map. The squiggles are all intended as downhills; uphills have straighter alignments.
- Presentation material can be adjusted to provide more clarity
- A phased approach could stagger development (see below)

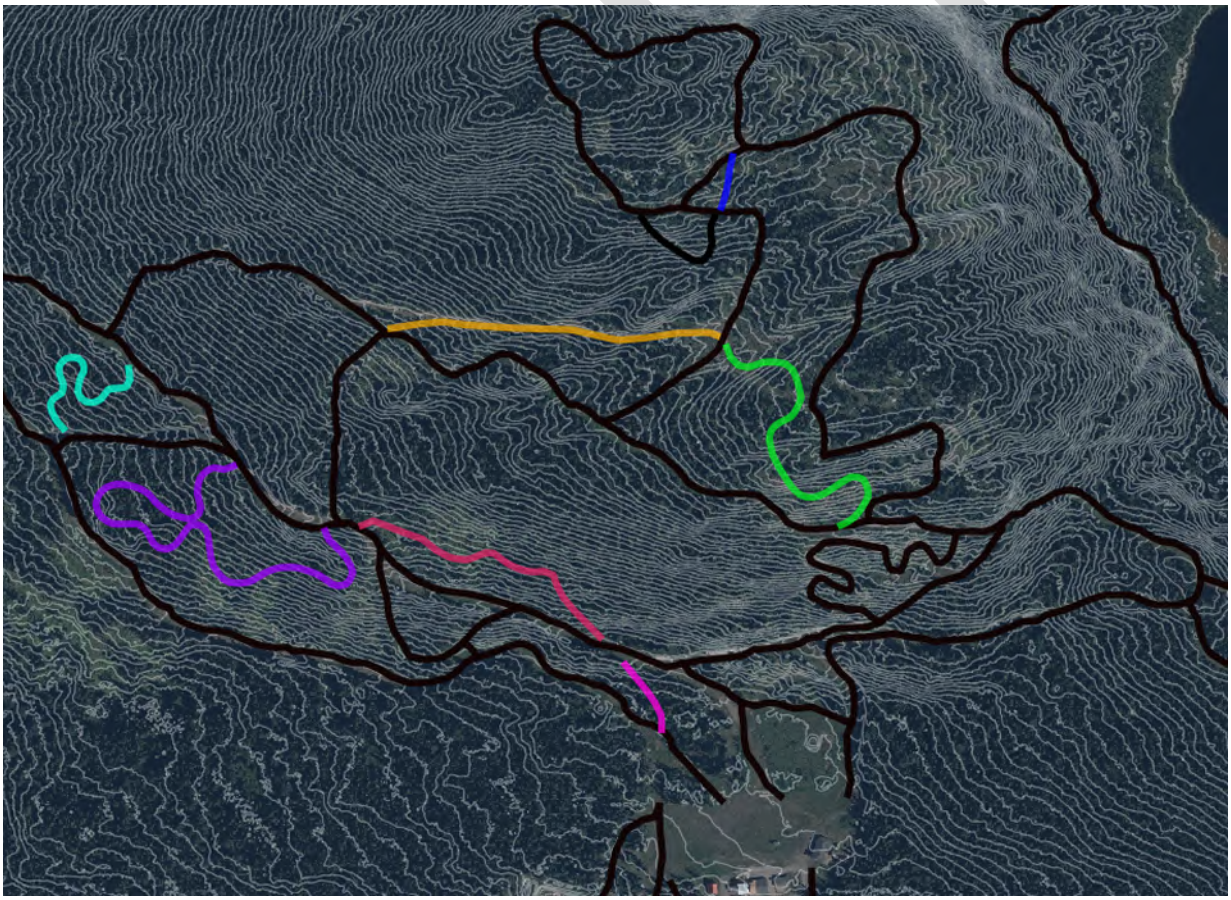
Club engagement

- Engagement to date with coaches (Andrea, Ryan), grooming staff (Kelsey), biathlon program (Peter and Lea-Marie), Race Committee, JoAnne Reed, other key club members
- Negative feedback around 'confusion' and trail density has been addressed in revised proposal

Phased Approach Option:

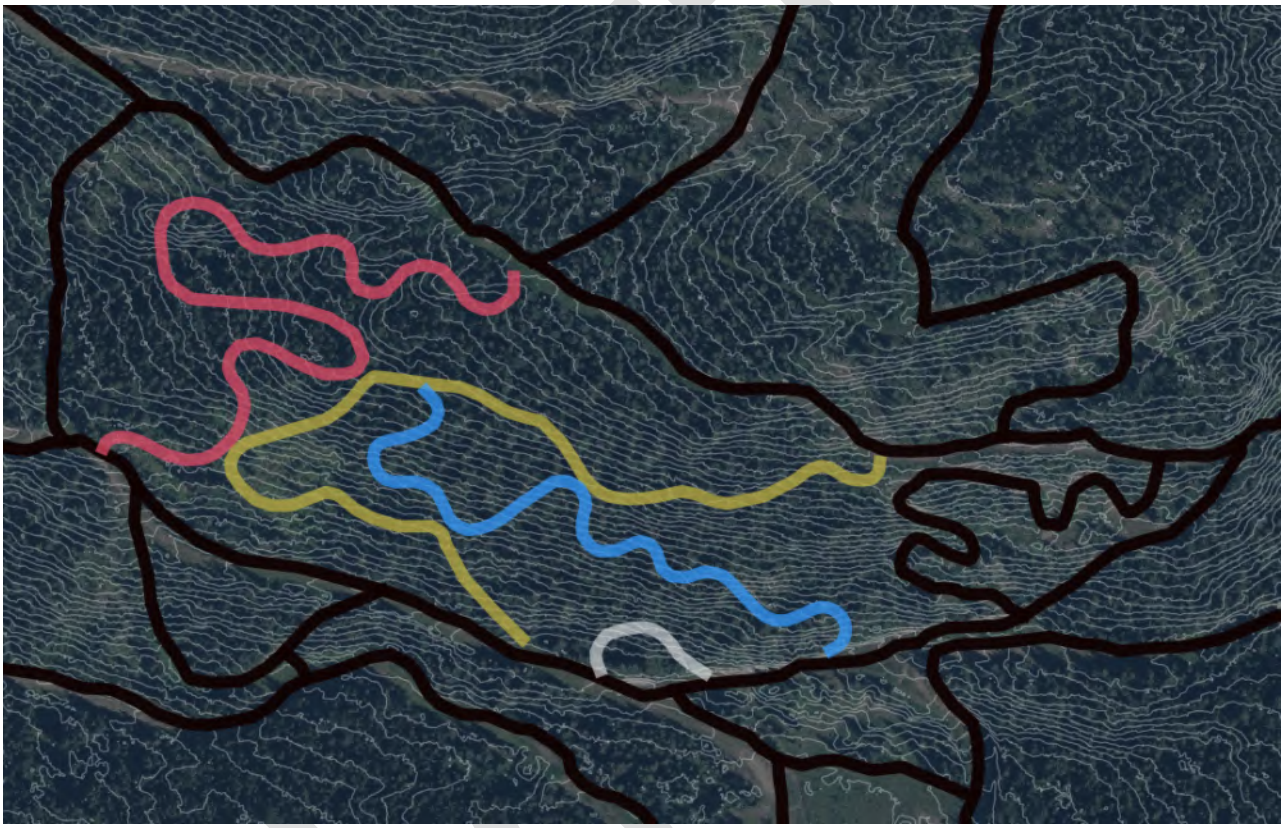
Phase 1:

- Focus on existing trail upgrades, adjustments
- Build selected new trails to update key main race loops, and partial grooming efficiencies:
    - Link to upper Dip (dark blue)
    - New Hilltop descent (green)
    - XYS (light blue)
    - Ear (purple)
    - Link to Dip (red)
    - New stadium link (pink)
    - Logging road between Hilltop and Games Trail (orange)

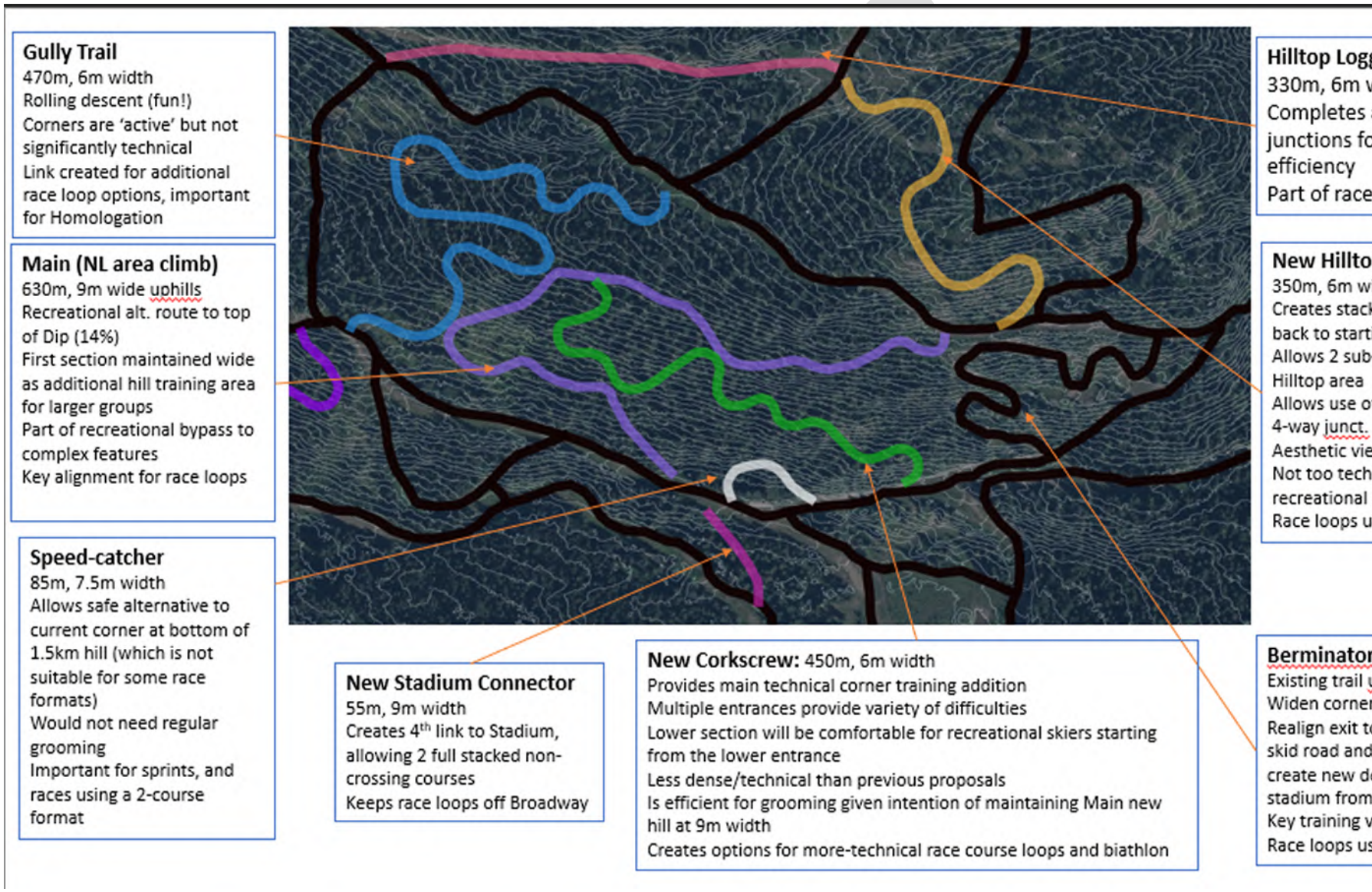


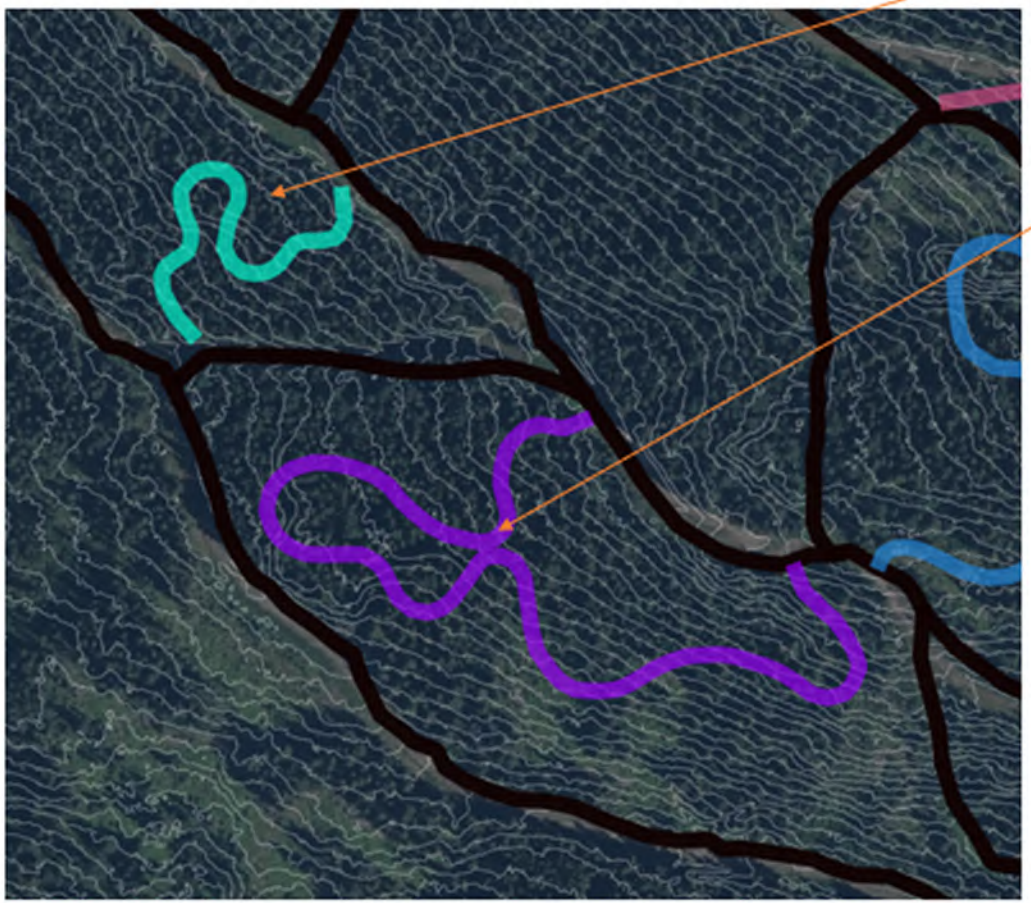
Phase 2:

- Complete existing trail upgrades
- Build remainder of trails for two-course races, training optimization, and full grooming efficiency
    - Gully Trail (red)
    - New Corkscrew (blue)
    - Main Climb (yellow)
    - Speedcatcher (white)



Description/Use of New Alignments:





XYS: 225m, 6m wide
This is the main additional technical right-hand corner
Two entrance options (from Games Trl, and from D&O) provide variable
Will be safe and easy to ski from D&O
No conflicts with other potential uses
Reduces existing collision risk of Games Trail - D&O Junct

The Ear: 570m, 6-9m wide
Two-way trail, corner difficulties have been reduced from pr
each instance
Optional cutoff make a lower Dip entrance useful for training
recreational skier (bypasses the upper steep pitch)
Internal junction provides important race loop options

Upper Dip connector, 50m, 6m wide
Connector for one-pass grooming of Upper Dip

APPENDIC C – Maps of Proposed Race Trail Network

C1 – Stadium Layout for Skiathlon and Relays

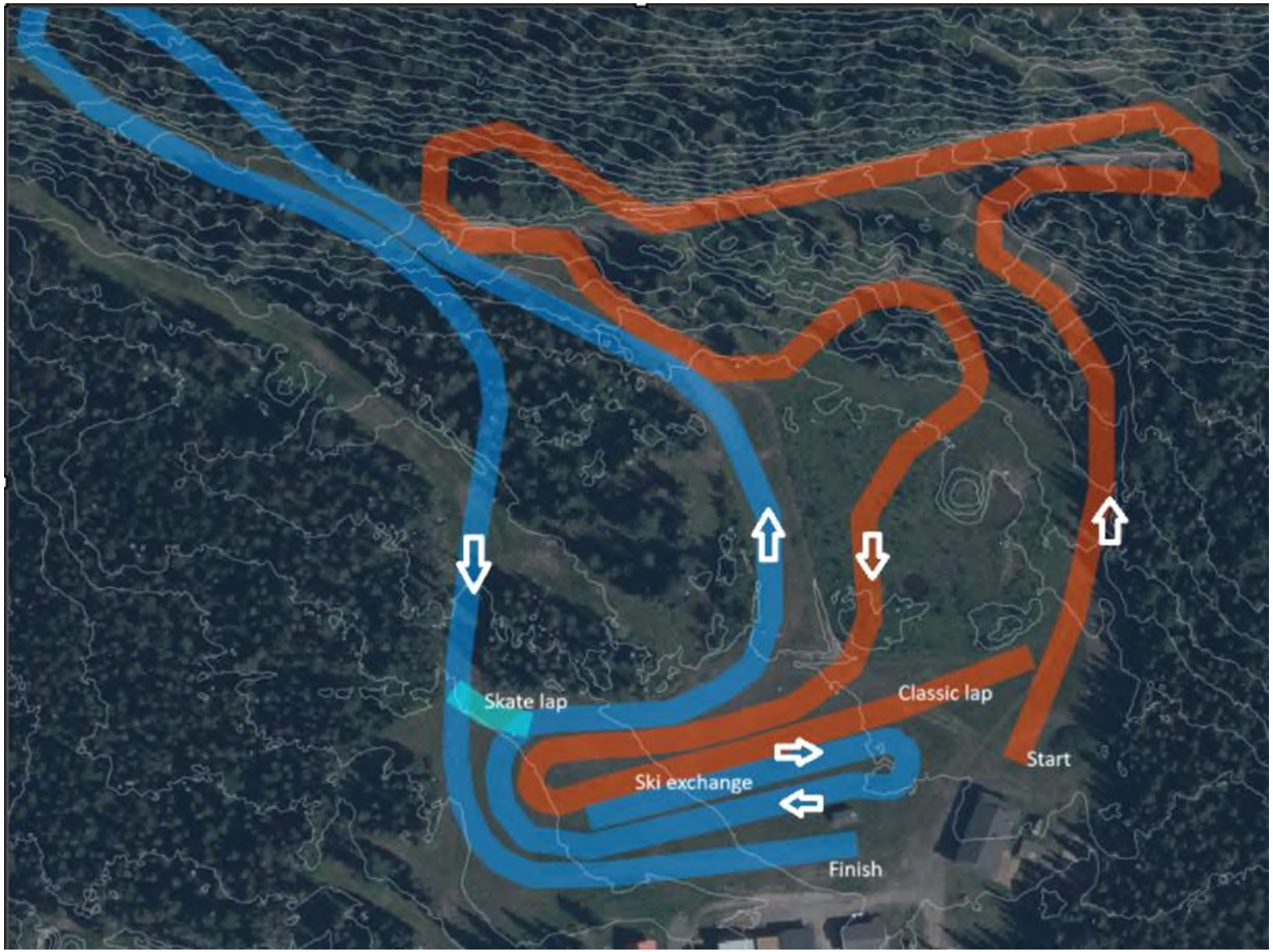
C2 – Main Race Trail Network

C3 – Two-Course Race Trail Network

C4 – Sit-Ski Race Course Options

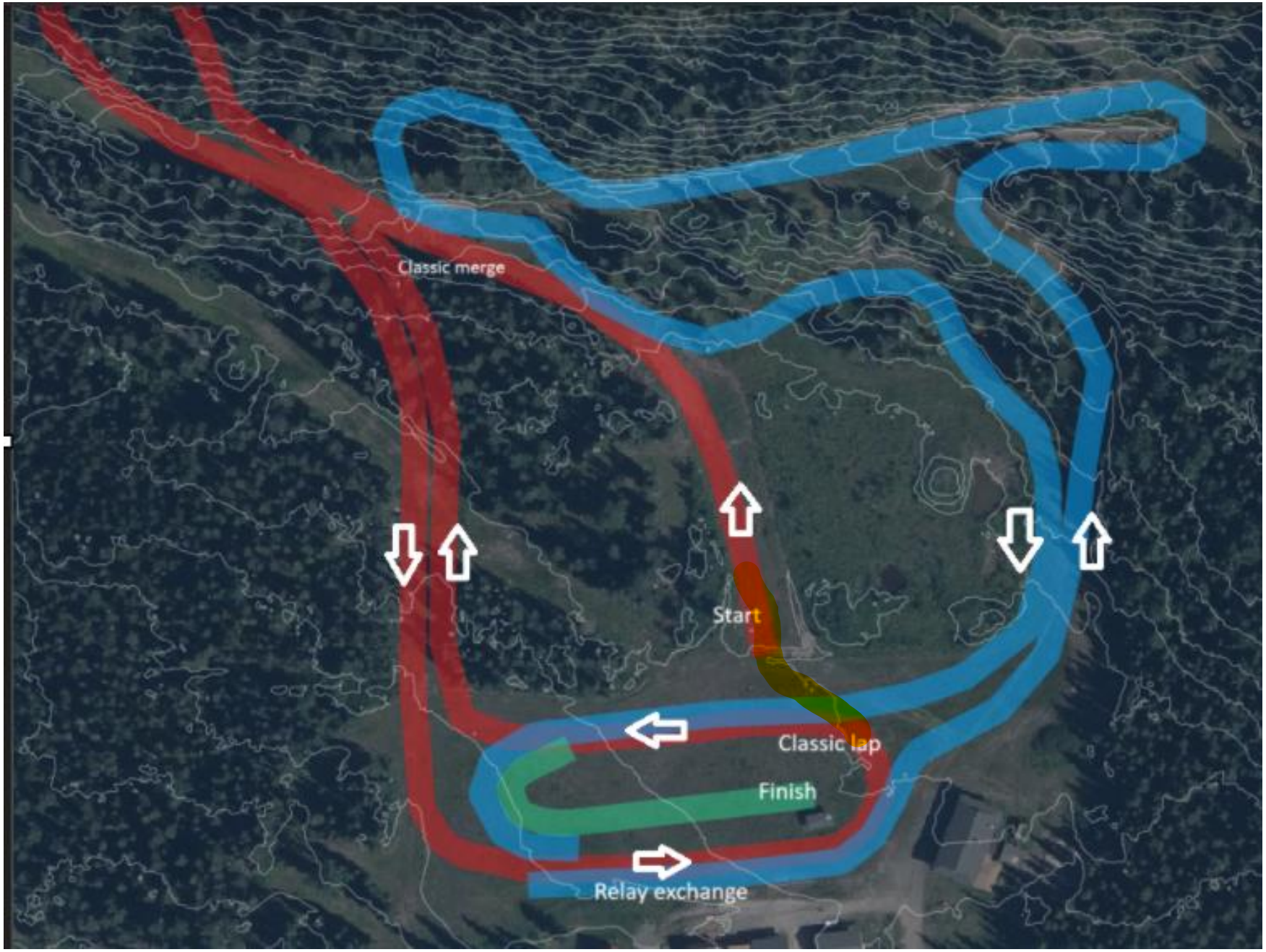
C5 – Sprint Race Courses

C6 – Practice Hill for Downhill Maneuvers



Skiathlon Stadium

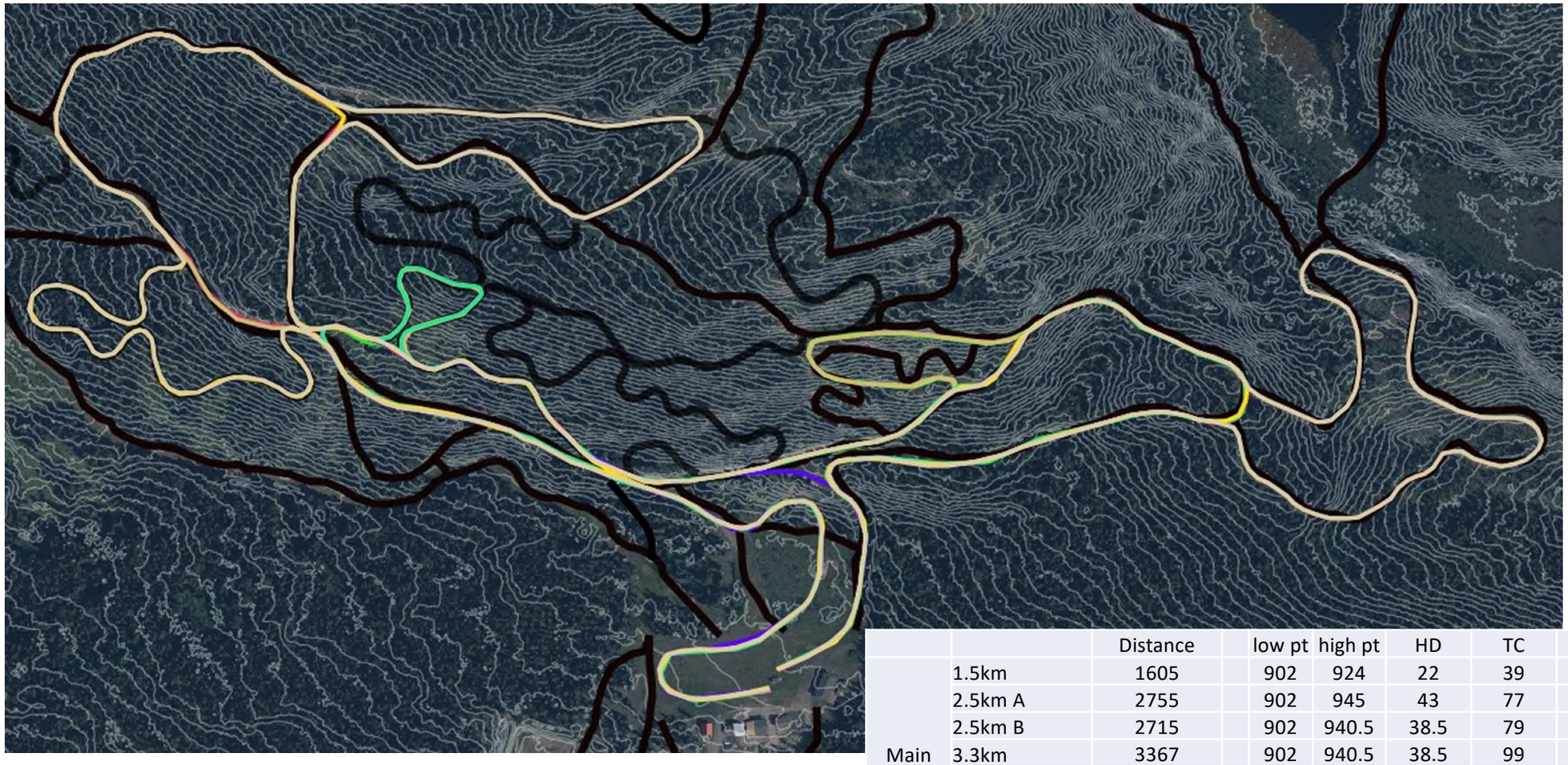
- Lanes on map are 8m wide
- Exchange zone is 100m long
- Skate lap lane cuts off the stadium accordion, important for not going over-distance on loops



Relay Stadium

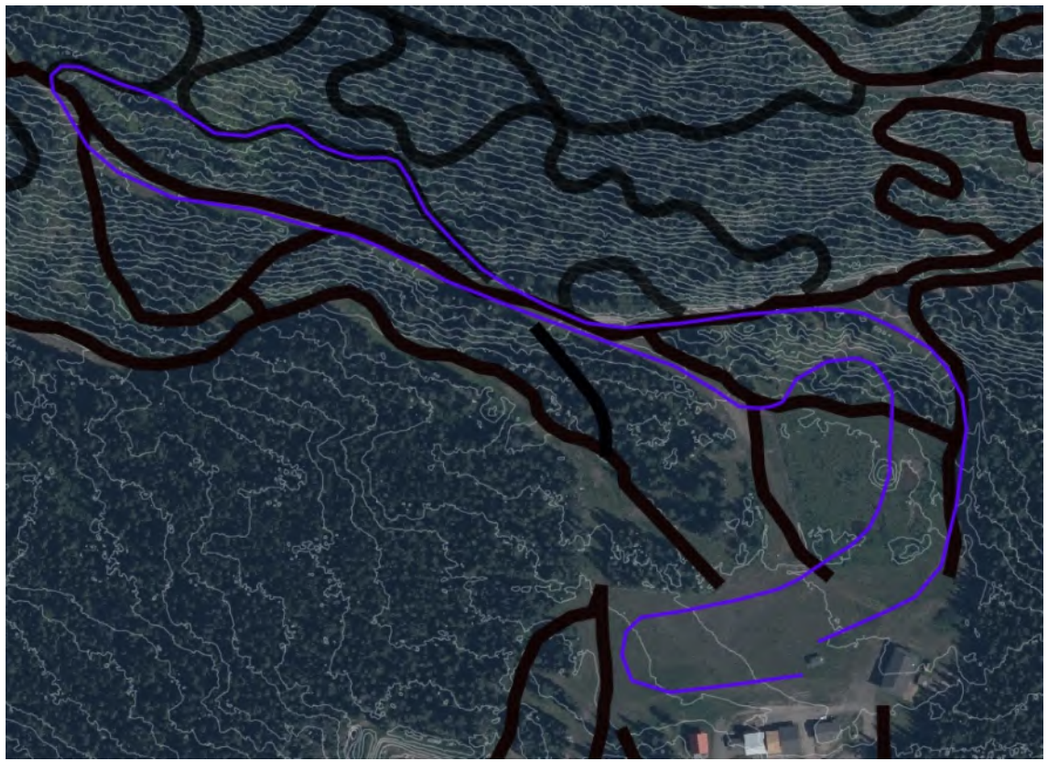
- Classic legs have to be on western course to avoid lengthy stadium accordion
- Course has a cross, but directionally aligned, easy merge in and out, and unlikely for racers to conflict between beginning of 2nd and end of 3rd laps

Main Race Trail Network

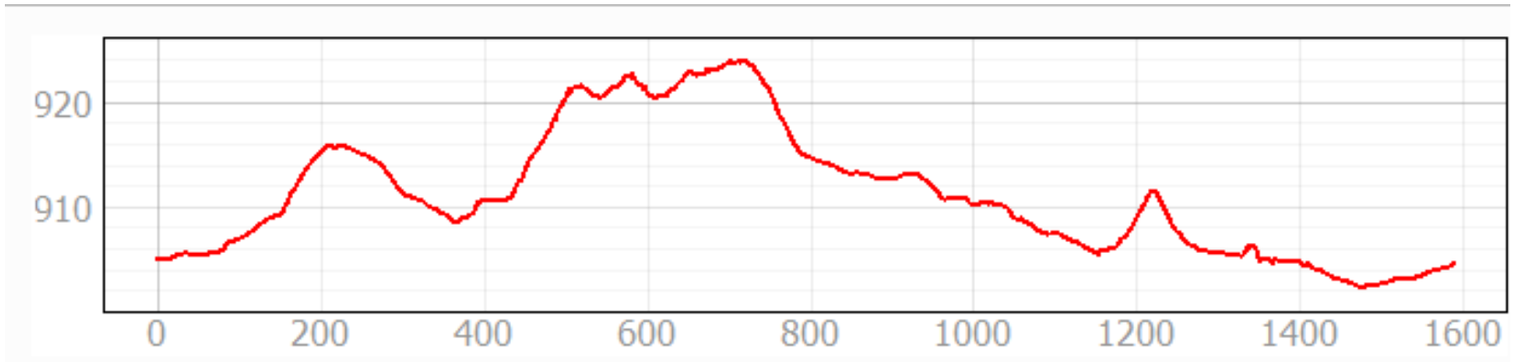


		Distance	low pt	high pt	HD	TC	A hills	B hills	C hills
Main Loops	1.5km	1605	902	924	22	39	0	2	0
	2.5km A	2755	902	945	43	77	1	2	0
	2.5km B	2715	902	940.5	38.5	79	1	1	0
	3.3km	3367	902	940.5	38.5	99	1	2	0
	3.75km A	3857	902	945	43	113	1	3	0
	3.75km B	3825	902	940.5	38.5	116	1	3	0
	5km A	5469	902	953	51	168	2	4	0
	5km B	5430	902	953	51	171	2	4	0

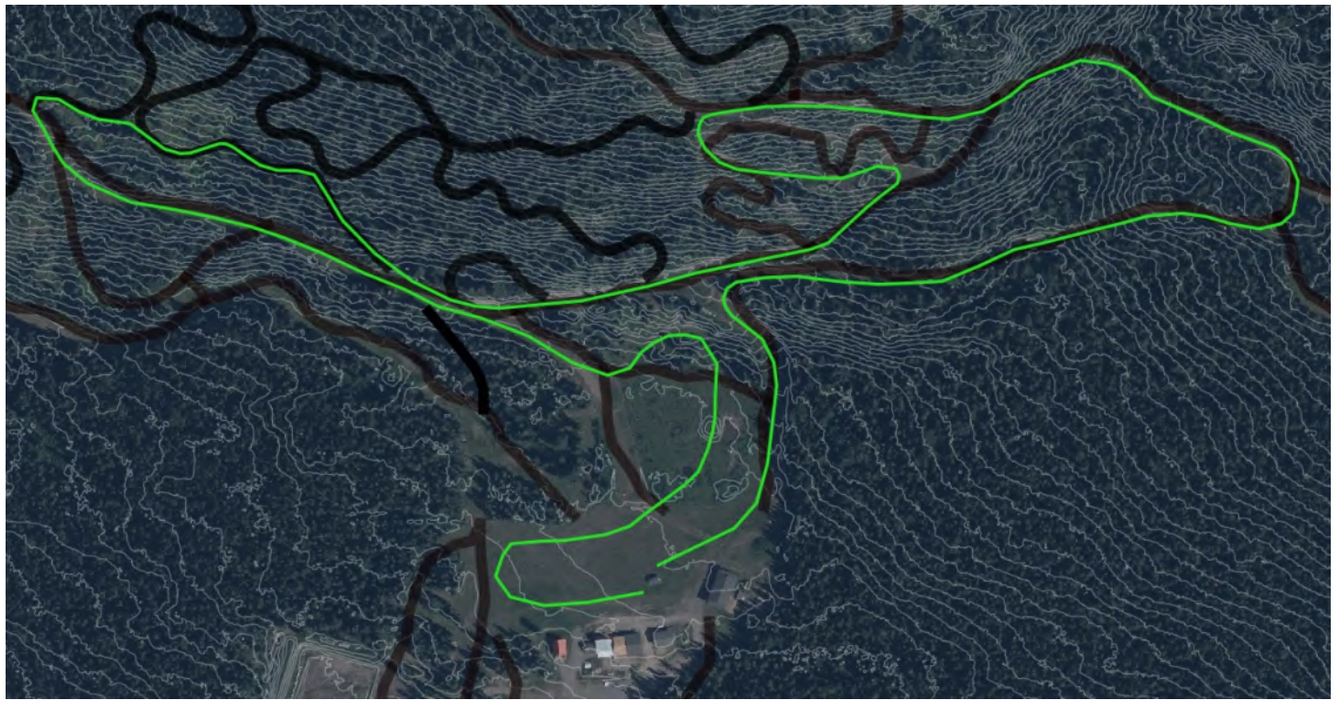
1.5km



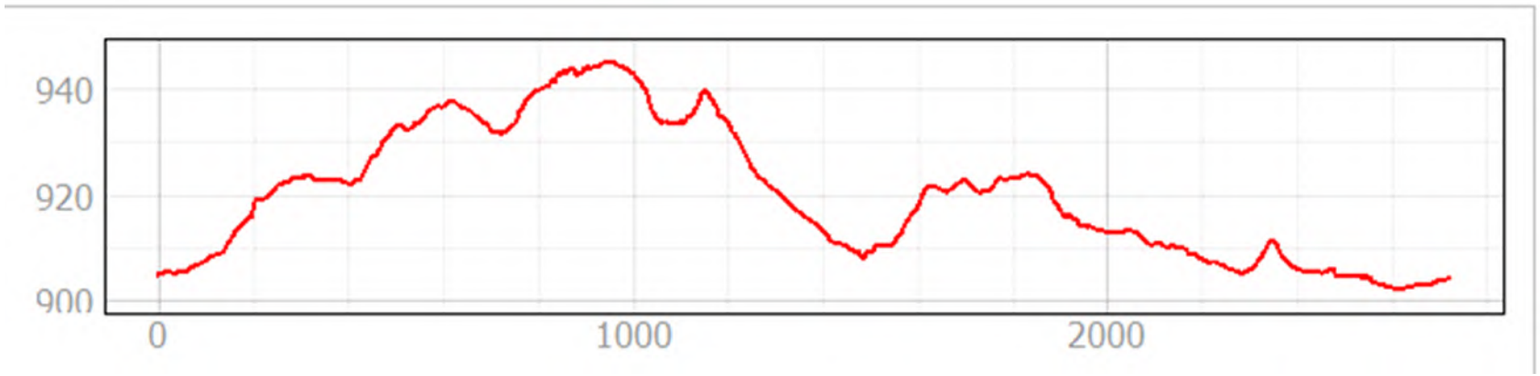
- 1589m



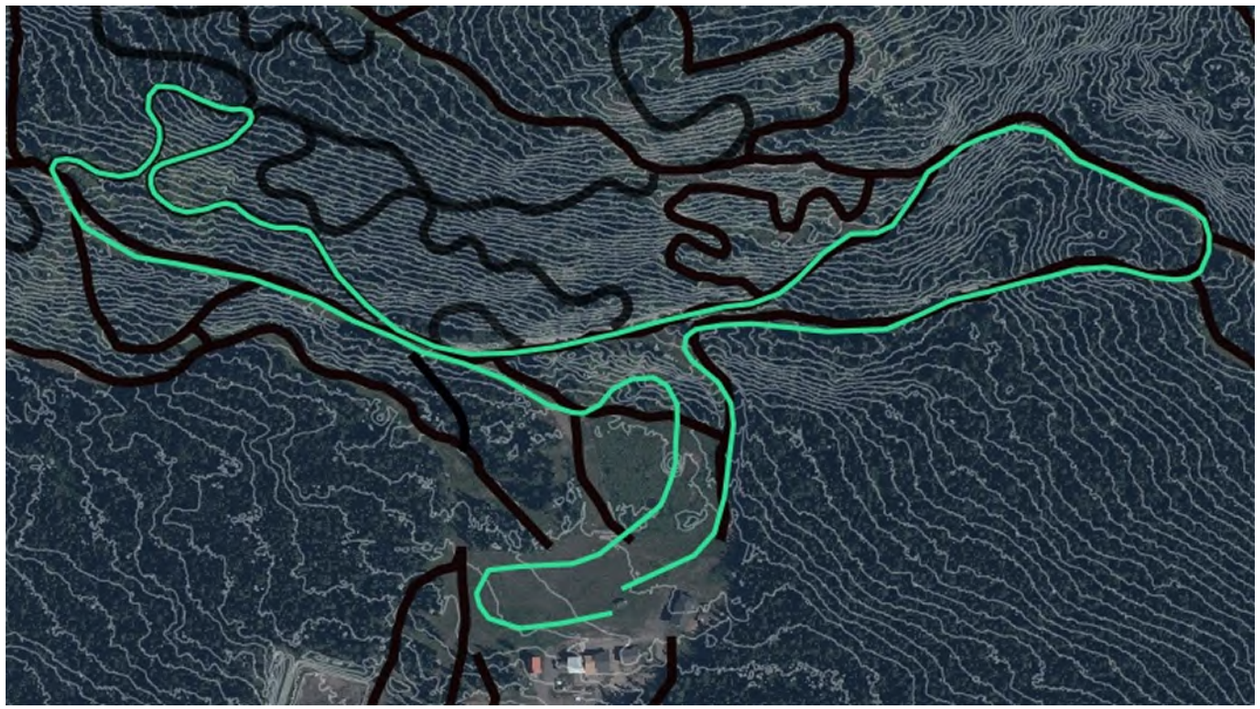
2.5km-Option A



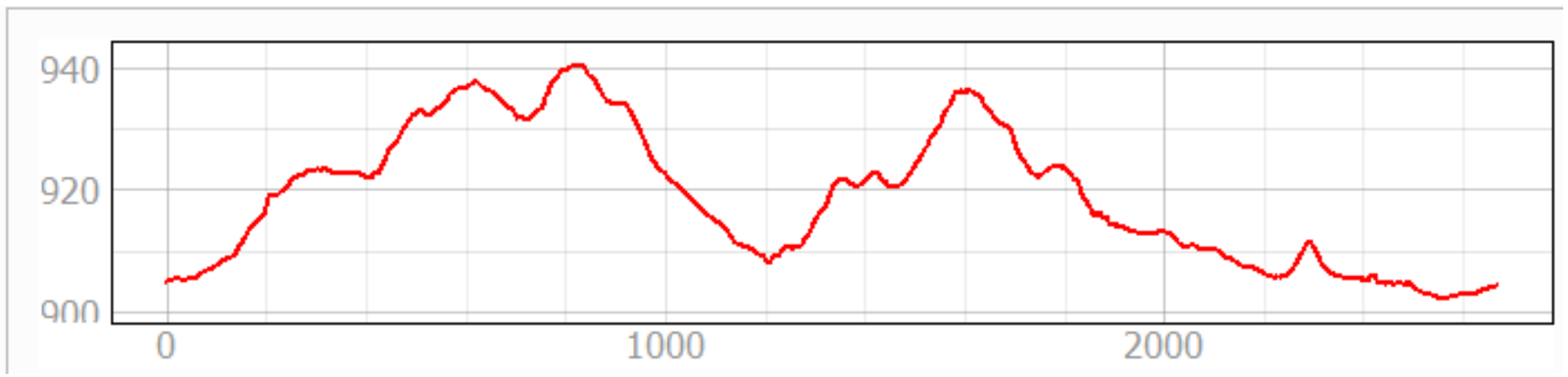
- 2668m



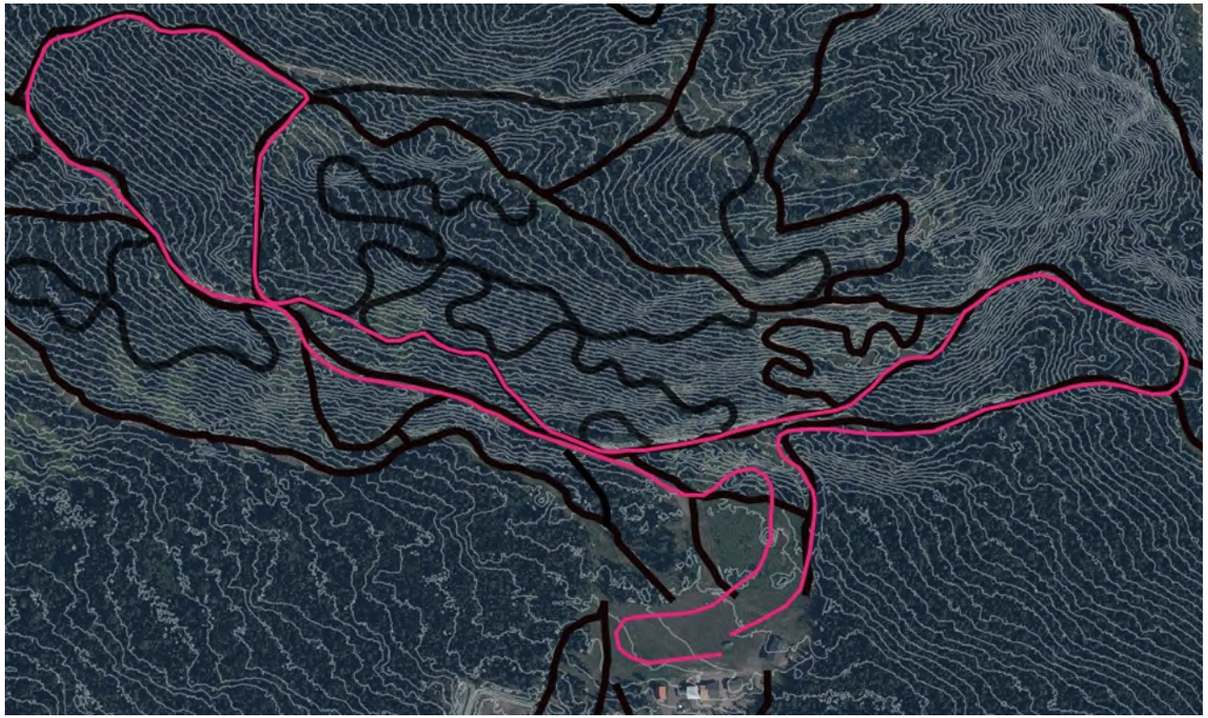
2.5km-Option B



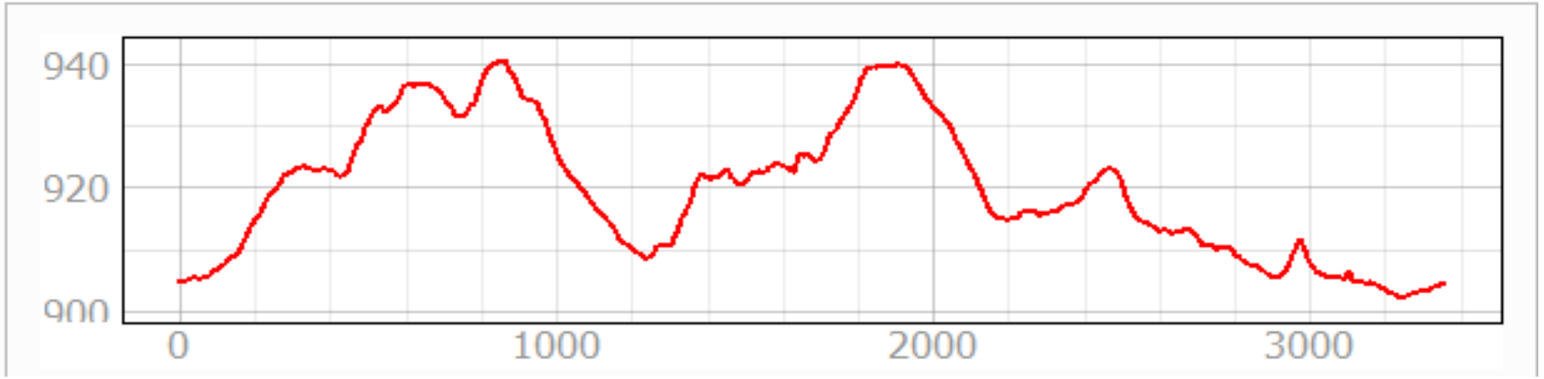
- 2668m



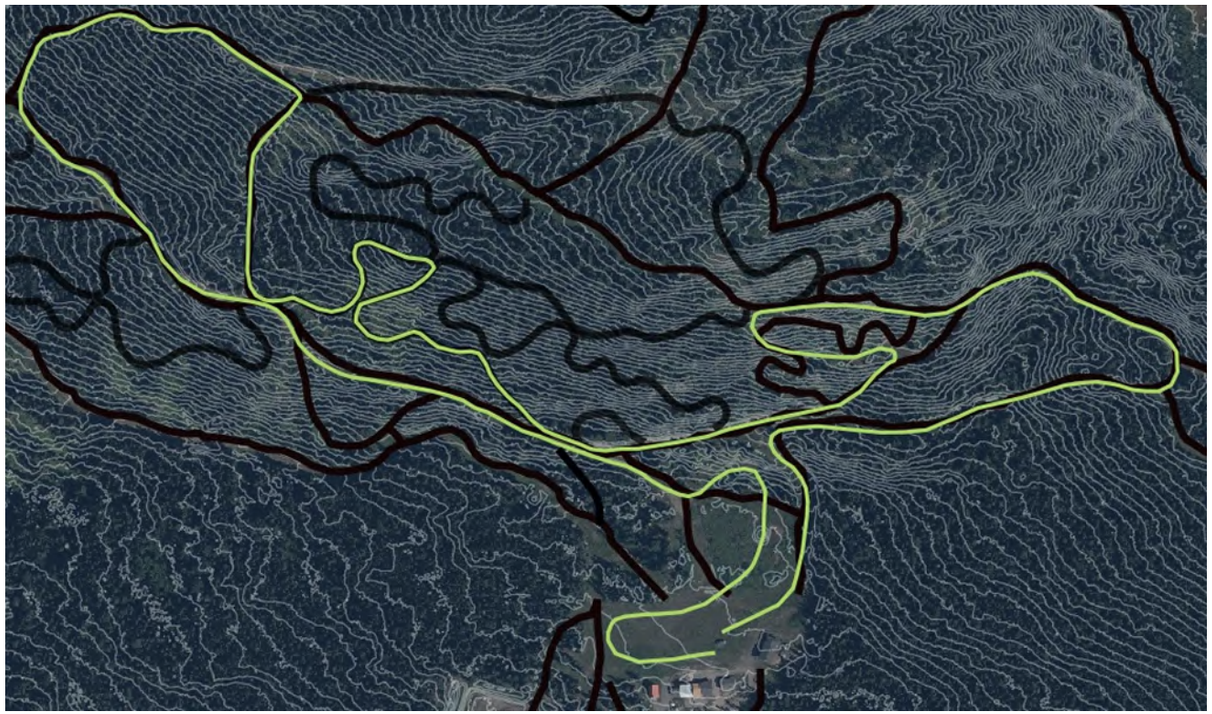
3.3km



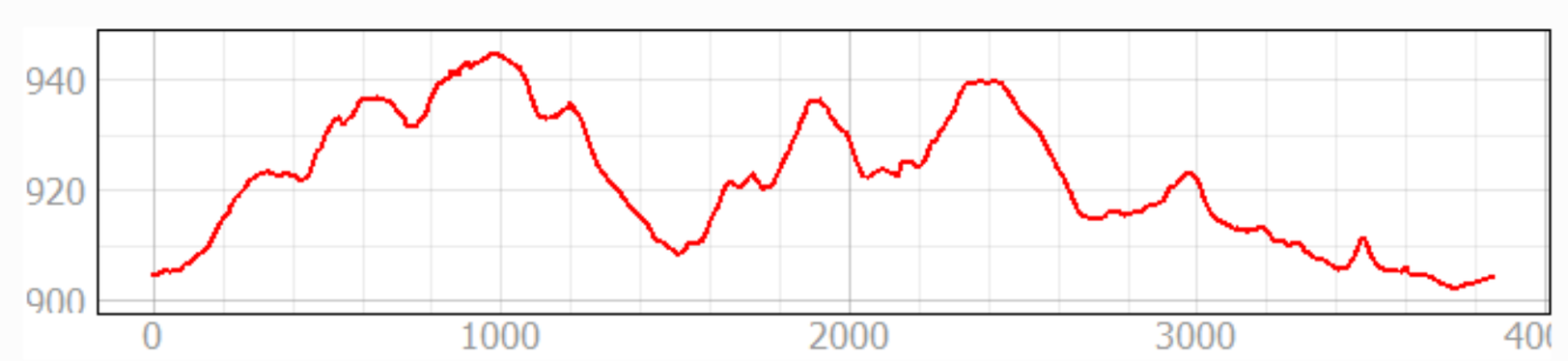
- 3357m



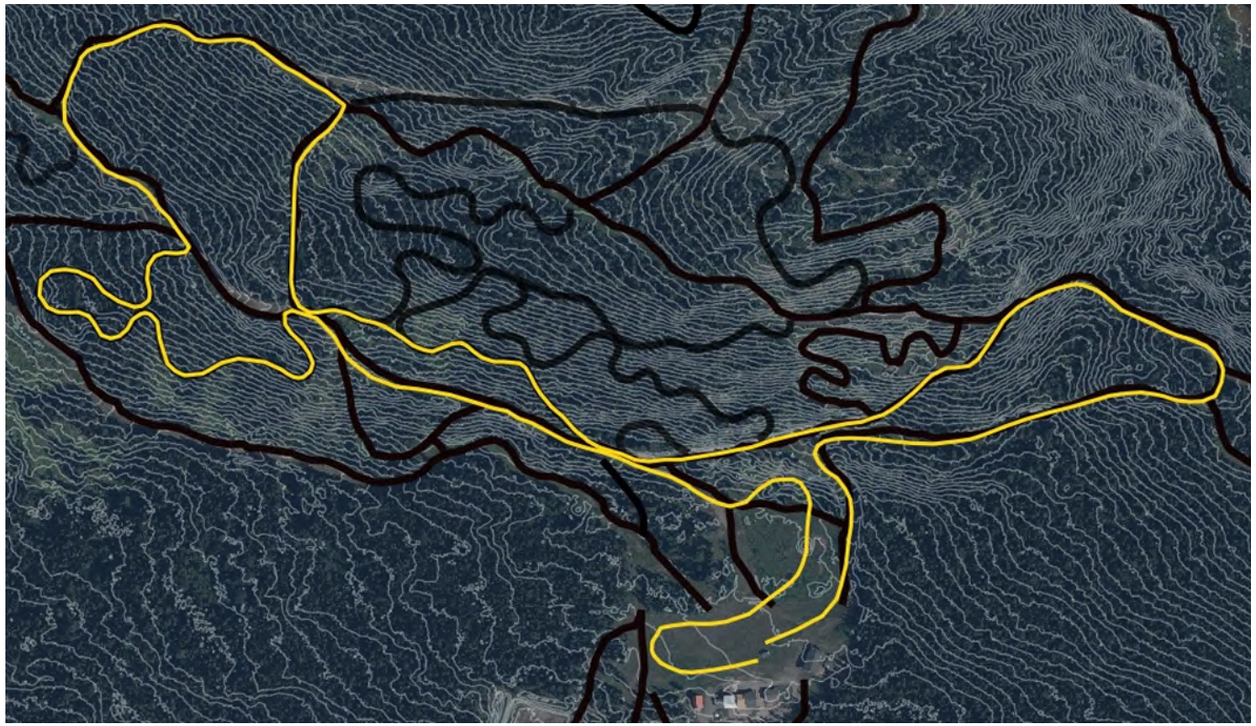
3.75km-Option A



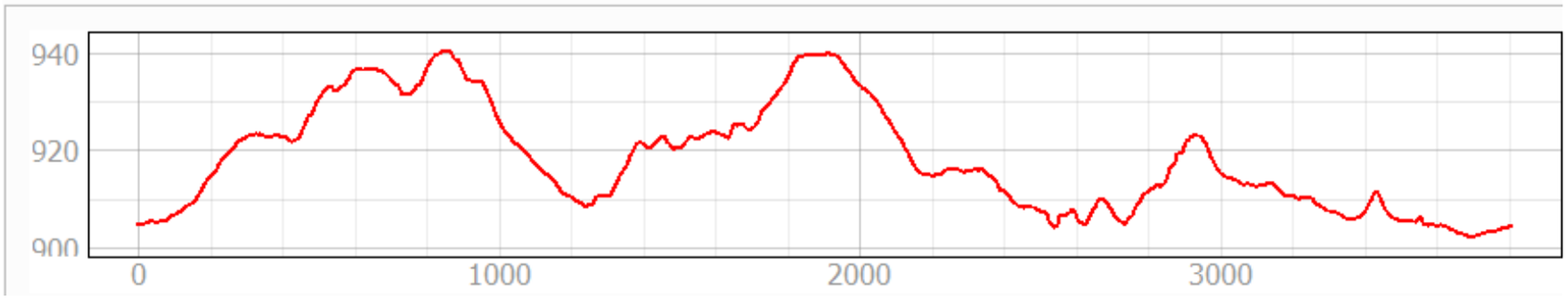
- 3853m



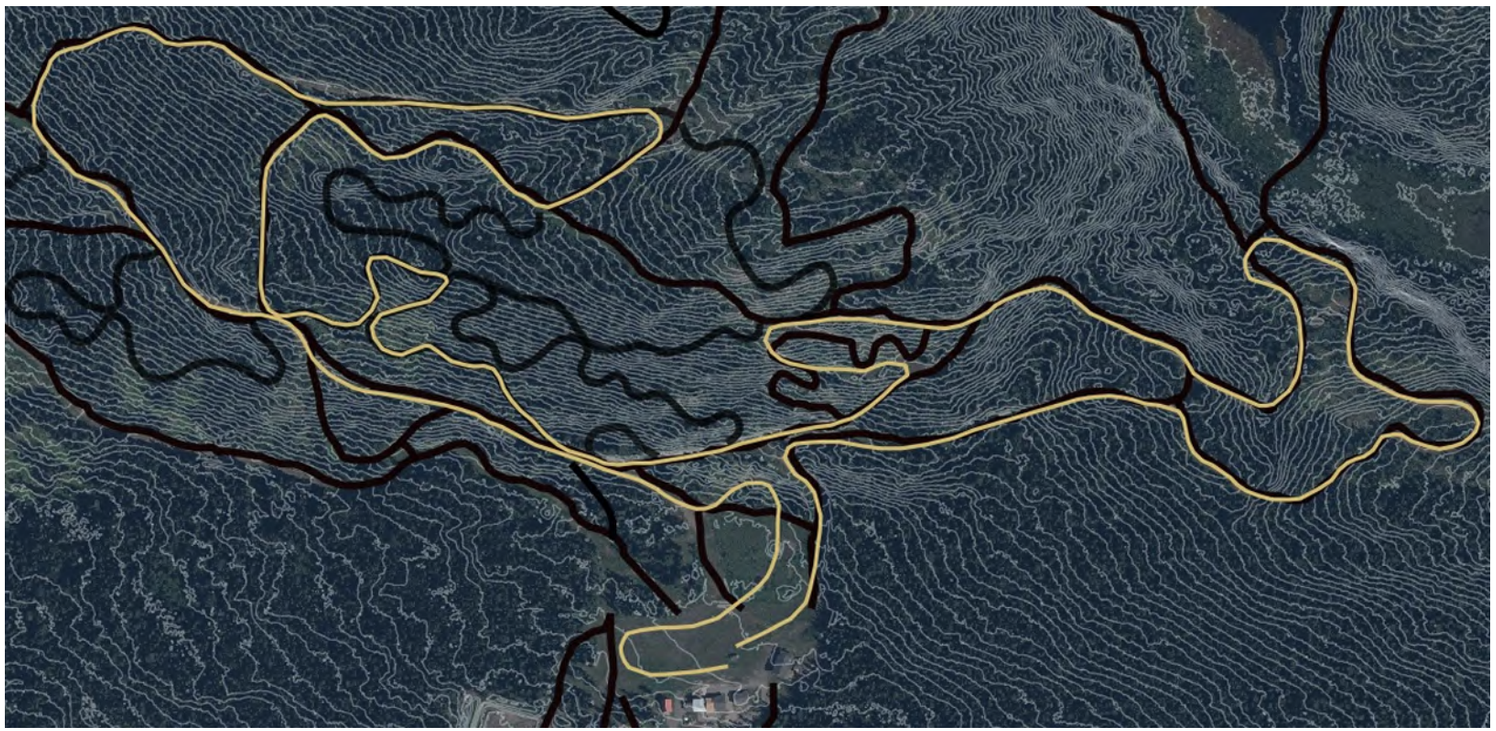
3.75km-Option B



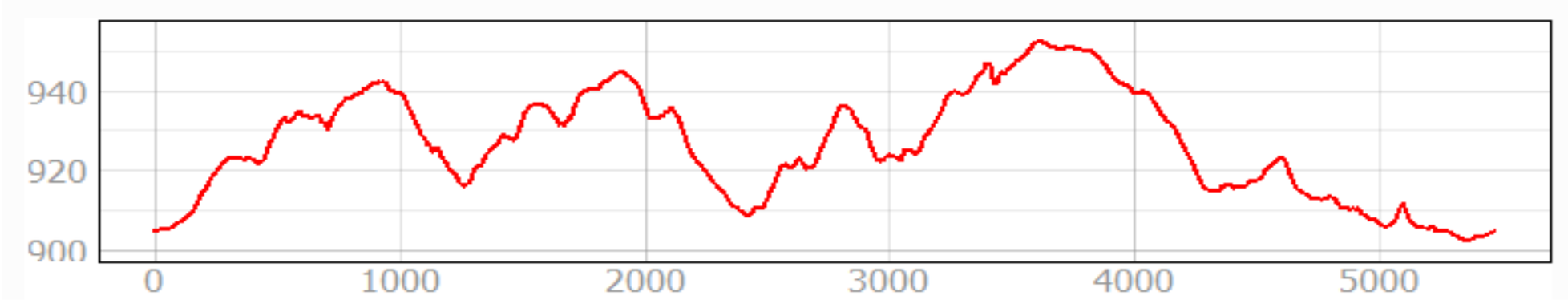
- 3807m
- Preferred



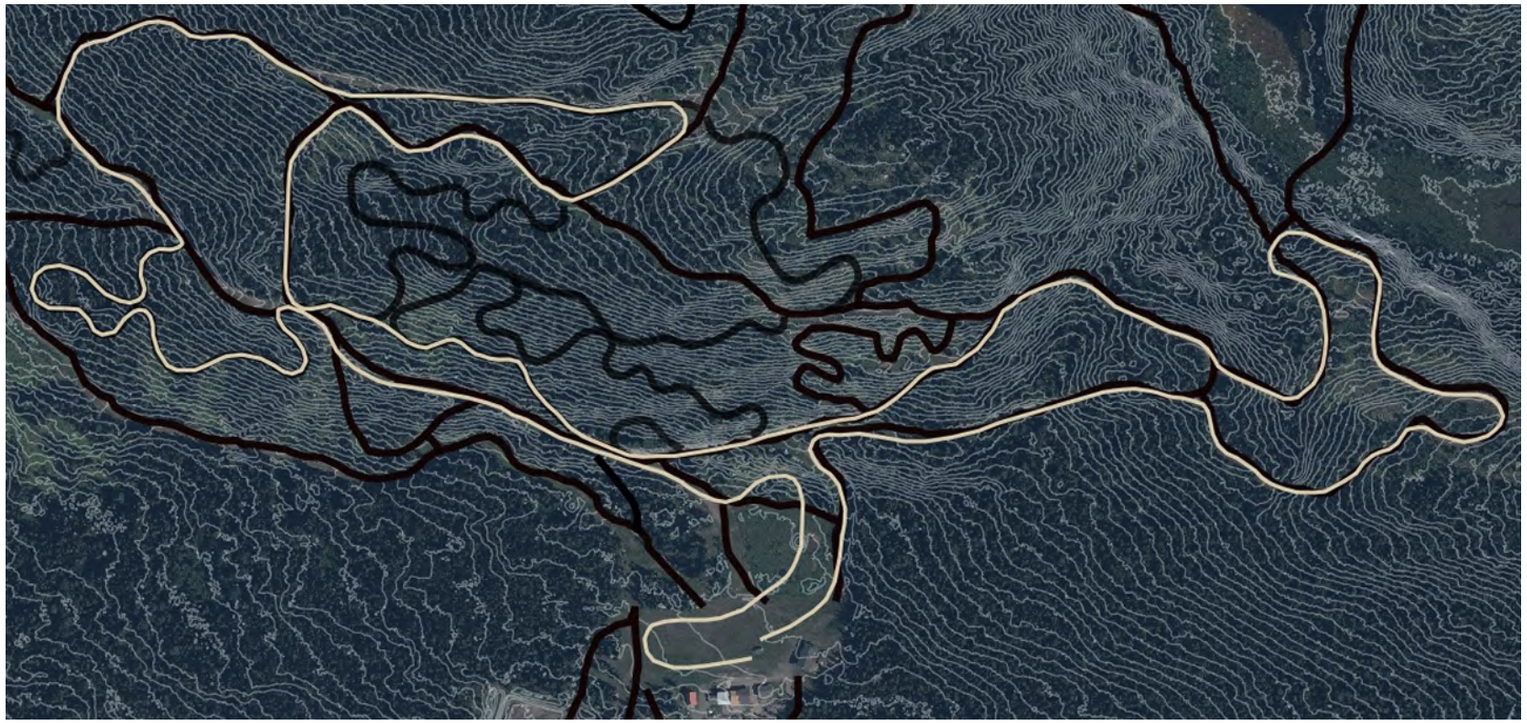
5km-Option A



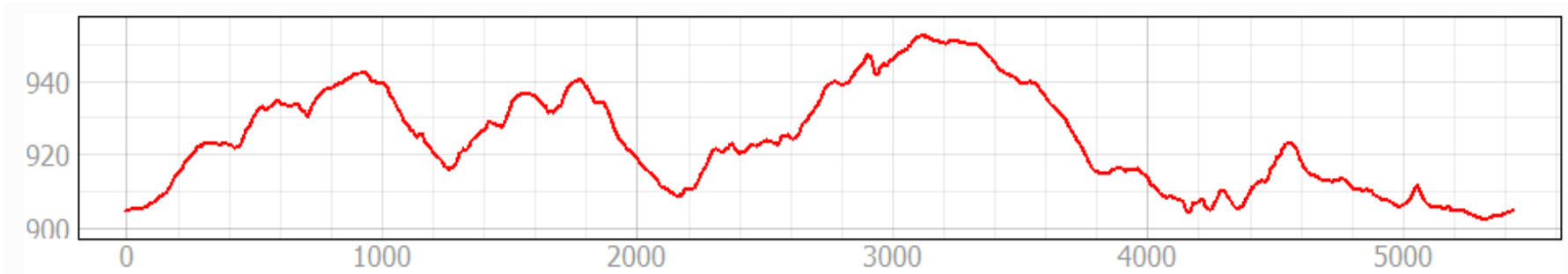
- 5469m
- Several options to reduce difficulty as needed



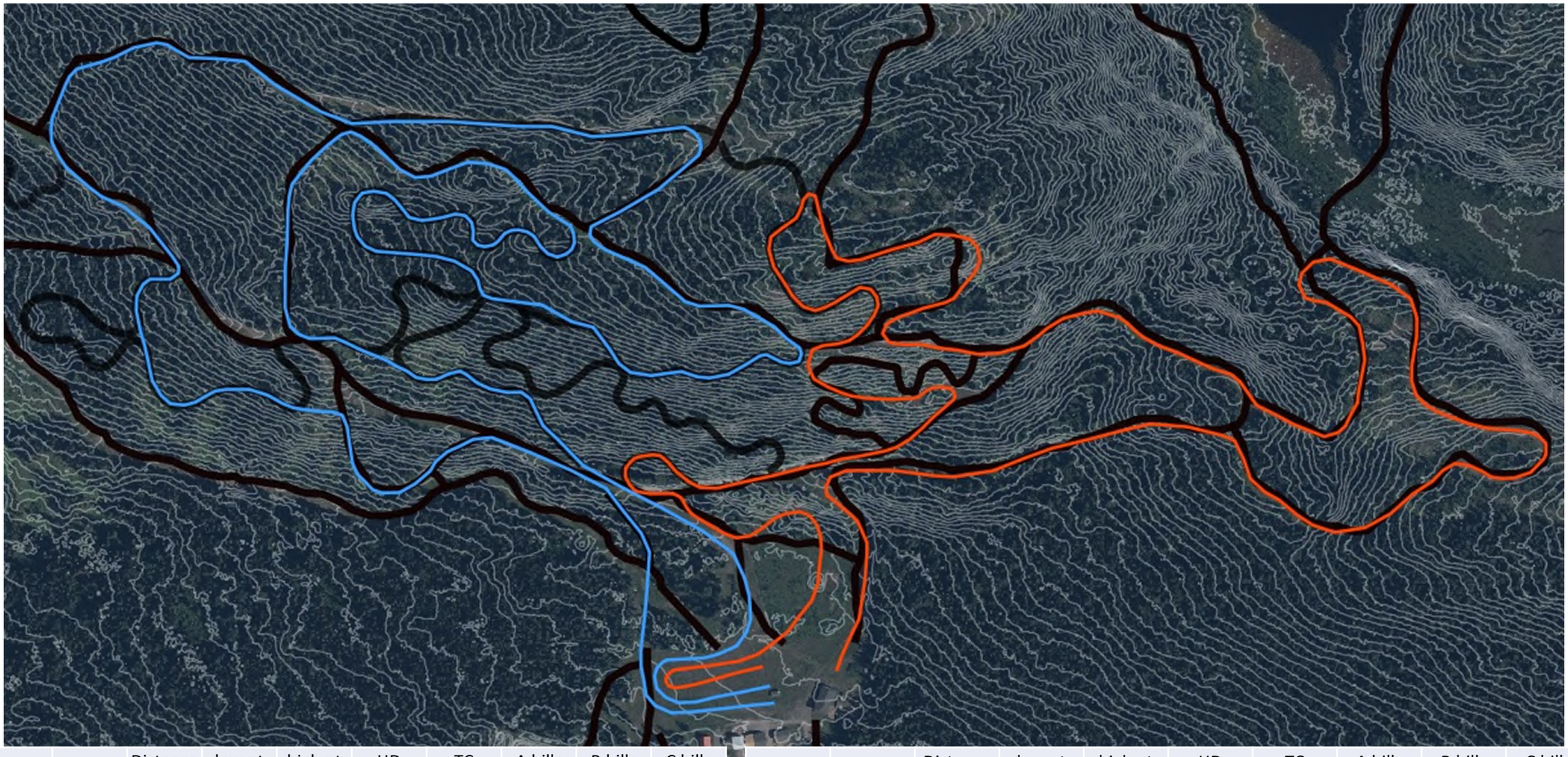
5km-Option B



- 5430m



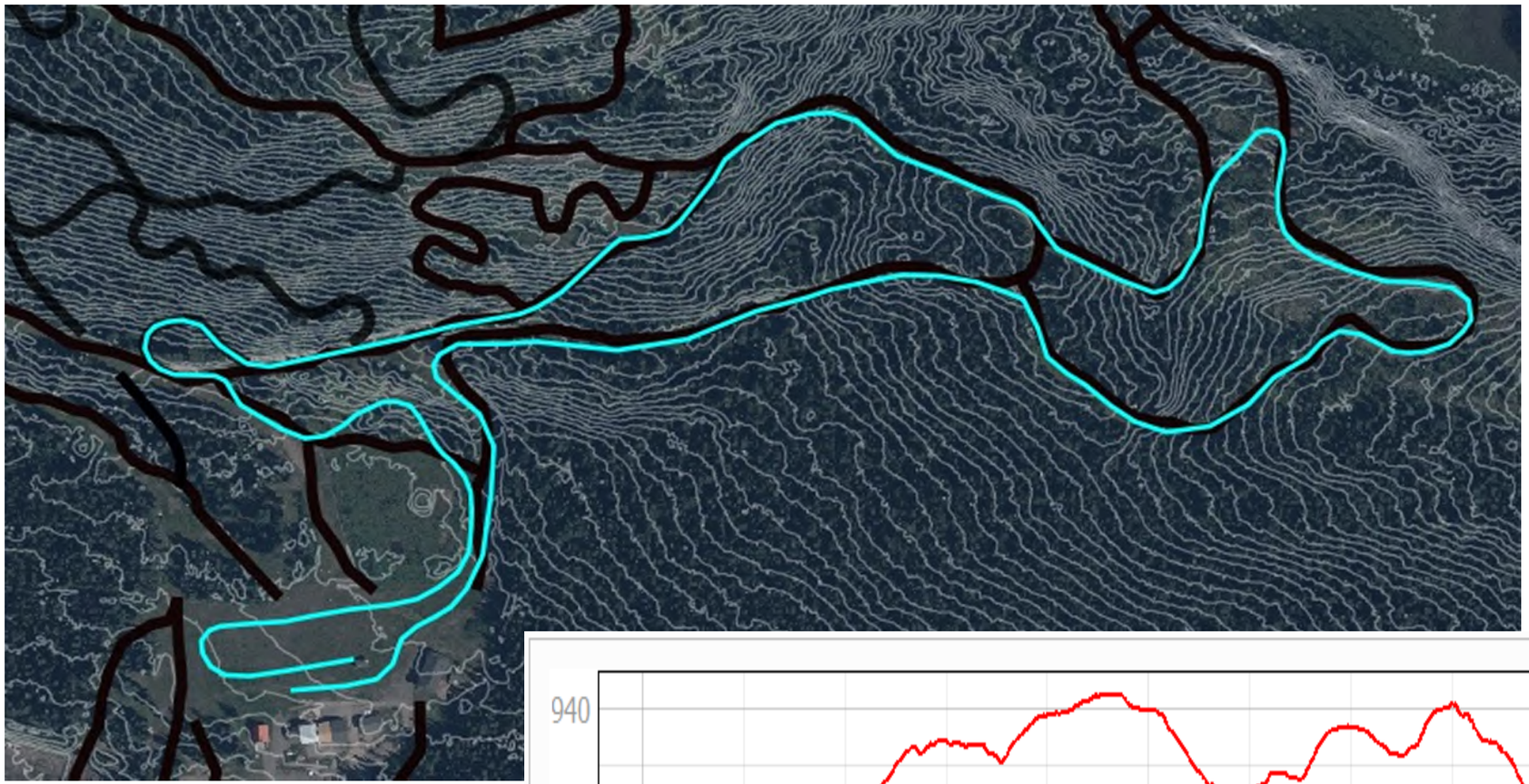
Two-Course Race Trails Network:



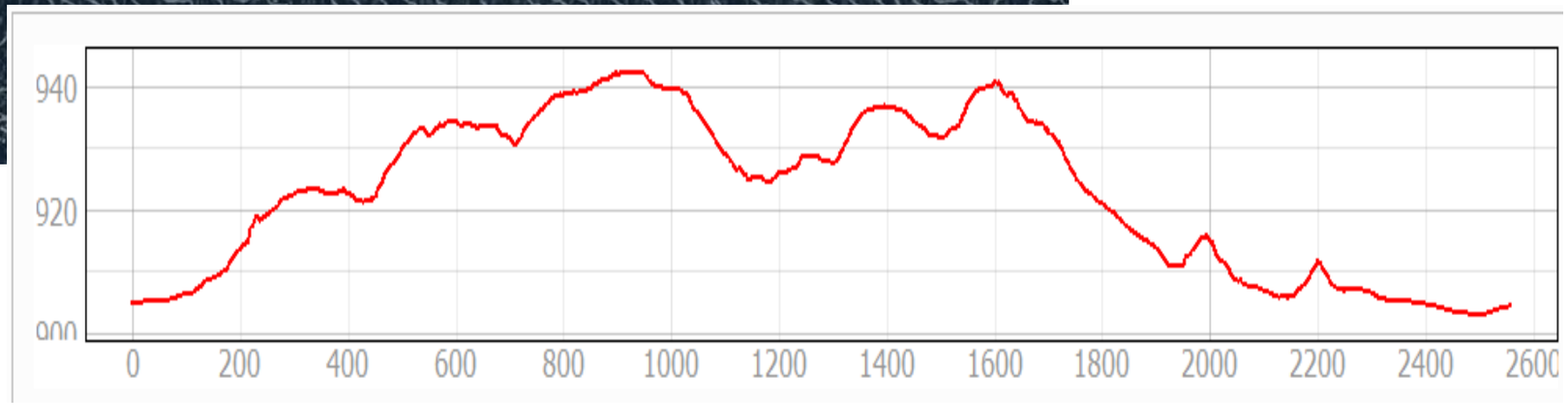
		Distance	low pt	high pt	HD	TC	A hills	B hills	C hills
Western Course	2.5km	2491	902	939	37	83	0	3	0
	3.75km	3990	902	953	51	124	0	4	0

		Distance	low pt	high pt	HD	TC	A hills	B hills	C hills
Eastern Course	2.5km	2557	902	940	38	82	1	2	0
	3.75km	3600	902	960	58	118	2	2	0

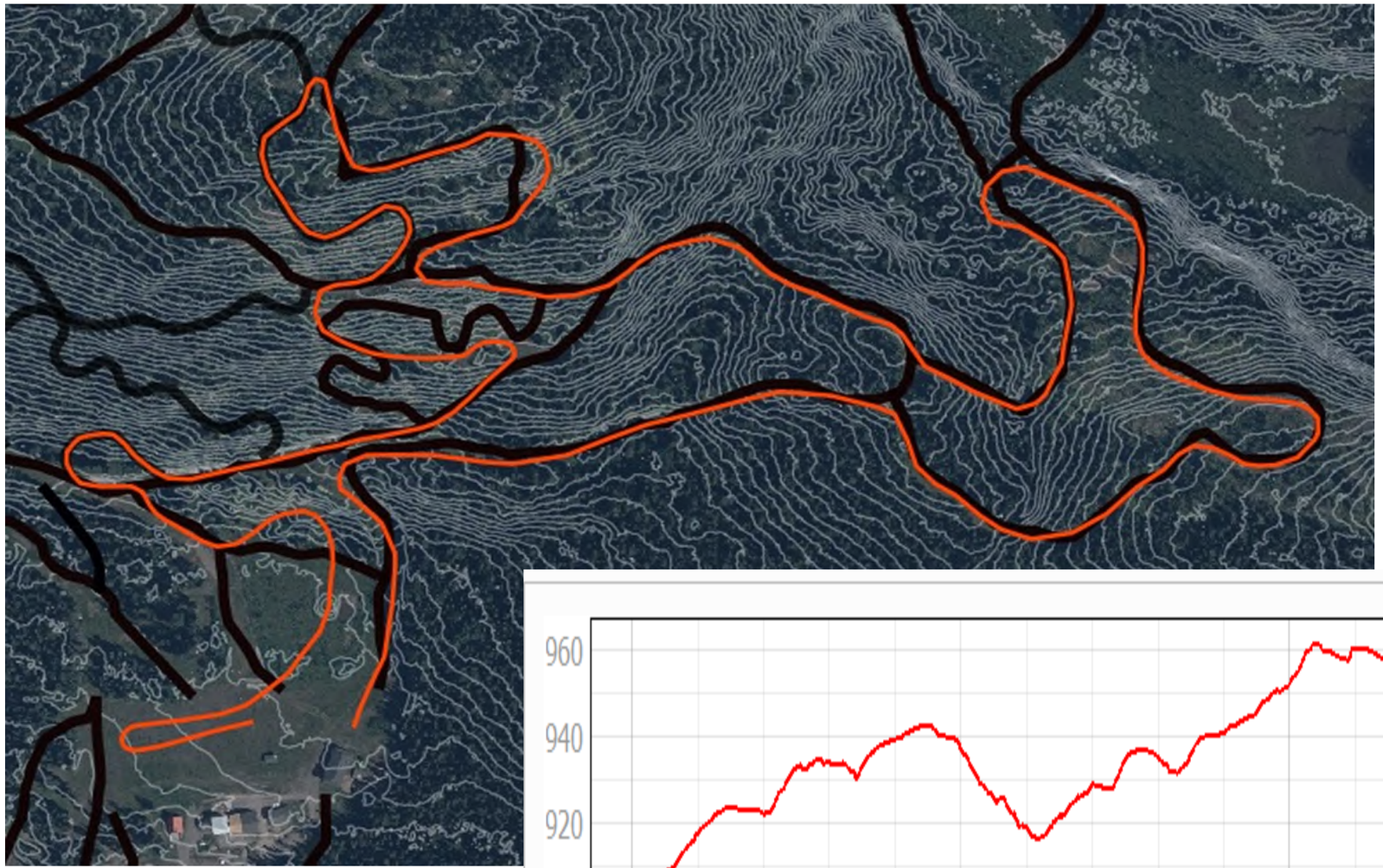
Eastern Course: 2.5km



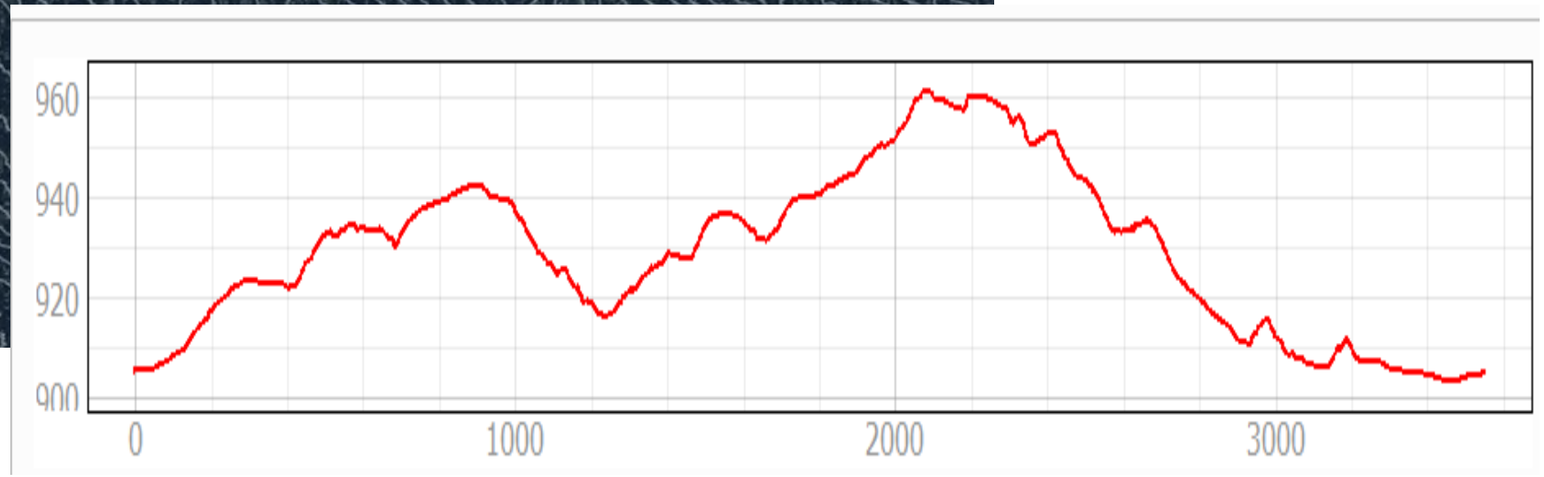
- 2557m



Eastern Course: 3.75km

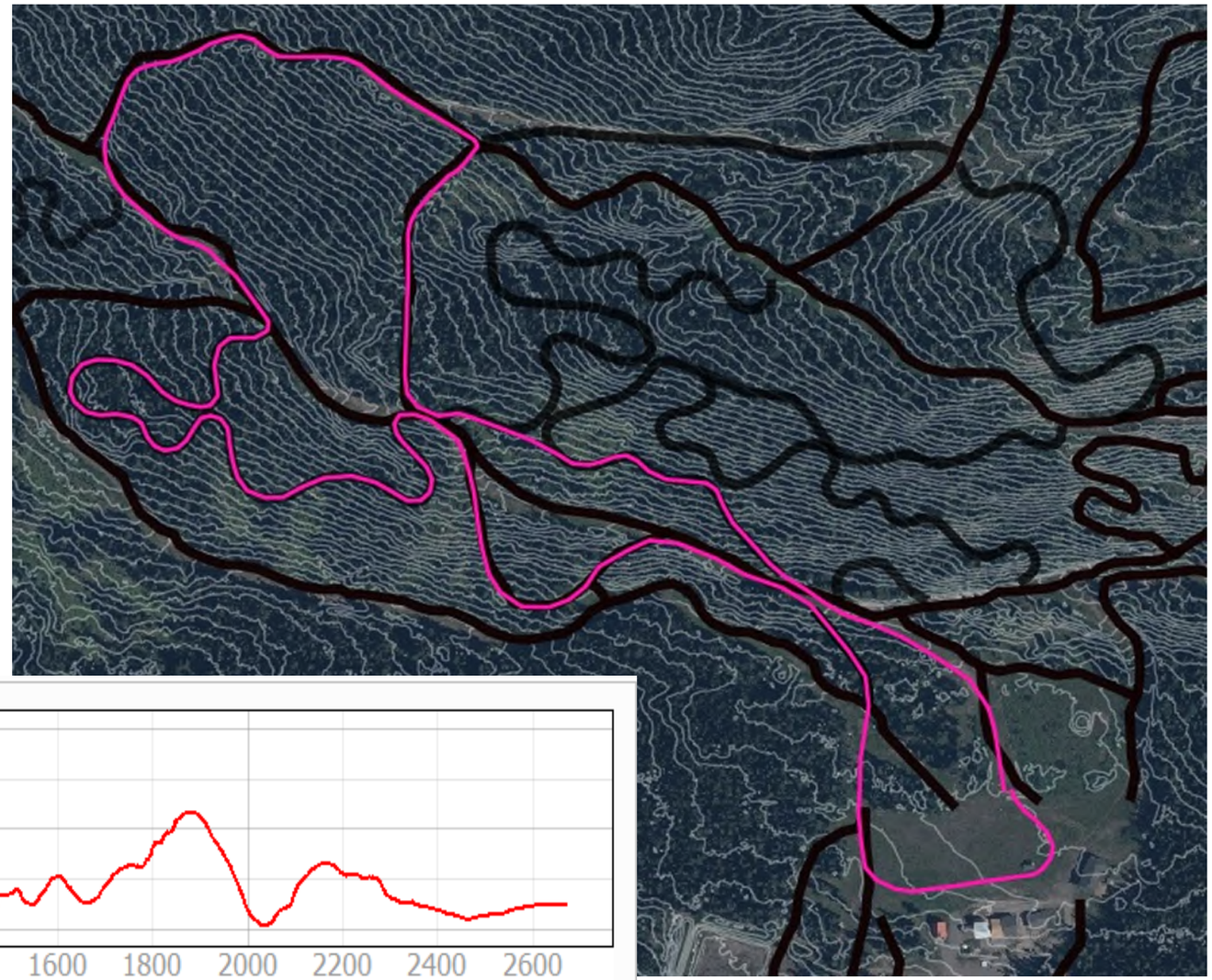


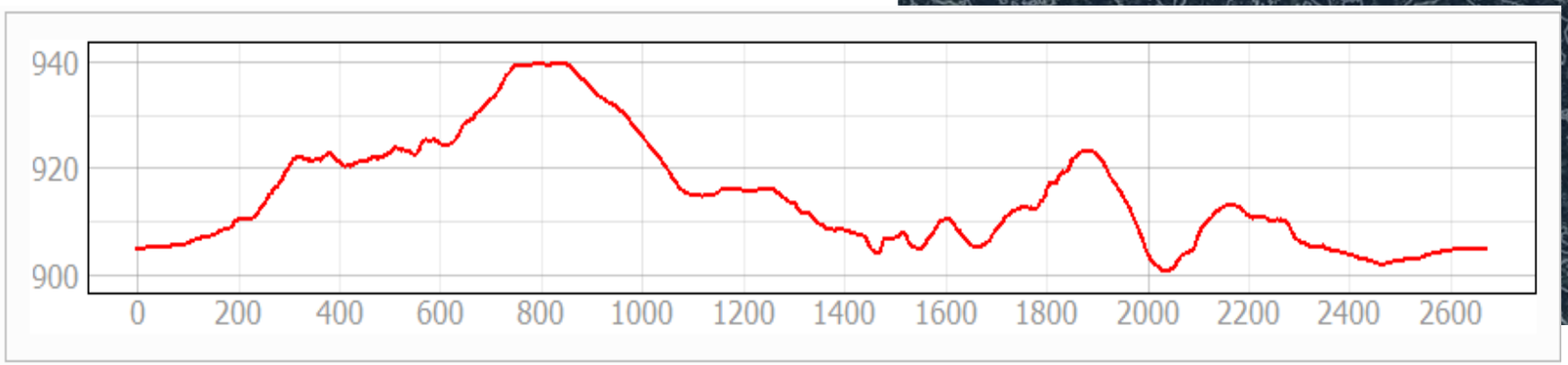
- Slightly short at 3550m, but can work



Western Course: 2.5km

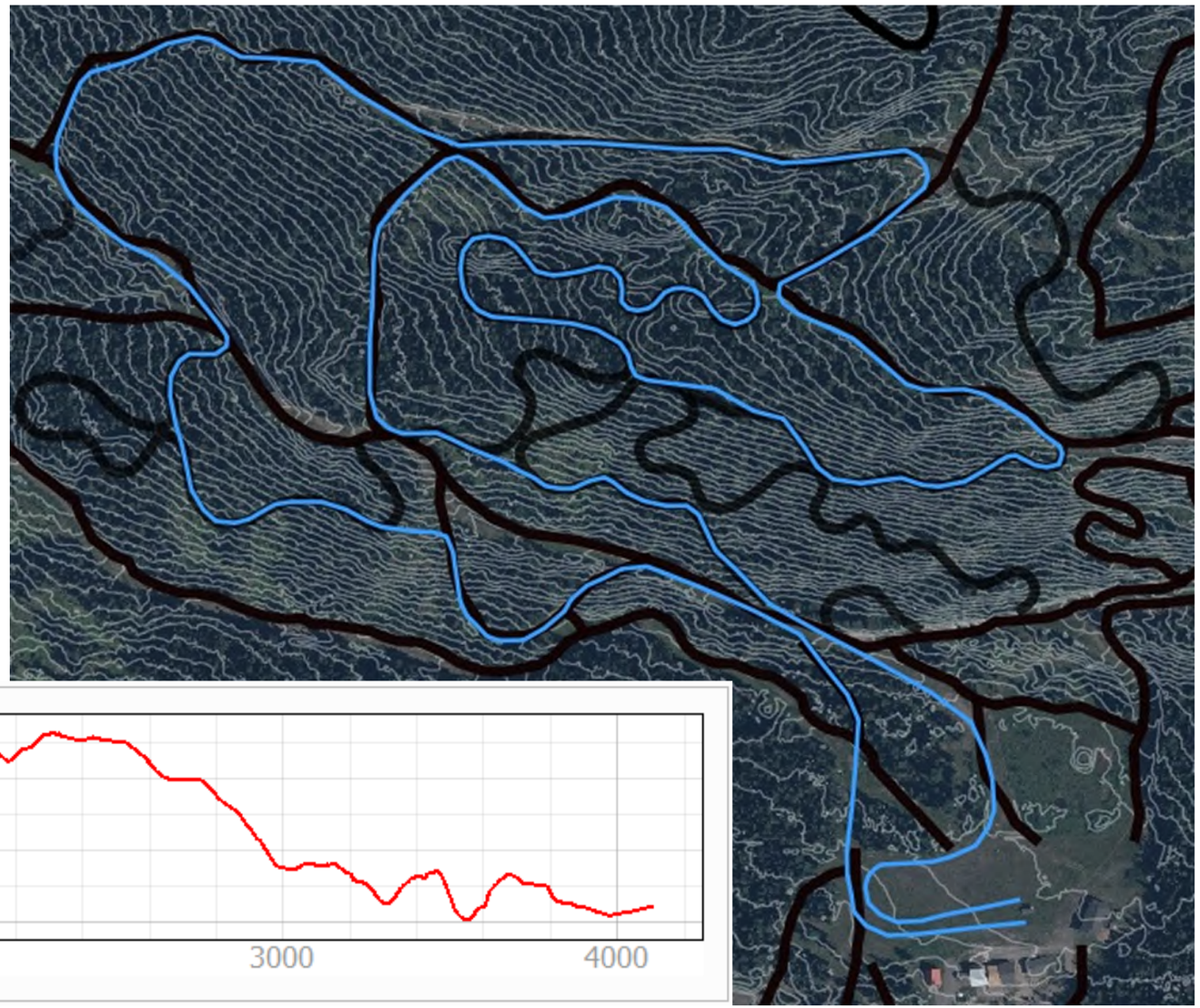
- 2491m

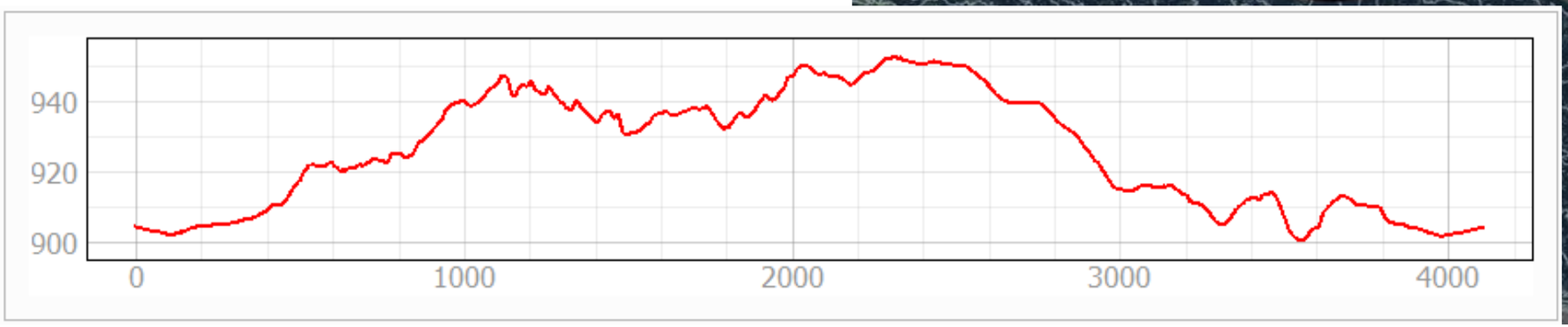




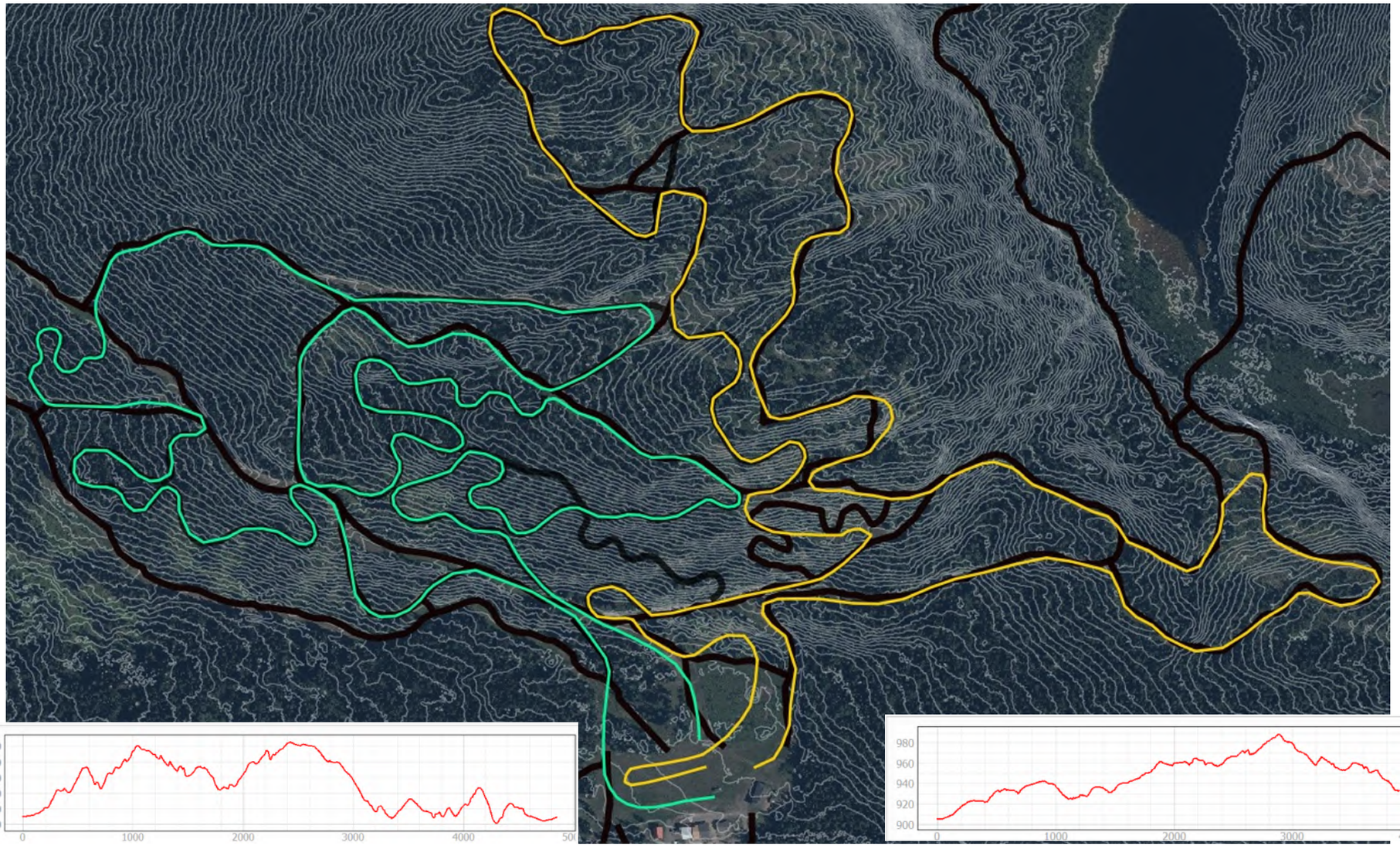
Western course: 3.75km

- 3990m





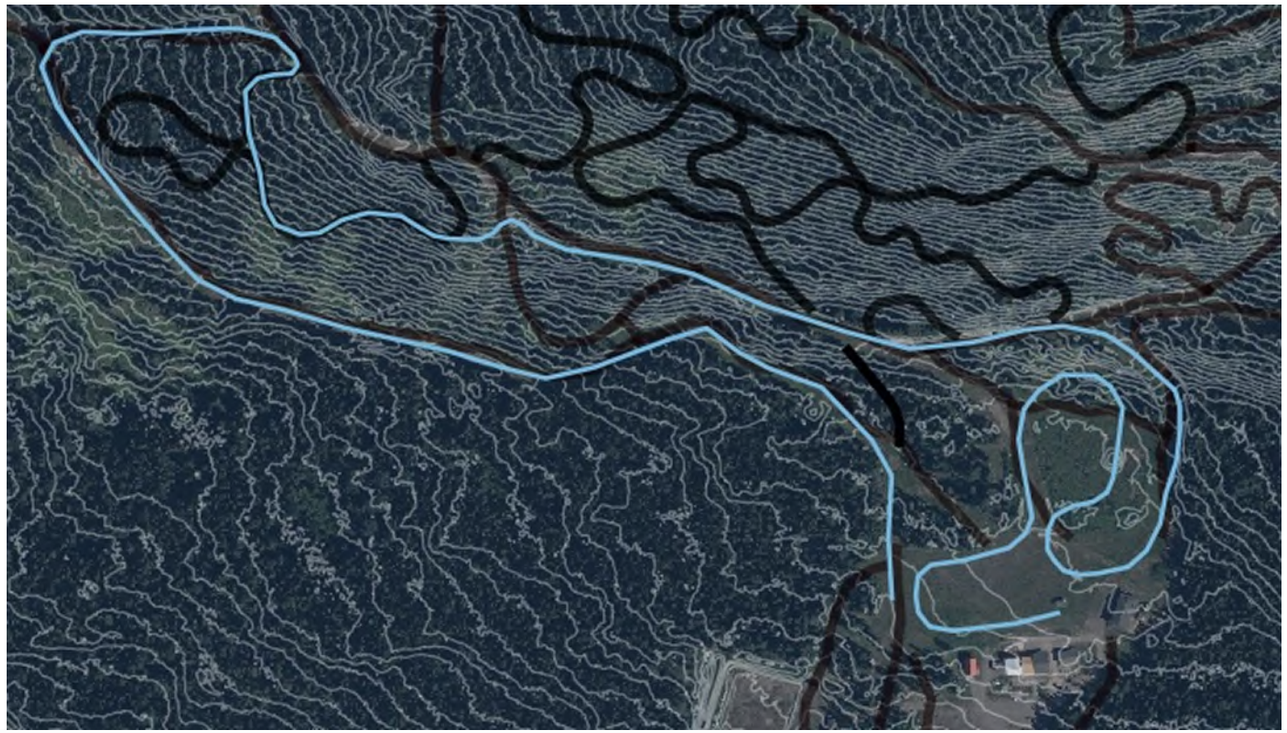
Fun 2 x 5km (non-homologated)



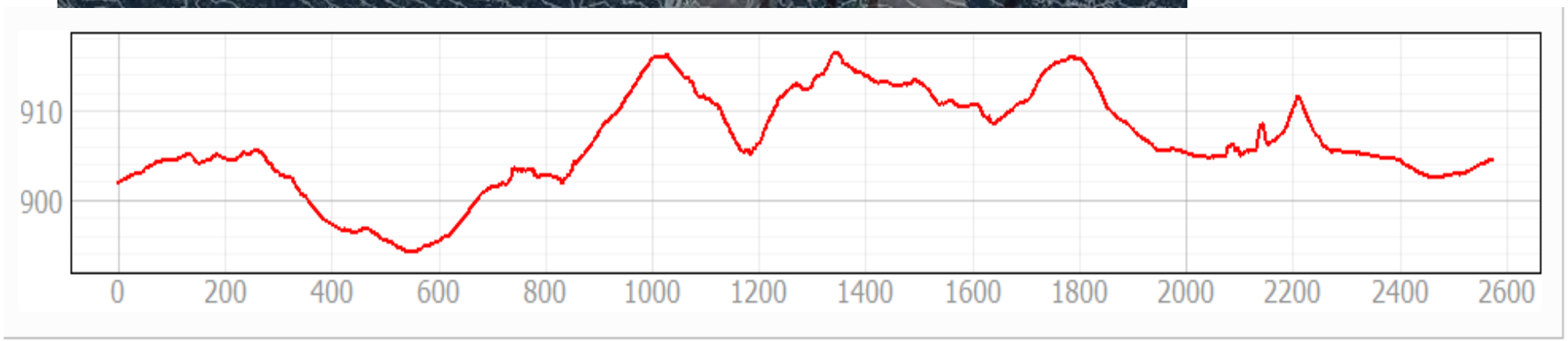
- Helps show full stacked loops and course potential

Sit-Ski Race Course Options

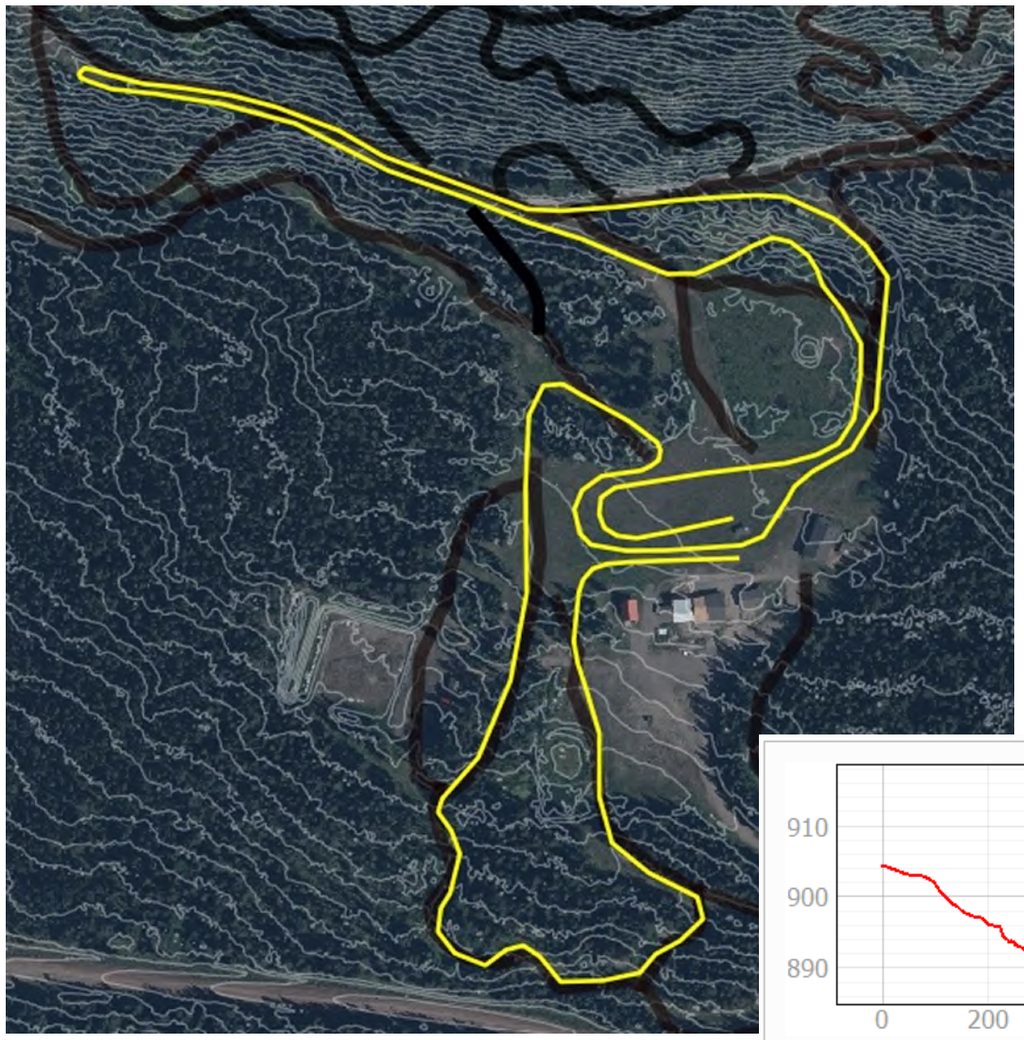
2.5km-A



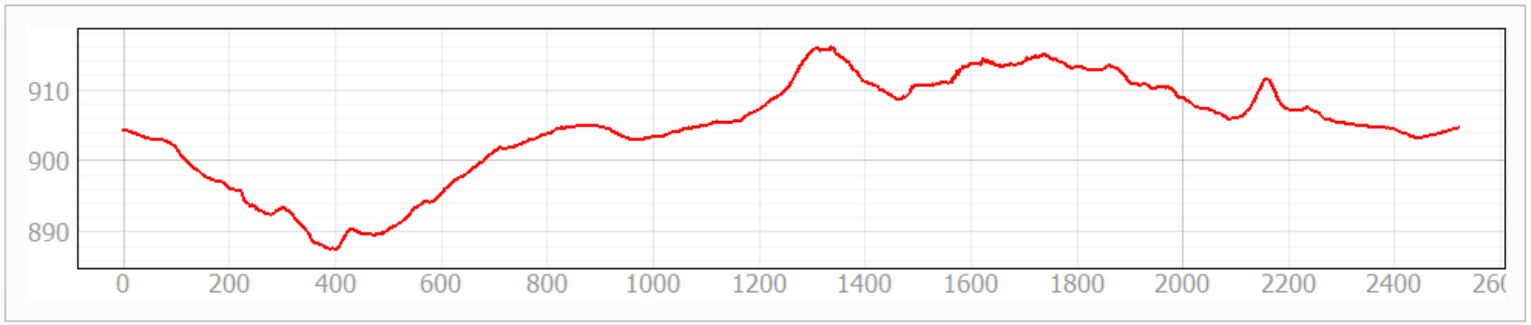
- Corner in front of lodge good spectating



2.5km-B



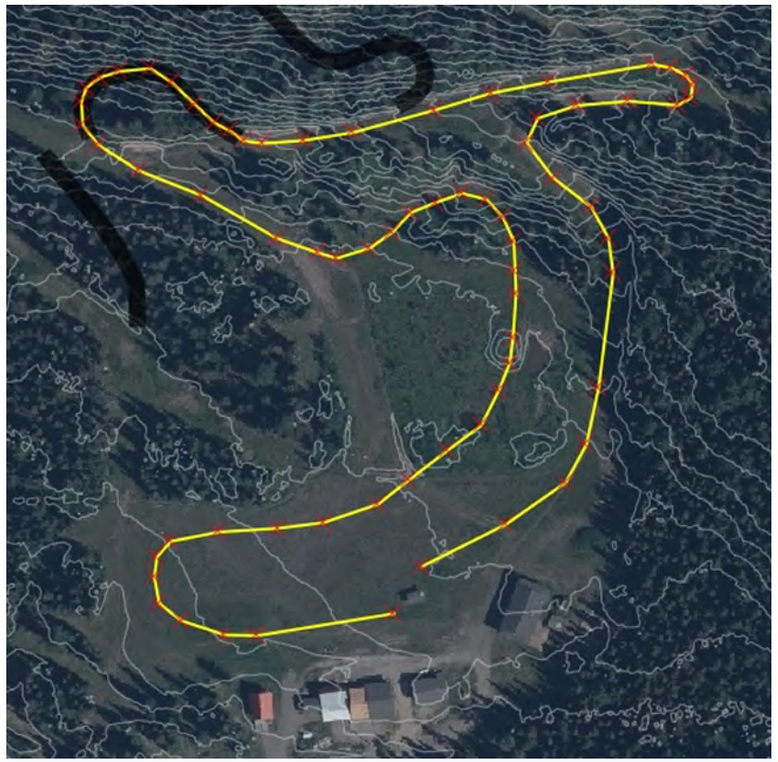
- Can do biathlon loop in either direction if the proposed half-click cutoff is too sharp (counterclockwise requires a different start location)
- TC=46m
- A hill from 410m to 725m, 4.5%, 14m climb (slightly long, should be 200m or less)
- A hill from 1177 to 1319m, 8%, 11m climb
- Preferred

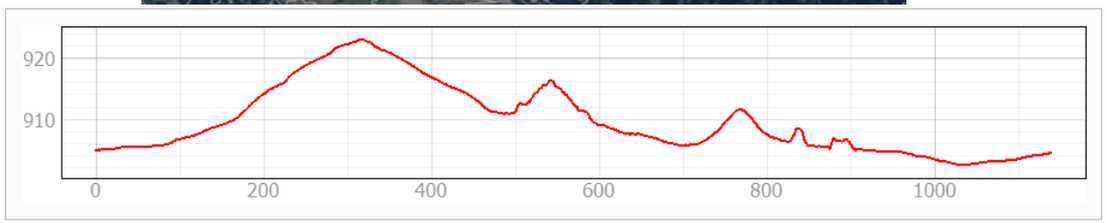


Sprint Race Courses

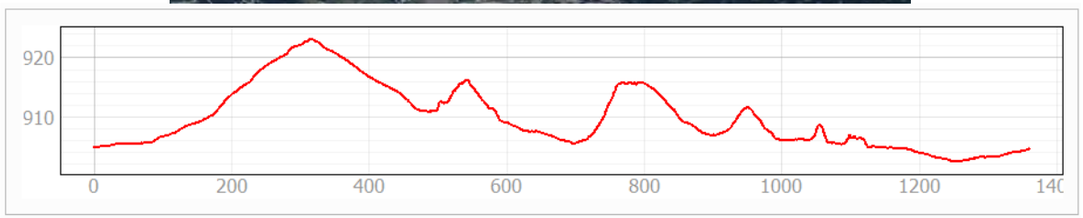
Sprint: Skate

Homologated 1200m (1141m), shorter variants available



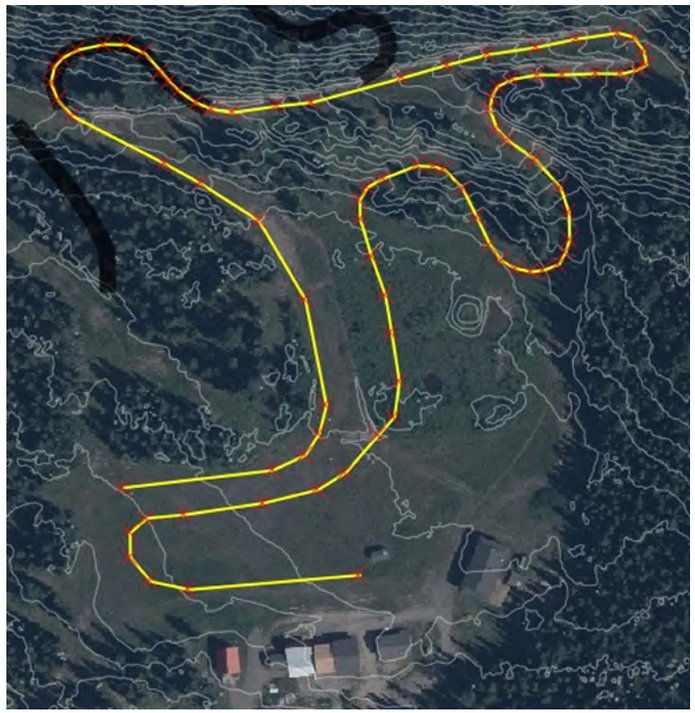


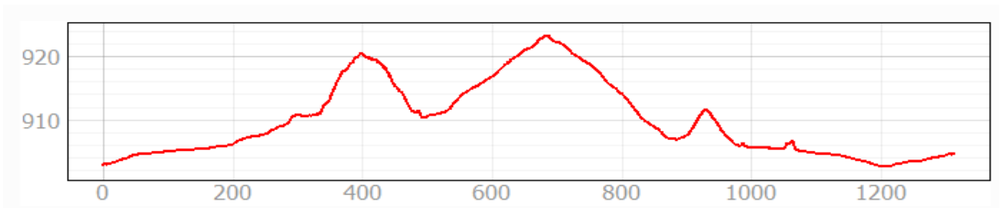
Fun club alternative 1400m (1363m) shorter variants available



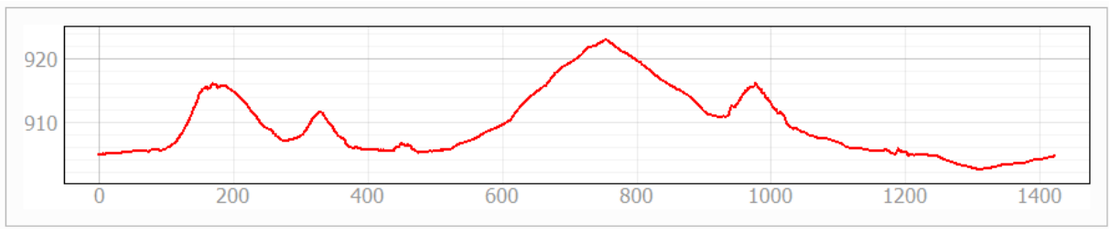
Sprint: Classic

Homologated 1200m (1167m clockwise)
Shorter variants available



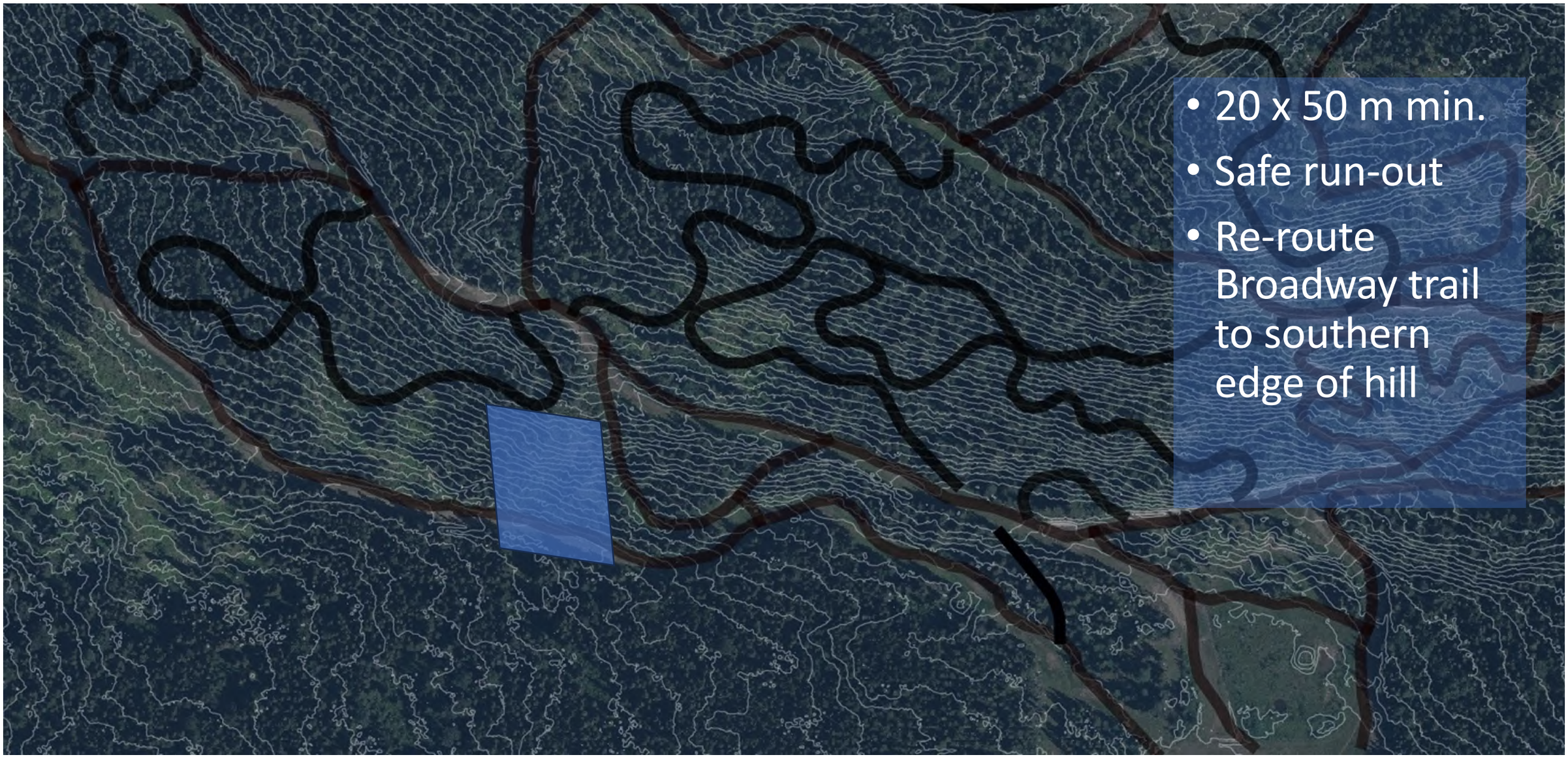


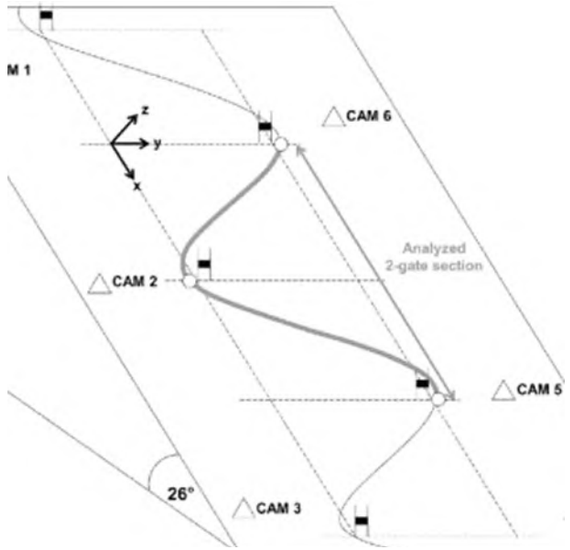
Fun Club Option 1400m (1423m)
Shorter variants available



Practice Hill for Cross-Country Turning Maneuvers

Proposed Practice Hill Location




M 1
z
y
x
CAM 6
Analyzed
2-gate section
CAM 2
CAM 5
26°
CAM 3

APPENDIX D – Homologation Statistics of Proposed Race Trail Netework

Appendix D Table - Preliminary Homologation Statistics and Allowable Ranges

Competition Courses	Distance, m (allowable plus 10%; minus [illegible])	Height Difference (HD)	Maximum Partial Total Climb (PTC), m	Total Climb (TC)	A hills (9-18%)	B hills (9-18%)	C hills (<10m; >18%)	Undulating Terrain, %	Minimum Hill Climb (PHD), m	Allowable Partial Total Climb (PTC), m	Allowable Total Climb (TC), m
SPRINT											
Free	1157	20	17	32	NA	NA	NA		NA	0 - 30	0 - 60
Classic	1300	20	14	32	NA	NA	NA		1 > 15	15 - 40	20 - 60
MAIN											
1.5km	1605	22	12	39	0	2	0		NA	NA	NA
2.5km A	2755	43	30	77	1	2	0		1 > 25 (1)	25 - 50	75-105
2.5km B	2715	38.5	30	79	1	1	0		1 > 25 (1)	25 - 50	75-105
3.3km	3367	38.5	30	99	1	2	0		1 > 25 (1)	25 - 65	100-140
3.75km A	3857	43	30	113	1	3	0		1 > 30 (1)	30 - 80	110-160
3.75km B	3825	38.5	30	116	1	3	0		1 > 30 (1)	30 - 80	110-160
5km A	5469	51	35	168	2	4	0		1 > 30 (1)	30 - 80	150-210
5km B	5430	51	35	171	2	4	0		1 > 30 (1)	30 - 80	150-210
EAST											
2.5km	2557	38	30	82	1	2	0		1 > 25 (1)	25 - 50	75-105
3.75km	3600	58	30	118	2	2	0		1 > 30 (1)	30 - 80	110-160
WEST											
2.5km	2491	37	25	83	0	3	0		1 > 25 (1)	25 - 50	75-105
3.75km	3990	51	30	124	1	3	0		1 > 30 (1)	30 - 80	110-160

NOTES:

1. Course width:

Mass Start Classic: Uphill = 6 m; Undulating = 6 m; Downhill = 6 m

Mass Start Free: Uphill = 9 m; Undulating = 7.5 m; Downhill = 6 m

Mass Start for Skiathlon and Relay on same course: Uphill = 12 m; Undulating = 9 m; Downhill = 6 m

2. All homologation measurements need to be confirmed by more detailed survey methods.

APPENDIX E – FIS Homologation Criteria

E1 – Cross Country

E2 – Sit-Ski

FIS Homologation procedure for cross-country skiing courses

1. FIS Homologation

The FIS homologation is the approval issued by a FIS appointed homologation inspector and certifies that the homologated Cross-Country course is suitable to host FIS competitions.

Homologation represents a “system of evaluation” that is meant to guide the development and the upgrade of Cross-Country competition courses and venues. It is not just a set of numbers and standards but is a process towards certification, that provides a forum for constructive discussion between Organizers, FIS and Inspectors.

1.1 Application

The application for a new FIS homologation certificate or for a renewal of an existing one must be done by the National Ski Association (NSA) to the FIS Nordic Office (copy to FIS Para Nordic Office in case of para nordic courses) that appoints a HI. For the appointment procedure see the Rules for the organization, education and nomination of FIS Cross-Country Technical Officials **7.2 HI Nomination**.

The application for a renewal of existing FIS homologation certificates must be submitted latest before August 15th for the Northern Hemisphere and February 15th for the Southern Hemisphere. Otherwise the expired courses will be cancelled without any replacement.

The application form is published in the Cross-country documents section of the FIS website.

When appointed by FIS the HI cannot be paid as course designer (or consultant) for the same courses.

Course designers are not appointed by FIS.

For OWG/NWSC/World Cup competition sites the inspector must be from a different country, for all other competition sites and for WC city sprints the inspector can be from the same country and NSA can propose a name.

The NSA must provide the following documentation:

- stadium diagram(s)
- digital line files (.gpx or .kml format) for each course(s)
- accurate elevation data (e.i. waypoints, digital elevations model, contours) for each course(s)

2. Homologation Report

Upon the completion of a site visit, the appointed HI is responsible for providing the organizers, the NSA and the FIS Nordic Office a written report of the inspection. The report should include:

- analysis of the elevation profiles of the proposed courses with any comments on any elements that are deficient in terms of the ICR requirements;
- a clear report of any required adjustments to the courses for width, alignment, gradient, or safety accompanied with photos and a location map for reference;
- analysis of the capacity of the stadium;
- analysis of the warm up and wax testing facilities;
- analysis of the supporting infrastructure.
- analysis of transition and staging area for sit-ski athletes in order to access start, finish and warm up areas (in case of para nordic courses)

The need for temporary protection and other special measures that the organiser must take into consideration under certain course conditions should also be also mentioned in the homologation report.

3. FIS Certificate

The homologation certificate draft is done by the appointed HI within the given homologation software and sent to the Regional HI coordinators (and to the Chief of HI coordinators) for the final approval and they send it to the FIS Nordic Office.

The FIS Nordic Office adds all required dates, signatures, stamps and registration number and informs the respective NSA and homologation Inspector that the certificate is completed and uploaded to the FIS website.

3.1 Certificate validity

The certificate is valid for 5 seasons (expires 30 June for Northern Hemisphere / 30 December for Southern Hemisphere). The FIS Nordic office sends a notice of expiring certificates to the respective NSA and Regional HI coordinator no later than May 15 for the Northern Hemisphere and November 15 for the Southern Hemisphere.

If the given course has been used in a FIS Competition, there have been no significant changes to the alignment, width, or profile and no negative comments to the safety or functionality have been recorded in a TD Report within the 5 previous years, the certificates can be renewed, with a new certificate number, for an additional five years.

Certificates may only be renewed one time. After ten years, courses are subject to a new homologation.

In case TD report shows that the course is no longer as it is described in the certificate, the Chief of HI coordinators evaluates the case and decides how to proceed.

3.1 Provisional certificate

A NSA may request provisional homologation certificates for courses that have not yet met the final homologation. The application must be done by the NSA to the FIS Nordic Office at least 4 weeks before the course is used for a FIS competition under the following conditions:

- A HI has been appointed and has verified that the elevation profile meets the ICR requirements
- The appointed HI (or the FIS race director) has made a site visit

Provisional certificates expire 30 June for Northern Hemisphere / 30 December for Southern Hemisphere.

4. Costs

4.1 Administrative costs

The National Ski Association (NSA) is charged the cost of the certificate, and must itself invoice the OC if applicable. The following homologation fees will be charged to the NSA by the FIS Nordic Office:

- Application fee: CHF 100.-
- Homologation certificate fee: CHF 125.- for each new course certificate (included provisional one)

There is no cost for the first renewal while courses which are due to new homologation are subject to certificate Fee, but not the application Fee.

4.1 Homologation inspector costs

The FIS appointed HI is entitled to reimbursement for all appointment related travel expenses according to ICR 304.1.1. The daily rate is 125 CHF.

For his or her work at home related to the FIS appointment, both after the site visit or without it, the HI has the right of reimbursement of maximum one additional day.

FIS cross-country course and venue design guidelines

Edition spring 2023

1. Introduction

This manual contains useful resources for cross-country course designers, organisers of FIS competitions and FIS Officials. The FIS International Competition Rules (ICR) lists the requirements for homologated FIS cross-country courses, these guidelines provide recommendations for how to meet the requirements in the best possible way.

The goal is to provide a resource for those who are involved in developing courses and stadiums that meet the best traditions in cross-country skiing, are suited for all competition formats and techniques, and provide safe conditions and fair chances for all competitors.

This guideline represents the collective experiences of course designers, organisers and homologation inspectors going back to the venue development for the Nordic World Ski Championships in Oberstdorf 1987 and will continue to evolve on an ongoing basis based on the experience of the users and new developments in cross-country sport.

2. Aspects and philosophy of Competition Course Design

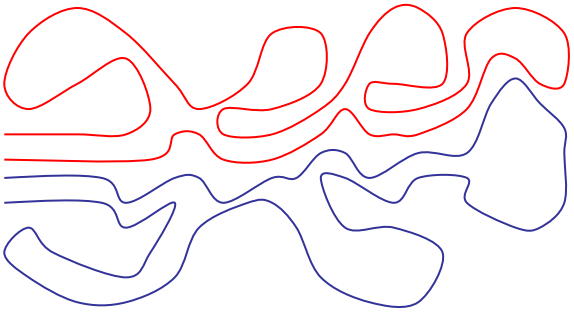
Preserving Cross Country Heritage

In the beginning of the ski history the trails used for cross country skiing were the same trails as used for transportation in the summertime, with limited grooming and no mechanical influence. Cross Country skiing was the means of transportation in the wintertime. The layouts of the first competition courses were made in the same way: *"The best possible trails given the possibilities of the natural terrain"*. Some competitions were also conducted on trails used daily for travel. With the increased use of heavy equipment used in today's trail construction there is a considerable risk that we will lose the "feeling for the natural terrain" that is in the soul of the cross-country skier. Even though we are designing courses for competition, it is extremely important that we take every opportunity to preserve the athlete's contact with the natural undulations of the terrain. This implies that course designers and inspectors have a responsibility to minimize the need to modify the terrain with machinery, but instead must find ways of using the natural terrain whenever possible. The joy of skiing should be the ultimate goal.

Environmental Aspects

Society expects cross-country skiers to be close to nature. We therefore have an inherent responsibility to protect the natural resources. In order to preserve the relationship with nature, course designers must be aware of environmental factors and set a positive example. This includes the need to work with a variety of environmental organizations and landscape architects. The following lists some key areas of concern:

- Avoiding excessive side cuts
- Managing water flow and drainage
- Employing materials that blend into the natural surroundings
- Investigating rehabilitation/reforestation of the site, pre- and post-event
- Focusing on preservation of the snow (using north-facing slopes as much as possible, etc.) and optimising the conditions for artificial snow production



This is a principal layout of a course system that can accommodate all competition formats. It consists of two separate courses, one for each technique in the skiathlon competition and each 5 km long. Cut-offs can make courses of 2.5, 3.3 and 3-75 km length. Also sprint courses can be laid out inside this system. These two courses can be considered as one 10 km course. Another option is a transition from the red to the blue course outside the stadium in order to make a 7.5 km loop that is more suitable for interval start formats.

If the environmental restrictions of the terrain are such that very limited construction is possible, the courses could be designed with minimum width and be homologated for interval start competitions only.

Legal Aspects

It is the responsibility of the organizer or venue owner to perform the necessary research into any legal aspects that affect the proposed site selection and its development, for example:

- Land ownership
- Government authority regulations
- Environmental regulations

Course safety

The safety of the athletes under all conditions has to be considered when the technical elements of the course are designed. Where necessary, permanent and protective fences should be included in the design. Such fences must be constructed in a way that they themselves do not cause safety hazards or obstruct the view of the competition and must be erected with smooth surfaces and without sharp corners that can injure the skier if hit.

Separate spectators' and officials' access to and along the course must be considered, such that the competitors and the courses are not disturbed during the competition.

Course construction standard

The courses have to be constructed to a quality that allows for grooming and skiing in wintertime with a minimum of snow. This means that rocks, tree-stumps and trees on the course surface and in the skiers "fall-line" must be removed, that proper drainage ditches and pipes are constructed, and that a soft or smooth summer surface is planned.

Visibility

One challenge faced in course and venue design is maintain traditional heritage while also creating opportunities to display the sport of Cross-country skiing as modern events that attract in person spectators as well as a broadcast audience. This means creating stadium and course layouts where major parts of the course are visible for spectators and accessible for video production.

Venue planning should include consideration for the ability of the video production to capture the full range of competition tactics in all competition formats, as well as the natural beauty and/or the historical or human significance of the location.

Planning details should include spectator locations and access routes, location of camera positions, cable pathways, equipment load-in routes, and staging areas for production.

Important video production considerations are:

- The more compact the whole course system is, the better for video production.
- The courses for free and classic technique in Skiathlon or Relay should use the same paths as much as possible

- Wherever possible, especially in uphill sections, there should be an extra two meters width for a camera snowmobile, or a separate path close to the course for the snowmobile.
- Occasional trees or bushes between the camera and the athletes is good and gives a better sense of the speed
- Long, straight parts are not desirable. A bit of variation with slight turns and ups and downs are better. This applies for uphill, downhills and undulating parts
- The courses should all have the same approach to the stadium
- The stadium should have one common entry and exit for all competition formats, and provide maximum visibility for the skiers before the finish

Coaching and Feeding Zones

Locations for coaching and feeding stations should be incorporated into course design. These are 10 to 30 m long sections of the course with an additional 3 to 6 m of width to accommodate groups of coaches. Feeding locations are best located within undulating terrain, and on a straight section followed by a slight downhill. Optimally, feeding zones include extra space on both sides of the course. Coaching zones should be located on major uphills and following course segments such as sharp corners or downhills where competitors might break their equipment.

Touristic courses

A broad group of users should be considered when designing venues. Whenever possible, courses and facilities for children and tourists should be included in the design. Competition courses can be modified by creating cut offs to reduce the amount of climbing and technical downhills. Locating skii play areas and tourist trails adjacent to the competitions stadium will allow for universal use of the venue.

Para Competition Integration

To be done.

3. Competition Course General Design Criteria

Requirements

The specific requirements for cross country courses are defined in the cross-country International Competition Rules. In general, the competition course and stadium must:

- Test the skier in a technical, tactical and physical manner
- Provide a degree of difficulty that matches the level of competition
- Be laid out as naturally as possible using the terrain in a balanced manner
- Avoid wind exposed areas
- Be laid out in such a way that impact on nature and the environment is minimized
- Provide reasonable transitions between the varying techniques of the skier
- Remain safe in marginal snow or icy conditions
- Have a distribution of the terrain of approximately 1/3 uphills, 1/3 downhills and 1/3 undulating terrain
- Include space in and adjacent to the stadium for start/finish zones, mix zone, team preparation area, warm-up and ski testing

Classification of Terrain

Basic terrain classification definitions are included in the cross-country International Competition Rules. The following are some further elaborations of these principles.

Partial Total Climb (PTC)

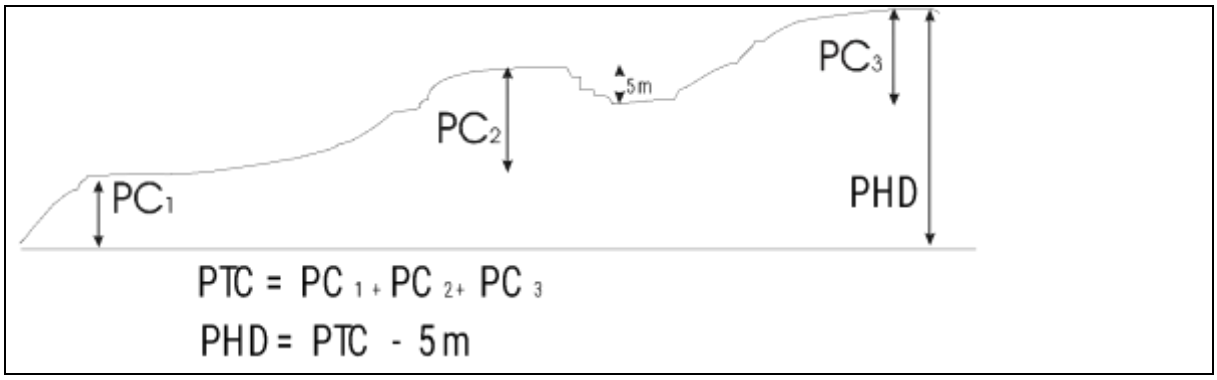
PTC (Partial Total Climb) is the sum of all partial climb segments of a climb that make up an A or B climb that has some varied gradients or short downhill breaks (see figure below where PTC = PC1 + PC2 + PC3).

If an A or B uphill has no downhill parts then the PTC = PHD.

PTC is used to calculate the Maximum Climb and Total Climb.

Partial Height Difference (PHD)

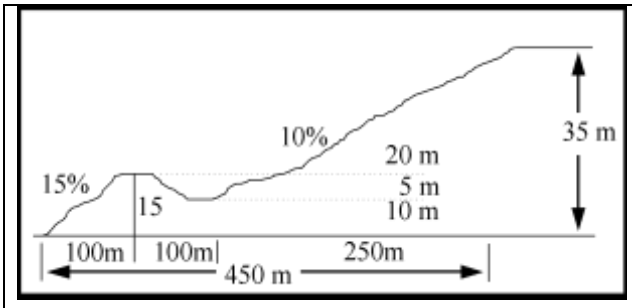
PHD is used to calculate the average gradient of the climb (PHD x 100/distance)



A-Climb

An A-climb is a segment of a course that has a PTC equal to or greater than 30 m. The average gradient must be between 6 and 14%. They typically include short segments that have gradients less than 9%, including negative gradients (downslopes). They may include C-climbs.

The following is a **good** example of a major climb. The main climbing segments (9-18% gradients) are interrupted by some undulating terrain, including a small (5m PHD) segment of downslope gradient:



Specific climb gradient = 15% & 10%

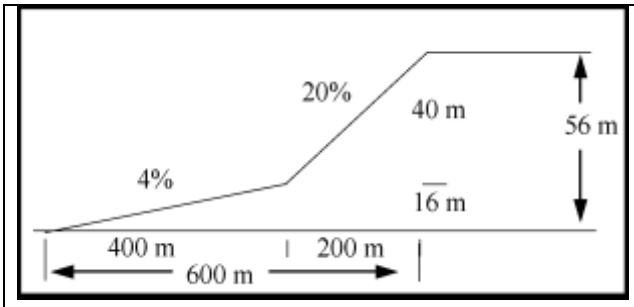
<u>Average gradient</u> of climb = 7,8%

Overall HD of climb = 35m

Added to TC from this climb = 40m.

(15 + 25m)

This following is a **poor** example of a major climb. Even though the average gradient of this segment is within the defined range of 6 - 14%, the uphill segment gradients of 4% and 20% are outside the defined range of 9-18 %:



Specific climb gradient = 4% & 20%

<u>Average gradient</u> of climb = 9.3%

Overall HD of climb = 56m

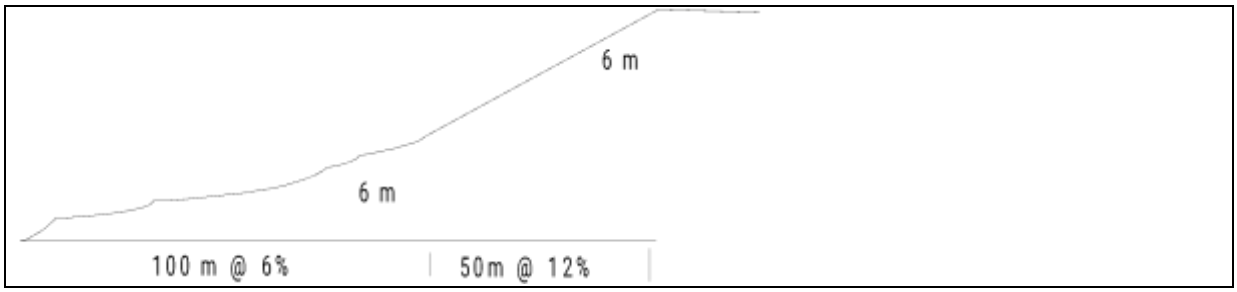
Added to TC from this climb = 56m (16 + 40m)

B- Climb

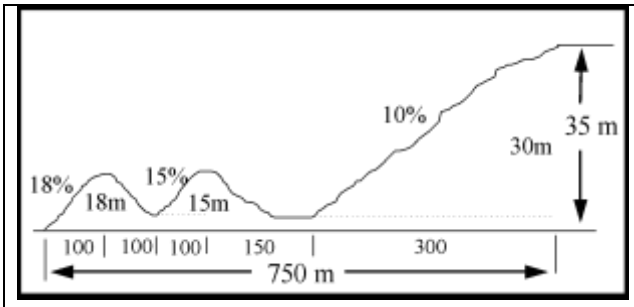
A B-climb is a segment of a course that has a PTC between 10 and 29 m. The average gradient must be between 6 and 14%. They may include short segments that have gradients less than 9%, including negative gradients (downslopes). They may include C-climbs.

The following is an example of a piece of terrain that would be classified as a B-climb.

The PHD is 12 m, it includes segments ≥ 9%, and the average gradient is 8%:



The following example would be classified as three separate climbs, two individual B-climbs and one A-climb.:



Specific climb gradient = 18%, 15% and 10%

Average gradient of climb = 4.6%

Overall HD of climb = 35m

Added to TC from this climb = 63m (18 + 15 + 30m)

Undulating Terrain as part of a climbs

Undulating terrain should normally be part of an A Climb and can be part of a B Climb.

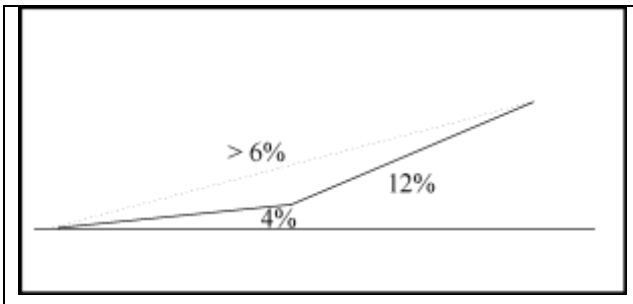
The inclusion of undulating sections within a major climb is based on their location and length. If an undulating section is included as part of a climb it counts as part of the uphills in the overall calculation of the terrain distribution.

When undulating sections occur in the middle of the climb it is a simple situation. If they are less than 150 m in length or include a downhill of less than 10 m HD, the climb is not broken and the overall HD is used to determine the climb's average gradient.

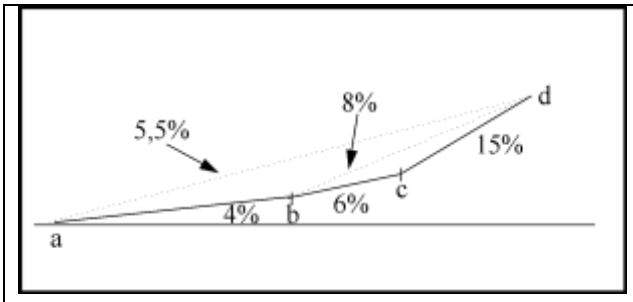
When the Undulating Terrain occurs at the beginning or end of the climb, then the decision to include them will depend on three basic principles:

a) if the average gradient is between 6% - 14% when the segment in question is included
b) sections of uniform gradient must either be completely included or excluded
c) the included segment adds sufficient physical demand to the skier.

Examples:



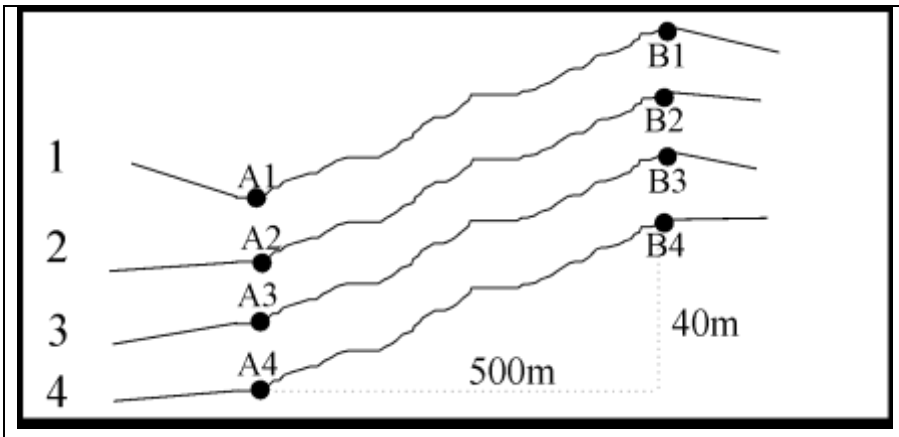
Normally included, providing the 4% section is not excessively long.



The A-climb is from B to D only. The HD from A to B is not included as part of this major climb. AB is an undulating part of the course, and the TC from this section is added to the TC of the course.

Effects of Surrounding Terrain on the Uphill

For course designers it must be appreciated that the following 4 examples represent sections that get progressively more difficult for the skier to ski, yet our classification system would rate them all with average gradient of 8% with HD of 40m from A to B.



In each of these examples, the segment from A to B would all be classified as an A climb.. The nature of terrain before and after the climb can add substantial physical demand without affecting the definition of the climb itself. Even though the specifications are the same for all of the above examples it should be recognized that example no. 4 is much more demanding to ski than the others because of the characteristics of the terrain before and after the uphill section.

Distribution of Climbs

There are many factors that can contribute to the test of the competitor's ability. In designing a course, the possibilities for various types of climbs should be emphasised. A good course should include major and short climbs and a variety of lengths and gradients.

The location of the major climbs along the course is as critical as their total climb or elevation values, and together these factors determine the flow and balance of technique as well as where and when the maximum physical demands are placed on the skier. The location of the major climbs should be spread out along the course, and the course should optimally start with a smaller climb. The most critical climb is towards the end of the course, where decisive action can play out among the competitors. The locations of the climbs will however in many cases be given by the natural terrain and the need to minimize the environmental impact.

The location of major climbs in the terrain is also a primary influence on where the stadium should be placed so that there is good access to the best terrain at appropriate distances along the course. If possible, the ideal solution is to place the stadium close to the middle between the highest and lowest point. The reason for this is that it gives flexibility for course design.

Theoretical Climb Distribution		
Nominal Course Length	A Climbs	B Climbs

Sprint Classic		2
2.5 km	0-1	1-3
3.3 km	0-1	2-3
3.75 km	1	3-4
4 km	1	3-4
5 km	1-2	3-5

A-climbs should represent 20% - 55% of the Total Climb (courses 3.3 km and longer)

B-Climbs should represent 20% – 55% of the Total Climb

Design of downhills

Safety together with technical and tactical challenges for the skier should be taken into consideration when a downhill is designed. A good cross-country competition course includes various kinds of downhills, long and short, steep and slowly falling terrain.

Design of downhill sections must take the following into consideration:

- Downhills should be laid out so that they provide technical challenges to the athletes, and avoid opportunities for drafting (e.g. very long and straight downhills)
- Consideration for the athletes' safety is very important, so corners must be sweeping and with a constant radius, especially at the bottom of downhills. There are formulas developed for how to design downhill corners based on the skier's estimated speed and the radius of the curve (see below)
- High speed downhills must be wide enough such that skiers can get around other skiers in case of a crash
- Dangerous areas adjacent to the course must be fenced or protected (steep banks and ditches, trees, rocks)
- Avoid sections that create compressions such as a high speed downhill followed by an immediate steep uphill
- Avoid high speed "blind corners" where skiers cannot see the bottom of the hill or around the corner etc.

Undulating terrain can be included in a downhill. If those sections include small uphills, the elevation of these uphills also counts to the TC of the course.

In fast downhill curves the need for proper radius and banking must be considered.

The course designer must first consider the relationship between the radius R and the speed V in the curve. The **V^2/R Factor** should be within the maximum values shown in the table below:

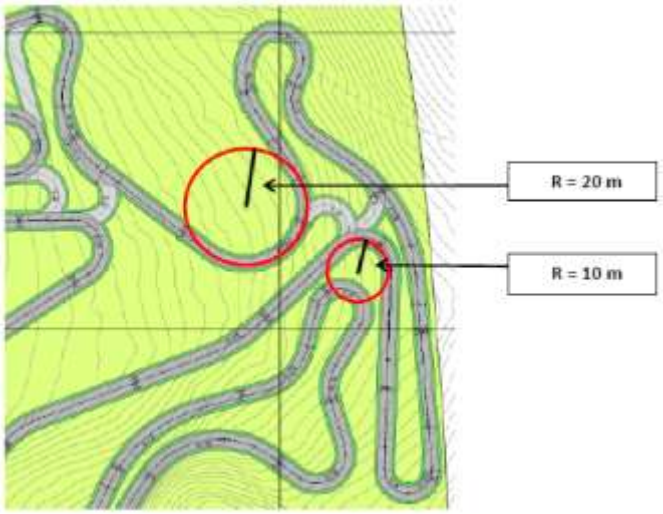
V^2/R Factor	Interval Start	Relay/Pursuit	Team & Individual Sprint	Mass Start / Skiathlon
5	+	+	+	+
10	+	+	+	R
15	+	+	R	-
20	+	R	-	-
25	R	-	-	-

"+" means that the downhill and corner can be used

"-" means that the downhill and corner is not safe

"R" means that the downhill should be reviewed

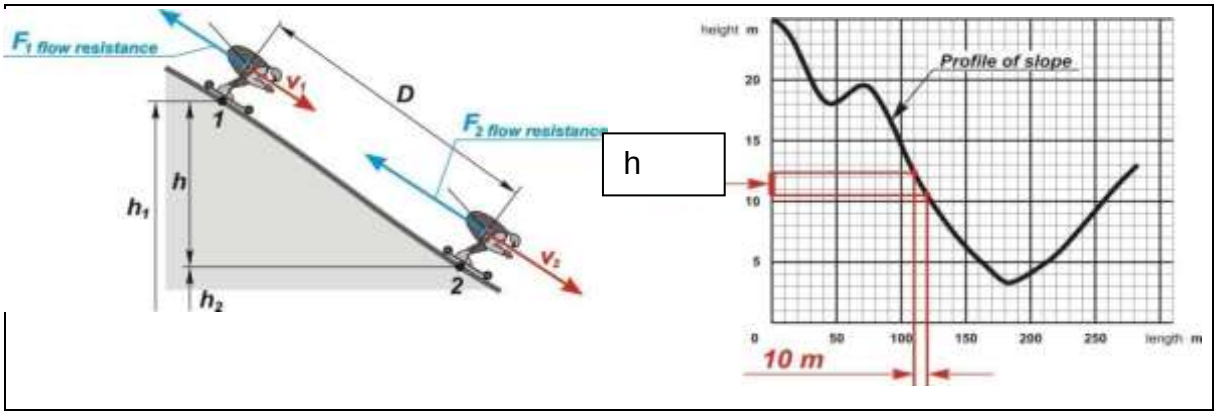
The radius can easily be measured from the course plans (see figure below):



To calculate the theoretical speed is a bit more complicated, but it can be estimated by dividing the downhill into 10 m sections (the detailed profile of the planned course is required) and using the formula:

$$V_2 = \sqrt{0{,}95V_1^2 + 20h - 4}$$

where the variables V_1 and h are as shown on the drawings below.



The speed and speed/radius ratio are then calculated by entering the formula and data into an Excel spreadsheet:

Length	Part-length	HD	PHD	Calculated			
m	m	m	m	speed m/sec	km/hr	V2/R (R=15)	V2/R (R=30)
0				6	21.6	2.4	1.2
10	10	783	-2	8.3	29.8	4.6	2.3
20	10	781	-2	10.0	35.9	6.6	3.3
30	10	779	-2	11.3	40.8	8.6	4.3
40	10	777	-1	11.7	42.2	9.1	4.6
50	10	776	-1	12.1	43.4	9.7	4.9
60	10	775	-1	12.4	44.6	10.2	5.1
70	10	774	0	11.9	42.9	9.5	4.7
80	10	774	0	11.4	41.2	8.7	4.4
90	10	774	-1	11.8	42.6	9.3	4.7
100	10	773	0	11.4	40.9	8.6	4.3
110	10	773	0	10.9	39.2	7.9	4.0
120	10	773	0	10.4	37.5	7.3	3.6
130	10	773	-1	10.9	39.3	8.0	4.0
140	10	772	-1	11.4	40.9	8.6	4.3
150	10	771	-1.5	12.2	43.9	9.9	5.0
160	10	769.5	-1.5	12.9	46.6	11.2	5.6
170	10	768	-2	14.0	50.3	13.0	6.5
180	10	766	-2	14.9	53.6	14.8	7.4
190	10	764	-2	15.7	56.5	16.4	8.2
200	10	762	-1	15.8	56.9	16.7	8.3
210	10	761	-1.5	16.2	58.4	17.6	8.8
220	10	759.5	-1.5	16.6	59.8	18.4	9.2
230	10	758	0	16.1	57.9	17.2	8.6
240	10	758	0	15.5	55.9	16.1	8.1
250	10	758					

=SQRT(0.95*(POWER(E4,2)-20*D5-4))

Course Length & Principles of Multi-lap Competitions

The actual range of the course lengths (up to 5 km) is defined in the International Ski Competition Rules from 95% to 110% of the Nominal Course Length. However, for Nordic Combined and Biathlon courses, where two disciplines (jumping and skiing, or shooting and skiing) are elements of the same competition, the course distances have a more exacting standard. This should be considered when designing a venue that includes those sports.

For competition distances using multiple laps, the course length should be measured from start to start, including lapping sections and excluding sections (finish) not skied during the laps. For horseshoe shaped stadiums, this means normally that the finishing straight is not included in the (one-lap) course length. The entire competition distance is then the length from start and back to start again multiplied by the number of laps plus (+) the length of the finishing straight.

For ski-through stadiums the final loop is normally shorter than the other loops. The calculation will then be the length from start and back to start again multiplied by the number of laps minus (-) the length of the lapping curve.

Ideally, two laps are the maximum number for an interval start competition. This will reduce the amount of passing, minimize interval timing confusion, and provide the best possible video production. A combination of two or more courses can be considered as a single lap provided that the course can be laid out such that there is no confusion to the competitors as to which route to take for continuing on course, lapping, or finishing.

Classical technique considerations

Gradients from 14% – 18% are most suitable for diagonal striding. Course design for classic technique should include segments with at least 6 m PHD at these gradients embedded within the middle to end of the classified climbs. An uphill with these characteristics should be located within 500 m of the Finish.

4. Course Design Consideration for Specific Competition Formats

Interval Start

For competition courses where skiers are mostly skiing one by one, more technical elements (e.g. more curves and transitions) can be designed. An important thing to still consider is that overtaking and passing can take place, for example by including straight uphill sections.

Mass Start

These competition formats are also of great interest for spectators. The course layouted for multi-lap competitions and should provide for a good view of the course from the stadium.

For classical technique competitions, the course should have the capacity to be prepared with a minimum of four classic 4 tracks. The need for turning zones in uphill segments of the course should be minimized.

For free technique competitions, the course width and alignment should be as such that three competitors should be able to ski side by side in all critical parts of the course without interfering with each other.

The start area must be wide and long enough to allow for starting up to 150 athletes at the same time. The slope of the start corridors should be minimized to allow for the competitors to remain still prior to the start.

Congestion points, including sharp transitions from downhills into uphills, narrow sections, and long and steep C-climbs, must be avoided. Narrow sections resulting from a bridge, tunnel, or landform restriction may be included provided that these are not located at a decisive part of the course. Highly technical downhills should not be located before the first significant climb

Approaching the finish, the course layout should focus on allowing for passing. If possible, a climb with PHD of 10 m or greater should be located on the approach to the stadium.

Skiathlon

Skiathlon requires separate courses for mass start classic (C Category) and mass start freestyle (D Category) with a common stadium entrance and exit, or an extra wide course that can accommodate both techniques (E Category). The Skiathlon design principles follow those of the Mass Start.

Special attention must be given in the design of a Skiathlon stadium to the area for equipment exchange. Exchange boxes require 1 - 1.25 m of length per competitor and adequate width for the entry and exit of the boxes.

Val di Fiemme, ITA

Planica, SLO

Individual and Team Sprint

For classical technique competitions, the course should have the capacity to be prepared with a it is required a minimum of four classic 4 tracks and minimizing the need for turning zones in the climbs and undulating terrain.. For free technique, the course width and alignment should be as such that three competitors should be able to ski side by side in all critical parts of the course without interfering with each other.

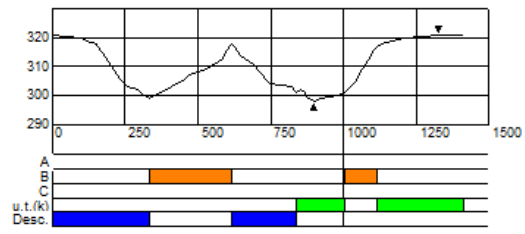
The overall goal when designing a classical technique sprint course is to make sure that the diagonal technique is used, which means hilly enough such that the competitors find it necessary to use the diagonal stride technique or when a reasonable Diagonal Technique Zone can be utilized.

- Include minimum two uphills with gradients of 14 – 18%
- The PHD of one of the uphills should be minimum 15 m (preferably the last one)
- The PHD of the other uphill should be minimum 10 m
- Both flat and uphill sections should include straight sections that allow for passing. Too many curves on flat parts provide an advantage to those athletes using skating skis in classical technique competitions
- A slight uphill gradient towards the finish should be included
- Downhills with curves where several technical and tactical choices of best line is possible, is also recommended

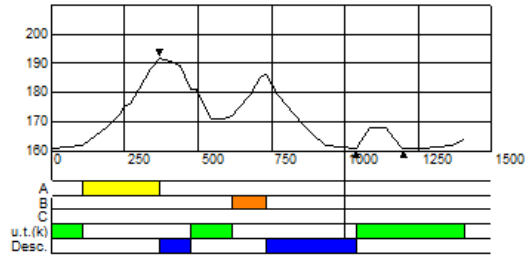
There are no climb requirements for Sprint in free technique. However, it is important to provide significant straight sections that allow for passing and adequate course width for the terrain.

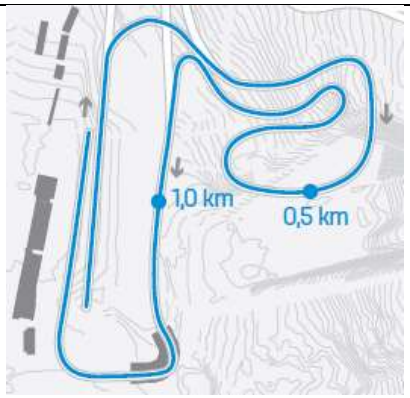
In some situations, the best solution to create a Sprint course with two uphills is to utilize a two-lap course.

Examples of classical technique sprint courses

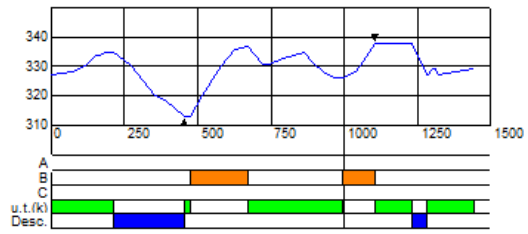


Kuusamo, FIN

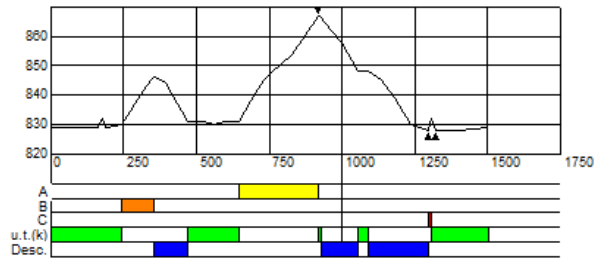


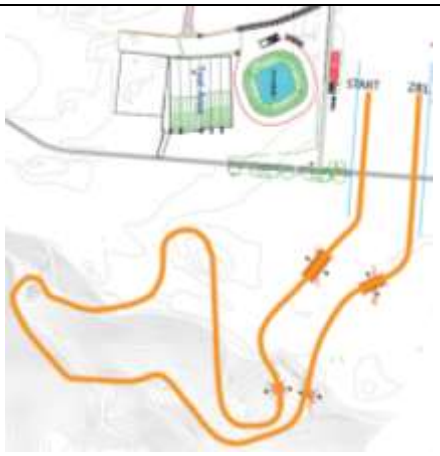


Falun, SWE



Holmenkollen, NOR





Oberstdorf, GER

Relay

Relay competitions are of great interest for spectators, and the course layout should therefore provide for good views of the competition. Generally multiple laps of a 2.5 km or 3.75 km course should be used for relays. If both techniques are used on the same course, the course must be wide enough to accommodate at least two classic tracks plus 6 m for the freestyle legs.

5. Stadium Design

Size, Location and Orientation

. The main objective is to design a stadium such that the athletes and spectators can experience an exciting atmosphere. This means that the stadium should not be larger than absolutely necessary, approximately 50 - 65 m wide and 150 - 200 m long (depending on if it is a horseshoe- or ski-through stadium). A good atmosphere between the competitors and the spectators can then be obtained.

When determining the location of the stadium access for athletes and coaches, officials and volunteers, spectators, media, and video production, must be considered. Space requirements of the user groups and universal accessibility should be considered.

Ideally the stadium should be located within the terrain somewhere in the middle between the highest and lowest point on the course. This would improve the flexibility for course design by permitting access to a greater variety of terrain. Sufficient space must be found adjacent to the stadium in order to provide easy and secure access for the various services for media, team cabins, warm up, wax testing and the start.

Maximizing the benefit of exposure to the sun is important for a successful atmosphere. The stadium should be oriented in such a way that the main spectator area is in the sun, and that the athletes have the sun in their faces as they approach the finish line. For optimal TV exposure and atmosphere, it is usually preferable to have spectators on both sides of the stadium.

Functionality

General

To plan for the highest level of competitions, the access for all categories of people to their designated positions without interfering with each other is of paramount importance. For example, the competitors should be able to reach the following areas without being disturbed by other groups:

- the team preparation area (wax cabins)
- the ski testing area and the warm-up tracks
- equipment control
- the storage for warm-up clothing
- the start
- the through lap or relay exchange (with exit to the mixed zone)
- the finish
- the ski control after the finish line
- the immediate care area (tents for the exchange of clothes, refreshments etc.)
- the exit

Athletes and Teams

The stadium :

- Easy and safe (non-slip) access between wax cabin service area, warm up track and start
- Provide fair start and finish conditions for all of competition format
- Provide good conditions for clothing and feeding services at the start and after the finish.
- Sufficient space for coaches, competition equipment and final warm up
- Good visibility to the scoreboard and video screen
- Adequate space for lapping lane, pit stop for equipment change and relay exchange zone

Video production and Media

To obtain good media conditions the following must be prepared:

- unobstructed camera positions
- Facilities for photographers, writing journalists, radio and TV reporters. The detailed organization of these facilities should be done in cooperation with press people who will function in the start and finish area
- Rooms for press people and press conferences that are close to the start and finish area
- High quality and quantity of electrical power and internet connection
- A parking area for production equipment
- Provide something that gives the stadium its own unique identity (mascot, art installation, etc.)

Mixed Zone

The mixed zone must provide space and working conditions for many groups. The overall size of the mixed zone will depend on the level of the event, where the highest requirements are for the World Championship and the Olympic Games.

Space for the following groups must be considered:

- TV Host broadcaster
- TV Rights holders
- Radio
- Electronic network gathering (ENG) crew
- Photographers
- Writing press
- Ski racing/industry supplier (SRS) representatives
- Doping control personnel
- Ski patrol/medical (when needed)

Planning solutions for all of these different needs, while keeping the athletes as a primary focus, requires active input from all groups working in the stadium. Looking at previous models from other successful organizers is a very important first step.

Examples of mixed zones are included in Section 7 of this manual.

6. Additional Competition Infrastructure

Waxing cabins

Waxing cabins have to be located so that the access to the Start/Finish area is unobstructed, safe (non-slip) and separated from spectators and media. The cabins can be in halls, tents, trailers or permanent buildings. For high-level events, each participating team and FIS equipment supplier should have their own cabin that can be locked in order to store the material under safe conditions. The size of the cabins (or space) should as a minimum be in accordance with event rules

In the cabins the installations should include:

- Several electric outlets
- Adequate heating and ventilation
- Shelves
- Waste bins
- Security installations
- For wax trucks, special power is required, and flat parking area is required, and the venue owner must be aware of this
- In addition to waxing cabins, separated changing rooms for women and men should be provided. In this area also enough toilets must be installed.


Wax cabins Sochi 2014

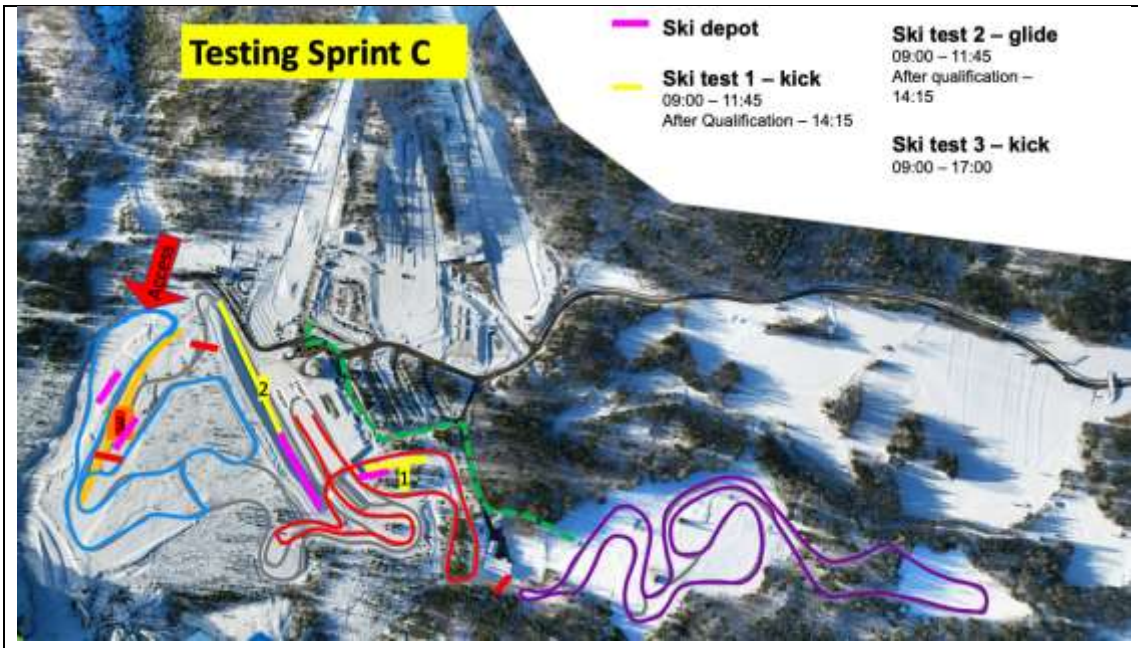
Ski test area and ski depot

Planning of ski test areas is very important. The testing areas should have a hill that can accommodate uphill testing of grip wax and a long glide out from a medium high speed. Course designersshould look for suitable areas along the course where extra width can easily be added. If the course is wide enough, ski testing can take place on a separate lane (marked with V-boards or fences) adjacent to the competition lane as long as it does not interfere with the warm-up, competition or video production.

If two or more totally different snow conditions can be expected on the same course, multiple test areas along the course should be designed.

It is also desirable to identify a testing area in the vicinity of the wax cabins that can be used during periods when the competition course is closed.

In the process of using the ski test areas along the course, the teams also need an area to stage the test skis. Therefore, a ski depot area should be planned adjacent to the testing areas where the wax technicians can store the large number of different test skis without interfering with the flow of training athletes.



Planica, SLO

Warm up and training courses

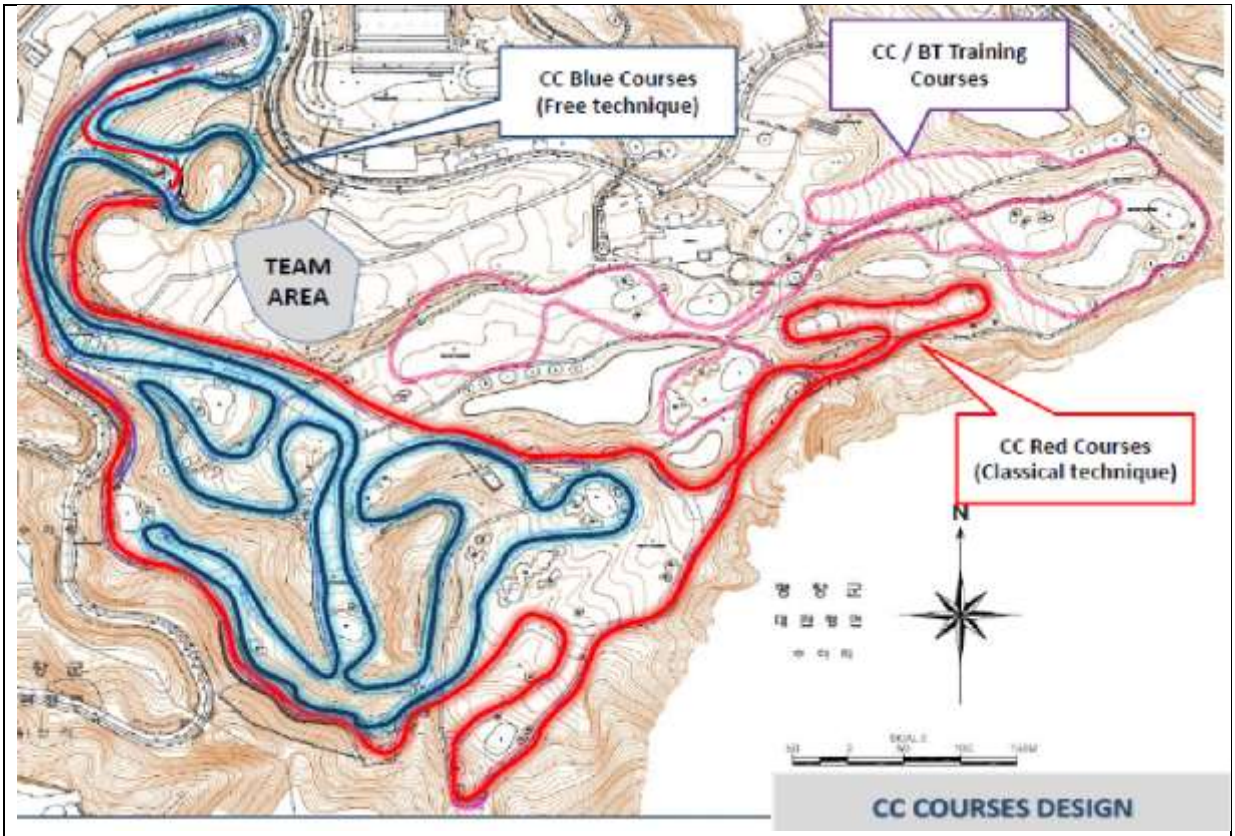
The need for a separate warm up and training course is mostly related to the competition formats individual start and relay. In these two formats competing athletes are on the competition course while athletes who have not started need a separate warming up course. For mass-start competitions the skiers can often warm up on the competition course.

The warm up courses should be designed in a way that provides use of all cross-country skiing techniques. Since many skiers are expected to be on this course at the same time, safety precautions should be considered. Blind corners, steep downhills and narrow passages should be avoided. The length of warm up courses should be approximately 1 km. This course can also be the course that provides access from the wax test area to the competition courses.

Unused parts of the competition courses can be used for warm up purposes. Individual start formats in classical technique do normally not require the whole course width. Therefore, half of the width can be used for competing athletes while the other half can be used for athletes warming up.

If a warm up course is used in both directions the course should be 10 m wide. The warm up course should provide for the same snow conditions as the competition courses, and special consideration should therefore be

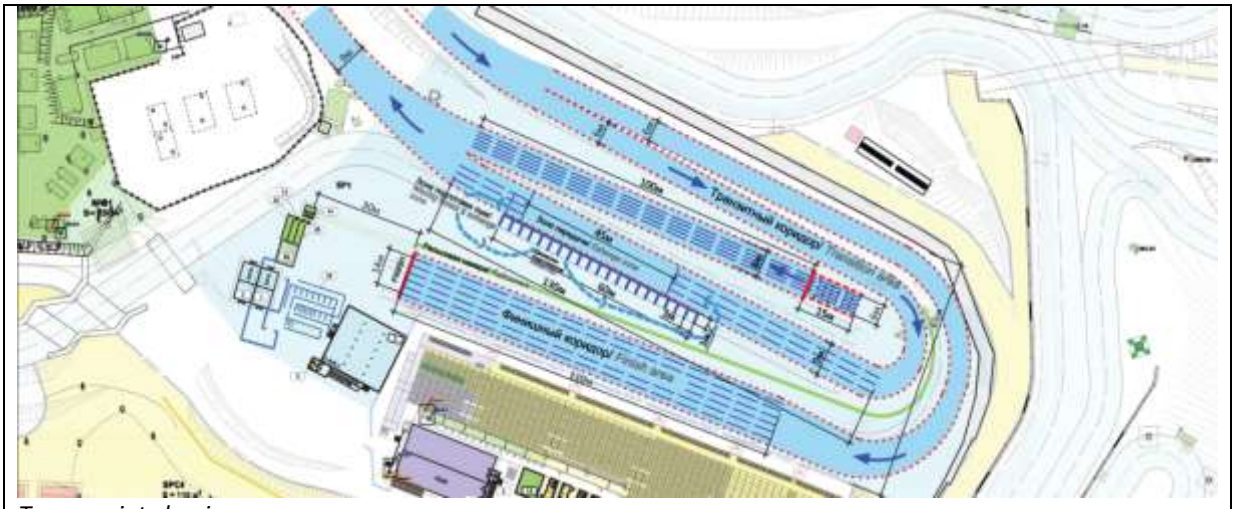
paid to the sun exposure. It has to be noted that for mass start competitions, where there is time for it, the warm up for the athletes can take place on the competition course.



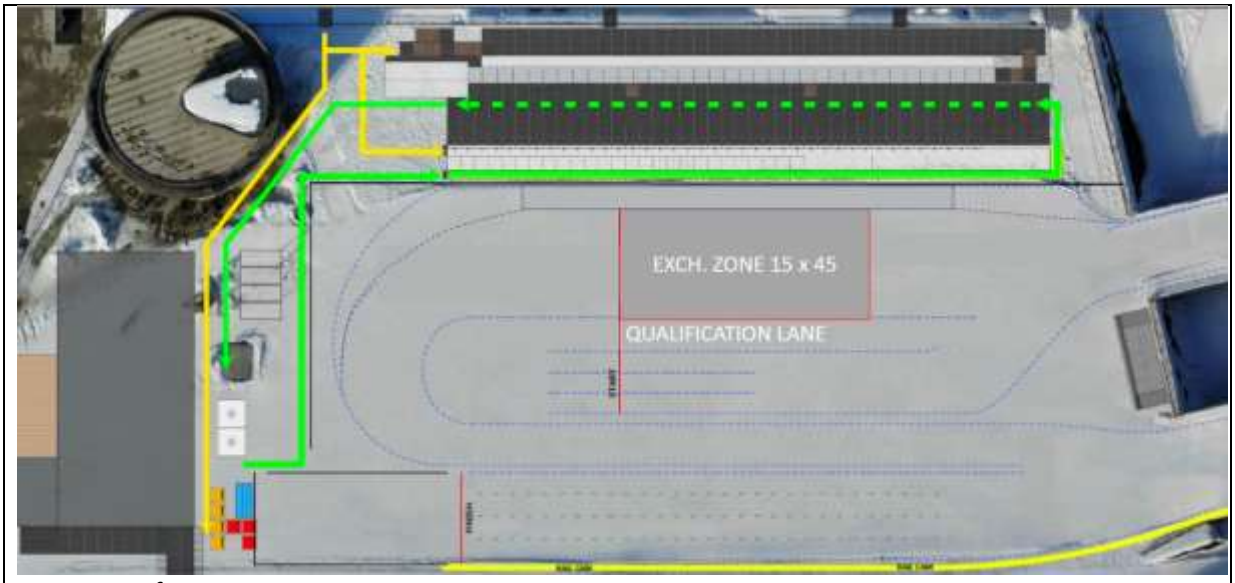
Venue showing competition courses and warm-up and training courses (KOR)

Examples of Stadium Configurations

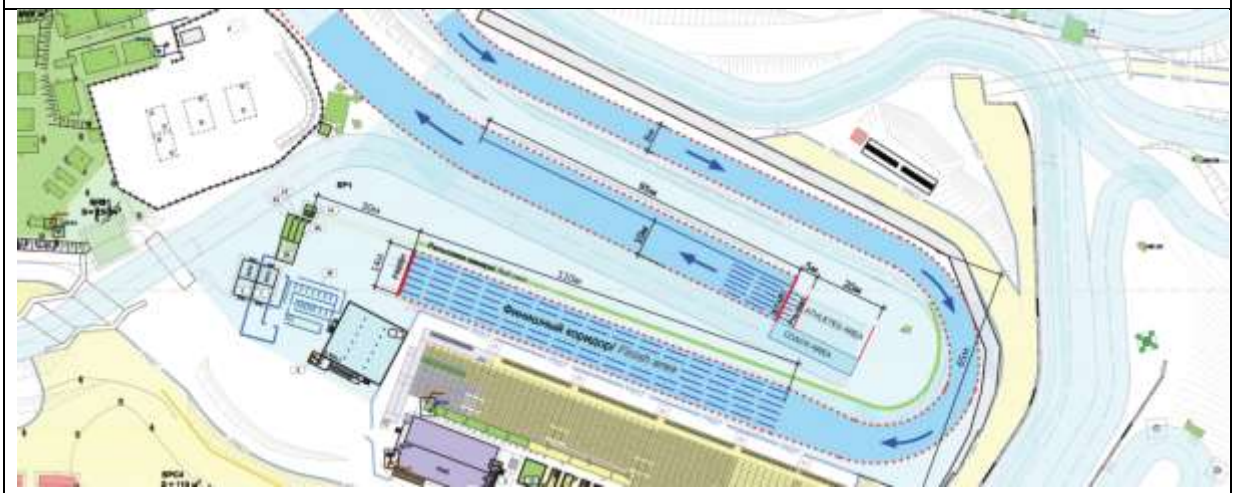
The pictures below (from Sochi OWG and Planica WSC) show stadium layouts for different competition formats.



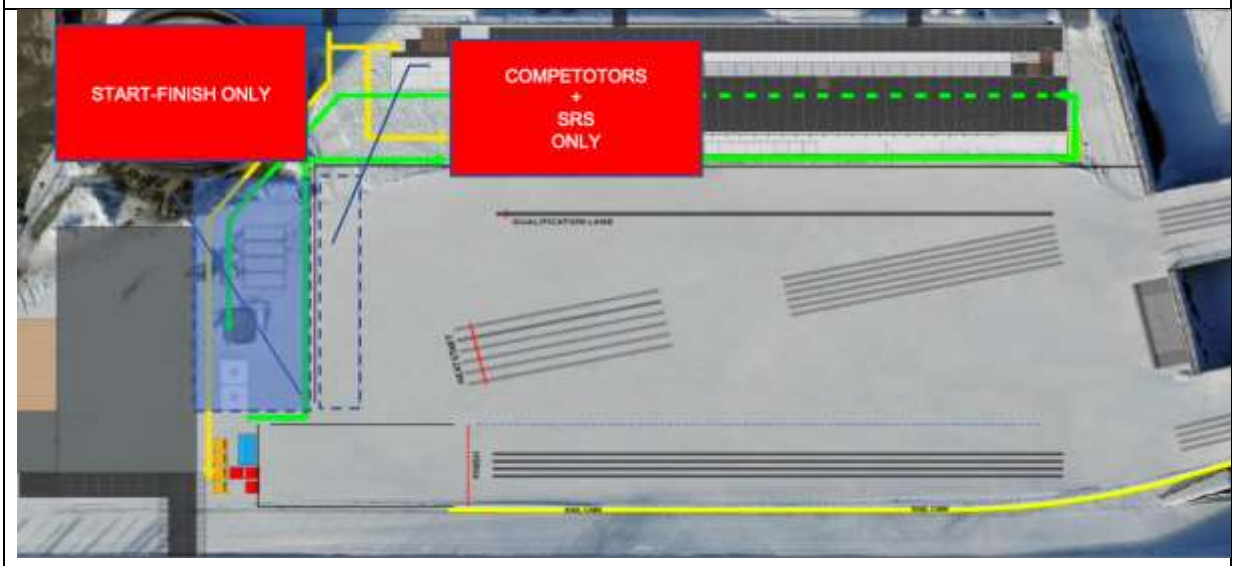
Team sprint classic



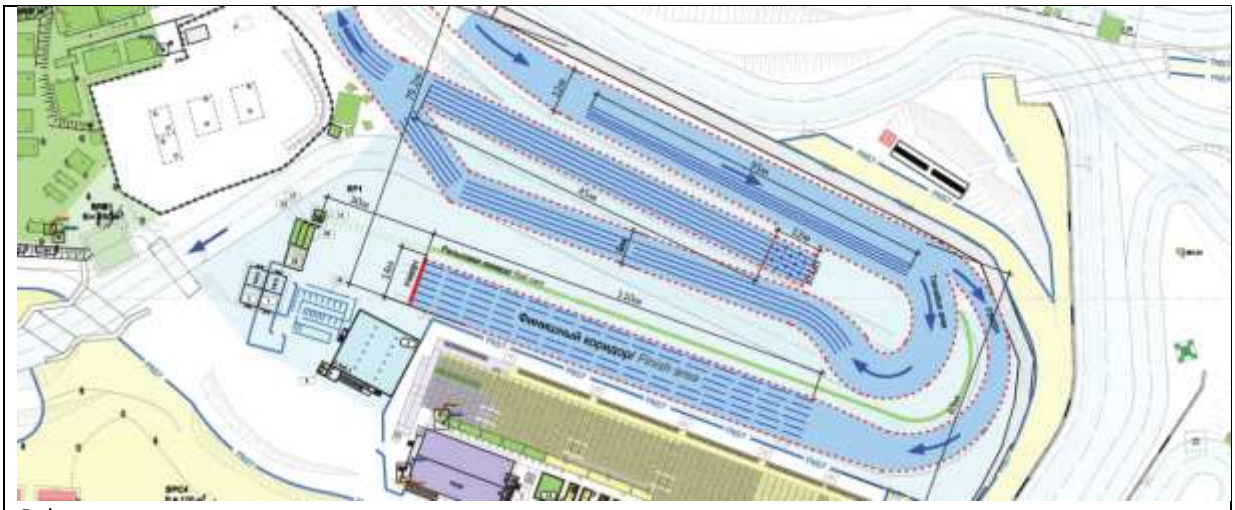
Team sprint free



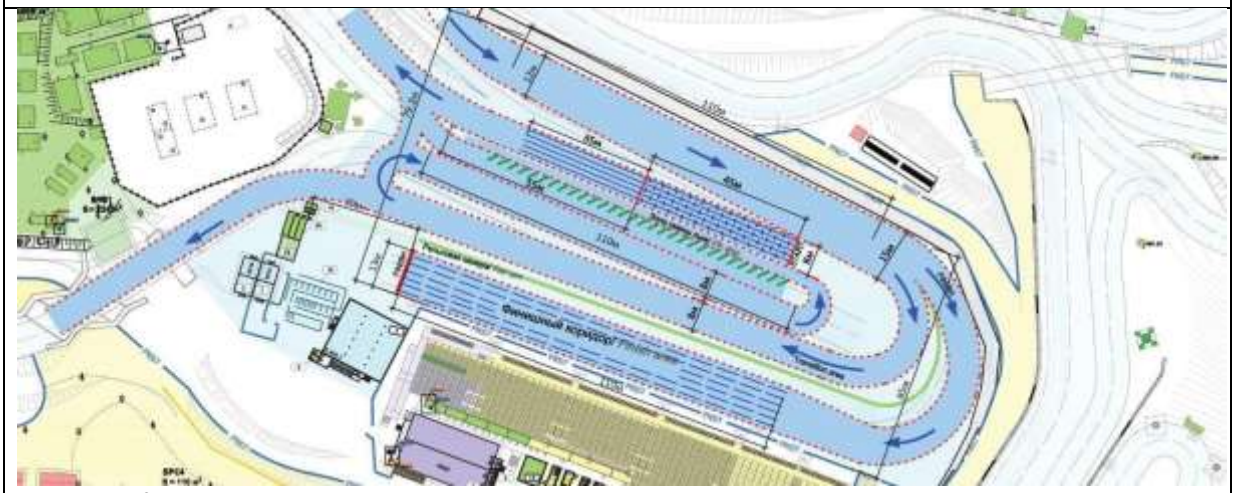
Sprint free



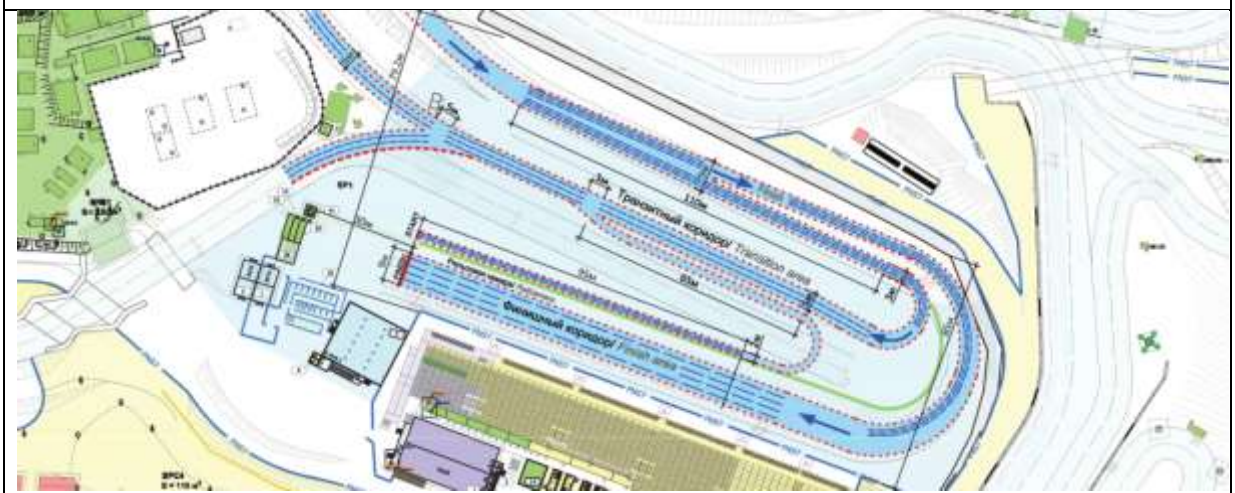
Sprint classic



Relay



Mass start free

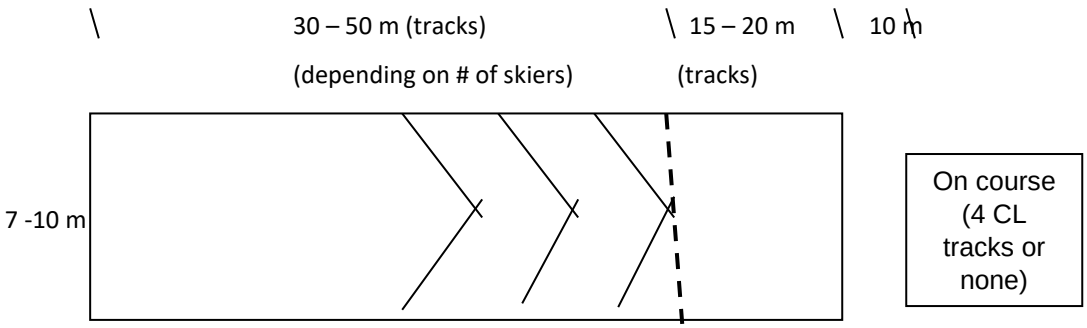


Interval start classic

Overview of skiathlon stadium setup (Falun, SWE)

Mass-start grid

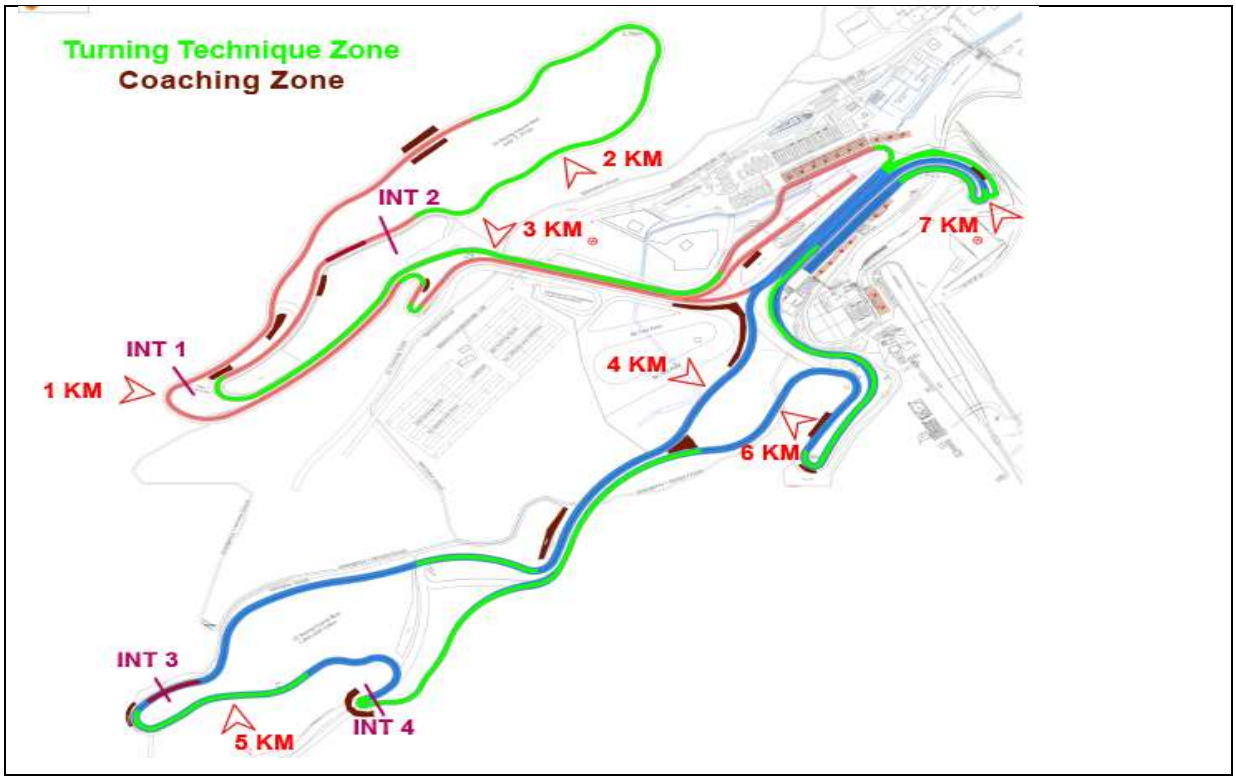
The following shows space requirements for a mass start (WC, WSC, OWG and JWSC):



For competitions in Classical technique the 5 or 7 start tracks should transition into 4 tracks on the course. The start tracks should be set 1.2 – 1.5 meters apart. For competitions in free technique the same 5 or 7 classical start tracks should transition into the free technique course.

Crossing of courses in the stadium

It is in general not advised to have courses where the skiers must cross each other's path during the competition. However, to avoid costly bridges this is sometimes possible in straight sections with good views – for example inside stadiums. Below (see next page) is an example of the Seefeld stadium where a crossing was possible during the long-distance competitions.

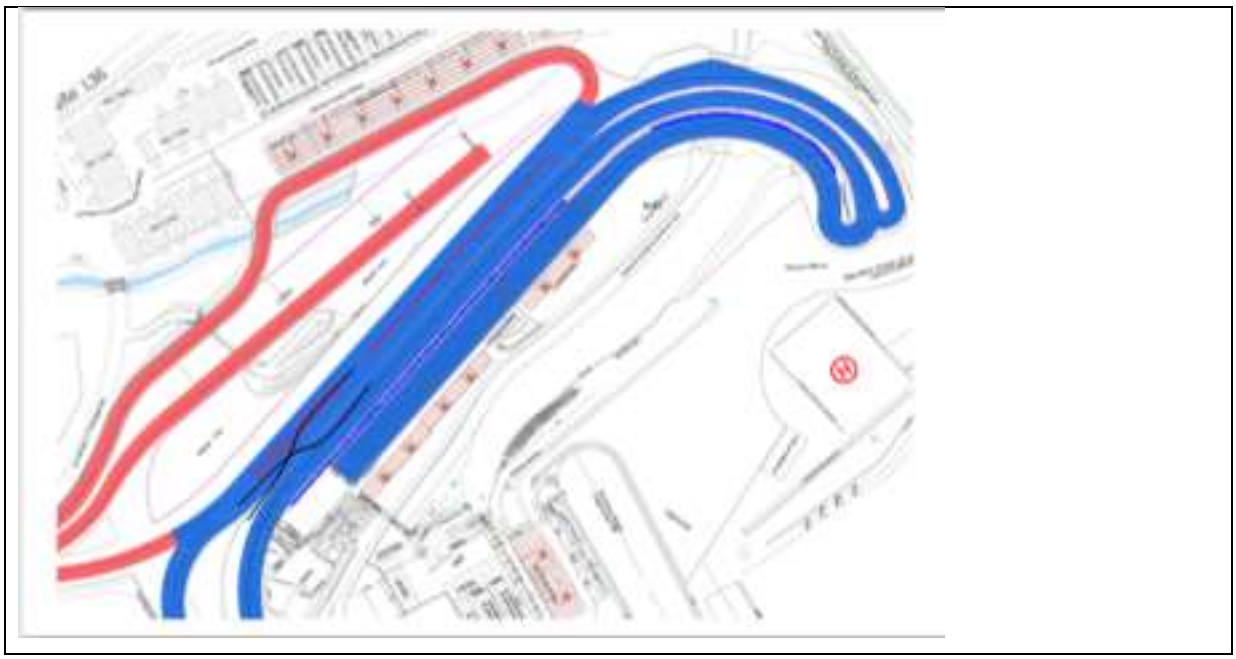


Situation:

Skiers could come from the red course and go over to the blue course while at the same time skiers could come from the blue course and go over to the red course for the second loop. It could happen that interference could take place since no bridge was built.

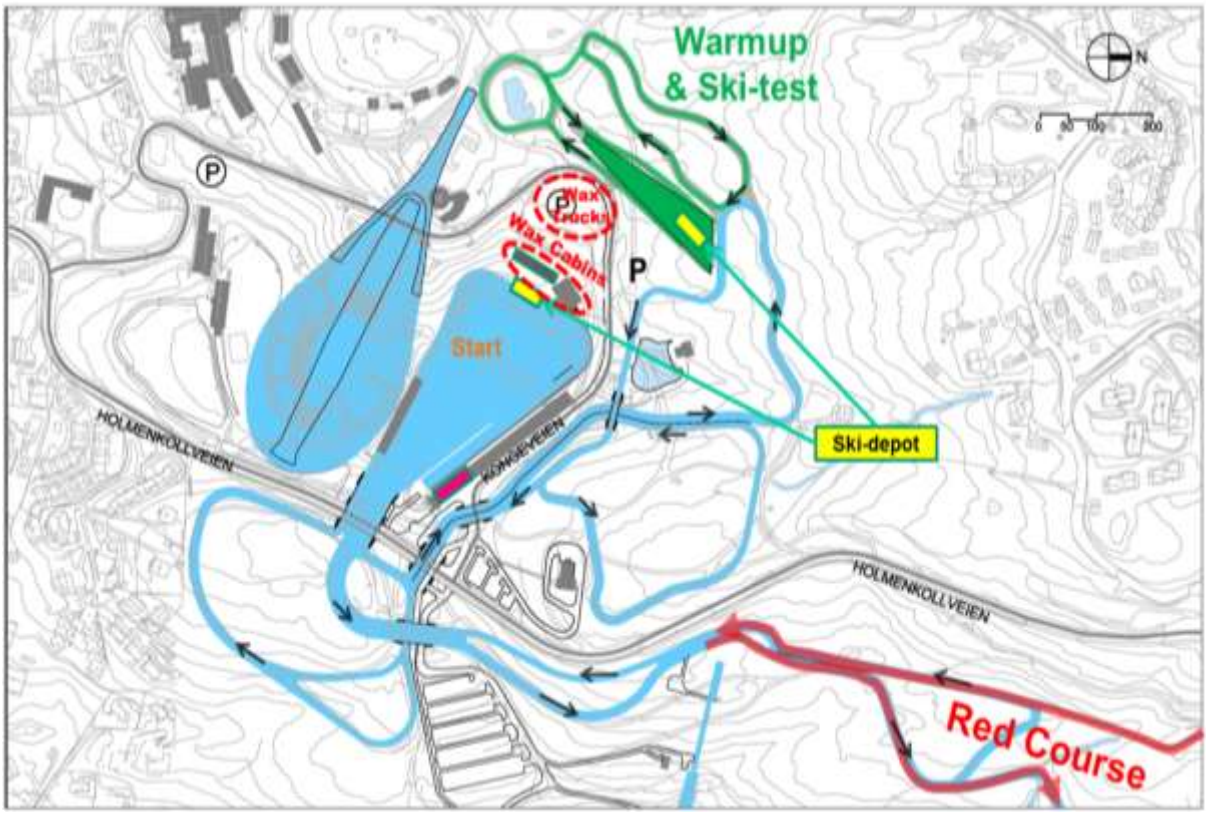
Solution: A 50 m long zone was introduced where the two courses were parallel, see the 2 red lines on the stadium drawing, where the crossing should take place. For the crossing see the 2 black lines.

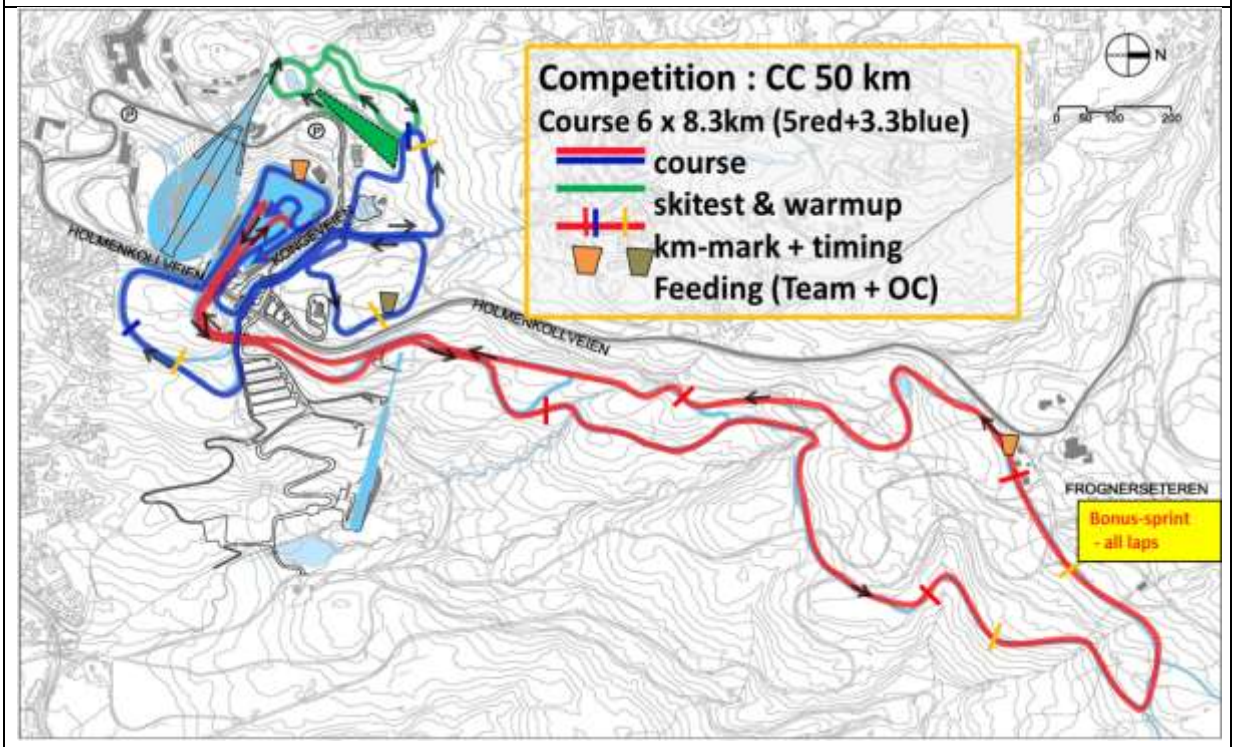
The WSC organizer saved money, and a bridge in the middle of the stadium would have been considered as a disturbance.



7. Venue Design

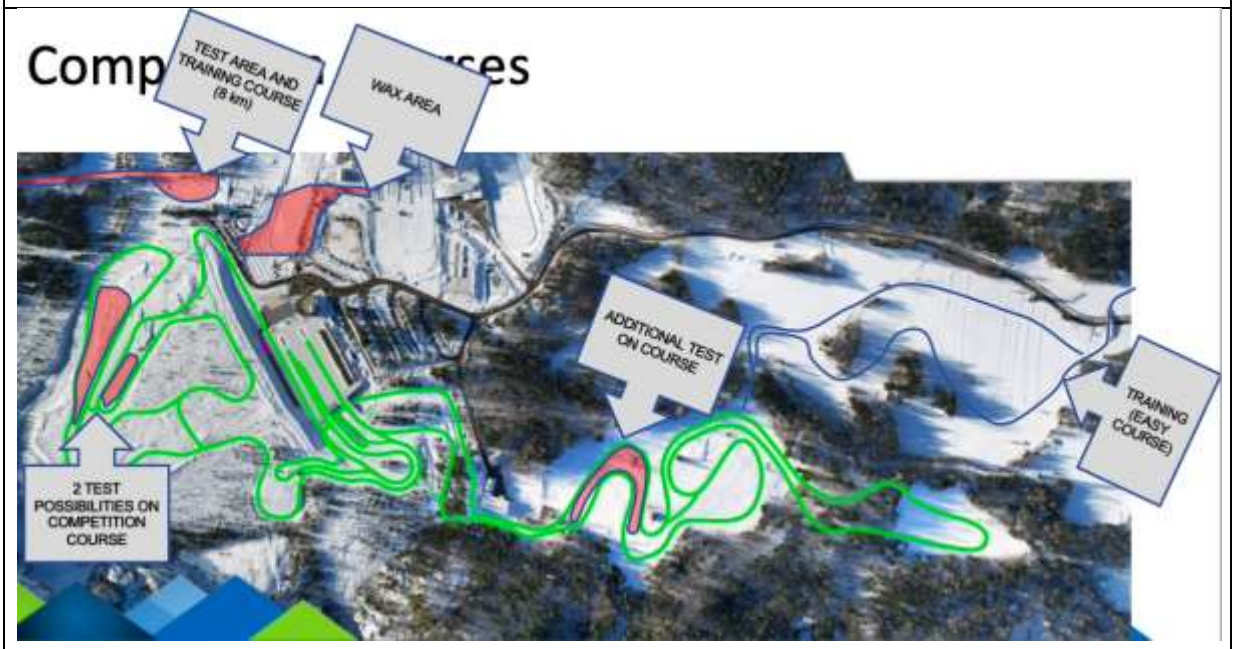
Venue layouts and other examples



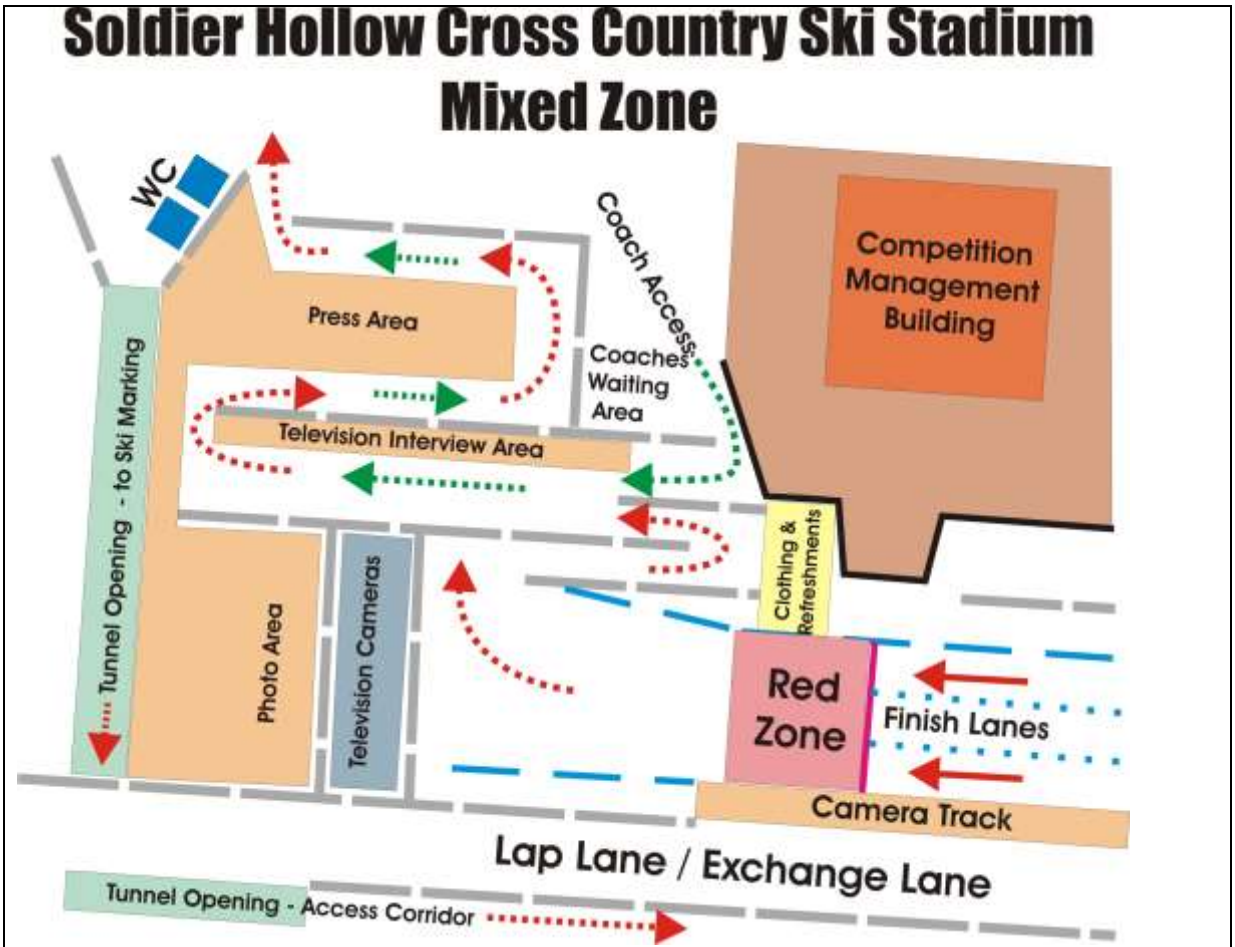


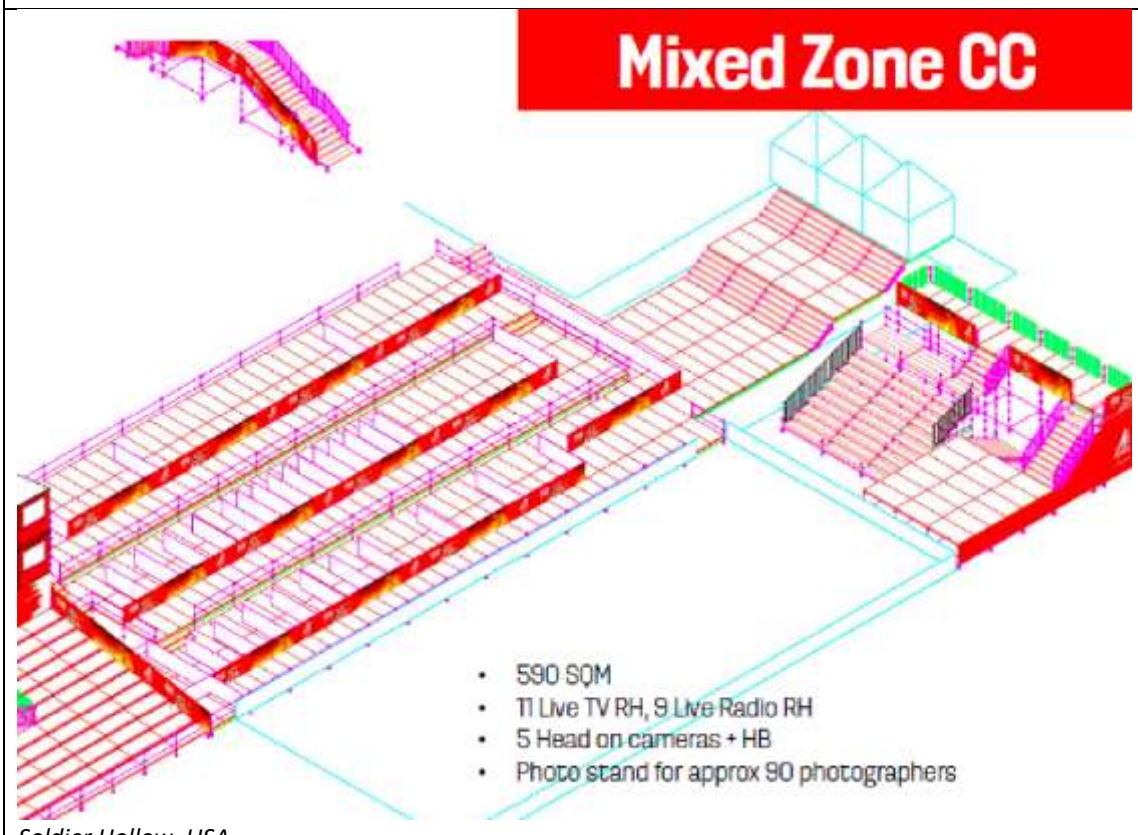
Holmenkollen, NOR


PLANICA
FIS NORDIC WORLD SKI CHAMPIONSHIPS
2023
PARKING OVERVIEW
PLANICA
KRANJSKA GORA - PLANICA.....6,5 km
PODKOREN - PLANICA.....5 km
RATEČE - PLANICA.....1,6 km
P2 SRS-CC
P1 TVC1
P3 TEAM1
P4 TVC2
P7 VIP
P6 TVC3
P8 TEAM3
P5 TEAM 2
P9 LOC 1
P11 LOC2
P10 HOTEL

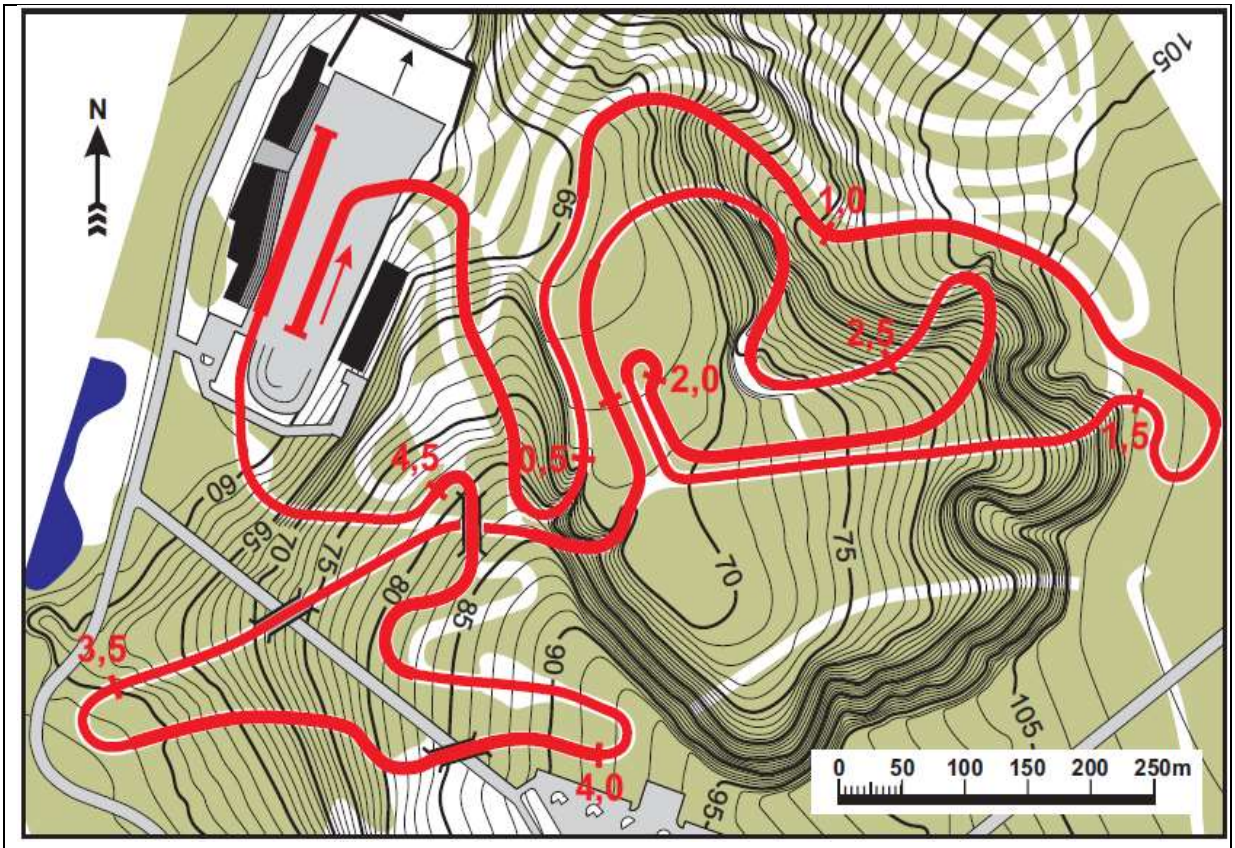

TEST AREA AND TRAINING COURSE (8 km)
WAX AREA
ADDITIONAL TEST ON COURSE
TRAINING (EASY COURSE)
2 TEST POSSIBILITIES ON COMPETITION COURSE

Planica, SLO





Soldier Hollow, USA



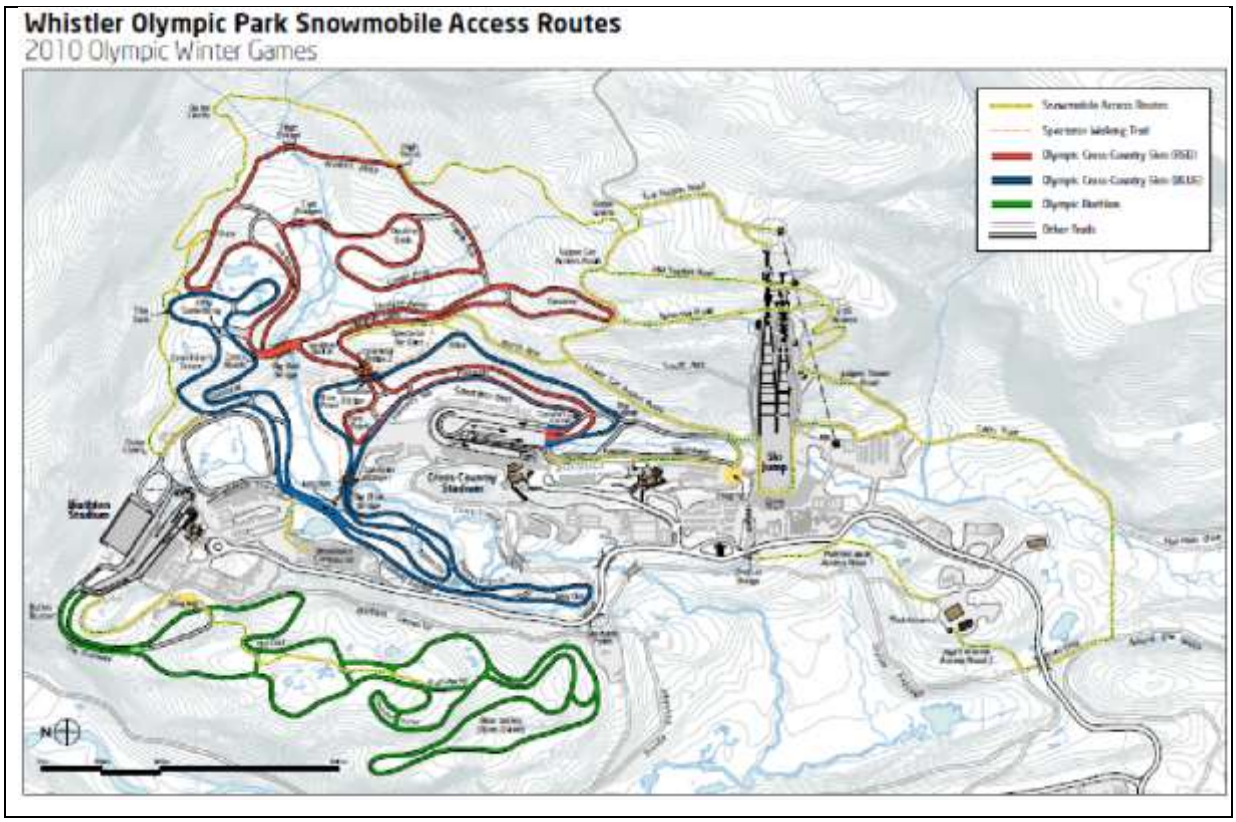
Detailed course plans with clear contour lines (Tyumen, RUS)

Course plans on top of satellite photos (PyeongChang, KOR)

Access Paths

Supporting personnel and their equipment need to be transported to their positions the day of the competitions without damaging the groomed competition courses. These people include medical responders, competition officials, video production and branding teams. Venue design should include creating paths to keep this activity off the competition course as much as possible. They can be narrow trails through uneven terrain but must be constructed such that a snowmobile with a passenger and/or a trailer can travel safely.

For major events, these paths can be quite elaborate. Below is an example from the 2010 Olympic Games (the yellow line marks snowmobile paths).



Appendix 1

Basic venue design procedure

For new venues, Course designer's involvement and work normally consists of the following steps:

Step 1: Conducting a brief survey of the terrain to get an impression of the area

- Course map provided (by the OC) with scale 1:5000 with 1 or 2 m contour lines (5 m is also acceptable).
- Old courses to be visible on the maps
- Plan of stadium provided (by the OC) with scale 1:500

Step 2: Together with the venue owner, the NSA or the OC requesting the homologation, defining the initial sport masterplan that includes the following elements:

- Courses (with approximate distances)
- Stadium with location of buildings
- Access roads or paths
- Parking areas with location of waxing cabins/trailers
- TV compound
- Ski test and ski depot areas, and warm up course

Depending on the requirements for this initial plan, the venue owner/OC may need to bring in a mapping resource/expert.

Step 3: Providing input to the design and construction team (engineering company or OC) on the collection of preliminary course data and production of the following information:

- Professional stadium and course maps
- Exact measurements of the course alignments (length and elevation, width specifications for the different course sections)
- Extract profile data for courses (normally in Excel format)
- Data points with distance and elevation at start and at every 20 m throughout the whole loop for each course (alternatively data at every point where the gradient changes)

Step 4: Verify that the preliminary elevation data meets the the FIS ICR requirements.

Step 5: For World Cup or OWG/Championship courses, the course designer should involve a TV expert

Step 6: After agreeing on the course layout, the venue owner, OC or respective organization must start the legal and regulatory process. The legal process often consists of:

- Agreement with landowners (private or publicly owned land)
- Confirmation from local, regional and national authorities
- Identification of restricted areas - for example regional park status
- Surveys likely to be concluded are:
- Area zoning review
- Environmental review
- Biological review
- Archeological/cultural review
- Special considerations – for example if native people have certain rights or requirements

Step 7: When the paper-plans are confirmed, a detailed assessment of the terrain must be done:

- The organizer takes part and if necessary, invites local authorities
- The plan is taken from the paper to the terrain
- Adjustments from the paper-plan are noted (trees etc. are marked)
- Necessary adjustments are made such that the best terrain options are selected:
- Use depressions in the terrain where the snow is normally deeper
- Avoid sun exposure
- Minimize sidecuts
- Consider water drainage

Step 8: Construction phase

- Site inspection visits for review and feedback by the course designer should be made at 50% and 90% of construction project completion

Step 9: When the construction work is completed, the final inspection takes place together with the Homologation Inspector (see below)

- Final measurements are done, and an update of the profile data is completed
- Corrected data must be entered into the homologation program

FIS PARA NORDIC HOMOLOGATION GUIDE

NOVEMBER 2023

INTERNATIONAL
SKI AND SNOWBOARD
FEDERATION

INTERNATIONAL
SKI AND SNOWBOARD
FEDERATION

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Table of Contents

1 General

In general, the philosophy for FIS Cross-Country homologation, and the requirements and recommendations for FIS stadium and course design applies to FIS Para Nordic as well.

Important: Courses for the sit-ski categories cannot follow FIS Cross-Country homologation rules. The categories for A-, B-, C-climbs are different.

However, since certain classes and categories have clear physical limitations, the courses must in general be made easier, with special attention to fast downhill sections, sharp curves, and steep or long up hills. The following sections will describe areas within homologation work that specifically should be considered when designing courses for FIS Para Nordic athletes.

2 Classification

Para Nordic athletes are classified according to the following table:

Category	**Class**	**Region Impairment**	**Main sport equipment and degree of impairment**
Standing	LW2	Impairments in one lower limb (ex. above knee)	Skiing with 2 skis and 2 poles
	LW3	Impairments in both lower limbs	Skiing with 2 skis and 2 poles
	LW4	Impairments in one lower limb (ex. below knee)	Skiing with 2 skis and 2 poles
	LW5/7	Impairment in both upper limbs	Skiing with 2 skis and no poles
	LW6	Impairment in one upper limb	Skiing with 2 skis and 1 pole
	LW8	Impairment in one upper limb (ex. below elbow)	Skiing with 2 skis and 1 pole
	LW9	Impairment in one upper limb and one lower limb	Equipment of choice, but with 2 skis
Sit-ski	LW10, 10.5	Impairments in both lower limbs (no sitting balance)	Using sit-ski
	LW11, 11.5	Impairments in both lower limbs (fair sitting balance)	Using sit-ski
	LW12	Impairments in both lower limbs (good sitting balance)	Using sit-ski
Vision Impaired	B1	Slight to no light perception in either eye	Must ski with a guide Must wear blackout glasses
	B2	Up to visual acuity of 2/60 and/or visual field of less than 5 degrees	May ski with a guide
	B3	Up to visual acuity of 6/60 and/or visual field of less than 20 degrees	May ski with a guide

FIS Para Nordic Event Distances and Recommended Courses

The table below shows the standard event distances that are used at FIS Para Nordic World Cup, FIS Para Nordic World Ski Championships and Paralympic Winter Games.

Courses:	LW 10-12	800m, 2.0km, 2.5km, 3.0km, 5.0km
	LW 2-9 / B1-3	1200m, 2.0km, 2.5km, 3.0km, 4.0/5.0km

3 Cross-Country Skiing

Competition	Class	Gender	Total Distance		Course	Loops
CC Sprint	LW 10-12	men	800 - 1000m	sit ski	400 - 1000m	1 or 2
Qualification (all)	LW 10-12	women	800 - 1000m	sit ski	400 – 1000m	1 or 2
Semifinal B1-3 (best 8)	LW 2-9	men	1200 – 1400m	standing	600 - 1400m	1 or 2
Semifinal LW (best 12)	B1-3	men	1200 - 1400m	standing	600 - 1400m	1 or 2
Final B1-3 (best 4)	LW 2-9	women	1200 - 1400m	standing	600 - 1400m	1 or 2
Final LW (best 6)	B 1-3	women	1200 - 1400m	standing	600 - 1400m	1 or 2
CC 5 km	LW 10-12	men	5.0 km	sit ski	2.5 km	2
	LW 10-12	women	5.0 km	sit ski	2.5 km	2
	LW 2-9	men	5.0 km	standing	2.5 km	2
	B1-3	men	5.0 km	standing	2.5 km	2
	LW 2-9	women	5.0 km	standing	2.5 km	2
	B 1-3	women	5.0 km	standing	2.5 km	2
CC 10 km	LW 10-12	men	10 km	sit ski	2.5 km	4
	LW 10-12	women	10 km	sit ski	2.5 km	4
	LW 2-9	men	10 km	standing	2.5 km	4
	B1-3	men	10 km	standing	2.5 km	4
	LW 2-9	women	10 km	standing	2.5 km	4
	B 1-3	women	10 km	standing	2.5 km	4
CC 20 km	LW 10-12	men	18 - 20 km	sit ski	3.0 – 5.0 km	4 - 6
	LW 10-12	women	18 - 20 km	sit ski	3.0 – 5.0 km	4 - 6
	LW 2-9	men	18 - 20 km	standing	3.0 - 5.0 km	4 - 6
	B1-3	men	18 - 20 km	standing	3.0 - 5.0 km	4 – 6
	LW 2-9	women	18 – 20 km	standing	3.0 – 5.0 km	4 - 6
	B 1-3	Women	18 - 20 km	standing	3.0 - 5.0 km	4 - 6
Relay 2 x 2.5km classic + 2 x 2.5km free	mixed (335%)	classic	5km	sit ski	2.5km	2
		free	5km	standing	2.5km	2
	open (375%)	classic	5km	sit ski	2.5km	2
		free	5km	standing	2.5km	2

4 Biathlon

Competition	Class	Gender	Total Distance		Course	Loops
BT 7.5 km Sprint	LW 10-12	men	7.5 km	sit ski	2.5 km	3
	LW 10-12	women	7.5 km	sit ski	2.5 km	3
Penalty loop	LW 2-9	men	7.5 km	standing	2.5 km	3
sit ski: 100m	B1-3	men	7.5 km	standing	2.5 km	3
standing: 150m	LW 2-9	women	7.5 km	standing	2.5 km	3
2 shootings	B 1-3	women	7.5 km	standing	2.5 km	3

BT Middle	LW 10-12	men	10 km	sit ski	2.0 km	5
	LW 10-12	women	10 km	sit ski	2.0 km	5
Penalty loop	LW 2-9	men	10 km	standing	2.0 km	5
sit ski: 100m	B1-3	men	10 km	standing	2.0 km	5
standing: 150m	LW 2-9	women	10 km	standing	2.0 km	5
4 shootings	B 1-3	women	10 km	standing	2.0 km	5

BT Individual	LW 10-12	men	12.5 km	sit ski	2.5 km	5
	LW 10-12	women	12.5 km	sit ski	2.5 km	5
Penalty	LW 2-9	men	12.5 km	standing	2.5 km	5
1 minute	B1-3	men	12.5 km	standing	2.5 km	5
4 shootings	LW 2-9	women	12.5 km	standing	2.5 km	5
	B 1-3	women	12.5 km	standing	2.5 km	5

BT 10 km Pursuit	LW 10-12	men	10 km	sit ski	2.0 km	5
2 day Pursuit	LW 10-12	women	10 km	sit ski	2.0 km	5
Penalty loop	LW 2-9	men	10 km	standing	2.0 km	5
sit ski: 100m	B1-3	men	10 km	standing	2.0 km	5
standing: 150m	LW 2-9	women	10 km	standing	2.0 km	5
4 shootings	B 1-3	women	10 km	standing	2.0 km	5

BT Sprint Pursuit	LW 10-12	men	2.4 - 3.0 km	sit ski	800 - 1000m	3
Qualification + Final	LW 10-12	women	2.4 - 3.0 km	sit ski	800 - 1000m	3
Penalty loop:	LW 2-9	men	3.6 - 4.2 km	standing	1200 - 1400m	3
75 m	B1-3	men	3.6 - 4.2 km	standing	1200 - 1400m	3
	LW 2-9	women	3.6 - 4.2 km	standing	1200 - 1400m	3
2 shootings	B 1-3	women	3.6 - 4.2 km	standing	1200 - 1400m	3

BT Team Sprint Qualification + Final	LW10-12	Mixed	800 - 1000m	sit ski	800 - 1000m	4
Penalty loop: 75m 4 shootings	LW 2-9 B1-3	Mixed	1200 - 1400m	standing	1200 - 1400m	4

5 Course width categories

Course widths for competition formats should conform with the following table:

Category	Minimum course width			Used for
	Uphills	Undulated terrain	Downhills	
sit ski	3 m	3 m	3 m	Sit ski only (2 tracks) Relay classical technique
sit ski	5 m	5 m	5 m	Sprint, Pursuit (3 tracks)
standing classical	3 m	3 m	3 m	Interval start (2 tracks)
standing classical	5 m	5 m	5 m	Sprint, Pursuit (3 tracks)
standing free	6 m	6 m	6 m	individual, standing only (1 track along the side of the entire course)
standing free	9 m	9 m	6 m	Sprint, Pursuit, standing only (1 track along the side of the entire course)
sit ski + standing classical	3m	3m	3m	Interval Start, Relay (2 tracks)
sit ski + standing classical	5 m	5m	5 m	Pursuit, Sprint (3 tracks)
sit ski + standing free	3m + 6 m	3m + 6m	3m + 6 m	Interval start (2 tracks for sit ski, 1 track for standing)
sit ski + standing free	3m + 9 m	3m + 9m	3m + 9 m	Pursuit, Sprint (2 tracks for sit ski, 1 track for standing)

6 Standing and Vision Impaired categories

In general, the Standing and Vision Impaired categories can ski on courses that are very close to FIS homologation standards. However, design considerations in the following areas should be considered:

- Fast down hills with curves and corners that can be difficult and unsafe for Vision Impaired skiers
- Use of shorter loops such that Vision Impaired skier more easily can become familiar with the course
- Reduction of A-climbs (should be replaced by B-climbs)
- Range for TC should in general be in the low range (for example 150 – 180 m for 5 km)

7 Norms FIS Para Nordic Cross-Country and Biathlon courses

7.1 Norms for LW 2-9 / B1-3 (Standing and Vision Impaired) Cross-Country and Biathlon courses

The HD, TC and MC of the homologated competition courses should be within the following norms:

Course	**TC**	**MC**	**HD**	**Hills**
5.0 km	140 - 180	40	75	0-1 A hill, 4-6 B hills, 0-2 C-hills
4.0 km	100 - 150	40	60	0-1 A hill, 3-5 B hills, 0-1 C-hills
3.0 km	80 - 110	30	50	2-4 B hills, 0-1 C hill
2.5 km	75 - 90	30	50	2-3 B hills, 0-1 C hill
2.0 km	50 - 80	30	50	1-3 B hills, 0-1 C hill
1.4 km	0-60	35		
WC: In case the above-mentioned courses aren't available, the following courses can also be used.				
3.3 km	90 - 130	30	50	3-5 B hills, 0-1 C hill
3.75km	100 - 135	40	50	0-1 A hill, 3-5 B hills, 0-1 C-hills
7.5 km	200 - 250	40	75	0-1 A hill, 6-10 B hills, 0-2 C hills
10 km	250 - 350	40	75	0-1 A hill, 8-12 B hills, 0-2 C hills

7.1.1 A-climbs definitions:
A= Major uphills = PHD > 30 m, gradient 9 - 18 %, normally broken with some short undulating sections less than 200 meters in length or a downhill that does not exceed 10 m, PHD. Normally the maximum PHD should not exceed 80 m. The average gradient of an A climb including undulating terrain sections must be 6-14%.

7.1.2 B-climb definitions:
B = Short uphills 10 m < PHD < 29 m, gradient 9 - 18 %
B-climbs can also permit sections with gradients of less than 9% providing that the B-climb includes some sections with a gradient of 9% and the average gradient is > 6%.

7.1.3 C-climb definitions:
C = Steep uphills 4m < PHD < 10m, gradient > 18%.
Climbs with < 4 m PHD will be included as undulating terrain or as part of an A- or B-climb.

7.1.4 Undulating Terrain (UT): A combination of flat and rolling terrain including short climbs, flat sections and downhills. Terrain with gradient < 9 % and climbs < 10m PHD with gradient ≥ 9% can be included.

7.2 **Norms for LW 10-12** Cross-Country and Biathlon courses.

The HD, TC and MC of the homologated competition courses should be within the following norms:

Course	**TC**	**MC**	**HD**	**Hills**
3.0 km	35-65	15	40	1 – 2 A hills, 2 – 4 B hills
2.5 km	30-60	15	40	0 – 1 A hills, 1 – 3 B hills
2.0 km	25-55	15	40	0 – 1 A hills, 1 – 3 B hills
800 m	0 - 30	15		
WC: In case the above-mentioned courses aren't available, the following courses can also be used.				
5 km	60 - 120	15	50	1 - 2 A hills, 3 – 6 B hills
3.75	45-70	15	40	1 – 2 A hills, 2 – 4 B hills
3.33 km	35-70	15	40	1 – 2 A hills, 1 – 3 B hills

7.2.1 **Courses for the sit-ski category cannot follow FIS Cross-Country homologation rules** due to the fact that sit-skiers have no use of their lower body, and push/pull themselves forward with poles from a sitting position (on their sledge).

The categories for A, B and C hills are therefore:

A-hills 10 – 15 m PHD and gradient between 4 – 12 %
B-hills 4 – 9 m PHD and gradient between 4 – 12 %
C-hills 2 – 4 m PHD distance < 30 m long and gradient > 12 %, **maximum 16 %**
Climbs with < 4m will be included as undulating terrain or as part of an A or B climb.

7.2.2 The following points should also be considered when designing courses for the sit-ski category:

- Sit ski courses should be placed on undulating terrain (not long flat courses) so that skiers have chances to rest. The 1/3 up, 1/3 down, 1/3 UT criteria applies equally to sit ski courses.
- up hills should in general not be steeper than **10 - 12 %** gradient
- A-hills should not be too long (**not over 200 m in length**)
- down hills should have straight run-outs preferably with a slight uphill to break the speed, the hills should not be steeper than 12 – 14 % gradient
- corners and turns should be placed where the speed is slow.
    - Corners on flat part of the course should optimally not be less than 90^{o} angle (larger angle required for downhill corners). This applies in the stadium as well, for example for lapping or into the shooting range. (NOTE: If you as a standing skier are poling without using the legs, the skis should easily follow the track both in curves/bends in flat parts and also in down hills – if we have to "work" with the legs, a sledge will have problems).
    - Banking to inside can help the skier make a sharp or a high-speed turn. Corners must not bank to the outside of the curve. 180^{o} turning platforms at top of climbs must be flat and wide enough for passing.
    - Sit ski turns of 180^{o} can be made at the top of climbs where speed is very low.
    - The minimum radius of a turn in a flat section or downhill section shall be 15m.
- Courses should be long and flowing and should not contain unnecessary sharp technical turns and steep uphills. A too technical course is a disadvantage to LW10/10.5.

- Courses must be flat from side to side through all sections (except on banked on corners)
- Junctions and merging zones require special placement and design and should occur in areas of lower speeds.

8 Stadium layout

In contrast to the newest development of stadiums and course layouts for FIS competitions, it is less important to ski through the stadium often, since most Para Nordic races are interval start races. Since Para Nordic events are divided into 6 categories (3 for men and 3 for women), it is difficult for announcers and spectators to follow the event if several categories are starting, passing through the stadium or finishing at the same time. For competitions with small fields, this situation can however be solved by letting each category finish the race before the next one starts.

A special consideration should be given to the transition and staging area for the sit-ski category. This should be provided with an easy and flat access to start & finish areas, with nearby covered and heated area for transition from wheelchair to sit-ski, as well as storage of wheelchairs out of the weather.

9 Biathlon Range

Since Para Nordic Competitions usually include both disciplines, stadium layout normally requires consideration of both biathlon and cross-country skiing formats. Venues with established biathlon ranges are ideal if the terrain and stadium access is suitable for sit-ski courses and sufficient stadium space exists for cross-country formats. Cross-country skiing stadia may also be used where there is sufficient space to install the 10m Para Biathlon Range and 150m/100m penalty loop. This requires a minimum of 27m x 62m for World Ski Championships and the World Cup range (14 LW / 12 VI lanes) or 27m x 73m for the Paralympic Winter Games range (18 + 12 lanes) ***plus*** space for a 150m penalty loop within 60m after the exit from the range.

10 Contact

Para Nordic Race Director: Georg Zipfel (zipfel@fis-ski.com)
Para Nordic Coordinator: Elke Gundermann (gundermann@fis-ski.com)

Documents regarding the Homologation procedures and requests can be found here:
https://www.fis-ski.com/en/inside-fis/document-library/cross-country-documents

APPENDIX F – Terrain Park Ideas

CROSS COUNTRY BC

Youtube video on how to build a Cross Country Ski Playground:

https://www.youtube.com/watch?v=0EDew_65Lgw

DOUBLE CROSS

The principal objective of a Double Cross activity is to bring together children between the ages of 5-12 to experience the fun and excitement of applying their cross-country skiing skills to challenging terrain in an environment of adventure and intra-group competition.

What is a "Double Cross" Competition?

Since the introduction of skate skiing, higher technology equipment, and new race formats such as sprinting, pursuits and mass starts, cross-country skiing has picked up speed and grown in excitement. At the leading edge of this trend is "Xtreme X-Country", which at a basic level involves learning to ski through jumps and bumps and other features in a 'terrain park' or 'ski playground'. Xtreme X-Country emphasizes basic athlete skills such as balance, agility, strength, and the ability to adapt basic sport skills to an unusual setting. To keep in step with this new dimension of cross-country skiing, CCC has developed the "Double Cross" program which uses a ski playground/terrain park for a competition course.

4.1 Ski Playgrounds and Terrain Parks

4.1.1 Ski Playgrounds

A ski playground is a designated location which has been developed or set up to assist children to learn to ski naturally, and which provides a variety of skiing discoveries.

Figure 4.1 - Terrain Park

The requirements of a ski playground include:

- ❑ varied terrain (both slope and flat terrain);
- ❑ close proximity to a day lodge; and
- ❑ shelter from the wind.

Features or components (not exclusive) that may be incorporated into a ski playground include:

- ❑ a terrain park;
- ❑ an adventure trail;
- ❑ an obstacle course; and
- ❑ animated cartoon characters.

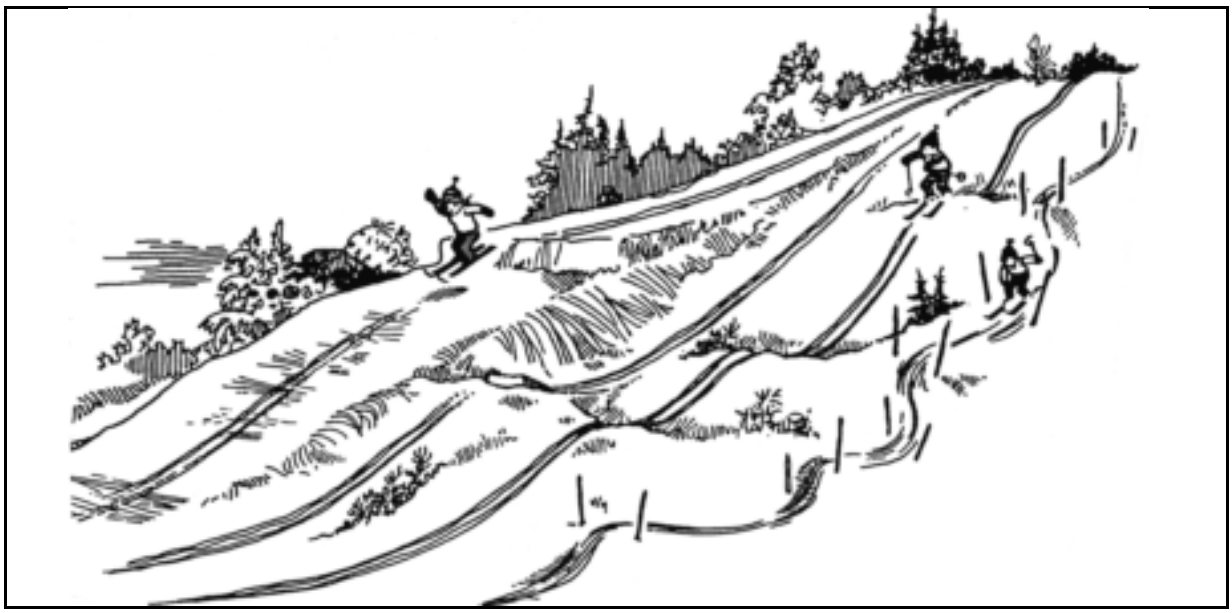
Choosing a Site

A ski playground could be developed almost any place there is snow. Although an established ski area is preferable, a snow-covered school playground, golf course, community park or pasture will also work. The playground requires a relatively large, flat surface with a gentle slope nearby. Shelter and washrooms should also be close by. Once a suitable site has been selected, it should be used for the duration of the program. Young children are comfortable with a familiar site and routine.

Preparing the Site

Ensure appropriate preparation of the snow surface. Young skiers are not ready to face the challenges of hard, icy conditions or deep, wet snow! Plan for one or more coaches to spend one-half to one hour repairing the ski area before each session. Pack and track-set with a snowmobile, and prepare the bicycle dips, etc. with snow scoops and shovels. Each week the site can be altered to provide variety and new challenges. By changing the snow surface in a few places to create corridors, bumps, ditches and so forth, a new dimension can be added to the play area. Use a pair of skis to move around on while manually preparing the terrain features. Being on skis will allow you to test the features and you will be better able to match the size and spacing of bumps to the skill level and size of your skiers. This will have the additional benefit of preventing you from sinking in the newly prepared snow and leaving big footprints.

Figure 4.2 – Terrain Park



Features of a Ski Playground

A ski playground should provide a variety of terrain that will help develop a child's balance and coordination skills. It can include the following features:

- **Cartoon Characters.** Try a different theme every session (e.g. Sesame Street, animals, a trip to the zoo, choo choo trains, Jungle Book, dinosaurs, Ninja Turtles, Disney characters...).

- **Obstacle Course.** Easily obtained materials such as stakes, poles, plastic pipe, course flags and signage can be used to create obstacles. Rolls of two inch diameter ABS plumbing pipe or natural gas pipeline are suitable for making archways. Cartoon characters can be cut out from painted corraplast signboard.

- **Adventure Trails.** This component of a ski playground is a favorite with children. Each trail should have its own theme – e.g. jungle, Peter Pan or Star Trek. Use your imagination and develop adventure trails that are unique to your own ski area.

  Forest trails which have narrow access and plenty of bumps, uphills, downhills, dips and turns throughout make an exciting route. Trees are essential in order to create a closed in "tunnel" effect. Tunnels appeal to a child's sense of adventure. Moreover it is important to choose trails that have a variety of terrain variations because this encourages the natural development of ski skills.

  It is best if the trail is a circuit route, both departing and returning to the main ski playground in the stadium area. Because the route should be narrow, it will require packing and setting with a snowmobile. Use weight shifting creatively and bank up the turns to add to the challenge.

- **Roller-Coaster Dips.** Roller-coaster dips are gradual bumps and dips that are added to a slight downhill trail. The downhill should permit the skier to carry enough speed to get over the dips. Use a snow scoop to create a dip in the track and pile the snow beyond the dip to create the hump. Repeat this process along the track and ski it in to compact the snow and smooth out the humps. This teaches balance, coordination and control of parallel skis. Refer to section 4.1.4 for detailed information.

- **Bicycle Dips.** This is the next step up in challenge from roller-coaster dips. These can be made on a slight downhill or on flat terrain. More advanced skiers can use steeper slopes. Select a downhill track that has been skied in. Scoop out snow from a track to make a dip, and pile some of it on the parallel track to make a hump. Alternate this procedure as you move down the hill. Round off the hills and dips and ski them in yourself. Space the crest of the humps about 3-4 meters apart. Prepare this course so that the height differences between the bottoms of the dips and the crests of the humps are half the leg length of the smallest child to use it. This teaches balance, coordination and independent arm and leg action on skis, plus it provides a lot of fun. Refer to section 4.1.4 for detailed information.

The articles on the following pages (sections 4.1.2 and 4.1.3) give us a look at how two clubs have applied this concept.

4.1.2 Building an Adventure Trail

In 1997 the 100 Mile Nordics developed a "kid size" lit adventure trail for their youngest skiers (3 to 7 years of age). The purpose of this adventure trail was to teach technique through a combination of play, discovery and appropriate terrain. It was the first step in the club's plan to develop a full ski playground.

This new trail featured both "kid size" trail lighting and motion detectors to highlight animal characters posted in the trees. The trail is fun to ski night or day, but it is the most fun at night. Based on the 100 Mile initiative, the following are some tips for setting up your own adventure trail:

❑ **Lighting**

- ✓ When determining the location of the adventure trail, take into consideration access to your existing power supply and lit trails system.
- ✓ Use underground wiring.
- ✓ In this case, 20 mini-lights were used for a 254 meter trail. The height of the lights was determined by the average snow fall for the area and what would be appropriate in order to keep the trail kid size. For this trail, the lights were approximately ¾ meter (75 cm) high.
- ✓ The adventure trail lights turn on as soon as a skier moves from the club's main lighted trail system onto the adventure trail. A motion detector is at the start of the adventure trail and when the skier passes the sensor, it triggers the first spot light and starts up the 20 mini-lights. The lights were initially set on a 20 minute timer, and after 20 minutes, the lights shut off automatically. This amount of time turned out to be a bit short for this trail for some of the smallest skiers, but the timer is easily adjustable, as are the motion detectors, and the club can adjust the system to meet the needs of the children once those needs are determined.
- ✓ Four motion detectors are set up along the trail. As each child passes the detector, a spot light comes on highlighting one of the animal characters posted in the trees.
- ✓ The lights used for this project use an ordinary light bulb under a plastic shade. This allows the use of different colored light bulbs for different effects on different occasions, e.g. red or green for Christmas.

❑ **Terrain**

- ✓ The adventure trail needs to be easily accessible for the smallest skiers. It should be in close proximity to the stadium area.
- ✓ When determining the width of the trail, keep in mind that this is an adventure trail. It should have a narrow entrance, and give the impression of "skiing into the forest". This is all a part of the atmosphere that you are trying to create. Another factor to consider is that the width of the trail should be kept in proportion to the age of the skier, i.e. "kid size". This is because a regular ski trail may look like a super-highway to a four year old. The 100 Mile Nordics adventure trail is no wider than two metres, and this allows sufficient room for little skiers to both snow plow downhill and side-step up hill.
- ✓ The trail is packed with a snowmobile. No track is set.

- ✓ The intention of this project is to encourage the development of technique by creating situations in which children learn to ski naturally. The terrain used is quite challenging for the age of the skier. The trail system is geared towards fun, adventure and exploration so that children do not really comprehend that they are acquiring skills (balance, rhythm and coordination) and learning to master fairly difficult terrain.
- ✓ The trail drops somewhat in elevation between the beginning and the end, making the downhills quite challenging. The intention was to make the terrain difficult, but to keep it fun. It is important to find just the right balance.

❑ **Animal Characters**

- ✓ You can find suitable illustrated animal characters in books, coloring books, etc.
- ✓ Photocopy the illustrations that you want to use. You may want to enlarge the photocopy if the illustration is too small.
- ✓ Next photocopy your illustrated animal characters onto transparency paper (i.e. make overheads).
- ✓ Using an overhead projector, trace the illustrations onto sheets of corraplast. Corraplast is available at most hardware stores and comes in a variety of colors.
- ✓ Cut out the corraplast figures. In this case the corraplast was cut with a sharp exacto knife. Later it was decided that the figures should be strengthened with plywood, so the corraplast sheets with the figures on them were attached to pieces of plywood and both were cut out with a jig-saw.
- ✓ To paint the characters, the club used varathane paint and tremclad. The club also tried spray painting the clear corraplast, but this meant painting both sides and waiting for drying.

❑ **Protecting the Adventure Trail from Vandalism**

- ✓ During the summer the corraplast animal characters are removed and stored in a safe place.
- ✓ During the summer, the club placed five gallon plastic oil buckets upside down over each light to protect them. First the buckets were cleaned and the handles removed. Two holes were drilled, one on each side of the bucket close to where the handles had been. A (two foot) soft, pliable wire was attached to one side of the bucket. This wire ran down below the bucket, was wrapped around the post and then ran back up to the hole in the other side of the bucket where it was fastened.

4.1.3 Kid Magnet - A Ski Playground Primer

Why Build a Ski Playground?

The concept of ski playgrounds and terrain gardens has been around for quite some time. Experts agree that in the early development of ski skills amongst children the value of this type of learning environment cannot be overstressed. But too often these facilities are overlooked, as the tendency at most cross-country ski facilities is towards the development and maintenance of smooth, linear trails only.

For young children, a ski playground is just what it says it is. In the process of having fun in a playful surrounding, children develop the basics skills for cross-country skiing. This is referred to as the “natural learning” approach. Spontaneous fun and imagination are the motivators; the snow, terrain and obstacles are the teachers; and balance, coordination and confidence are the results. Skills are developed through repetition. There are no errors; there is no right or wrong way, only an ongoing learning process.

The primary role of coaches in the context of playgrounds should be to create learning situations that motivate children to become active in this environment. The notion that ski instruction is all about explanations and demonstrations of various techniques using technical jargon is out of place in a learning situation for children. Kids want action, not talk.

The following is an account of how this approach was put to the test when the Sovereign Lake Nordic Club in Vernon, BC introduced a “Ski Bunny” program for the first time. The main objective for the “Ski Bunny” group (age six and under) was to ensure a positive, outdoor winter experience on cross-country skis. It was felt that this could be achieved by creating a dedicated environment with fun as the focus.

Setting Up a Ski Playground

The first step in establishing a playground (or terrain garden) is to assess the potential in your ski area. A specifically designated area that will not interfere with or be interfered with by other activities is ideal. In this way, children will become comfortable with the location and the terrain features can be developed over the winter without disruption. The area should have a gentle slope nearby for up and downhill manoeuvres. Access to forest adventure trails is a bonus, and close proximity to a day lodge is always important for young skiers.

The Sovereign Lake trails conveniently had a location with all of these attributes. The first component to be developed had an obstacle-type course (flat slalom, duck under/reach up, gentle up and downhills, loose powder, small bumps and ditches). This course was important for the development of initial skills. Children would keep moving around the circuit without encouragement, because they were motivated by their own enthusiasm.

The “obstacles” were created using easily obtained materials such as stakes, poles, plastic pipe and course flags, together with appropriate signage. Archways were popular with the children as they were a very visible object in the course and their function was obvious. Two inch diameter ABS plumbing pipe that comes in big rolls or natural gas pipe-line are excellent for this purpose. Basic flattening and sloping of the playground area was done with the groomer and an Alpine snowmobile was used for track-setting a new course configuration each week.

Anyone who has ever shoveled a driveway, made a snowman, set ski tracks or built an igloo is familiar with snow’s tremendous potential for shaping. With this understanding, additional features that created new challenges were developed in the playground area throughout the season. Snow corridors, bumps and ditches and the “roller coaster” were all built by the use of a standard snow scoop. With this tool, mountains of snow can be move without being picked up. The scoop glides easily across snow surfaces and is the perfect size for building such attractions as the roller coaster.

Line ups are not something you would normally associate with cross-country skiing, but once the roller coaster trail was set up it was the site of constant activity. Inspired by pictures and descriptions in books and the well known Erik Roste video clip of the Norwegian National Team (where the men's team attempts to ski down a roller coaster trail, single file, holding onto the waist of the person in front), the roller coaster was one of the most popular activity centres with all ages. Any observer would have been impressed by the enthusiasm, confidence-building and skill development that was gained from that wavy slope.

The second component of the playground was a forest path which made use of an abandoned skidder trail. The path's disguised access, narrow width, and obvious bumps and turns made it an ideal kid's trail on two counts: it appealed to their sense of adventure; and it was loaded with the kind of terrain variations that naturally develop good skiing skills. To add to the wonderment, the path was dubbed the "Jungle Trail", and jungle animal cutouts made from painted corraplast signboard were mounted in the trees. Not only did the skiers have to negotiate the downhill slope with its dips and turns, but they also had to keep an eye out for a monkey, parrots, a lion and a tiger. The trail became a kid magnet. Sooner or later, every age group in the Ski League program discovered it and took numerous runs down the Jungle Trail. The older kids skied at much faster speeds than the Ski Bunnies, but they derived the same challenges and skill development. The trail rejoined the main network at a location not far from the day lodge and close enough to the playground to make for a rewarding circuit trek.

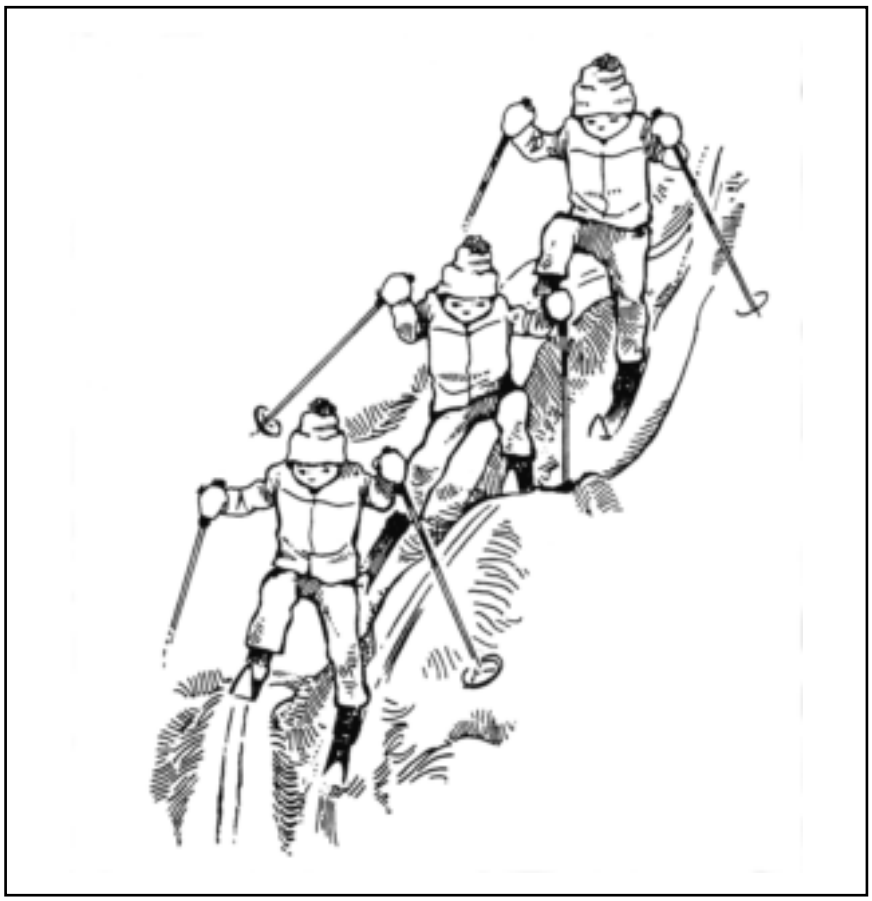
The Jungle Trail was track packed with an Alpine snowmobile prior to each session, whenever there was new snow. By weight shifting on the Alpine it is possible to bank up turns which gave the kids added thrills and confidence.

Due to the success of the terrain-oriented areas and paths, a second adventure trail was created. Unlike the Jungle Trail, which was a cleared trail, it was purely a bushwhack trail that meandered through the trees. It was just wide enough to pack with an Alpine so that the younger skiers didn't have to slog through the deep snow and become discouraged. Although there were no animal cut-outs in the trees, the branches were close enough to brush up against the skiers' jackets and visibility was limited enough to provide some mystery. Speed was not a factor as much of the trail was uphill – perfect for refining the herringbone. This trail linked the playground to the Jungle Trail, permitting skiers to move from one discovery area to the next, spurred on by their curiosity.

Variety was one of the keys to maintaining the motivation level of the young skiers. New learning situations present a stimulating environment, in both the imaginative sense and the physical challenge/skill development sense. Time ran out and the sessions ended before all options could be tried. Bicycle bumps were built after the fact as an experiment and these were subsequently added to the terrain garden during the following season. In addition, cartoon cut-out characters joined the playground as colorful, animated obstacles (more fun!).

The effort put into the playground and terrain features was rewarded with the reaffirmation that kids can do and learn by having fun. It was a relatively simple undertaking. All children's skill development programs are encouraged to set up their own unique playground sites.

Figure 4.6 – Bicycle Dips



4.1.4 Roller-Coaster Dips and Bicycle Dips

Roller-Coaster Dips

Find a gently sloping, well-packed hill, and build a series of small rolls on the hill. Start with three rolls and add more as the children gain skills. Create rolls as follows: shovel snow from nearby onto the track/slope the skiers will be using in order to build some higher spots. Then pack the snow firmly with your snow shovel and skis. The rolls should be 15-30 cm high and about four metres apart. Remember to "ski in" the roller-coaster dips yourself before you allow the children in your group to use them.

Children may fall frequently when they first try the roller coaster dips, but this is the initial stage of learning and falls are natural. "*Children will improve their skiing skills if they continue to ski on these kinds of features!*"

Always match the slope of the hill with the ability of your skiers. If some children have more difficulty in negotiating the rolls than is usually the case, take them to a flat area and encourage them to practise on that terrain first. On the other hand you should use higher rolls and steeper slopes for the more advanced skiers in your group.

Figure 4.4 – Roller-Coaster Dips - Skier Action

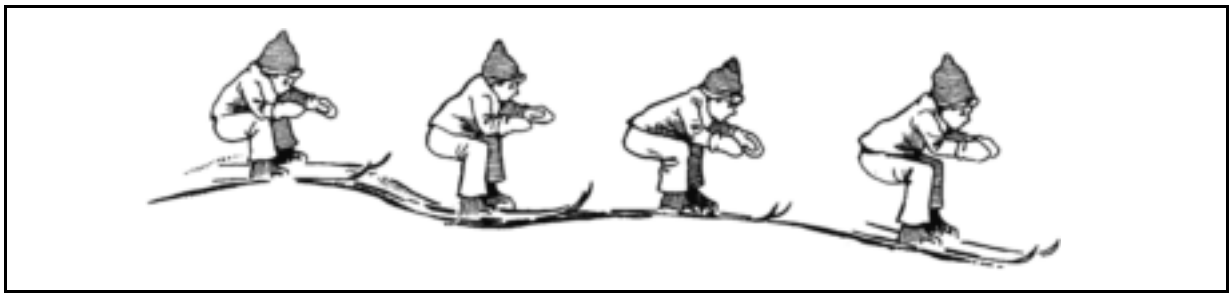
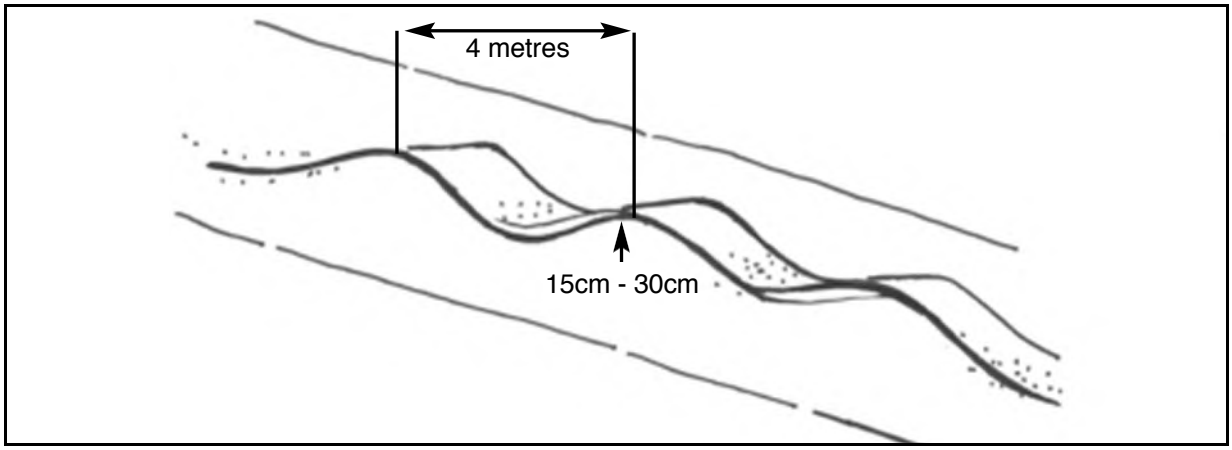


Figure 4.5 – Roller-Coaster Dips - Profile



Bicycle Dips

Bicycle dips are similar to roller-coaster dips in that the track skied is uneven. The main difference between the two features is that bicycle dips consist of a dip in one track accompanied by a parallel bump in the other track. Bicycle dips are a more advanced exercise than roller-coaster dips and can be created on either sloping or flat terrain.

To prepare the terrain for bicycle dips, lower one ski track by scooping snow out of it, and raise the other track by moving the scooped snow on to it to build it up. Always round off the dips and bumps you have made. Create four or five “pairs” of dips and bumps by alternating dips and bumps in each track (the distance between consecutive bumps on the same track should be about four metres). The final step is to ensure that the difference in height between each dip and bump is no greater than the distance between the knee and foot of the smallest child in your group. Again, “ski in” the bicycle dips yourself before you allow the children in your group to use them.

If your group has difficulty mastering this exercise, space the pairs of dips and bumps farther apart, and/or round off the bumps to reduce the difference in height between the dips and bumps.

Once your group can negotiate the dips and bumps competently, challenge them by increasing the difference in height between the two. You can also make the activity more difficult by having the children increase their skiing speed.

Figure 4.6 – Bicycle Dips - Skier Action

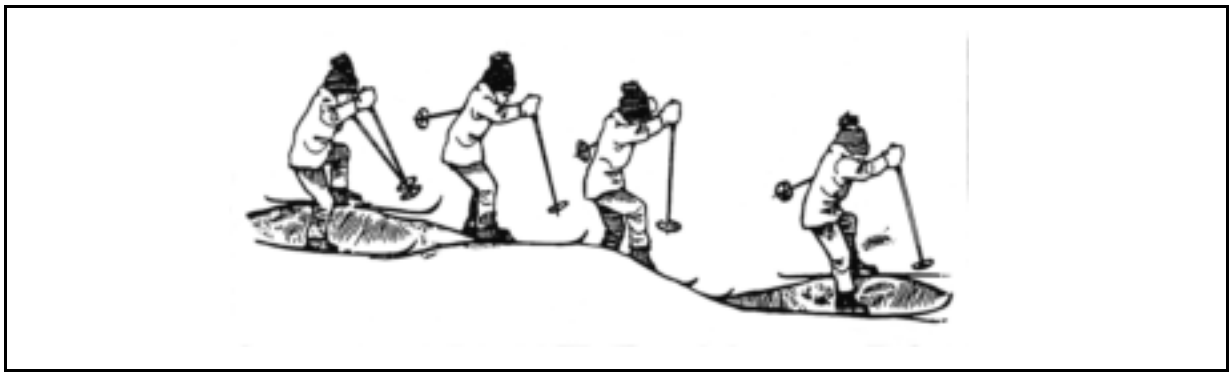


Figure 4.7 – Bicycle Dips - Profile