WINTER TOWNSCAPE REGENERATION

USING SNOW TO WEAVE ADDED QUALITIES INTO THE URBAN FABRIC

THESIS PROJECT, SEPTEMBER 2016
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Many thanks to my supervisor and the SUDEs team, BJörn Ekelund, Jónas Valdimarsson and colleagues at Akureyri municipality planning office, Danni and Ági for sharing their wisdom with me, Byggðastofnun and Edda Ívarsdóttir for her help. Last but not least, thank you to my family and friends for being an infinite source of help and happiness.

CONTENTS

Akureyri is a town of 18.000 residents, located in the north of Iceland and is the center of culture, education and leisure activities in the quarter. It sits at the bottom of a rather narrow fjord, Eyjafjörður, about 100 km south of the arctic circle. The town stretches from the coastline towards the mountains up to around 100 m elevation.
The town is a center for winter sports in Iceland, it has a ski-area, ice-rink, facilities for Nordic-skiing as well as the landscape around is ideal for hiking, off-piste skiing, trail running etc. Due to the towns northern location and Iceland's maritime climate, winters are long and dark and weathers can change frequently and dramatically.

WHAT IS THE AIM OF THE PROJECT?

Use the natural elements as a driving force for positive urban life in Akureyri with the snow accumulation as a leader to unite the town in a physical and social way. The elements of snow buildup in the urban environment are used to find ways to give the town added value in the form of recreational opportunities and commuting routes. Additionally using a system of snow storage to minimize problems due to build up of snow piles and flooding during thaw events.

WHY THIS APPROACH?

During the winter significant amount of snow accumulates in the town. As the snow builds up, it has more and more impact on people's daily lives. Sidewalks are often blocked due to snow piles formed as the streets are cleared. This results in pedestrians walking on the street with the cars. Restricted visibility due to the snow piles puts pedestrians and car passengers in danger.
In order for traffic to run smoothly the snow needs to be cleared from the streets but accessible space is scarce and fills up quickly. Some snow is dumped into the Glerá river that runs through the town but this is less than ideal solution since the snow collects pollution that can be harmful for aquatic ecosystems.
Since weather changes can be quick and dramatic in Iceland, sudden thaw events can occur during the winter as well as the snow melts in spring time. This can cause property damage and restricts movement within the town.
By storing the snow in pre-detemened spots, designed for that purpose, it is possible to control the flow of thaw water and minimize the amount of pollutants getting into the eco-system.
By creating a set system for storing and managing snow, it is possible to make the streets safer, keep the snow cleaner, manage thaw water and thus minimize flood damage as well as use the snow to give the town added qualities.

HOW?

Determine spaces for the snow to be stored during the winter where it will give the town added qualities. At these spaces the snow can be used for recreation and inconvenience can be lowered in the townscape. During thaw events and spring thaw, the water can be managed so it will cause minimum damage and inconvenience.
Identify four different strategies to store the snow: the Ribbon, the Cornerstones, the Centerpiece and the Skiswales. These different strategy elements translated into design principles provide different recreational opportunities, possibility to store large amounts of snow. The topography in the town is used to slow down and take advantage of natural filtration for the thaw water.

ANALYSIS

ICELAND

Iceland is a sparsely populated island in the North-Atlantic Ocean. Sometimes called the land of ice and fire due to it's glaciers and volcanoes that have shaped the landscape and lives of people.

Iceland's population counts 332.000 people as of January 1st 2016 and is estimated to grow to between 400.000 and 520.000 people in the next 50 years. (Hagstofa Íslands, 2016)

Tourism is a fast growing industry in Iceland, with about 20% increase each year since 2012. The year 2015 brought 1.289.140 tourists, 30% more than the year before. The summer is the most popular time of year to visit Iceland, about 40% of tourists came during June, July and August in 2015. About 30% visited during the spring and fall and 30% during the winter of that year. During the winter the majority of tourists stay in Reykjavík or visit the south coast. Only a small part, about 5% of overnight stays were in the north of Iceland. A little more travel to the north during spring and fall but in the summer about 20% of overnight stays are in the north. Domestic tourists travel mostly during the summer and the least during mid-winter. (Ferðamálastofa, n.d.)

It is not easy to determine Iceland's climate type as different references do not completely agree on the subject. The cool ocean water surrounding the island influence the climate so a simple classification is cool temperate maritime climate. (Ingólfsson, n.d.) The Köppler climate classification system determines it as Polar (ET) and warm, tempered, fully humid with cold summers (Cfc). (Kottek et al., 2006) The climate of the country is a lot milder than maybe is expected, given its location and name. A branch of the Gulf Stream runs along the south- and west coast of the island, moderating the climate. It also brings together mild Atlantic air and cold Arctic air resulting in frequently changing weather and storms. (Icelandic Met Office, 2016) In short, Iceland is not very cold, just not very warm and the weather changes are often fast and dramatic.

AKUREYRI

POPULATION & TOURISM

Akureyri's population was 18.294 people on January 1st 2016. (Hagstofa Íslands, 2016) In the past years population increase has been about 1% but is predicted to be a little less in the coming years. Population is estimated to be 20.000 in the year 2030. (Akureyrarbær, 2016)
Both foreign and domestic travellers visit Akureyri. In 2015 about 40% of domestic tourists visited Akureyri and 52% of foreign tourist. Cruise ships are a common sight in Akureyri, primarily during the summer. In 2015, 86 ships came to Akureyri bringing about 72.000 tourists. (Ferðamálastofa, n.d.)
Out of 86 ships 12 had an overnight stay. During their stay many of the tourists buy a day trip to destinations close to Akureyri or spend the day in town. (Akureyrarbær, 2015)
Even though Akureyri is a small town in regards to number of residents, the actual number of people seeking services and recreation is much higher. The fact that the biggest part of tourism happens during the summer and significant numbers of people stop only for a day or two, like cruise ship visitors, tells us that there are opportunities to increase winter-time visits. Thus, the townscape has to be readable and attractions easily accessible.

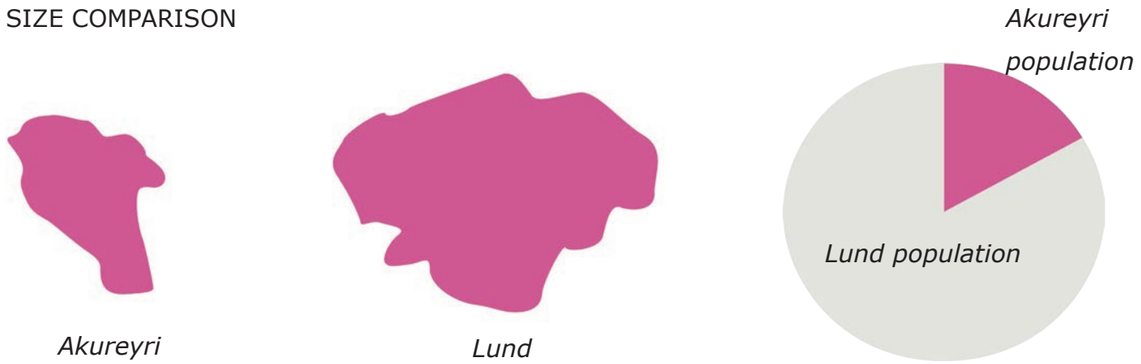
BRIEF HISTORY OF THE TOWN

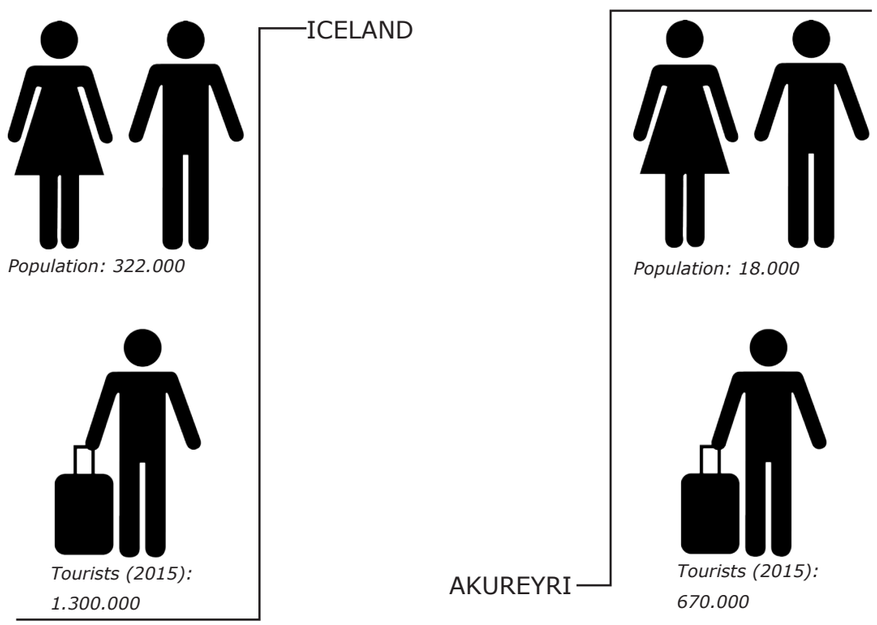
The area where Akureyri sits today was inhabited during the settlement of Iceland around the year 800 AC. First mention of a place called Akureyri is in documents dated 1562 and the town was established

LOCATION

Akureyri is the biggest town in Iceland outside of the capital area. It is a center for culture, services, education and retail in the north of Iceland.

SIZE COMPARISON





as a market place in 1602 when Danish traders from Helsingør got monopoly on trading in the area. Akureyri did not have permanent inhabitants until after the year 1776 and in 1786 it became an official market town, with 12 documented residents. 60 years later there were 286 residents. The merchants in the town were primarily Danish and Danish culture had a big impact on the town life. The first municipal council was elected March 1st 1863 and new municipal laws were established in 1885. In 1852 a printing company was established in Akureyri and in 1853 a newspaper was published. This set the scene for Akureyri to become the central hub of towns in northern Iceland. In the beginning of the 20th century a school was moved from Möðruvellir, north of Akureyri, into the town. (Steindórsson, 1993) Throughout the 20th century the town has grown, providing healthcare, education and recreation for residents and guests alike.

GEOLOGY & TOPOGRAPHY

Akureyri is located at the bottom of a 60 km long fjord, Eyjafjörður. The top half of the fjord is in an almost straight north-south direction but as it reaches further inland, it gets narrower and turns towards south-east/north-west direction. (Guðmundsson, 2000)
The geology of the area is very diverse, formed by eruptions and glaciers through millions of years. The main bedrock is basalt, around 9 million years old. The mountains around also have liparit and other types of rock, giving the landscape a divers colour range. Glaciers formed the mountains above Akureyri during the last ice-age and rockslides put their mark on the landscape. The land changes between the bedrock sticking out of the vegetation and deep wetlands. During the last ice-age, sea level was much higher than today and the old coastline can be seen at the top of a steep hill in the town, in some places 50-60m high. (Steindórsson, 1993) Lowland in Iceland is usually defined as anything below 200 meters elevation and in Eyjafjörður there is not a whole lot of that, the area around Akureyri is one of few such areas. (Guðmundsson, 2000)
The topography of the town is in a gradient from the shore up to about 100 m above sea level. The ice age coastline is where the elevation is the most dramatic and above there the land flattens out though the land is in general lifting up towards the mountains above.
The Glerá river runs through the town and creates a distinct boarder through it.

RECREATION IN & AROUND AKUREYRI

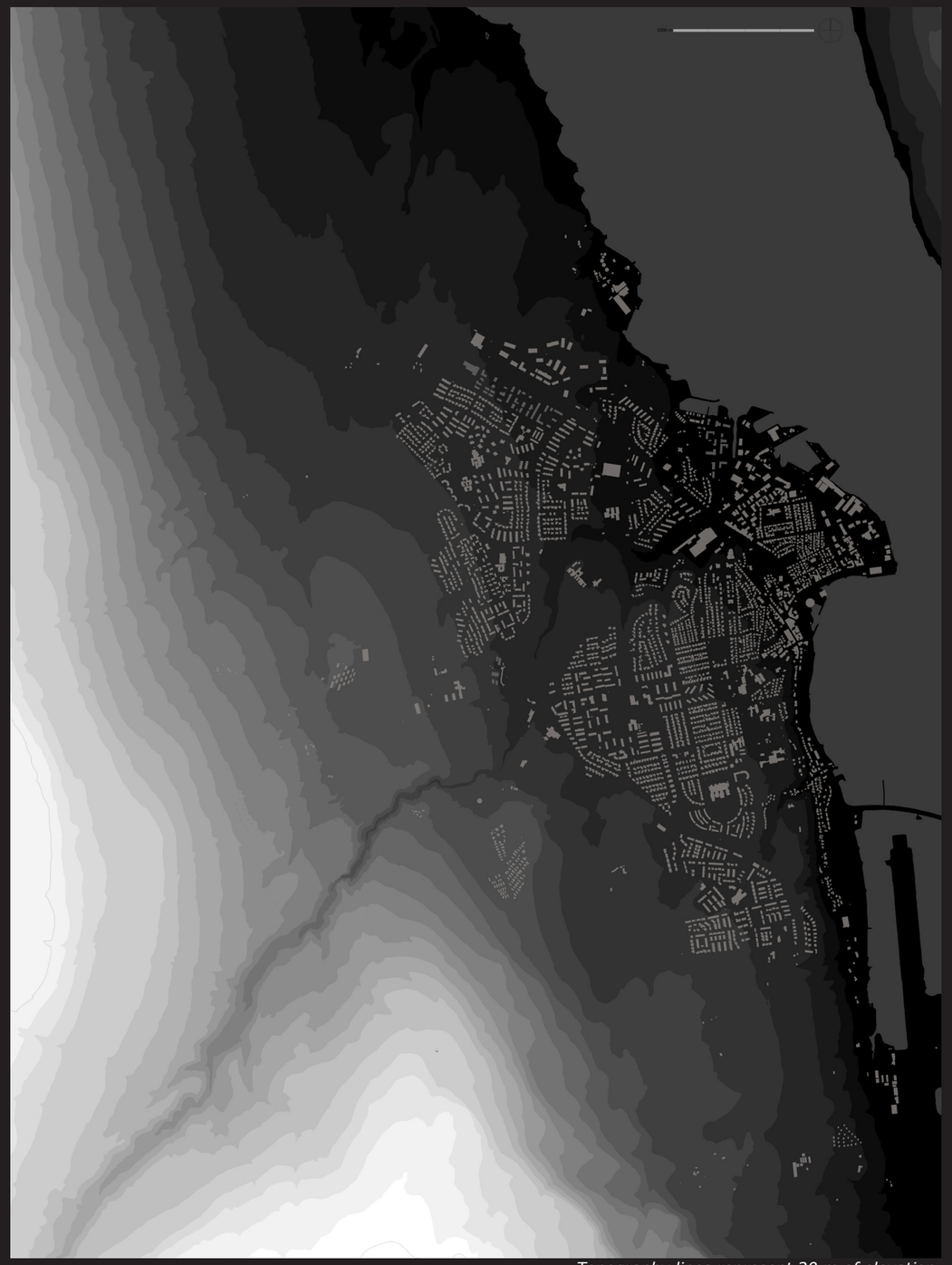
Akureyri and the Icelandic government had an agreement that Akureyri would be the winter sports center in Iceland and furhter development would be supported by the state. After the difficulties following the financial crisis in october 2008 the funding has stopped. However, the municipality continues to enhance the winter sports center identidy by providing diverse choises in wintertime recreation.
The nature and landscape is very present in the town with many natural recreational areas surrounding the town. The main areas are within 20 min driving distance or no more than 2-3 hours walking distance from the town center.
The main areas are:

Glerárdalur valley

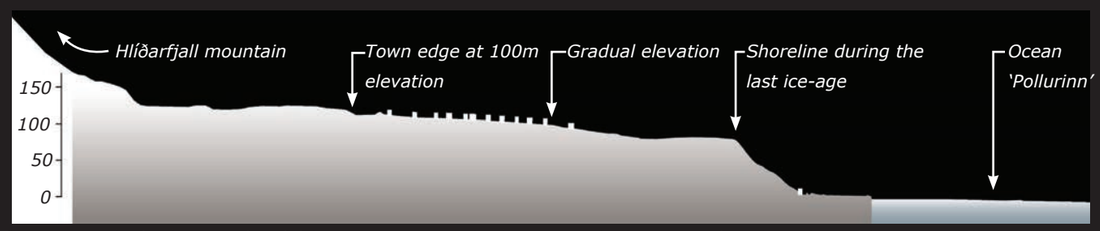
Glerárdalur valley was formed by running glaciers and has diverse geological formations and fossils from millions of years ago can be found there. In June 2016 Glerárdalur was declared a nature reserve to provide opportunities for recreation, protect intact geological formations and biological diversity. The size of the nature reserve is 74,4 km^2. (Umhverfisstofnun, n.d.)

Hlíðarfjall ski area

Hlíðarfjall ski resort is in close proximity to Akureyri, approx. 20 min drive from the town center. The



Topography lines represent 20 m of elevation.



The topography in the town is a fairly constant upwards slope towards the mountains above but with a steep hill close to the shore.

lifts can transport 4.920 people/hour and slope height is roughly 500 m. (Hlíðarfjall, n.d.) The infrastructure is only used during the winter but the municipality has been trying to expand the usage over the whole year. For many years it has been discussed to put up a cable car from the town to the top of the mountain.

Súlur mountains
Súlur mountains rise to 1.213m above Akureyri and are a popular destination for hikers. The round trip to the top takes about 5-6 hours. (Akureyrarstofa, n.d.)

Lögmannshlíð
This is a gravel road leading to farms outside of Akureyri and is a popular route for walking, running and biking.

Fálkafell
Fálkafell is an old hut, owned by the scouts organization in Akureyri. It is used by the scouts as well as being a destination for hikers and bikers.

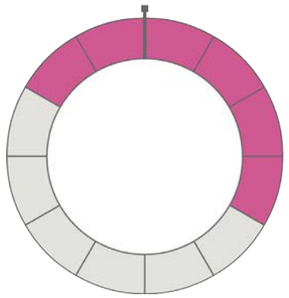
Krossanesborgir
Krossanesborgir is a nature reserve to the south of Akureyri. It is an important habitat for birds and plants among special geological formations. The protection of the area aims to ensure biological and geological diversity as well as provide a place of recreation. (Umhverfisstofnun, n.d.)

Jaðarsvöllur golf course
Jaðarsvöllur offers a 18 hole course, practice area, golf-store, catering facilities and rentals for golf equipment. It is most active during the spring, summer and fall but winter activities are on the rise. (Golfklúbbur Akureyrar, n.d.) At summer solstice the Arctic Open golf tournament is held during the night in the midnight sun. (Akureyrarstofa, n.d.)

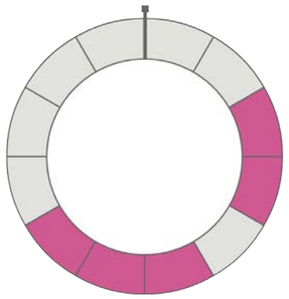
Kjarnaskógur forest
Kjarnaskógur is one of the most popular recreational areas for the residents of Akureyri. Planting started at a barren land around 1950 and today roughly 1,5 million plants have been planted, resulting in a lush and sheltered destination. The area offers playgrounds for kids, volleyball court, BBQ facilities, paths for hiking, biking and cross-country skiing. (Akureyrarstofa, n.d.)

Leirurnar
Leirurnar are a part of Eyjafjarðará river delta, protected as a recreational area and nature reserve. The area is the border between the land and the ocean and is partly covered by sea during the tide. This results in a diverse and peculiar flora and fauna. An old road runs over the area from east to west where residents of Akureyri go for a leisure walk. (Teikn á lofti, Akureyrarbær; Umhverfisdeild, Eyjafjarðarsveit, 2004)

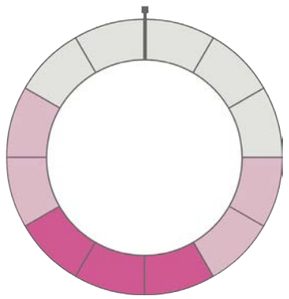
Listigarður Akureyrar, botanical garden
A group of women from Akureyri designed, financed and built a public



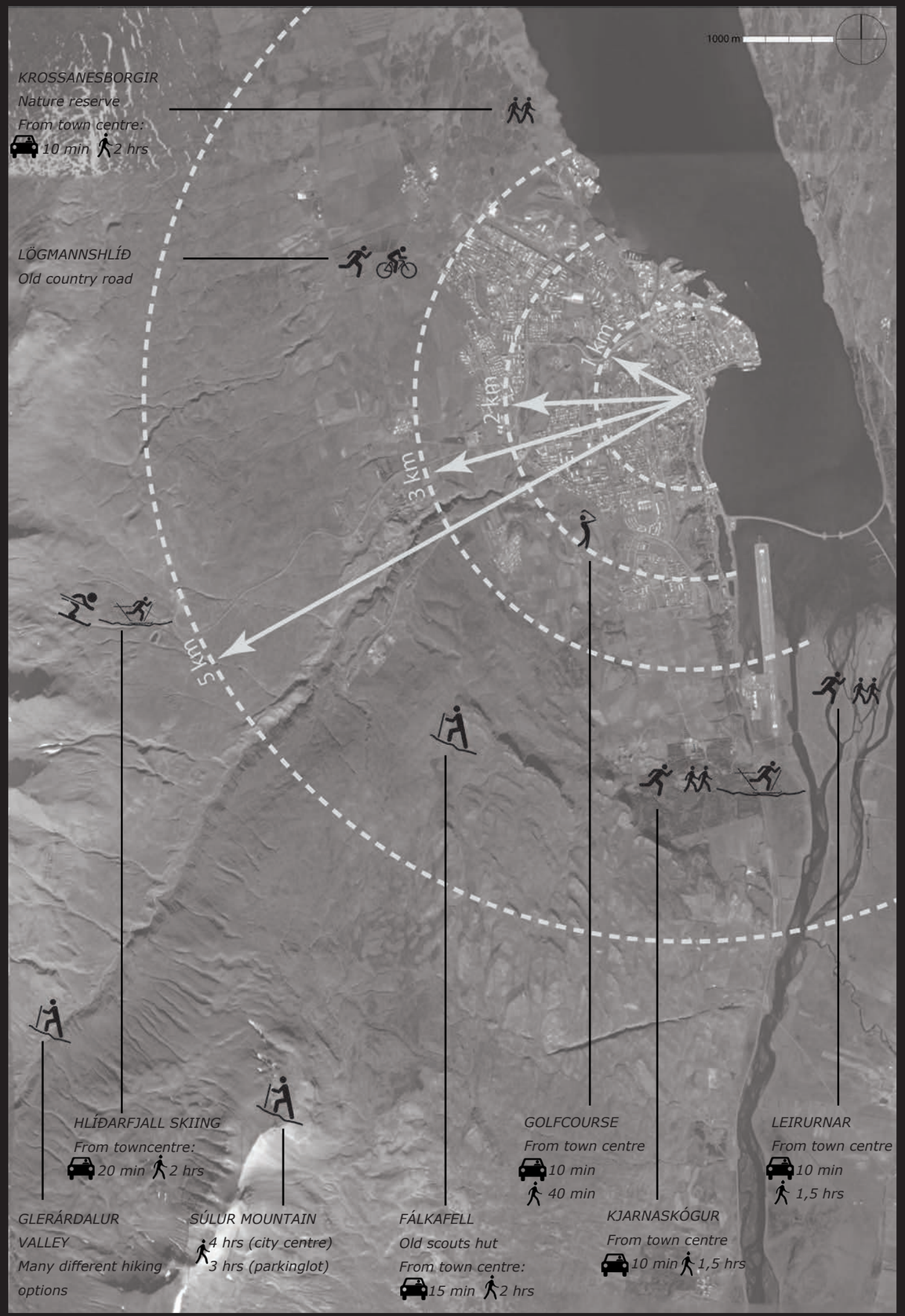
Active months at Hlíðarfjall ski area



Months with special events in the town.



Months with the most tourists



park which opened in 1912 that later would become the botanical garden. For the past century it has been expanded both in size and species diversity grown there. One of it's missions is to collect rare and endangered Icelandic plant species. The garden is a popular destination both for residents and visitors of Akureyri. (Steindórsson, 2007)
Glerárgil gorge
Glerá river cuts through the bedrock creating Glerárgil gorge. The gorge has mostly been left untouched through the ages, probably due to the fact it is steep and hard to access, reaching depths of up to 80 meters. Paths have been built at the lower parts providing access to enjoy the rich and diverse flora. (Akureyrarstofa, n.d.)

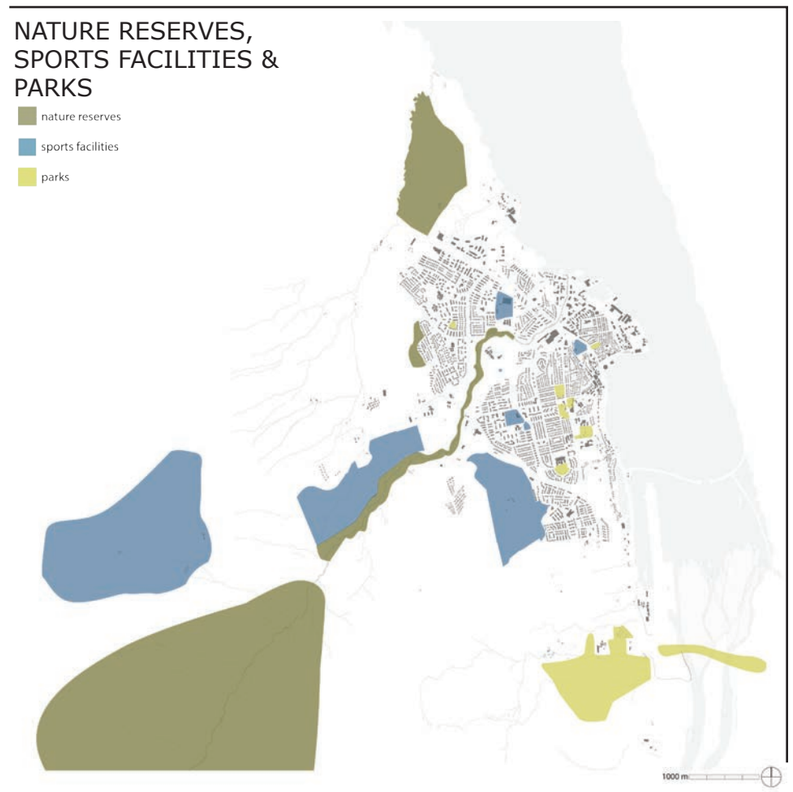
Mountainbiking has been rising in popularity in Iceland for the past years and Akureyri is no exception. Trails for bikers have been built in Hlíðarfjall and around Kjarnaskógur and more are planned in the future.

During the year there are a few special events in the town. At springtime the Icelandic Winter Games are held in and around Akureyri and a childrens ski tournament, Andrésar Andar leikarnir, is held in Hlíðarfjall. In June there are fotball tournaments for children and adults, the national day is celebrated on 17 June and a racing driving competition and show is a yearly event. During July and August weekend celebrations are frequent. The first weekend in August is the biggest festivals and travel weekend in Iceland and Akureyri is filled with guests of all ages.

The closeness to the nature and excisting infrastructure for activities in the landscape provide a perfect setting to further develop the recreational oportunities and the wintersports center identity of Akureyri.

TRANSPORTATION

Akureyri Airport was built in 1954 and serves domestic flights but meets international standards. There have been tryouts with scheduled international flights and with the ongoing tourism boom in Iceland there is a growing demand for direct flights to Akureyri from Europe and North America.
Highway no 1, or the Ring-road, runs through Akureyri, thus the town is both a destination for travellers as well as a pass-through town.
Public transport buses within the town are free of charge. The same company services elderly and disabled people. This service offers great opportunities to encourage walking or biking since it is easy to jump on the next bus when tired or if the route is too long for easy travel. There are 4 different bus lines in operation. The downside of this service is that the buses are infrequent, buses arriving once or twice an hour. With more use perhaps the trips could become more frequent.
Private cars are the dominant way of transport for the residents of Akureyri. The streets do not become overly congested but at rush hours in the morning and afternoon there can be congestion in certain spots. The town layout is designed to accommodate the private car but still has a fairly user friendly system of paths for pedestrians. The towns small size is a big strength in minimizing the negative effect of the car-traffic and encouraging alternative types of transport.



FUTURE PLANS FROM AKUREYRI MASTERPLAN 2006-2018

The current masterplan for Akureyri is for the years 2006 to 2018 but is currently being revised. The main themes relevant to this project are the following;
1) Akureyri shall be a strong center for services, culture, education and transportation in the north of Iceland. Special care shall be given to ecological systems and nature conservation in order to promote a healthy natural environment. Diverse and dynamic economy and increased quality of life for the townsfolk. The built environment shall be of high quality and special care given to the characteristics of

Akureyri.
2) Strengthen the closeness to nature. Natural areas outside and within the town shall be connected and easily accessible. Give people the chance to enjoy diverse recreation outdoors and the chance to learn from the environment as well as enhance the quality of the town's appearance and environment.
3) Contribute to public health by providing diverse facilities of high quality for sports and recreation during summer and winter.
4) Strengthen the image of Akureyri as a winter sports center in Iceland by providing winter sports facilities of high quality.
5) Provide a coherent system of paths usable year round to make walking and biking a real alternative to driving.
6) Use empty spaces to densify the town and thereby make a better use of existing infrastructure. New development should be in line with the existing built structure and aim to create pleasant micro climate.
7) Provide easy access from the town center to the seaside and the natural areas outside the town with attractive routes through the town.
8) In existing housing neighbourhoods new development should focus on housing but include services for the residents, such as shops, small scale and clean industry, service organizations, play areas etc that do not disturb with noise, smell or alike.

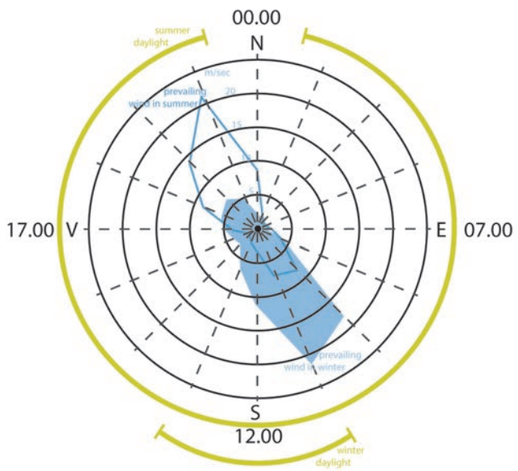
WEATHER & CLIMATE

Seasonal changes are quite dramatic, winters are dark and snowy but summer days are dry and fairly warm. Due to the towns northern location daylight lasts almost 24 hours during summer but only around 4 hours at Christmas. Due to the surrounding mountains the sun barely shines in the town during the darkest time of year. The highest angle of the sun in summer is 47° so shadow cast is considerable. Prevailing winds are dry winds from S to SE and N to NW winds that bring precipitation, rain in summer and snow in winter. The fjord is open towards the north causing northern sea breeze during the afternoon. In the summer days can be warm and sunny but in the winter snow and darkness take over. (Akureyri, deiliskipulag miðbæjar - austurhluti, n.d.)
The aspects of weather and climate most important to keep in mind when planning in Akureyri are the long summerdays and short days during winter, sea breeze from the north during the summer and snow-transporting southerly winds during the winter.

SNOW ACCUMULATION IN AKUREYRI

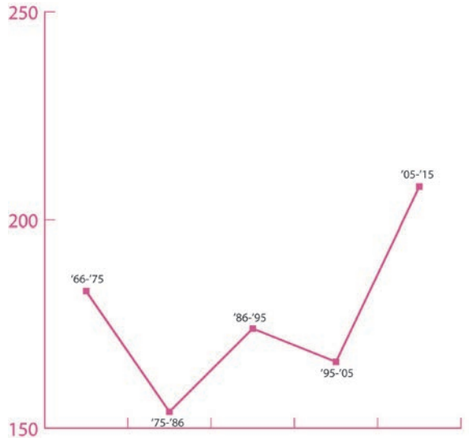
Average precipitation a year is 540 mm and there of about 30% falls as snow. Roughly 100 days a year, the ground is completely covered. (Jónsson, 2012) The yearly average snow accumulation has been on the rise for the last decade, with an average of 208 cm of snowfall. The accumulated snowfall in the winter of 2014/2015 was 295 cm and over 250 cm in 2015/2016. The snow is cleared from the streets and paths at the cost of 142 million ISK, roughly 10 million SEK. (Akureyrarbær, 2016)
With simple maths, using the 10 year average, we can see that the accumulated snow on only the streets is almost 2.3 million cubic meters. That would fill almost 900 olympic sized swimming pools or fill Central Park with about 1m of packed snow. This is only the streets, not including parking lots, sidewalks or pedestrian paths. With time the snow settles and the volume is reduced. Luckily since it is more volume than can easily be stored.
In addition to the snow falling from the sky, drifts now from the surrounding area ends up in the town. Drifts now, skafrenningur in Icelandic, is a weather phenomenon well known to all Icelanders. It happens when the wind is strong enough to pick up snowflakes and toss them forward, similar to wind erosion. This can transport huges amount of snow throughout the winter.

WEATHER, CLIMATE AND SNOW IN AKUREYRI

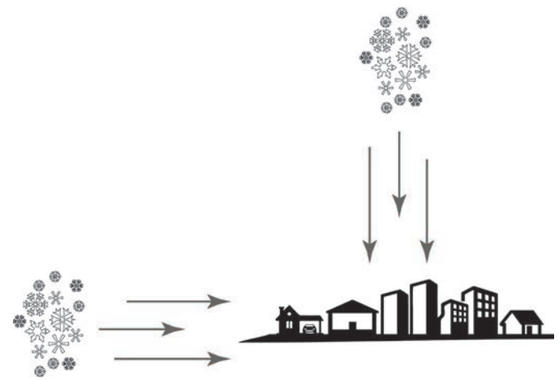


average precip/year:
540mm

Important weather aspects in Akureyti are long days during summer and short winterdays, afternoon sea-breeze from the north and southern winds bringing drift snow into town during winter.

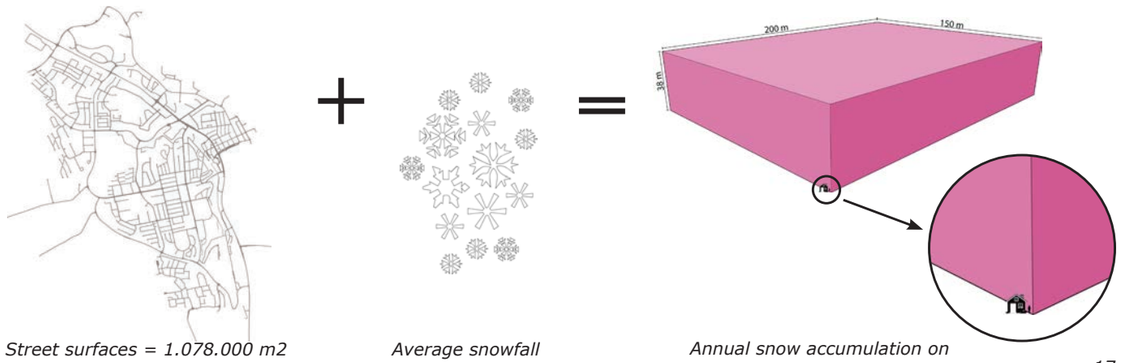


Average snow accumulation is rising



Snowfall and drift snow contribute to the snow accumulation

ACCUMULATED SNOW ON STREETS IN AKUREYRI



Street surfaces = 1.078.000 m2

Average snowfall = 2,08 m

Annual snow accumulation on streets = 2.242.000 m3

HOW DOES THE SNOW ACTUALLY AFFECT THE TOWN?

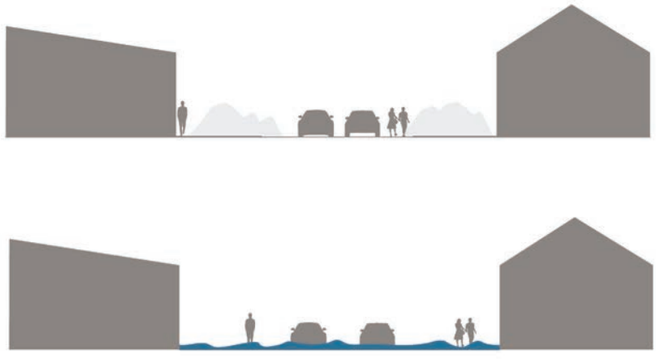
It is a wonderland for kids to play, explore and gain new knowledge and abilities. The snow also lights up the darkest time of year so it has the potential to lift peoples spirit. The downsides are that the snow often builds up on the sidewalks, forcing the pedestrians to walk on the streets. The snow piles reduce visibility for the drivers, increasing the risk of accidents. Due to the often rapid changes in the weather, sudden thaw can occur causing flooding on the streets with associated inconvenience and damage. Since the amount of snow is too much to store properly, a significant amount is dumped straight into the Glerá river and since there is always some pollution that builds up in the snowpack that can have a negative impact on ecosystems in the river and ocean.

UPSIDES:

Recreation for all ages.
Kids can play and explore their abilities.
Snow lights up the dark days during winter.

DOWNSIDES:

Build-up of snow restricts movement of pedestrians and visibility for drivers.
Flooding on streets during thaw events causes inconvenience and damage.



SNOW MANAGEMENT IN THE URBAN ENVIRONMENT

URBAN SNOW

In winter cities the snow accumulation is a big issue for a smooth running society. The same goes for seasonal changes since, as the summer gets nearer, the snow melts and can cause issues, especially during a sudden thaw event or unusually heavy snowfall. Clearing roads and paths is essential for life to run smoothly but where and how to store the snow can be challenging.
As the snow pack grows, so do various pollutants such as airborne fallout, roadside deposits, litter, anti-skid and de-icing materials. If these pollutants are left untreated it can cause negative effect on the quality of receiving water bodies and ecosystems. Cold climates experience higher rates of chemical and material accumulation due to increased influx of pollutants from heating, less efficient running machines due to the cold and usage of anti-skid / de-icing materials. The pollutant build up in the snow pack is an ongoing process of influx during deposit and precipitation on one hand and thaw events where the pollutants are released. Eventually spring thaw melts the snow pack completely and the pollutants are discharged or left behind. In order to protect urban aquatic ecosystems it is vital to take care of urban drainage in cold climates. Conscious snow management systems can be used to control where and how the pollutant build-up in the snow pack is released. These include transporting the snow to designated snow-storage sites. The pollutants can either be allowed to slowly infiltrate and be filtered through the soil or removed from the surface after the snow has melted, disposed of or used in some way, depending on the type of pollutants. (Marsalek et al., 2003) Two types of pollution shock loads often occur as the snow pack melts. Starting with a ‘first flush’ of soluble pollutants early in the thaw cycle. Towards the end or after the snow has melted solids and hydrophobic substances are left which need to be removed. (Blecken et al., 2012) Storing snow upland is an effective way of promoting infiltration and mimic a natural pre-development hydraulic cycle. This way the topography can also be used to filter the thaw water and prevent pollutants getting into aquatic ecosystems. Previous surfaces on dump sites can reduce flood risk during thaw-events and increase on-site infiltration. Infiltration basins and filter strips can double as dump sites during the winter season but high concentration of pollutants and/or sand can reduce the effectiveness of the storm water management. (Caracao and Clayor, 1997)
It goes without saying that during sudden thaw events large amounts of water get released and can easily overwhelm a traditional sewer systems. Open air storm water solutions are thus ideal to slow down and manage the thaw water. They can also provide pleasant and interesting spaces in the townscape.
Open air storm water management in cold climates requires special care due to both quantity and quality of the water. It should start with source control and focus on reducing negative effect of pollution and presence of chlorides. (Marsalek et al., 2003)

STORM WATER BEST MANAGEMENT PRACTICE IN COLD CLIMATES

Frost, snow and thaw cycles and short growth seasons are prominent challenges of open air stormwater systems in a cold climate. Frost can cause pipes to burst and reduces soil infiltration, ice sheets can cause the melt water to flow freely and increase flood risk. Biological mechanisms have reduced function since plants are dormant for a large part of the year and pollution build up in the snow pack can have negative effect on the surrounding ecosystems. Thus choosing appropriate methods to store, treat and channel storm water are crucial. Ponds, wetlands and open channel

systems need relatively little modification to be effective in cold regions. (Caracao & Clayor, 1997)

Ponds
Ponds are highly recommend by Caracao and Claytor (1997) even though they have reduced effectiveness. Wet ponds, dry extended detention ponds and wet extended detention ponds can all be used in cold climates but wet ponds are least effective due to frozen water and less effective pollution filtration. Multiple pond system is recommended in order to minimize flood risk as well as it provides additional storage area to make up for loss of storage due to build up of ice.
Wet ponds need permanent water body to function where inflow of new runoff water replaces the treated water that flows out of the system. Dry extended detention ponds treat the runoff water by capturing and slowing it down, allowing pollutants to settle. Wet extended detention ponds are a combination of the two, dividing the filtration between a permanent pool and detention. Cold climate adaptation include protection for the outfall so ice or debris will not block it, using fast growing plants planted in the beginning of the growing season and/or using structural measures to stabilize water channels.
Dry extended detention ponds can serve as a snow storage sites during the winter and thus have a double function in cold climates. Permanent pools are not suitable for this purpose as vegetation can be damaged. (Caracao & Clayor, 1997)

Storm water wetlands
Storm water ponds and storm water wetlands are similar in function but vegetation plays a bigger role as well as wetlands tend to be shallower. Different types are shallow marshes, pond/wetland systems and extended detention wetlands.
Shallow marshes require the most space of the wetland options and can have a significant habitat value. Pond/wetland systems are more effective in pollution treatment than shallow marshes and require less space. However they have less habitat value. Extended detention wetlands provide settling and biological treatment of pollutants and extended detention of water. The detention zone needs to be able to cope with saturation, flooding and changing water levels.
To adjust wetlands for cold climates the methods are quite similar to pond systems. Some of the wet storage should be exchanged for dry storage and extended detention storage should be 25%. During the winter when the ground is frozen the aim is to provide at least some treatment to filter pollutants. (Caracao & Clayor, 1997).

Open channel system
Caracao and Claytor (1997) deem open channel systems that treat runoff water through a vegetative cover and infiltration as very suitable for cold climates. Four basic types are:
1) Grass channels; broad, thickly vegetative channels in a gentle slope.
2) Dry swales; vegetated channels where the soil bed is prepared in a way to filter the runoff water and an under drain system collects and discharges the water into conveyance system or stream.
3) Wet swales; use wetland vegetation to treat and slow down storm water runoff.
4) Vegetative filter strips; usually grassed channels reducing the speed of the water flow, providing some pollution filtration.
Open water channel system is a desirable solution in cold climates, along with ponds and wetlands since they can provide melt water infiltration, can be used as a pre-treatment device or used to transport water to a treatment site. Water channel systems can also be used as snow storing sites. (Caracao & Clayor, 1997).

Additional considerations
Likelihood of damage and/or problems due to flooding is increased if the ground is frozen in infiltration basins, permanent pools are frozen or outlets for pond systems clog up due to frost or debris in the water. Significant flooding can be caused when rain falls on snowy ground. During these events the soil is often impervious due to frozen ground and rain causes rapid melting. Water management systems in cold climates need to be inspected after thaw events where sand and/or vegetation is removed if needed. If vegetation is to be used for pollution filtration fast growing species should be planted as early in the season as possible. (Caracao, D. & Clayor, R. 1997).

CURRENT SYSTEM IN AKUREYRI

Akureyri has a traditional sewer system today where rain- and melt water is channeled through a pipe system to a treatment center and out to sea. (Jónas Valdimarsson, personal communication, 6 January 2016)
A conversation with representetives from the municipality of Akureyri relveiled that pollution buildup in the snowpack has not been studied in detail but the concentration is not believed to be very high. The municipality uses sand as anti-skid material and at the biggest intersections it is mixed with salt (5%). (Jónas Valdimarsson, email 10 March 2016) The properties of the anti-skid material and the size of the town indicate that pollution is not as great as in bigger towns and cities or where i.e. salt is in more use as anti-skid material. However, finding ways to minimize the influx of pollution to the river and ocean is advisable.
Incidents have occurred where heavy flooding due to sudden thaw have caused significant damage in the town. For an example in 1990 a sudden thaw event cause great damage when water flooded into basements in Grenilundur street. (óþh, 1990 & Jónasson, 1994) In 2006 a sudden thaw event caused significant flooding, damaging property and the flow of water cut through roads. (Akureyri.net, 2006)
In conversations with people from the town they can recall numerous incidents where flooding caused significant inconvenience and/or damage.

DISCUSSION

Urban strategies for winter-cities need to be able to cope with accumulated snow, melt-events and deal with pollution in the snow-pack. That could be done in different ways such as by early snow removal to limit the amount of pollution build-up, determine snow storage areas and thaw water channels/ponds to contain and slow down thaw water.
The topography in Akureyri can be used as an advantage when handling thaw water management. Since most of the town is already fairly high above sea level, determining sites for snow storage and controlling the thaw water with water channels is a viable option for further development within the town.
Removing the snow from the streets and determining snow storage away from the traffic prevents pollution build-up in the snowpack throughout the season and makes the streets safer for both drivers and pedestrians.

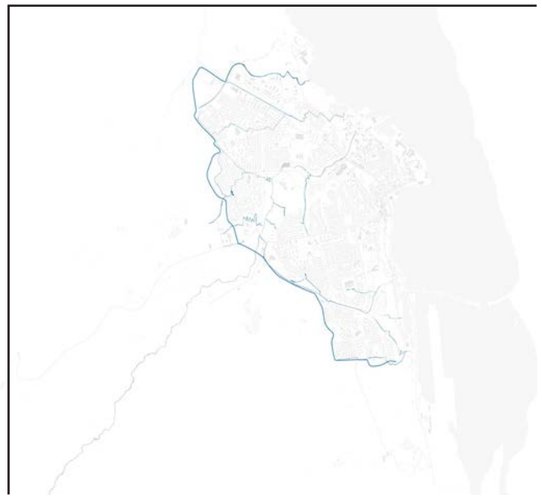
STRATEGY

DEVELOPMENT STRATEGY FOR AKUREYRI

The development strategy is a proposal of a comprehensive plan for the snow management where snow becomes an resource and an investment for the town. Branding it as a sustainable snow paradise, a livable place for it's residents as well as a winter destination for tourists, expanding the influx of positive economic growth.
The strategic principles are to locate storage sites where the snow is given a purpose, use the topography of the town to manage thaw water and use the snow storage infrastructure to guide the future development and growth of the town.
Following the strategic principles are four design elements that aim to combine them in a physical way, building on the excisting situation in Akureyri, giving the sites added qualities for the town.
The four design elements are: the Ribbon, the Cornerstones, the Centerpiece and the Skiswales.

SNOW MANAGEMENT SYSTEM

In order to ensure easy movement and safe environment in the town, the snow is relocated at pre-determined storage sites. The sites are located away from the traffic, which prevents pollution from building up throughout the winter season and helps to keep movement on the streets running smoothly. As snow piles are highly attractive for children to play, it also keeps the children safer than if they play in snow-piles on street corners. The snow is manipulated to use for recreational and practical purposes, so the snow becomes an asset for the town, enhancing its qualities.



THAW WATER MANAGEMENT

As the town is built in a sloping landscape, the topography of the town can be used to manage thaw water during thaw events and spring thaw. The snow storage infrastructure doubles as water management infrastructure but adapted to be functional in a cold climate. Water channels and pond systems through the town slow down and lead the water on towards the Glerá river and the ocean. On the way the ponds can be used to filter pollution from the water so it does not reach the ecosystem in the river or ocean.

EXISTING TOWN LIFE AND FUTURE DEVELOPMENT

Future development is concentrated within the boarder the Ribbon provides. This will link different parts of the town better than they are today, shorten mental distances and create a united urban fabric.
A path-system through the town ensures easy transport using alternative modes of transport than driving, both in winter and summer.
Links from the town to the landscape are available for everyone. Paths and routes leading from the town and a cable car connecting the town and Hlíðarfjall ski area ensure easy access to the nature and landscape.

DEVELOPMENT MASTER PLAN

Akureyri today

Great setting for outdoor recreation

Snow accumulation restricts flows within the town

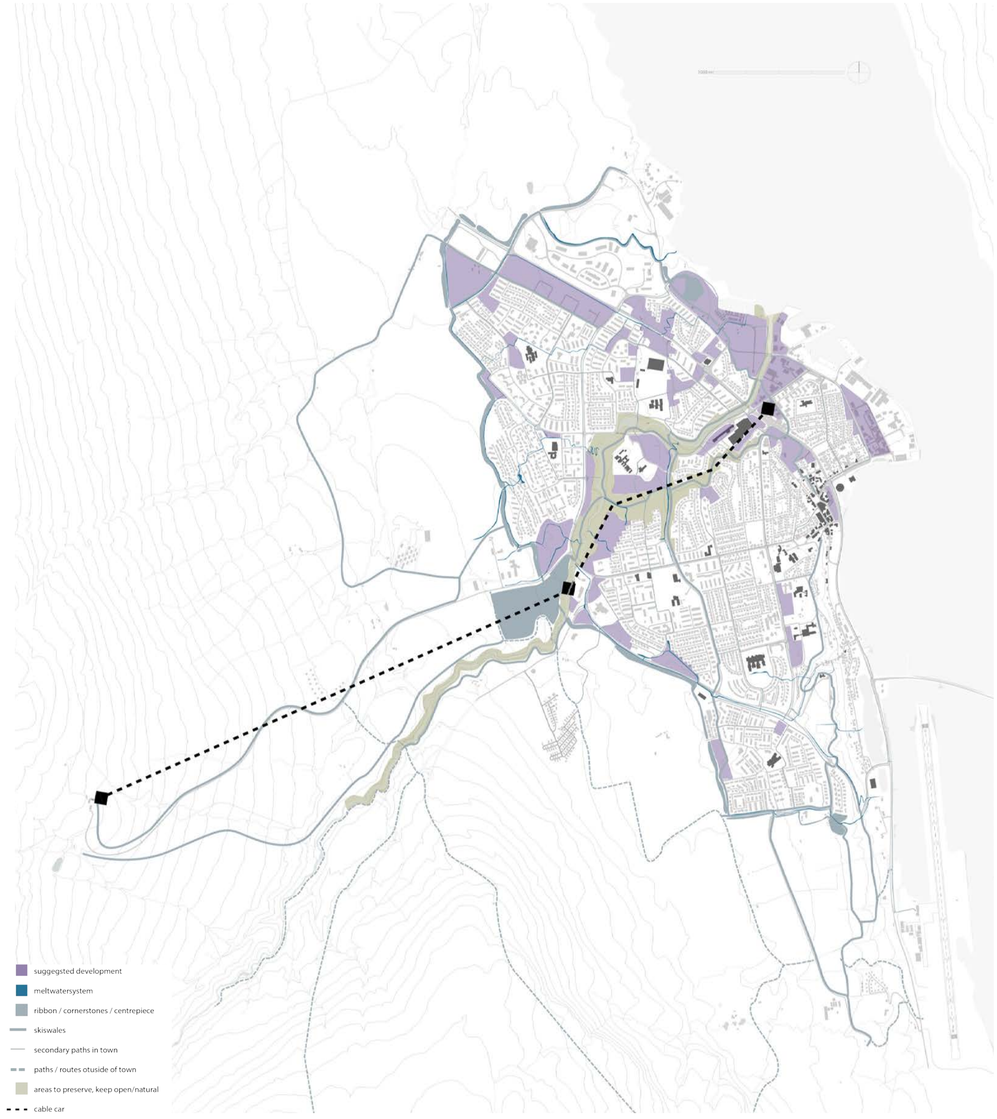
Center for winter sports in Iceland

Akureyri of tomorrow

Bring the outdoors closer to the people

Use snow accumulation to bring added qualities in the town

Build on the identity of a winter sports center



DESIGN ELEMENTS OF THE DEVELOPMENT STRATEGY

THE RIBBON

THE SKISWALES

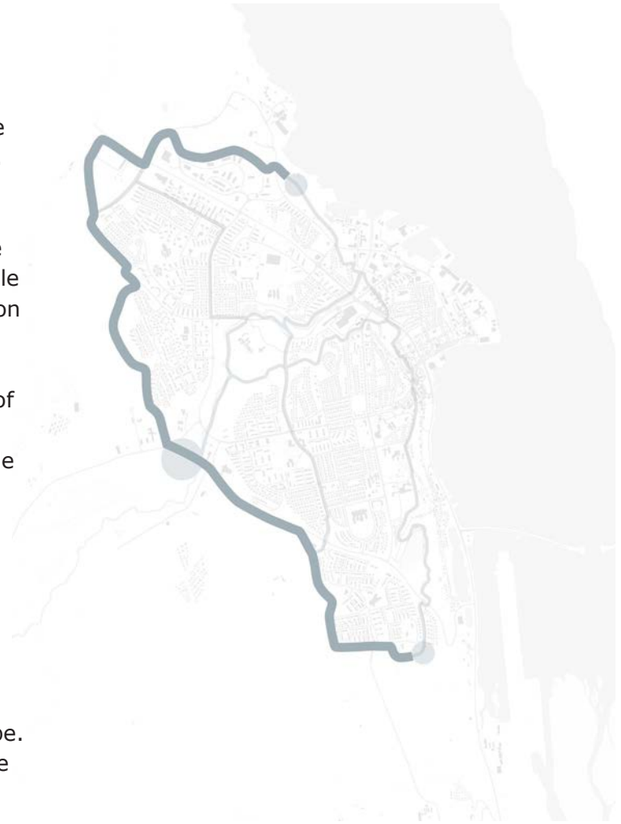
THE CORNERSTONES

THE CENTERPIECE

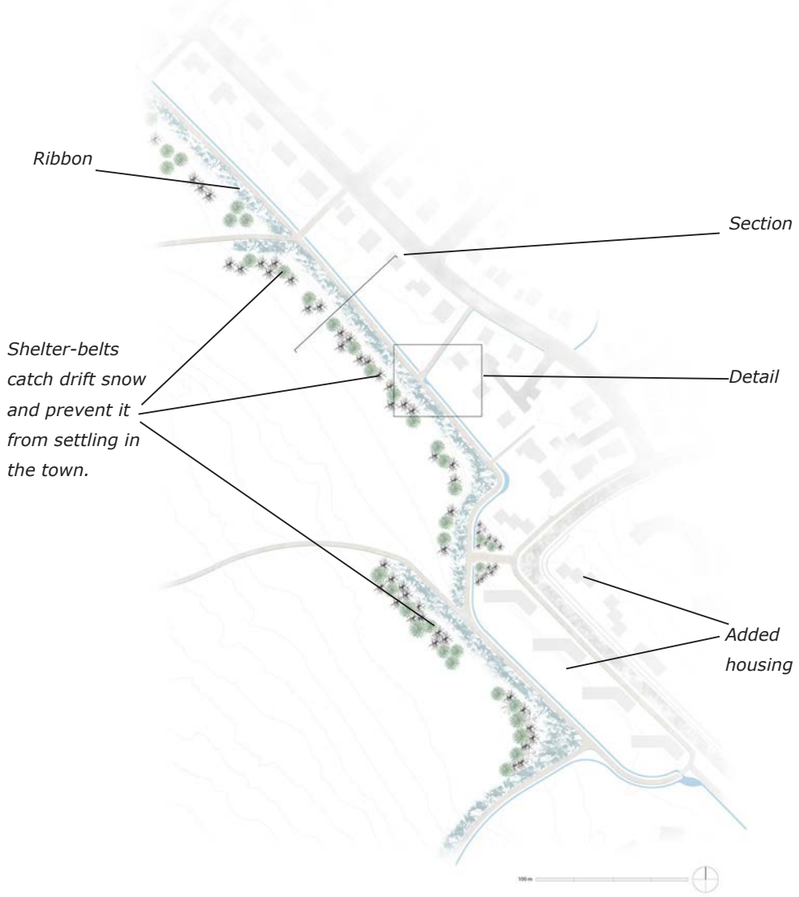
DESIGN

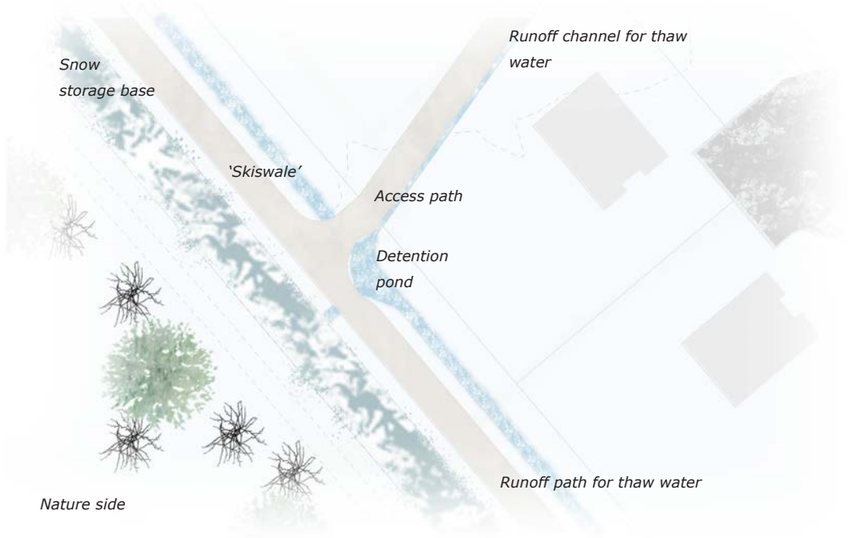
THE RIBBON

Excess snow is removed from the streets of Akureyri and dumped in a linear snow-storage at the edge of town, framing it and marking the boundary between the town and the landscape. The snow-piles accumulate throughout the winter season and with time create a variable environment at the town's edge, away from the traffic. This creates a linear snow-park accessible for locals and visitors to enjoy outdoor recreation and at the same time ensuring safe mobility on the streets for both vehicles and pedestrians.
A basin is used as the base for a wall built out of snow and the basin collects the thaw water as the snow melts. The basins surface is permeable to take advantage of natural filtration straight through the soil. If the flow is too much for natural filtration or if the ground is frozen, the water is channelled away through a system of water channels and detention ponds to avoid flooding and property damage.
A Skiswale path follows the Ribbon, linking the different parts of the town and gateways at regular intervals link the town and the landscape. The Ribbon thus becomes a boarder and a place of flows.



EXAMPLE OF THE RIBBON IMPLEMENTED AT AN EXISTING NEIGHBORHOOD



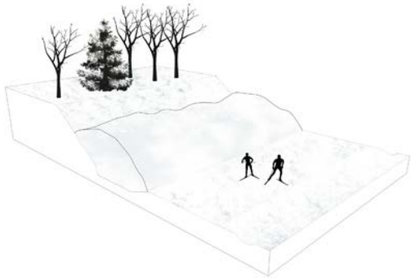


Paths along and through the ´Ribbon´

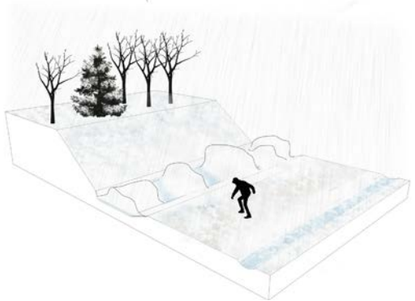
Channels for thaw water

The base for the Ribbon and access for snow dump

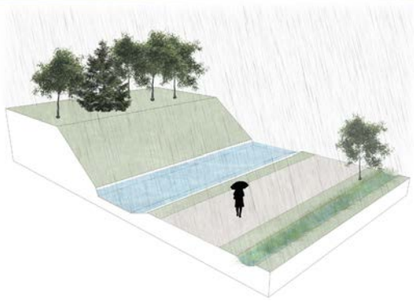
SEASONAL CHANGES AT THE RIBBON



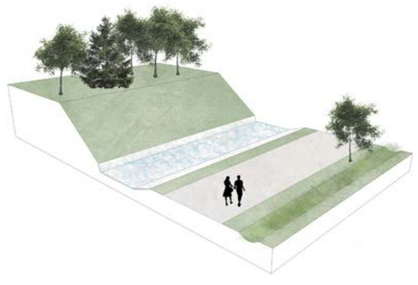
During the winter the snow pack grows, creating an enclosing wall around the town.



During thaw events the base of the snow storage collects the thaw water, reducing floodrisk.



During thaw and rain events the basin and bio-swale collect and distribute the water.



During the summer the Ribbon is a linear park, marking the edge of the town where people, flora and fauna can flourish.

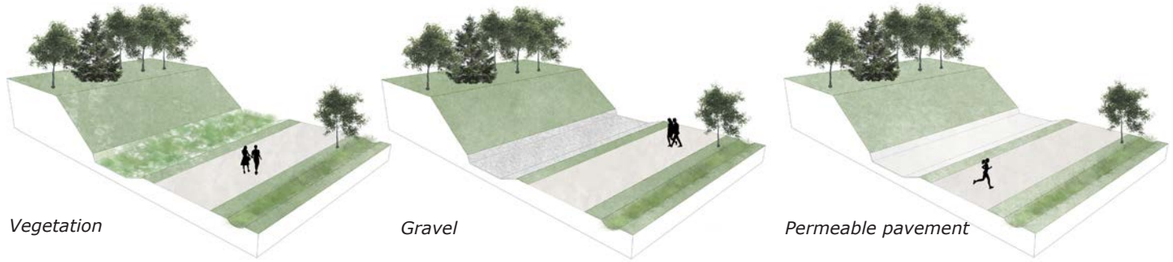
Vegetated shelter-belt stops drift-snow and creates shelter from wind.

Snow-storage basin and snow-pack.

'Skiwale' path

Existing private house and garden.

SUMMERTIME AT THE RIBBON

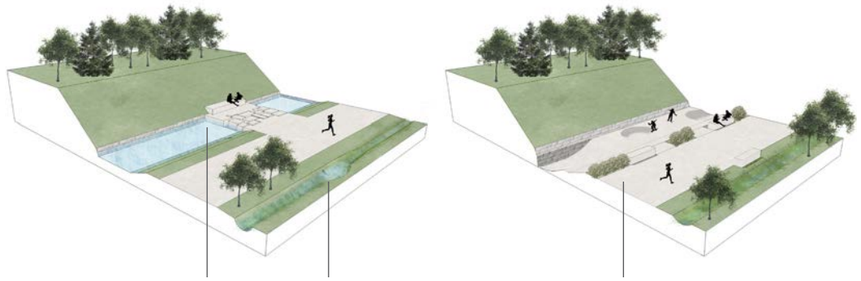


Vegetation

Gravel

Permeable pavement

Different surfice materials along the Ribbon different experiances along it. All surfaces are permeable for natural infiltration on site for thaw- and stormwater.



Area to sit and stay. The water can flow between the stepping stones.

Pipe for excess water to flow into the bio-swale.

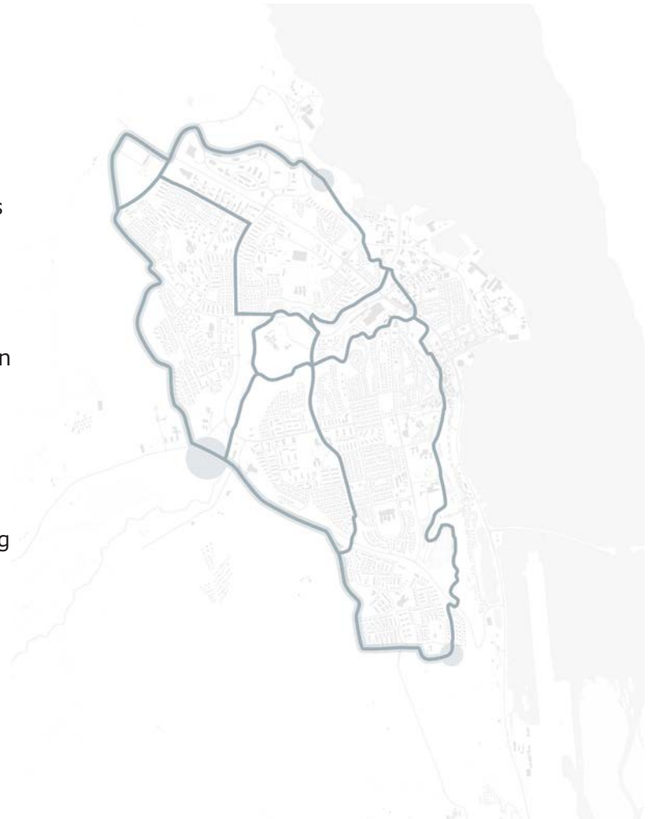
Bowls in the pavement create a skatepark and allow for extra water storage.

Activities along the Ribbon include seating areas, elevations in the surface create oportunities for play and channels for excess water to drain from the Ribbon basin. These differences along the Ribbon create a diverse attractions during the time of year when snow storage is not needed.

The Ribbon in summer-mode where the snow-storage basin becomes a storm-water basin. The Skiswale path is a regular path for pedestrians, bikers and a space for play.

THE SKISWALES

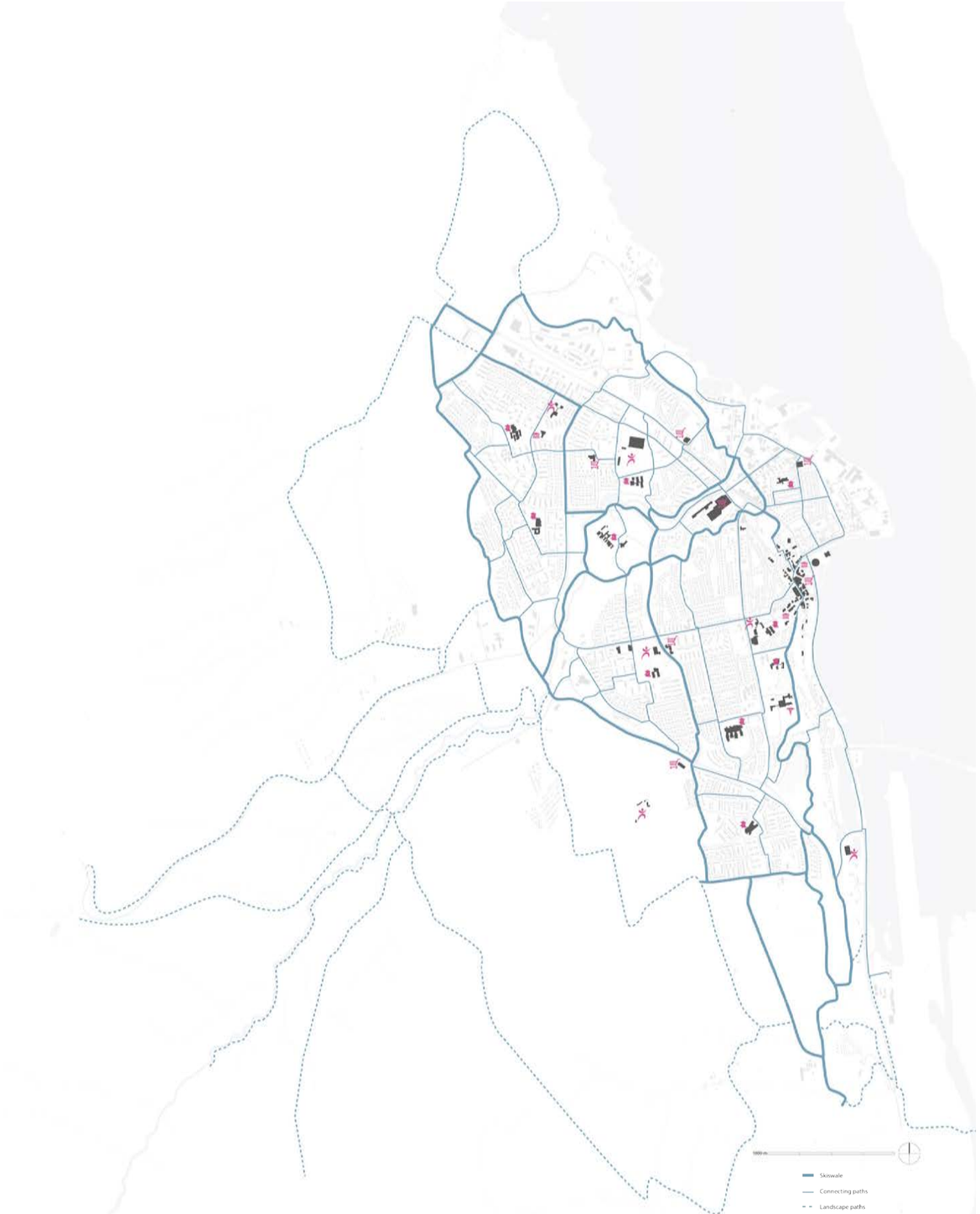
The Skiswales are a network of paths where snow is collected, pressed down and manipulated to create smooth snow-surfaces for skiing highways, linking the town centre and the different neighbourhoods to the Ribbon and the landscape beyond. This makes it possible to use skis, sled and other sliding equipment for day-to-day travel within the town. It would even be simple and easy to ski all the way from the top of Hlidarfjall mountain to the apre-ski downtown. The Skiswales are also connected to a more extensive path-system to ensure easy transport throughout the town for commuting and leisure.
During thaw events, as the snow melts from the Skiswales, thaw water is collected in water channels, where it can filter naturally through the soil or is sent towards the detention pond system.



Skiswale path space doubles as a bioswale allowing natural filtration, providing water for the surrounding vegetation, and channeling ecxess thaw water towards detention ponds.

During the summer the path-space at the Skiswale sites becomes an open space and regular path in the town, for pedestrians, bikers and outdoor activities.

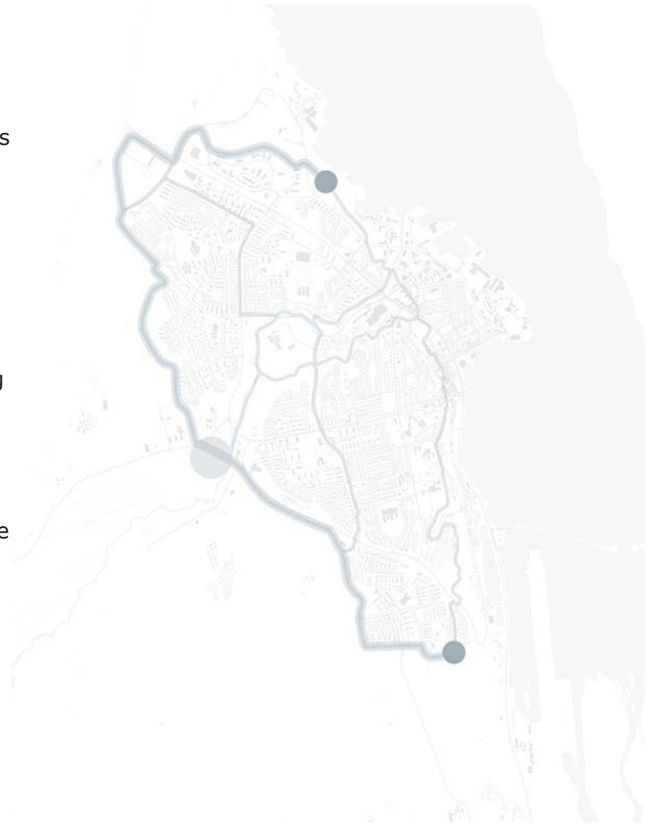
SKISWALES, CONNECTING PATHS IN TOWN AND PATHS IN THE LANDSCAPE



Skiswale paths are accompanied by connecting paths to important destinations within Akureyri and paths to connect the town and the landscape beyond the Ribbon.

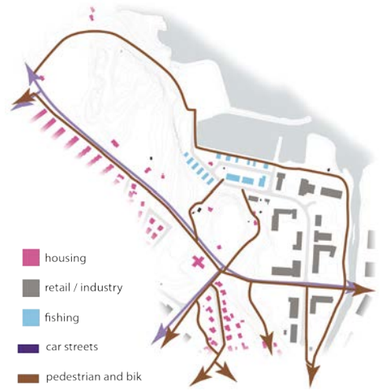
THE CORNERSTONES

The Cornerstones are essentially open spaces reserved for larger snow storage away from the traffic, which prevents large amounts of pollution to build up in the snow pack throughout the winter. The Cornerstones mark the beginning and end of the Ribbon. They have flexible recreational function, when there is little snow they can be used as play-areas for kids, for people out walking for leisure, perhaps looking for northern lights, or alike. When the amount of snow is significant they could be used for sports, such as fat-bikes, snow scooters or even snow hotels in co-operation with hotels in the town.
Thaw water is either filtered through the soil on the site or channelled away towards the detention pond system.

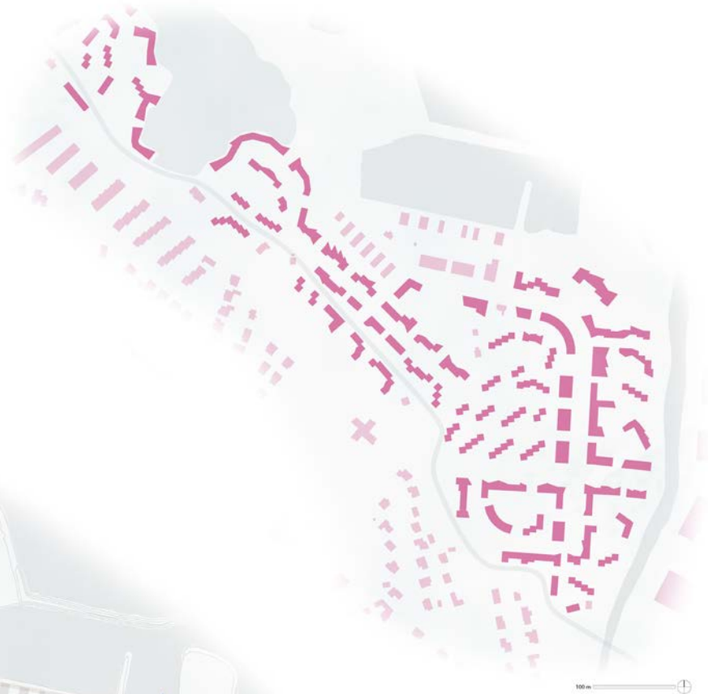


EXAMPLE FROM THE NORTHERN CORNERSTONE SITE

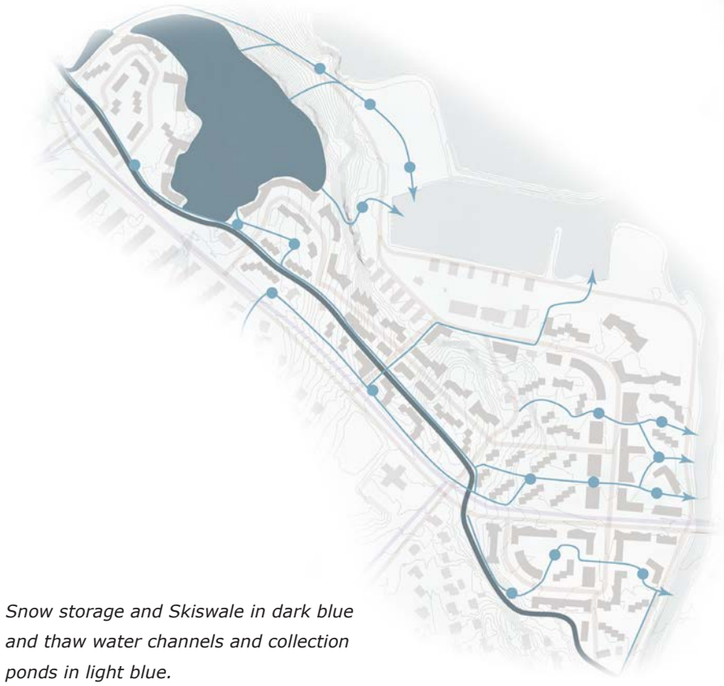
The site sits at the periphery of the town, where the Glerá river meets the ocean. The function on the site is mostly small scale industry, specialised shops and there is a harbour for small fishing boats. The area is lively during the day but mostly empty after office hours. As the town center is only about 15 min walk away from this site, it is ideal for redevelopment and densification of the town. The hill at the northern end of the site serves as the actual Cornerstone so it is kept open for snow storage but buildings form a frame around it. The topography of the site is used to control the flow of thaw water with ponds on the way to slow it down and make room for pollution filtration.



Current situation



Existing housing (light) and new development (dark).



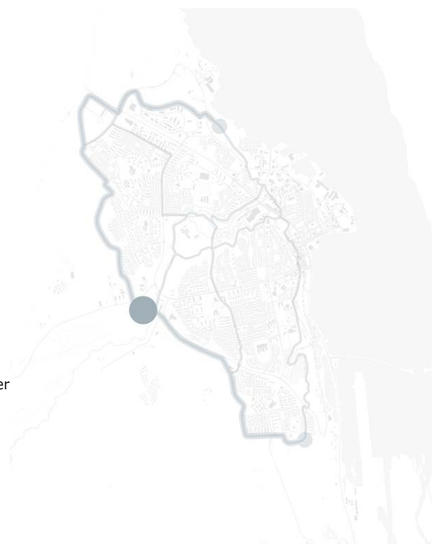
Snow storage and Skiswale in dark blue and thaw water channels and collection ponds in light blue.

CURRENT SITUATION

The area is largely empty and creates a void in the town.
The river creates a boundary between the neighborhoods but the void creates a barrier.
Recycling station and small scale industry is located to the north-west of the river and on the other side of it is more small scale industry.
The road crossing the river is an important transport connection.
The Glerárgil gorge is protected due to its unique and beautiful rock formations.

THE CENTERPIECE

This site sits at the gateway from the town towards Hlíðarfjall ski area, Súlur mountain and Glerárdalur valley, all popular destinations for skiing and hiking. It is an ideal spot to enlarge the ski area so it will reach from the top of the mountain to the edge of the town.
The Centerpiece is a fairly large area so it can store huge amounts of snow if needed and the snow can be used to form a snow-park with jumps and such for skiers and snowboarders.
Managing the thaw water is similar as for the Cornerstones where water that is not filtered through the soil is controlled by water channels and ponds.



PROPOSAL

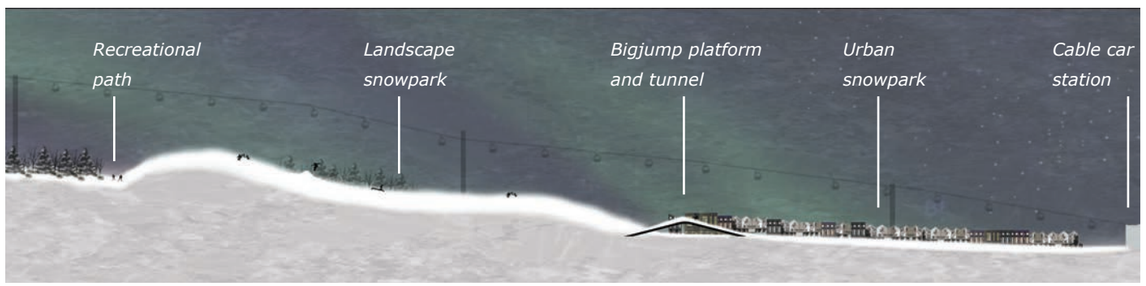
This proposal transforms the area into a townscape snowpark for skiers and snowboarders. It becomes a destination for locals and visitors, a unique landmark which furhter strengthens Akureyri's identity as a wintersports center.
The site is an extension to the ski area in Hlíðarfjall, a snowpark where excess snow from the streets and paths is used to form jumps for adventurous skiers and snowboarders. The site is divided into two parts, outside and inside the Ribbon; landscape and urban. New housing development to the west and east of the Glerá river frames the snowpark and a row of houses represent the Ribbon through the snowpark. The new cable car ski lift, with stations close to the town center, the snowpark and in the moutain provides an alternative and enjoyable transportation mode to the ski area.
The snowpark has different character within the site. Outside of the Ribbon, the area closest to the road is for small jumps and rails but within the trees closer to the river, riders can choose an 'adventure' route. The gateway into the urban part of the snowpark is a platform for a big-jump with a tunnel underneath for an uninhibited continuum for the Skiswale path following the Ribbon. The platform allows daredevils to literally jump into town. Those who are more cautious can choose to skip the jump and ride on either side of the platform. The urban part of the snowpark is where riders can meet up and decide whether they want to catch a ride with the cable car back to the mountain or go down town, either by cable car or use the in-town Skiswale paths to their home, hotel, apré-ski bar etc. A small tow-lift on the site allows riders to get to the top of the snowpark if they feel like practicing jumps and tricks.

Channels and detention ponds for excess thaw water.

Ribbon, Centerpiece snow-park and access points for snow-dump.

Flows within the site.

New housing (dark) and existing housing (light).



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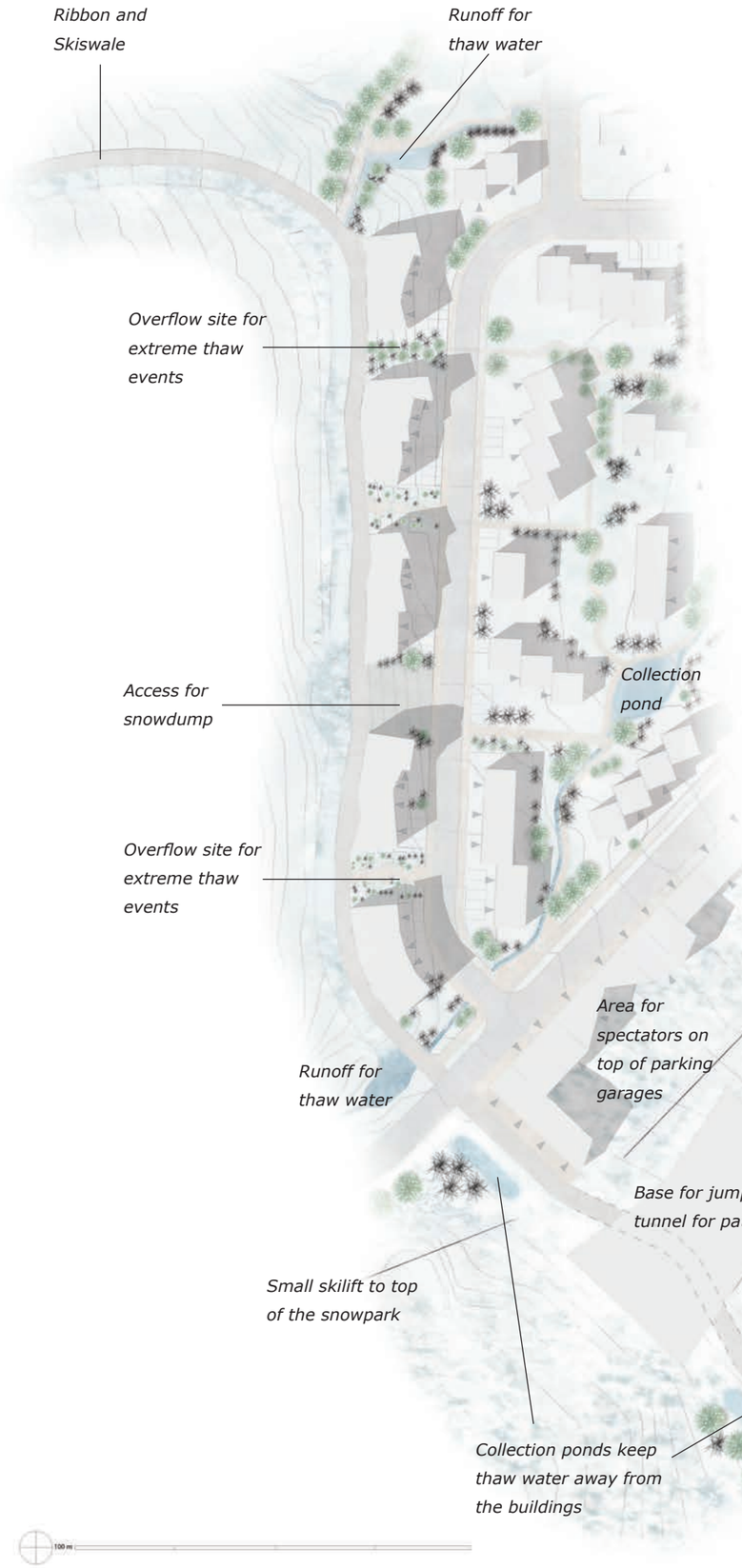


DETAIL PLAN

The Ribbon lays at the edge of the new develoment so it almost becomes one with the buildings, a sort replica of a medievil city wall. For the thaw water a series of channels and ponds are implemented between the buildings and in case of an extreme thaw event, the water can flow over at controlled points and is channelled towards collection ponds.

BUILDUP OF THE SNOWSTORAGE SYSTEM

The first part is the Ribbon and Skiswale along the Glerá river, building up a frame of what the snow storage will be like throughout the winter season.

As more snow builds up the rest of the Skiswales are formed and the Cornerstones and Centerpiece start to form. By forming the skiswales early in the season they can be used for recreation and commute for longer.

With more and more snow the system gradually becomes filled up and continues to grow untill the snow begins to thaw.

A DAY IN THE LIFE IN AKUREYRI

A LOCAL 'AKUREYRINGUR'

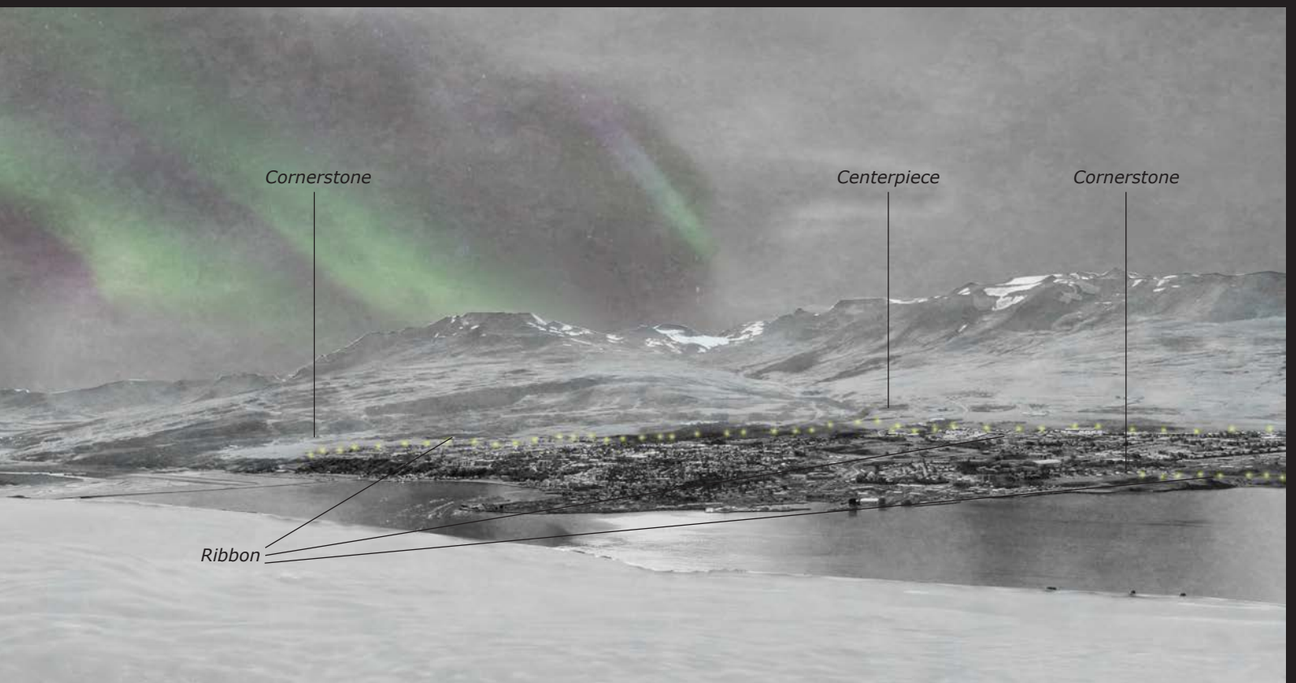
I wake up on a February morning at 7 o'clock. Even though the daylight is longer every day now, it is still dark until about 10 o'clock. The temperature outside is not so cold, about -5°C and slightly windy. After breakfast I put on my outdoor-gear and grab my backpack with clothes to switch to when I get to work. I put on my nordic-ski boots and grab my skis to go to work. It has been snowing for the past days and the town-workers have been keeping busy maintaining the paths for skiing commuters. The way to work is mostly downhill since I work in the town center and on the way I meet the usual crowd, my fellow-commuters. I meet a friend and we decide to meet up after work for a coffee. The ride to work takes about 10 minutes. I change from my outdoor clothes to work attire and I´m at my desk at 8.15, morning coffee in hand and feeling energized after the ride. At 4 in the afternoon I walk to a café to meet the friend from the morning. We plan to go skiing next weekend, since neither of us have a car we will take the cable car from town and decide to meet at the station on Saturday morning. When it's time to go home I decide to take the longer route to get some exercise. On my way home I see many familiar faces and stop to chat with a few acquaintances. After dinner I walk to the swimming pool to soak in the hot tub and relax before going to bed. Tomorrow I´ll wake up early to take a longer route to work, going out to the Ribbon and follow the path along the outskirts of town and from there towards the office in the center.

A VISITING OUTDOOR ENTHUSIAST

I came to Akureyri to go skiing and biking on my new fat-bike. I stay at a hotel in the town center and plan to stay for a long weekend. First day is biking-day. My friends and I wake up before it gets light but when we are ready to go the daylight is bright but it is snowing and a bit windy. We take our bikes and head on towards the north, planning on biking to the north Cornerstone to try out a route with jumps we know has been made there. After having fun there for a while we continue along the Ribbon and decide to go out further out from the town, using one of the paths leading out towards the landscape. It is like an obstacle run but we have fun. After learning that we can take the cable car up to the ski-area we decide to try that out and ride down the mountain. It´s a blast so we do a couple of rounds of that. Soon we get hungry so we stop and have lunch at a restaurant by the mid-way cable car station. After the break we decide to do one more round of riding down the mountain and then continue towards the southern Cornerstone but we take our time by using paths leading to and from the Ribbon, like we are sewing the town and the landscape together with our route. When we have had enough for the day we bike to the center to meet other outdoor enthusiasts in town for apré-ski and swap stories. Tomorrow we´ll go skiing.

CONCLUDING REMARKS

One of Akureyri’s greatest strengths are the landscape and closeness to the nature, the ability to leave your house and be in a natural setting within a matter of minutes. The winter and dark winter days have a strong presence in the town and it is easy to perceive them as a negative, which is a shame since the winter is such a big part of the town life. The natural elements have not been used as an asset in such a way as proposed here, today the snow removal serves only the practical purpose of keeping the streets clear.
The benefits of implementing a pre-determined snow storage system are, for example, the streets become safer for commuters, on foot and by car. By placing the snow storage away from traffic, children who are attracted to play in the snow piles are safer than if the piles are on sidewalks and street corners. Also, storing the snow away from the traffic also prevents pollution from building up over time, resulting in less pollution in the thaw water as the snow melts. The pollution in the snow pack also becomes easier to manage.
The recreational opportunities of this proposal are options that are existing in the town today but are made more present and accessible, further strengthen the town’s attractiveness.
Higher density in the town, together with options for muscle-driven commuting and recreation will have many benefits, i.e. better mental and physical health of the residents and create a lively urban life where people are out and about during all times of the year, both locals and visitors.
The hope is that by taking advantage of the natural forces so present in Akureyri, it will allow the town to reach its full potential as a winter paradise.



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