REINVENTING WINTER IN HELSINKI

RECREATING THE MULTI CENTRED SUMMERTIME ARCHIPELAGO CULTURE THROUGHOUT THE YEAR BY INTRODUCING HIGHLY SALINATED LIQUID STATE WATER AND SYNTHETIC DAYLIGHT

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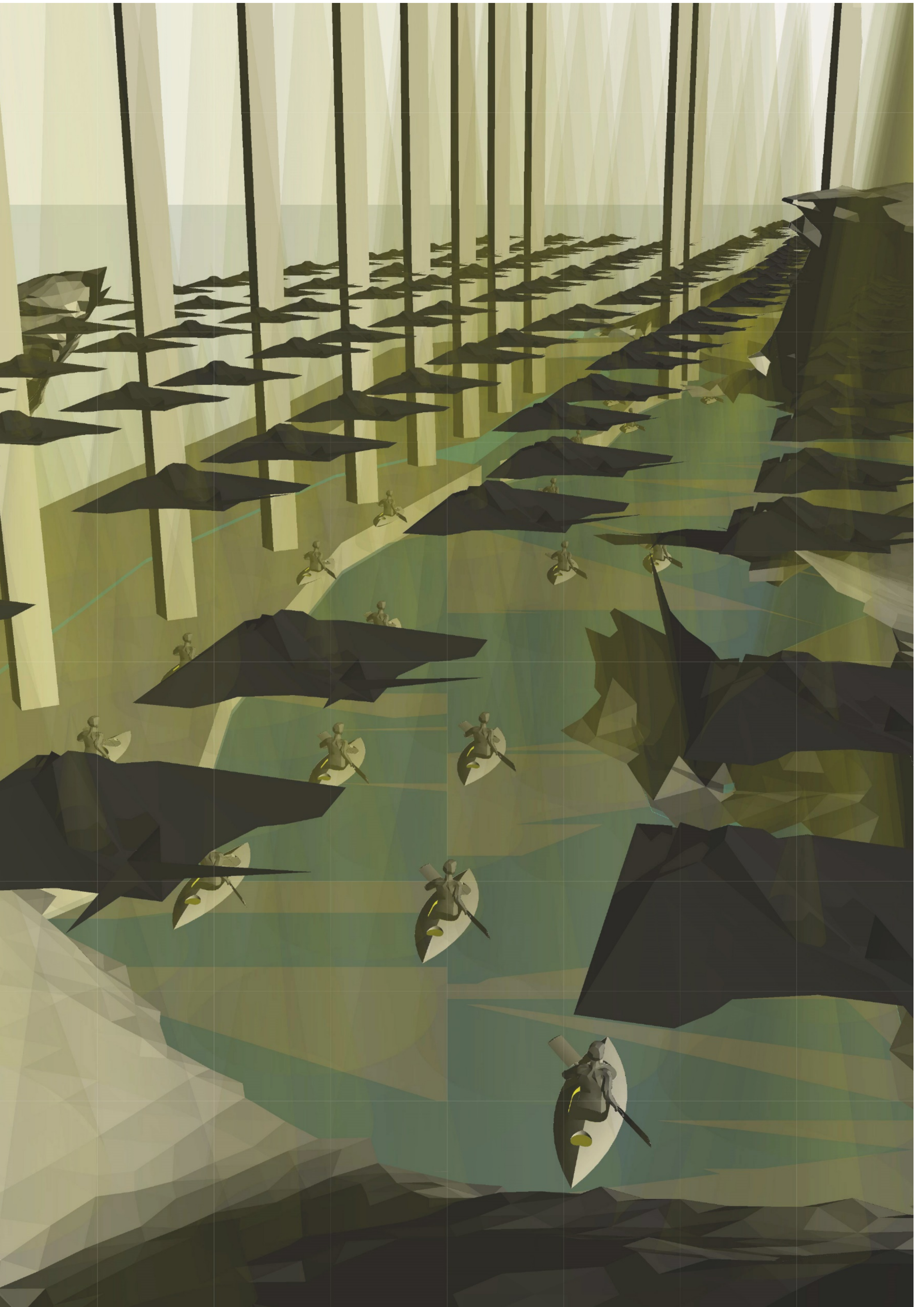

Image 01:
The new Helsinki master plan catalyst zone 01
Drone and lamp post synthetic daylighting system
and anti-freeze canal with winter time kayaking

Contents

ABSTRACT

Finland is the “land of a thousand lakes”[1]. Water is everywhere, in lakes, canals, and the Baltic Sea. Throughout the spring and summer these waters are buzzing with activity, sailing, kayaking, fishing and more. Helsinki comes alive during the summer; the days are long with nearly 19 hours of bright daylight[2] and temperatures reach as high as 32^{0}C[2].

Helsinki people take advantage of the daylight and the warm temperatures, by sailing, kayaking, hiking, swimming, foraging and the typically Scandinavian activity of “island hopping”[3] - a practice of going by boat between the different islands and experiencing the activities each has to offer, then moving on to the next.

However, during winter the days are short and dark, the shortest having only 6 hours of daylight. This dim light is cold in colour and the temperature averages - 6^{0}C. [4]

The waters freeze over[5] typically for four months of year and sea ice restricts water actives including “island hopping”[6] in the archipelago. Winter is depressing in Helsinki. Many people suffer from Seasonal Affective Disorder (S.A.D.)[7]. Alcoholism is rife[8] Even the tourist board has run out of recommendations in winter.[9]

This thesis proposes to reinvent winter in Helsinki by introducing wintertime liquid state waters and synthetic daylight. Low temperature liquid water will be achieved by adding large quantities of salt to a manmade canal and sailing basins to lower the freezing temperature. The synthetic daylight will be created using tall lamp posts and drones carrying angled LED lights. The impact on the wider eco system will be considered for both systems.

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1 A well-established nickname for Finland, referenced in the official Finish tourism website
(visitfinland.com, 2015)
2 (Finnish Meteorological Institute, 2012)
3 (Visit Helsinki, 2015)
4 (Finish Meteorlogical Institute, 2015)
5 (Finish Meteorlogical Institue, 2015)
6 (Visit Helsinki, 2015)
7 This article discuss the correlation between high latitude locations and (S.A.D.
(Peter Paul A. Mersch, 1999)
Helsinki has a high latitude of 610 (Long Lat.net, 2015)
8 “Alcohol has become the leading cause of death in Finland for men, and is a close second for women, a study says.”
This article goes on to explain that alcohol consumption has gone up significantly following the recent tax cut.
(BBC News Correspondent, 2006)
An article in the guardian newspaper asks the question “But what about suicides, depression, alcoholism and our cold, dark winters?” when considering Finland as the best country to live in.
(Harakka, 2010)
9 www.vistitfinland.com the official tourism website of Finland recommends over 12 different actives that you can do during spring and summer, however it only recommends 6 activities that can be done during winter.
(Visit Finland, 2015)

This wintertime liquid state water, and synthetic day lighting will provide an environment which will stimulate development and activity, a *catalyst zone*. A multi-centre city plan will develop from these catalyst zones. This will replicate a culture similar to the multi centred islands of the archipelago and island hopping. However *catalyst zone hopping will be accessible all year.*

Image 02:
4Finland the land of 1000 lakes from above
(Opposite page)

METHODOLOGY

The first chapter will focus on the anti-freeze canal and sailing basins.
It has been found that 5 parts per thousand (ppt) of salt reduces the freezing temperature of water by $0.28^{0}C$[10]. This information will be analysed to determine the quality of salt required to prevent the canal from freezing in Helsinki's winter. The principals of a brine delivery, drainage and filtration system will be analysed and act as a feasibility study to scope out the concept design.

The second chapter will investigate characteristics of daylight;
lux levels, light colour, direct light , sky light and angle of elevation.
Data showing the hourly lux levels for Helsinki on a mid-winters day will be analysed. Together this information will inform a brief to design a synthetic daylighting system in the *light zones.*

In both chapters some of the pertinent parameters will be analysed and explored in order to determine if this scheme is feasible. The effect of salt on the freezing temperature of water

This thesis will be used to support and develop the accompanying design project. The design project will focus on the form and function of the cluster of buildings that occupy the environment created.

[10] See sub chapter "The effect of salt on the freezing temperature of water"

Natural light augmentation precedent:
Mountaintop mirrors of village of Rjukan

The proposed scheme is within a wider context of environment altering masterplans in northern Europe.
For example the mountain top village of Rjukan, Norway, was hidden in the shadow of a neighbouring mountain Gaustatoppen. This meant it was constantly lacking daylight. However, in 2013 artist Martin Andersen has introduced a giant mirror on the opposite mountain. This mirror is used to reflect the sun's light onto Rjukan to create light where before there was only shadow. [11]

"...for the first time ever, the small town of Rjukan, Norway, saw the winter sun."

(Myers, 2013)

Technically the mirror was installed using;

"Helicopters flew in three 17-square-meter (183-square-foot) solar- and wind-powered mirrors, or heliostats, and placed them on a mountain roughly 450 meters (1,475 feet) above the center of town. Engineers based in Germany can now control the mirrors which were activated this week -- by computer, tilting them to follow the course of the sun across the horizon to bring light into Rjukan's main square."

The mirror has had an effect on the local population's health and mood, an article in The Mirror 2013 describes the town's seasonal affective disorder [12] problems before the introduction of the mirror.

"The town is home to 3,500 people - some believed to be suffering from seasonal affective disorder, known as SAD.
The sun moving low across the sky during winter, behind the mountains, means the town gets no direct sunlight between September and March."

(Myers, 2013)

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11 (Johanson, 2013)
12 "Seasonal affective disorder (SAD) is a type of depression that has a seasonal pattern."
(www.nhs.uk, 2014)

The article implies that the local population no longer go elsewhere to seek sun during winter as now the sun is reflected onto the main square.

This sunshine has reduced many of the locals S.A.D. issues.

This improvement in daylighting conditions, and in the population's mood are similar to the ambitions of my project.

Interestingly great lengths have been taken by Andersen to mimic the nature of the sun's light, creating a specific lighting zone in the main square.

"The reflectors - known as heliostats - have been designed to trace the movement of the sun and reflect the light directly onto Rjukan's main square."

(Myers, 2013)

Image 03
Rjukan’s mirror installation on site

Image 04
Giant MIRRORS brighten the winter darkness for town which gets NO sunlight (diagram)

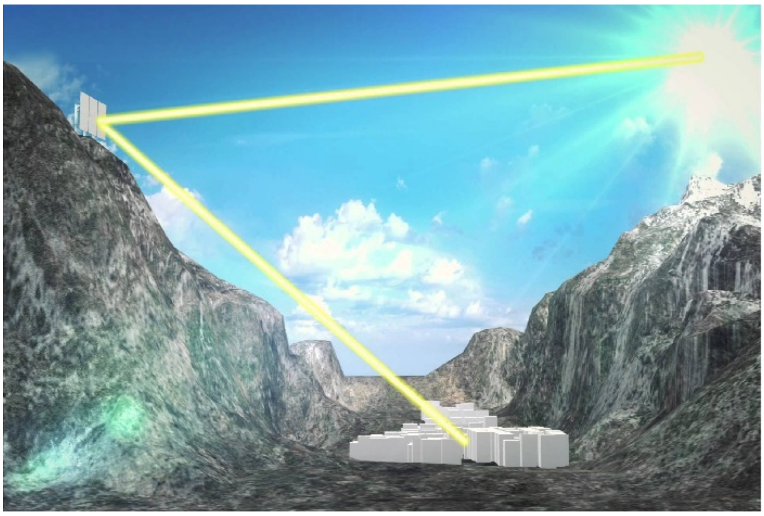


Image 05
Giant MIRRORS brighten the winter darkness for town which gets NO sunlight

THE ARCHIPELAGO

"Finland's capital is surrounded on three sides by the sea, with over 300 islands in her unique archipelago. Many of these islands can be used recreationally, and are reached easily by ferry; … One of the best ways to explore the archipelago, if you don't have a boat of your own, is to take one of the cruises that depart from the Market Square. These will usually skirt along the coast for a while, allowing you to see Helsinki's oldest districts and the historical buildings, before cruising past the private island villas and out into the archipelago proper. Often you can choose to disembark on Suomenlinna and spend some time exploring that island, or relaxing in the sun, before taking one of the many ferries back to the capital."

(Discovering Finland, 2015)

Water activities, and day light are intrinsic to much of Helsinki's positive culture. As is the multi centred typology of the archipelago and the culture of island hopping.

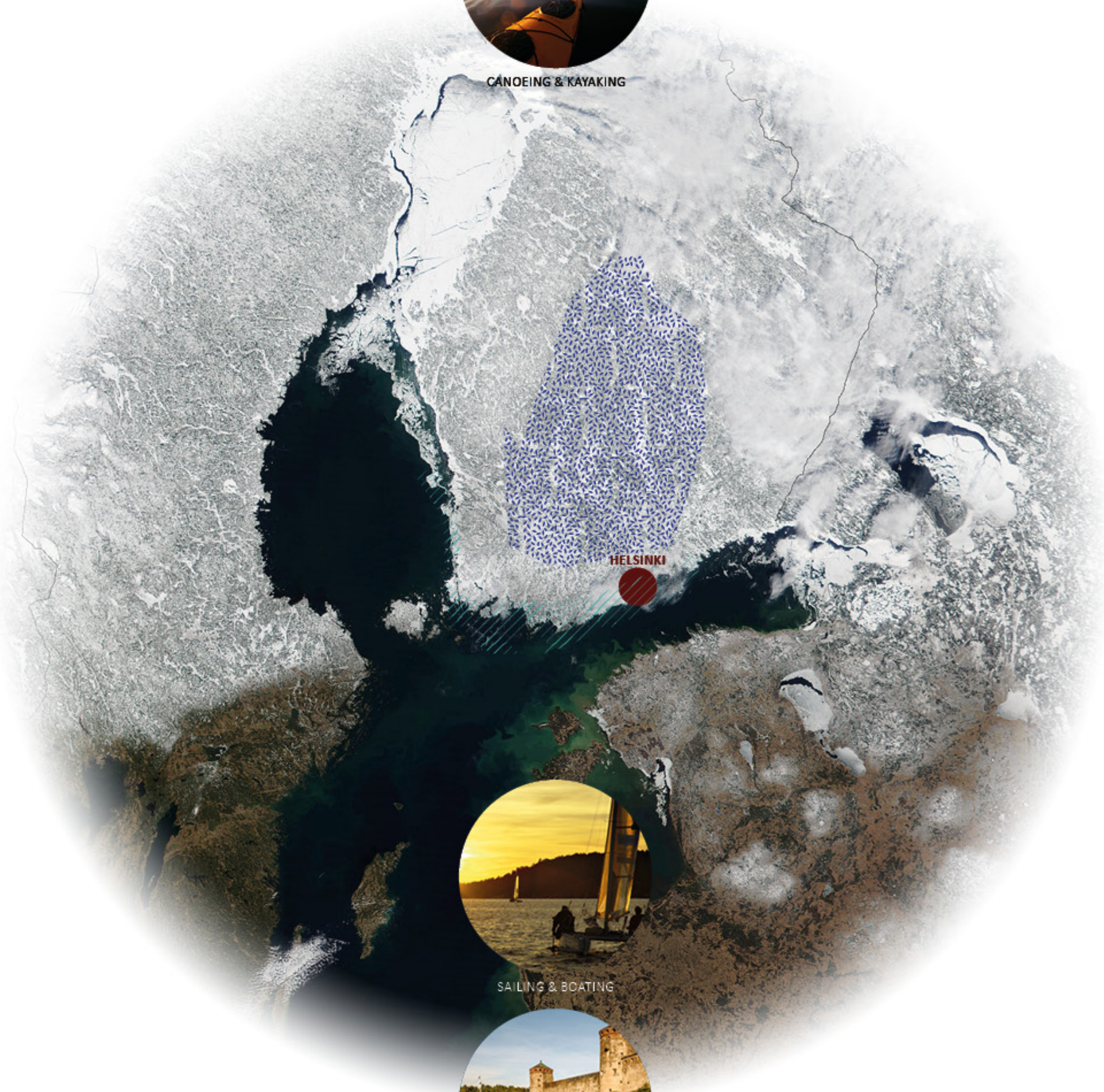
"Island-hop
Verb (used without object), island-hopped, island-hopping.
1.
To travel from island to island, especially to visit a series of islands inthe same chain or area."

(Dictionary Reference, 2015)

Image 06: Helsinki Archipelago

SHOOTING THE RAPIDS

CANOEING & KAYAKING



SAILING & BOATING

CRUISES ON INLAND WATERWAYS

COASTAL CRUISES

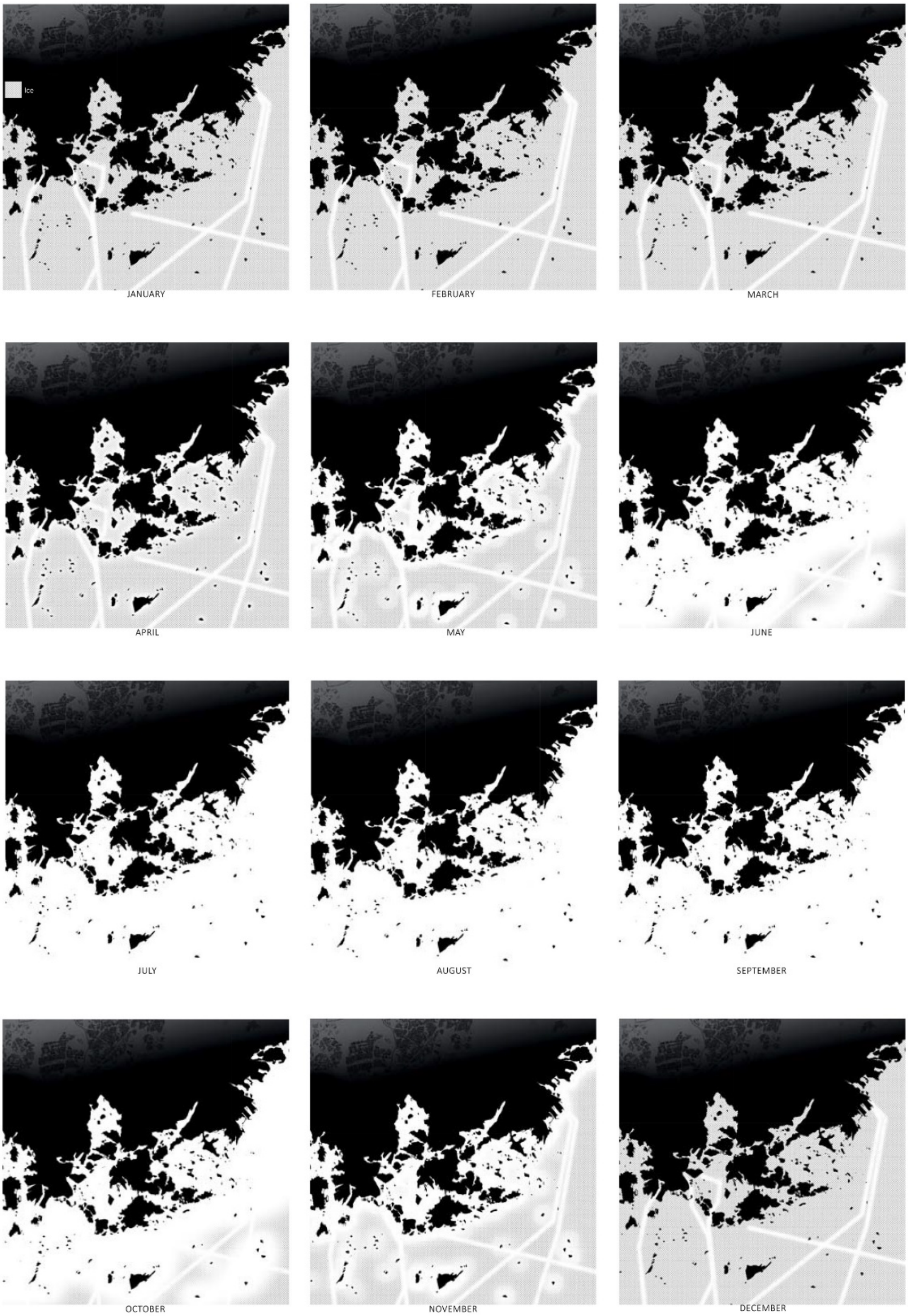
HELSINKI CLIMATE

"Helsinki is the second most northern capital in the world, located on the 60th latitude…. Yet, Helsinki's climate is mild for its latitude and there are four distinct seasons. The temperature ranges from 18^{0}C in summer to -6^{0}C in winter. Daylight conditions vary dramatically: there are around 6 hours of daylight (the sun stays above the horizon line) in the heart of winter, and over 19 at the peak of summer, in addition to associated twilight. On summer solstice, the sun sets at 10.50pm, and the summer sky becomes completely dark. Icy conditions can last from November through March, and the sea off Helsinki normally freezes, but these conditions vary from year to year."

(Peter Corbett, 2009)

The sea ice is unpredictable, some years the entire Gulf of Finland will freeze over other years it will only partially freeze. The Meteorologists can only predict in the January if the Gulf of Finland will freeze, and even then the prediction they are able to make is not precise[13].
Despite the inaccuracy of the sea ice predictions, the ice does seem to form a general pattern. The cycle of sea ice melting and freezing starts in March. From March/ April to May the ice from the previous year melts. Throughout June, July and September the waters are clear of ice. In October and November the water starts to freeze and the ice builds up again. Normally, during the 4 months of December, January, February and part of March the Baltic Sea is frozen.

13"Meteorologist can predict what areas closest to the nearest hundred meters will freeze, however they cannot predict with accuracy if various routes or stretches will freeze over. They makes their predictions by collecting and analysing data from previous years however there are often anomalies that remain unpredictable. " (Finish Meteorlogical Institue, 2015)


Ice
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER

CRUISE SERVICES

Due to the sea ice freezing over the Gulf of Finland in the winter the boat and the cruise operators close their services for several months. The *Finish Cruise Company* show a map of the routes their boats take around the archipelago (see following page), also shown are the months in which they operate cruises. We can assume they are not operational in winter due to the frozen sea.
Without the cruise liners in operation the islands are inaccessible and lie dormant throughout the winter. Thus, a large part of Helsinki culture dies for the winter months.

Image 09: Image 10: Helsinki Cruises map showing winter time closures

IHA-Lines Ltd Helsinki Cruises ~ m/s Doris ~ Route Map 2012

Blue route: **'Beautiful Eastern Archipelago'** 1 1/2 hours (5 May - 30 Sept)
Departures: DAILY at 11:30 and 14:00, welcome 1/2 h earlier, no reservation for sightseeing seats
Red route: **'Helsinki and its Fortresses'** 1 1/2 hours (5 May - 29 Sept)
Departure: MON-SAT (not Sun) at 16:30, welcome 1/2 h earlier, no reservation for sightseeing seats
Black route: **'Evening & Dinner Cruise'** 2 1/2 hours (5 May - 29 Sept)
Departure: MON-SAT (not Sun) at 19:00, reservation recommended for dinner guests, check-in at 18:30
Green route: **'Special Military Island Trip'** 3 ½ hours. This special military base trip is open
for foreigners only on 11th and 12 of August 2012, passport required, bookings +358 (0)9 6874 5050.

Print | Close the window

IHA-Lines Oy

HELSINKI CRUISES

Safely, reliably and pleasurably since 1979

Image 10: Frozen Finland

ICE BREAKERS

The government has a fleet of ice breaker ships that is used to create routes through the sea ice for the major commercial shipping routes. However these routes are not used to connect the small islands.

DAYLIGHT IN HELSINKI

The light conditions in Helsinki vary dramatically throughout the seasons. In the summer the Fins enjoy up to 19 ½ hours a day of daylight and warm sea waters. Whereas in winter the days become as short as 6 ½ hours.[14]

The wonderful long summer days, allow summertime celebrations to continue long into the night. A description about the midsummer celebrations on one of the islands in *Frommer's 500 Extraordinary Islands reads*:

> *"Seurassari is at its most festive during its midsummer celebration, with traditional craft displays, folk dancing and music performances. Every year, one newlywed couple is chosen to light the huge bonfire along the coast of Seurassari, igniting the main event of this island's midsummer party.*
> *The warm weather and long light season is when Helsinkiers take to Seurassari with provisions in tow for lazy picnics, whether on the islands Baltic beaches or on the smooth rocks slopes that seem tailor-made for lounging. "*

(Holly Hughes, 2010, p. 358)

This is in stark contrast to the short, dull, winter days. The quality and colour of the light is cold, blue and dull. These factors all contribute to a many people living in Helsinki developing S.A.D. [15] [16]

One Helsinkier describes winter;

> *"I hated winter in Helsinki. People seemed grey and withdrawn. Darkness overwhelms everything. The city is eternally windy and raw."*

(Westo, 2013)

Helsinki's summer is regarded as glorious and bright, with lots of activities and summertime fun. The winter appears to be a gloomy sedentary time of year, both dark and frozen.

Helsinki needs to reinvent its winter.

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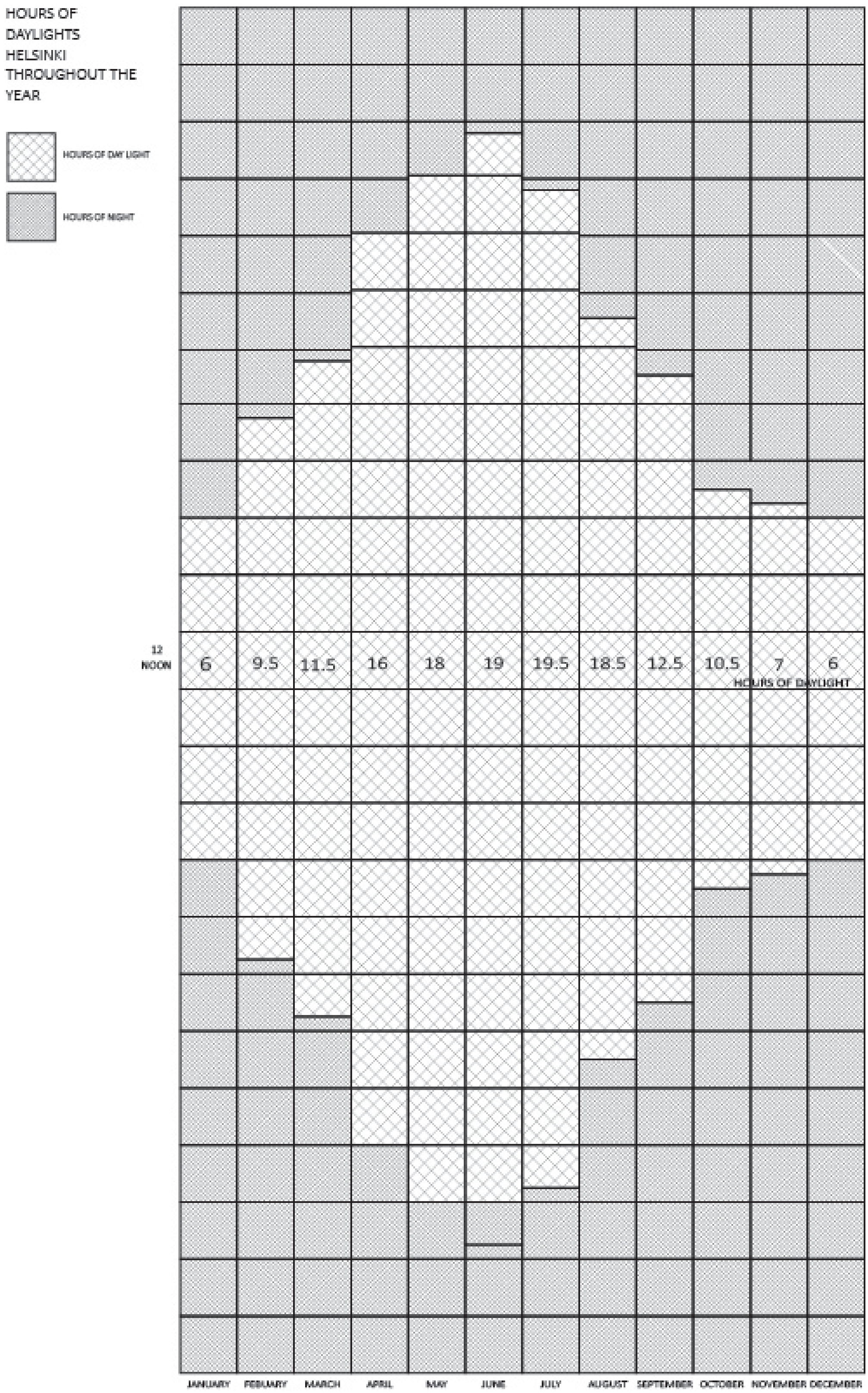
14 time and date www.timeanddate.com
15 The www.nhs.uk describes this disorder as "…a type of depression that has a seasonal pattern. The episodes of depression tend to occur at the same time each year, usually during winter…thought to be linked to reduced exposure to sunlight during the shorter days of the year."
(www.nhs.uk, 2014)
16"14% of Finish residents suffer from winter time blues, whereas 9.5% suffer from the more intense S.A.D."
(.greatsaunas.com, 2015)

Image 12: Annual hours of daylight in Helsinki per month



DESIGN PROPOSAL

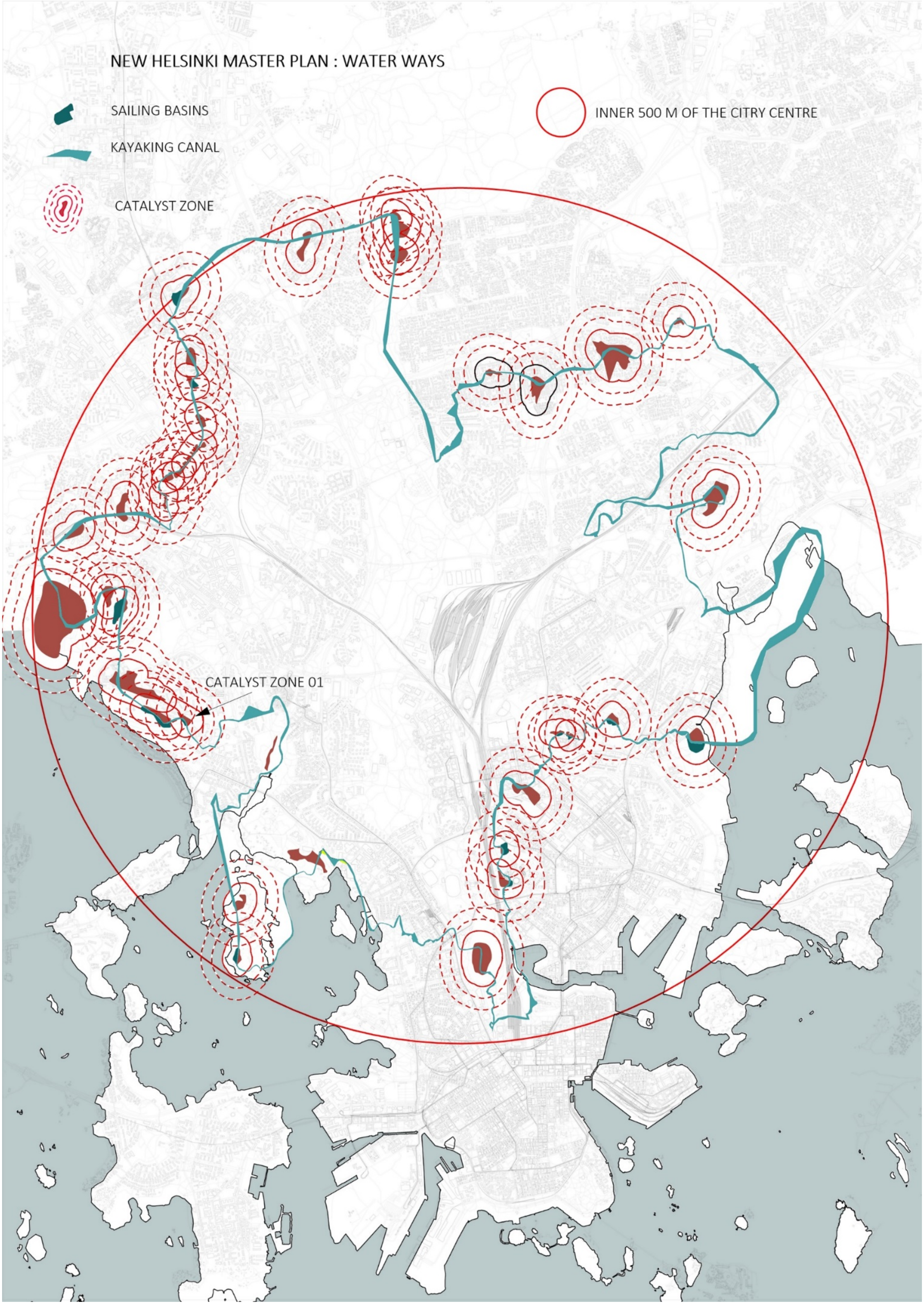
I propose to reinvent Helsinki's winter by developing a multi centred masterplan. This will include an anti-freeze canal, sailing basins, area of dense development called *catalysts zones* and in them areas of synthetic daylight called lighting zones.

The anti-freeze water will be achieved using salt to lower the freezing temperature of the water.

The lighting zones will be achieved by simulating the characteristics of daylight using drones carrying LEDs and tall lamp posts. These will be above the water in the *catalyst zone* area.

The catalyst zone development will include the canal, a sailing basin, sailing clubhouse, salt factory, drone coup, shops and food and drinks kiosks.
A key area of the development will be the concrete beach. The *beach* will house restaurants, cafes, bars, kiosks, *beach objects* and beach games.

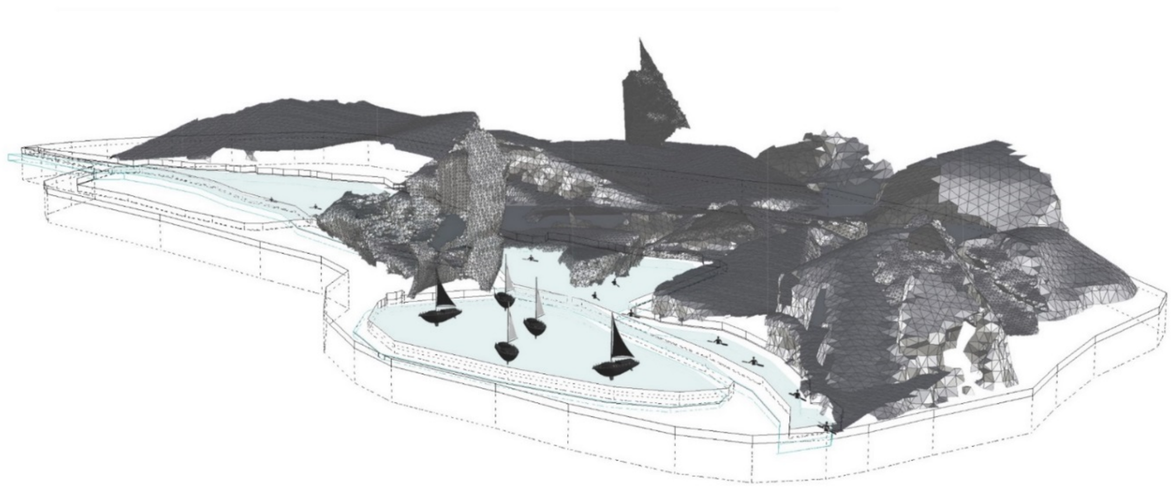
Image 13: (opposite page) the new Helsinki master plan: water ways


NEW HELSINKI MASTER PLAN : WATER WAYS
SAILING BASINS
KAYAKING CANAL
CATALYST ZONE
INNER 500 M OF THE CITRY CENTRE
CATALYST ZONE 01

CHAPTER 01:

CREATING AN ANTI-FREEZE CANAL

Image 14: water ways in catalyst zone 01



CONCEPT DESIGN

To reinvent winter in Helsinki I propose to introduce an anti-freeze canal that will provide liquid state water all year round to allow water activities such as kayaking as well as a transport network. Sailing basins will provide dinghy sailing facilities, making use of the strong inland winds[17].

The canal will be prevented from freezing by adding salt, which will lower the freezing temperature of the water. To create and maintain this anti-freeze canal and sailing basins will be produced by filtering and pumping sea water from the nearby Baltic Sea via a pipe network to the salt factory. Here the sea water will be pumped into boilers which will evaporated the water, leaving salt. This salt will then be added to water to enable it to move through the pipes as it is added to the canal. This will also allow the factory to mix precise percentages of brine to achieve the correct salinity. Water from the canal will be pumped out to the salt factory and boiled to create salt. This will ensure the canal does not overflow due to the additional 650mm rain water per month.

The salt factory will have an adjacent spa which will use salt in the treatments provided, for example salt scrubs and skin treatments. There will be a steam room filled with steam produced as a by-product of the salt making process.

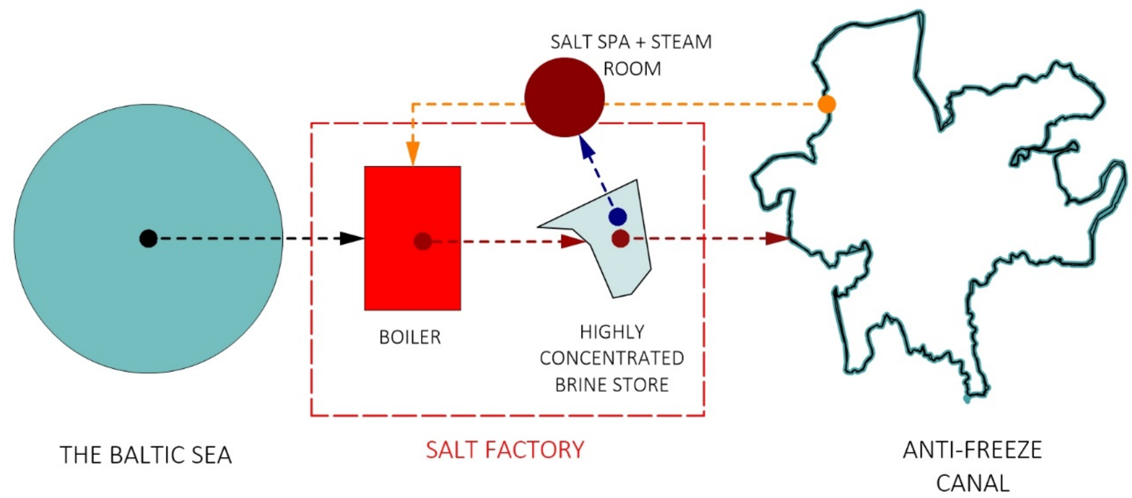
Image 15: (opposite page) salt production process

17 The mean wind speed in Helsinki is 5 m/s.
(Weather Spark, 2015)
"The most comfortable sailing is in winds from 5 to 12 knots."
(Windsong Sailing Charters & School, 2013)
5m/s is equal to 9 knots which is deemed " comfortable sailing"
(Unit conversion.org, 2015)

SALT PRODCUCTION PROCESS CONCEPT

KEY

- PIPE TRANSPORTING SEA WATER WITH PUMP AND FISH FILTER ATTACHED
- PIPE TRANSPORTING HIGHLY SALINIATED BRINE WITH PUMP AND FISH FILTER ATTACHED
- PIPE TRANSPORTING SALINATED EXCESS WATER (PRODUCED BY RAIN) INTO BOILER TO BE CONVERTED INTO SALT (PREVENTING CANAL FROM OVERFLOWING)
- SALTED STEAM FROM SALT BOILING TO STEAM ROOM + SALT TO SALT SPA



THE EFFECT OF SALT ON THE FREEZING TEMPERATURE OF WATER

The salt content of sea water has an effect on the freezing temperature. The more salt the lower the freezing temperature.

"Salinity is a measure of the concentration of dissolved salts in water. Until recently, a common way to define salinity values has been parts per thousand (ppt), or kilograms of salt in 1,000 kilograms of water. Today, salinity is usually described in practical salinity units (psu), a more accurate but more complex definition. Nonetheless, values of salinity in ppt and psu are nearly equivalent18. The average salinity of the ocean typically varies from 32 to 37 psu, but in Polar Regions, it may be less than 30 psu. Sodium chloride (table salt) is the most abundant of the many salts found in the ocean.

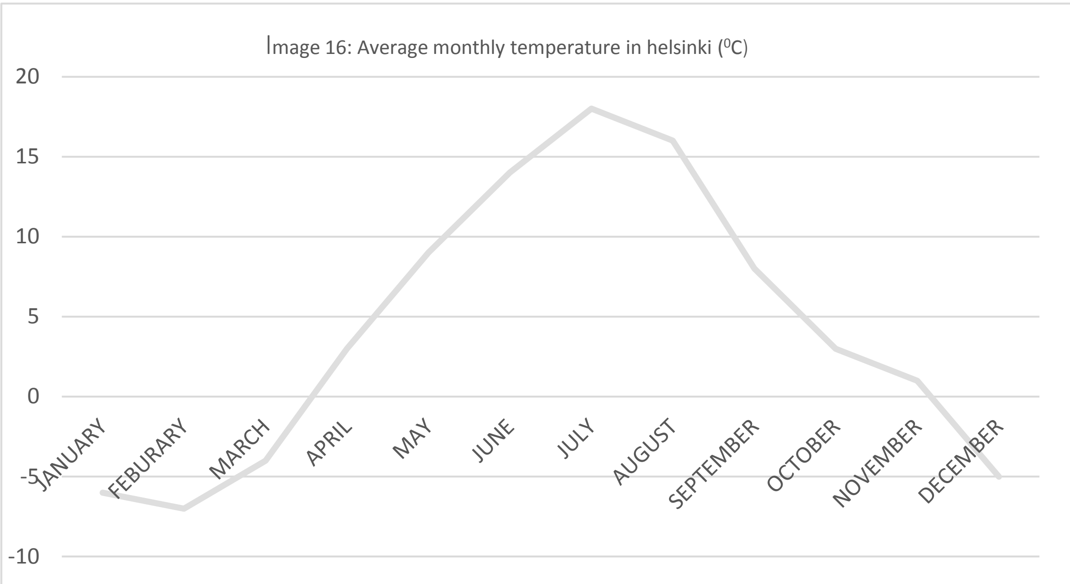
…Fresh water freezes at 0 degrees Celsius (32 degrees Fahrenheit), but the freezing point of sea water varies. For every 5 ppt increase in salinity, the freezing point decreases by 0.28 degrees Celsius (0.5 degrees Fahrenheit); thus, in polar regions with an ocean salinity of 35 ppt, the water begins to freeze at -1.8 degrees Celsius (28.8 degrees Fahrenheit)."

(Scambos, 2003)

[18] For the purposes of this investigation psu and ppt will be treated as the same numerical value.
(NASA, 2015)

HELSINKI'S CLIMATE: MONTHLY AIR TEMPERATURES

The graph below describes the average air temperature in Helsinki throughout the year.
The lowest annual air temperature[19] in Helsinki is in January at -6^{0}C.
The water will be salinated in order not to freeze at -7^{0}C (-1^{0}C to ensure it doesn't freeze at any time), and will remain salinated to this degree all year round.
To calculate the amount of salt required to keep the canal from freezing the volume of water in the canal must be calculated first.



19 *"...water temperature from year to year is almost the same as that which occurs in the air temperature."*
(Combie, 1959)
20 Chart by author, information source (Finnish Meteorological Institute, 2015)

HIGH SALINITY ANTI-FREEZE WATERS PLAN
1:10,000

THE VOLUME OF THE CANAL

The masterplan CAD drawing shows that the canal surface area is 260,000 M^2. The canal will be 3m deep to allow kayaks and small boats to move around in, therefor the volume of water that needs “anti-freeze salt” will be 770,000m^3.

Image 17: (previous page)
High salinity anti-freeze waters plan

CALCUATING THE REQUIRED SALT CONTENT TO PREVENT FREEZING

To calculate how much salt is needed to prevent the water from freezing at -7^{0}C follow the following[21]:

5 ppt of salt added to water to lower the freezing temperature by 0.28^{0}C.

Call this one step.

For -7^{0}C
Divide (7/0.28) =25 steps

25 steps =(25 x 5ppt) = 125kg of salt per m^3 of water.

To find the total amount of salt required to act as anti-freeze for the volume of water in the canal

TOTAL MASS OF SALT REQUIRED TO PREVENT WATER FREEZING AT -7^{0}C

= 125 (25x5) x 770,000m^3 $^{=}$96, 250 tonnes

21 These steps will set the principal for all the volumes of water to be salinated in the project.

SALT ALREADY PRESENT IN THE WATER

The canal will be originally filled with sea water from the Gulf of Finland which will already contain on average 35ppt [22] salt. The

Total salt content of the canal be for adding the "anti-freeze salt" will be as follows:

35 x 770,000m^3 = 26 950 tonnes of salt already existing in the Baltic Sea water in the canal.

22 "On average, seawater in the world's oceans has a salinity of approximately 3.5%, or 35 parts per thousand.
This means that for every 1 litre (1000 mL) of seawater there are 35 grams of salts (mostly, but not entirely, sodium chloride) dissolved in it."
(Science Daily , 1995-2015)

EXTRA SALT REQUIRED

Subtract the salt existing salt in the sea water from the total required amount of salt required.

96 250 tonnes – 26 950 tonnes

= 69, 300 tonnes of extra salt needed

This would give a salinity percentage of 12.5%, the maximum salt water can hold as a solute is 40%. [23]

23 (Science clarified , 2015)

CREATING THE CANAL

Stages:

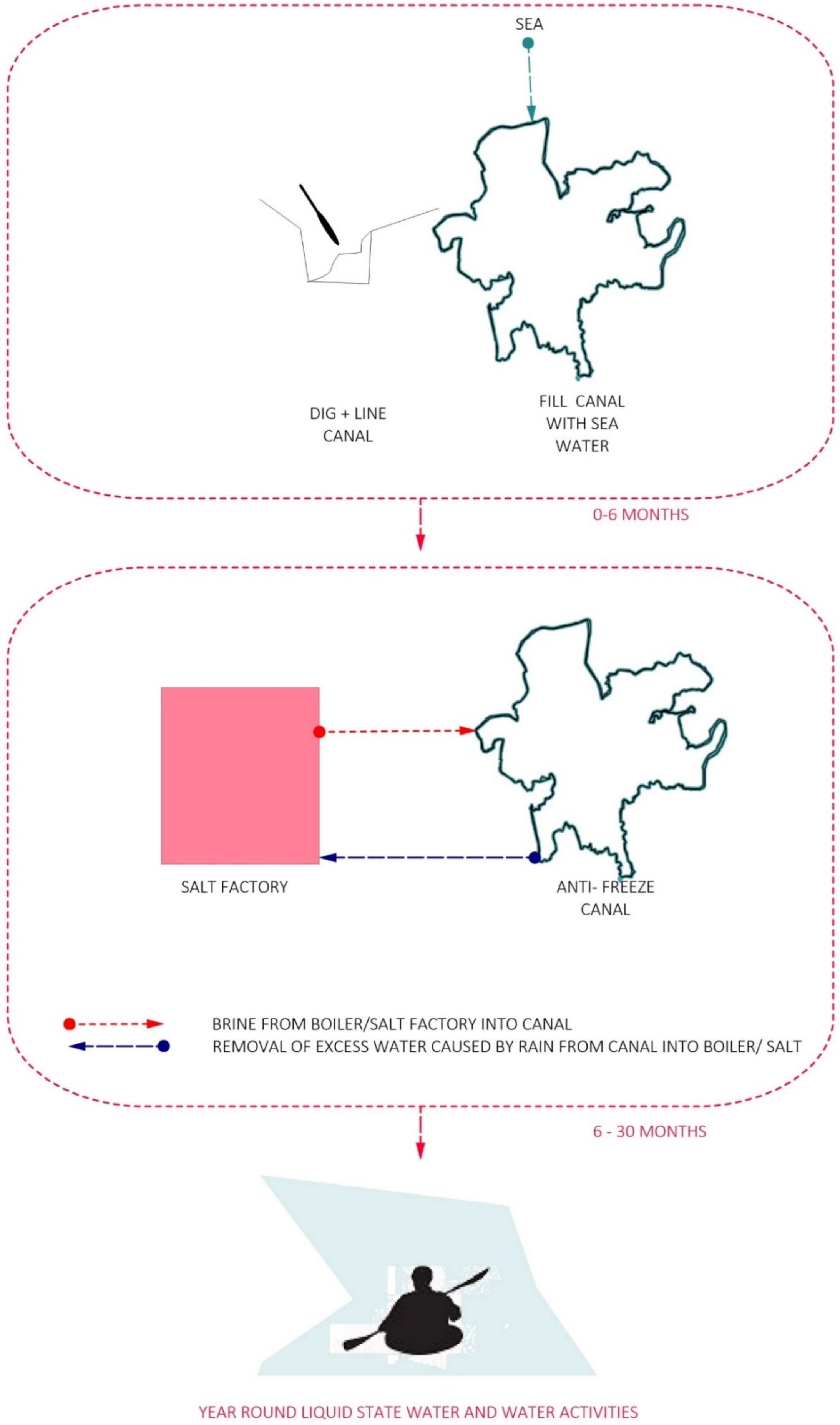
Dig the canal, winding along the streets and across the parks of Helsinki.

Line the canal with a salt resistant membrane in order to prevent highly salinated water contaminating the less salinated sea water. This could damage the eco system as the highly salinated water may leak out. It is very important that the highly salinated water and salt of the anti-freeze canal and sailing basins are contained.
In practice this needs to be a waterproof membrane, as any salt will be carried in the water.

Fill the canal with water brought up from the Baltic Sea by the pumps, pipes and filter system.

Salinate the canal and sailing basins using the brine delivery pipe network. Mix the required salt with water using pumps and turbines.

Image 18: (opposite page) Anti-freeze waters concept


SEA
DIG + LINE CANAL
FILL CANAL WITH SEA WATER
0-6 MONTHS
SALT FACTORY
ANTI- FREEZE CANAL
BRINE FROM BOILER/SALT FACTORY INTO CANAL
REMOVAL OF EXCESS WATER CAUSED BY RAIN FROM CANAL INTO BOILER/ SALT
6 - 30 MONTHS
YEAR ROUND LIQUID STATE WATER AND WATER ACTIVITIES

VOLUMES

The required salt has a volume of 31 500 M^3

This equates to 32 x 32 x 32M. [24]

The needed water has a volume of 770,000M^3 .

This equates to 92 x 92 x 92M. [25]

When considering the size of the buildings that will produce and store this salt, if produced in one sitting it will need to be larger than 32 x32 x 32 m to be able to cope with this level of salt production and storage.

Alternatively the salt production process will be done in batches.

Catalyst zone 01 is where one of the salt factories will be located (see New Helsinki masterplan water ways).

This entire catalyst zone is approximately 150 x 100 M. The catalyst zone has 12 other buildings. The salt factory has an estimated size of 25 x15 x7M.

Taking this into account, also the temporary nature of the high volume salt production, the building would be suited to being smaller and a batch salt production process.

[24] (Calculator Soup, 2015)
[25] (Calculator Soup, 2015)

SEA WATER REQUIRED TO BOIL PRODUCE NECESSARY AMOUNT OF SALT

The mass of extra salt needed is 69 300 tones.

To work out the volume of the salt need I have used the formula:

770, 000 m3 of sea water has 26 950 tonnes of salt.

Therefore 69 300 tonnes of salt we need

1, 979, 000 m3 of water.

Say, 2 mil m3 water

= 2 000 mil kg water .

Salt production time scale

The boilers measure 4.5m x 5mx2 m[26] = $45m^3$.

Water evaporates under a boiler with good ventilation at 300kg/hr[27]($0.3m^3$)[28]

300 kg x 10 boilers x 24 hours x 365 days x 33 catalysts zones

= 867 mil kg of salt per annum

= 2.3 years to produce the full load of salt required.

26 (Maldoon Salt Company, 2014)
27 (Engineering tool box, 2015)
28 (Convertto, 2015)

Image 20: Sea water boiling at the Maldon salt factory

WATER SYSTEM PUMP + PIPE REQUIREMENTS

The sea water need to be delivered to the boilers faster than or as fast as the water can be boiled.

The 10 boilers can boil 300kg water / hr

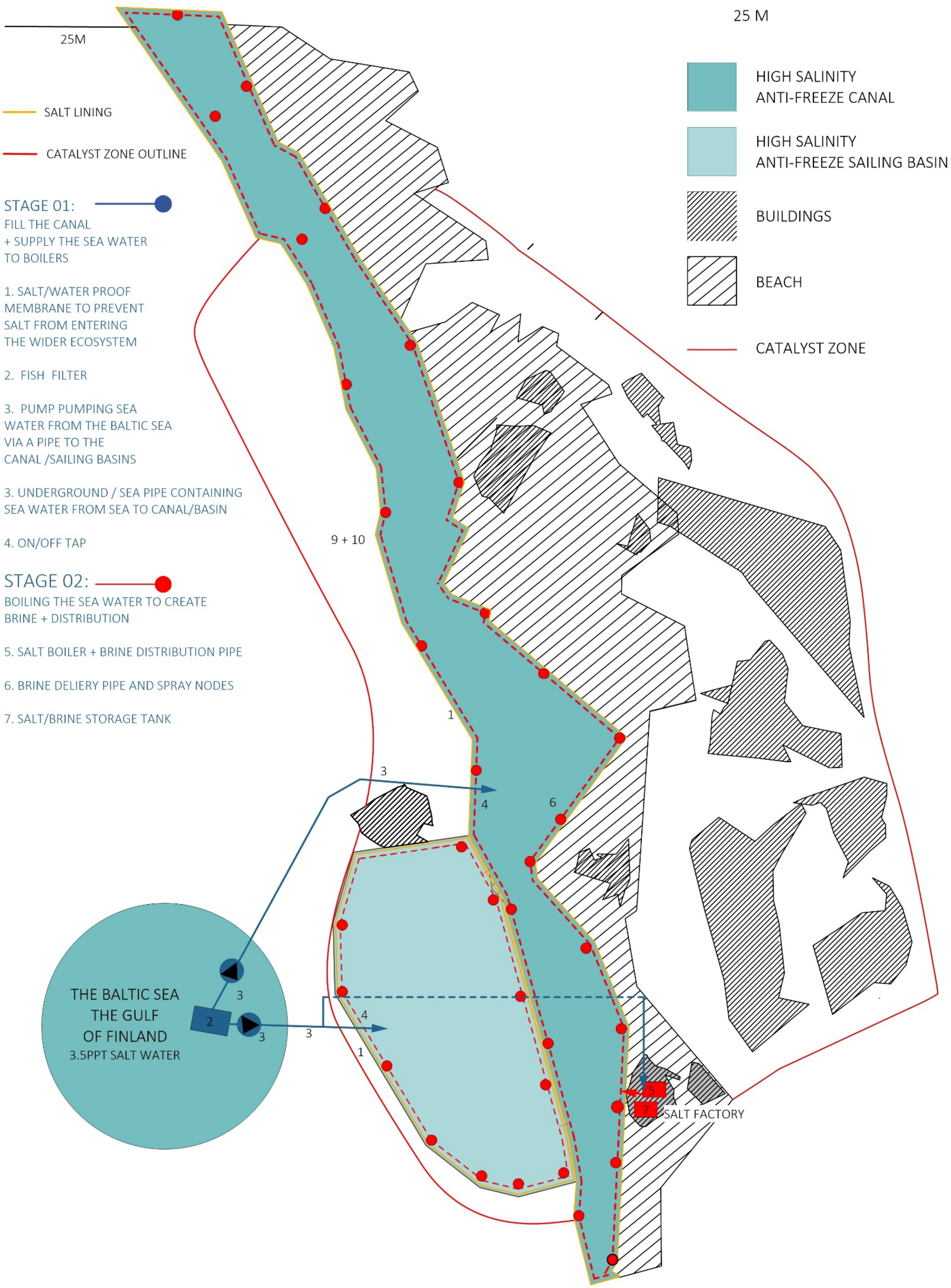
= $0.3m^3$ /hr.

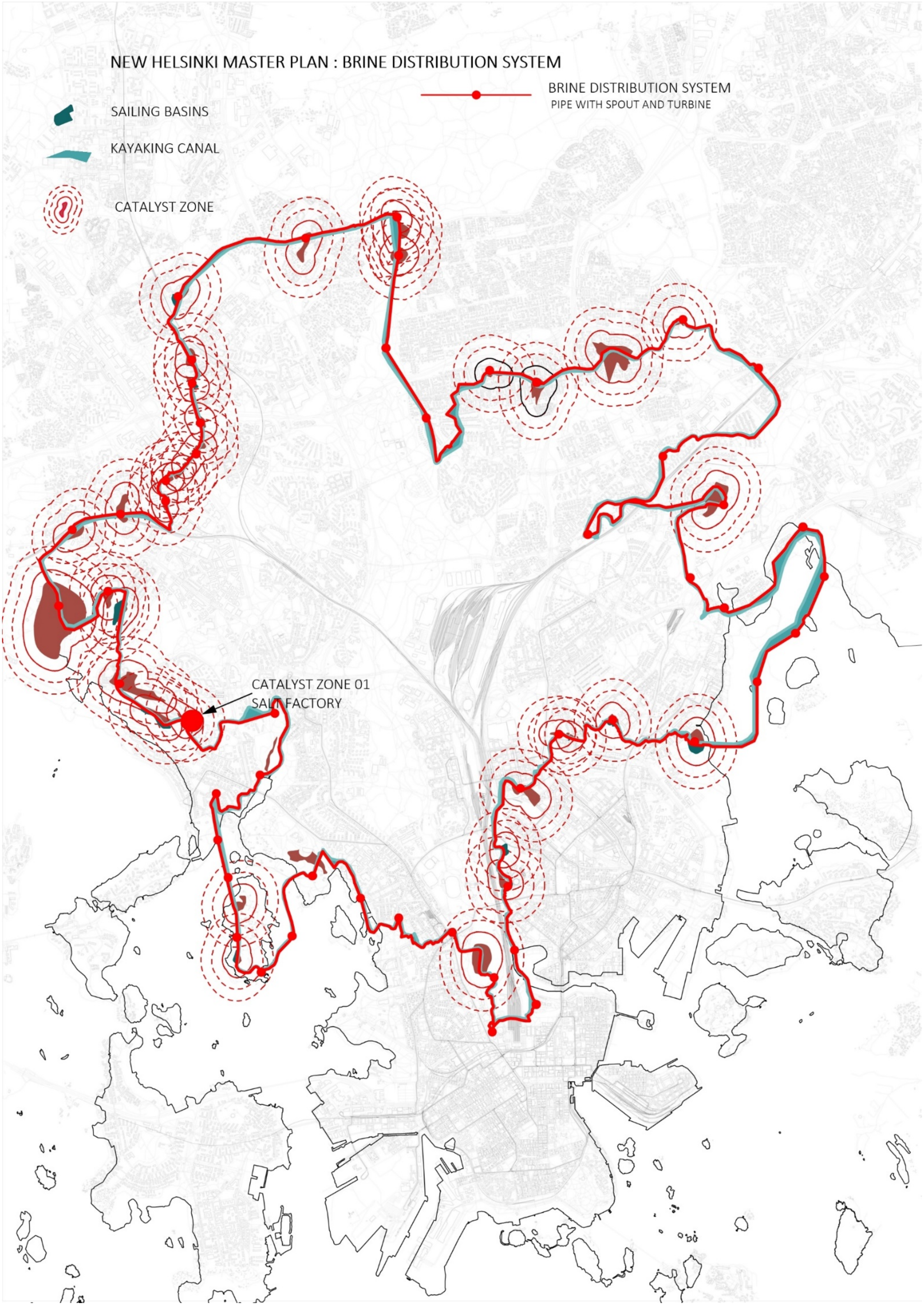
There will need to be a sea water holding tank in the salt factory to hold the next batch of sea water ready to be boiled.

With a flow rate of the pump $0.5cm^3$ /hour 14cm diameter pipes would be required.

This size pipe is a manageable size, however the wall that it is concealed in must have a 20cm cavity to accommodate the pipes. The build-up of this wall will sandwich the pipes with a waterproof lining to protect its structure should the pipes leak.

HIGH SALINITY ANTI-FREEZE WATERS : STAGES
1:10,000




NEW HELSINKI MASTER PLAN : BRINE DISTRIBUTION SYSTEM
BRINE DISTRIBUTION SYSTEM
PIPE WITH SPOUT AND TURBINE
SAILING BASINS
KAYAKING CANAL
CATALYST ZONE
CATALYST ZONE 01
SALT FACTORY

IMPLICATIONS OF SALT PRODUCTION PROCESS ON THE NEW HELSINKI MASTERPLAN

This investigation into the salt production process has lead me to conclude that the master plan will require 33 salt factories produce salt from boiled sea water, with a 14cm diameter pipe to bring the sea water from the sea into each factory. The salt factory will be able to produce enough salt to maintain a liquid state canal at -7^{0}C over a 2.3 year program after the canal is excavated, lined and filled.

A city wide pipe and pump system in the canal will distribute the brine from the salt factory, spouts and turbines will be used to mix the brine into the water.

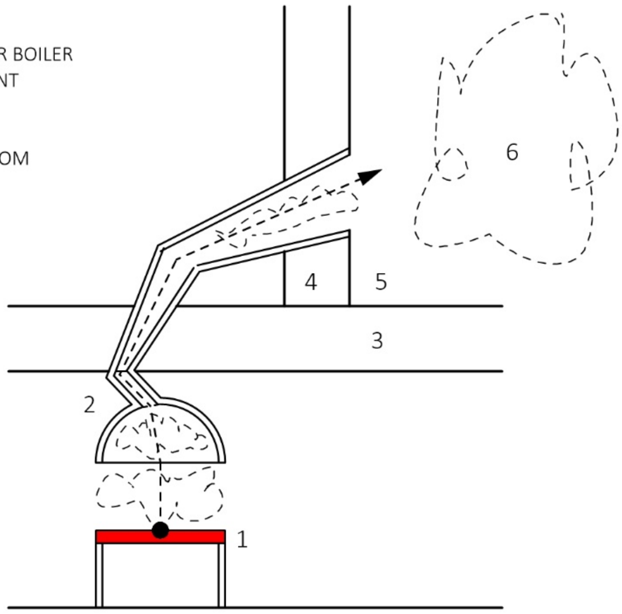
The average rainfall is 650 mm per month.[29] Despite the evaporation that may occur it would still be necessary to remove some water from the canal every month to prevent overflow. 650 mm of canal water will be pumped out in to the boilers to be converted into salt. This will also ensure water does not overflow into the surrounding environment and pollute the ecosystem.

[29] (Climate Data.org , 2012)

EXTRACTED STEAM FROM BOILING PANS TO STEAM ROOM

KEY

1. SEA WATER BOILER
2. STEAM VENT
3. CEILING
4. WALL
5. STEAM ROOM
6. STEAM



IMPLICATIONS OF SALT PRODUCTION PROCESS ON SALT FACTORY BUILDING

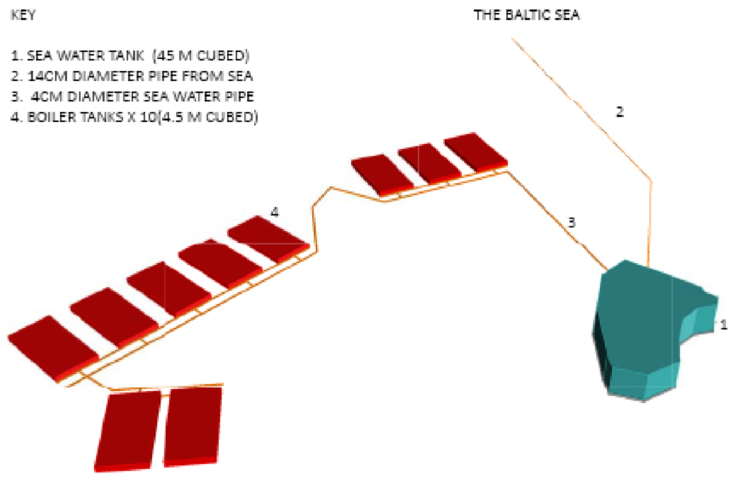
During this thesis it has become apparent that there will be effects on the salt factory building, both from the salt production requirements and also from the research into the salt spa.

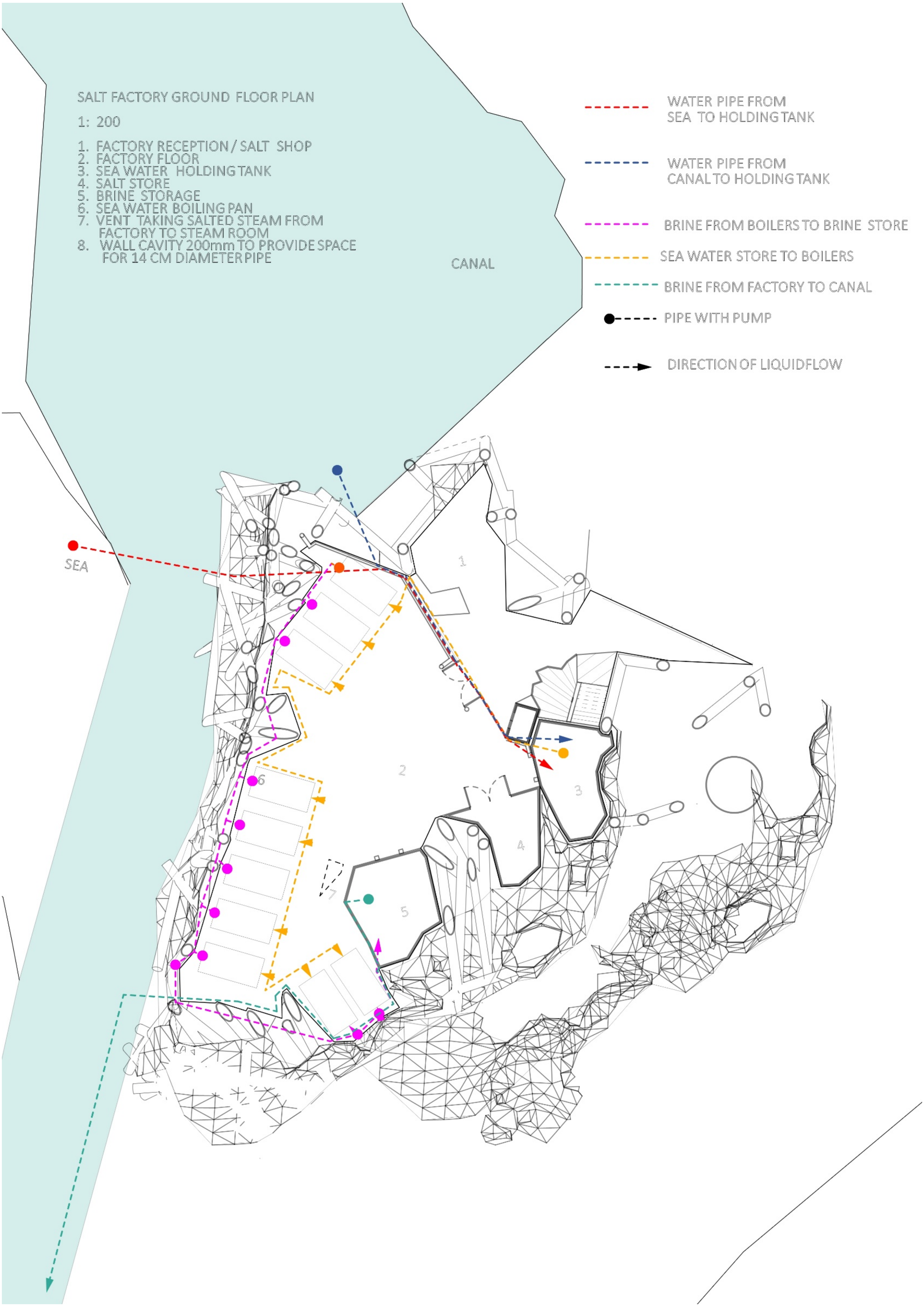
The salt production in each factory will require a sea water holding tank, with a minimum size of $45m^3$ and a 14cm diameter pipe connecting the canal to the sea water store, then the boiler tanks. The cavity in the walls must be at least 20 cm wide in order to accommodate these pipes.

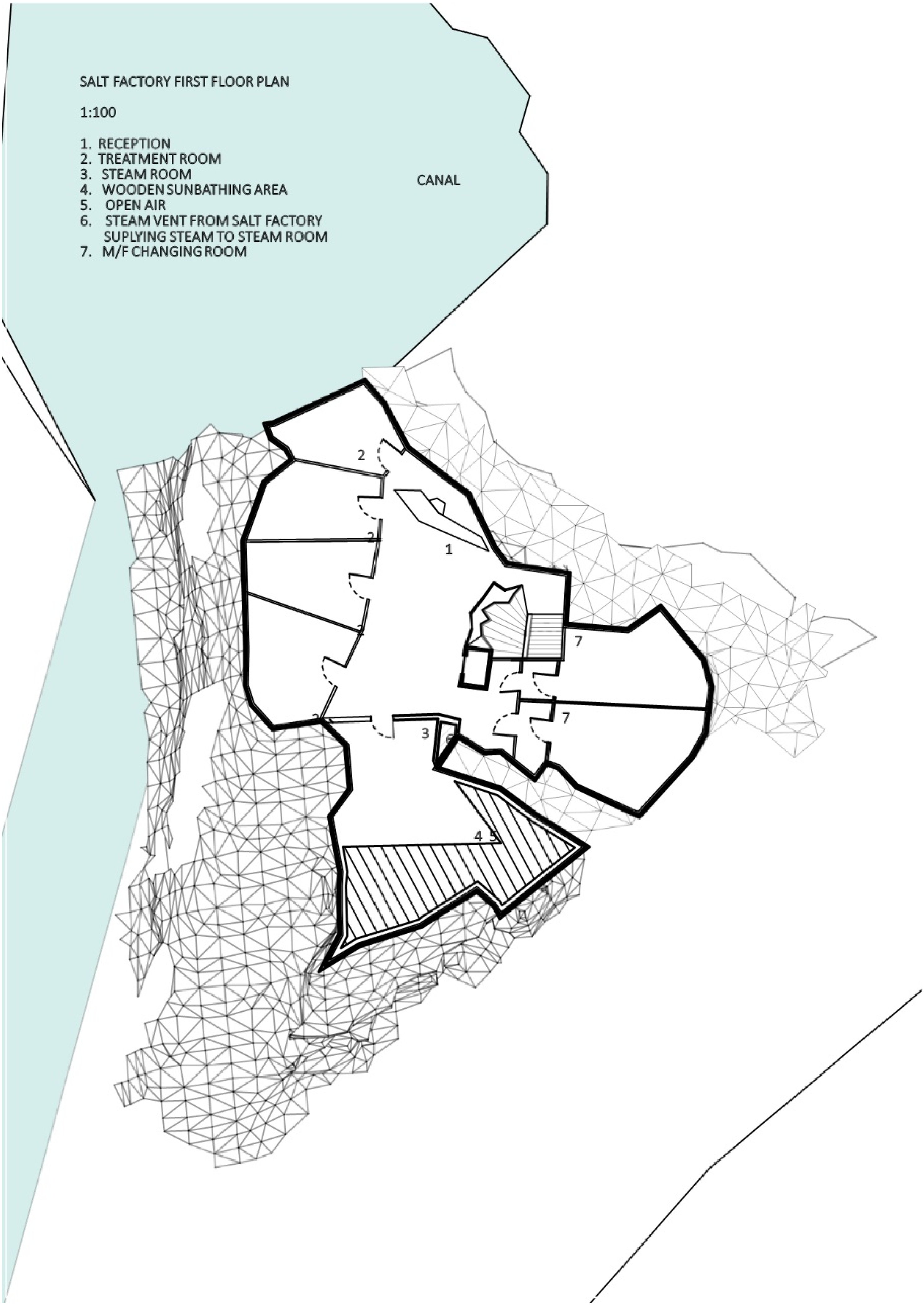
In the factories there will be a brine stores to hold brine ready to go into the distribution system in the canal. There will also be a salt store to accommodate salt produced for the spa treatments. 10 of boilers and space required for boilers per factory will be required to produce the necessary salt. A salt shop and display area will be required to sell the sea salt.
(See first Salt Factory ground floor plan).

On a higher level a salt steam room connected by a vent to the factory will be needed and used for a steam room.
Salt spa treatment room will be required for salt scrubs and salt facials.
(See Salt Factory first floor plan).

Image 25: salt factory diagram




SALT FACTORY GROUND FLOOR PLAN
1: 200
1. FACTORY RECEPTION / SALT SHOP
2. FACTORY FLOOR
3. SEA WATER HOLDING TANK
4. SALT STORE
5. BRINE STORAGE
6. SEA WATER BOILING PAN
7. VENT TAKING SALTED STEAM FROM FACTORY TO STEAM ROOM
8. WALL CAVITY 200mm TO PROVIDE SPACE FOR 14 CM DIAMETER PIPE
CANAL
SEA
WATER PIPE FROM SEA TO HOLDING TANK
WATER PIPE FROM CANAL TO HOLDING TANK
BRINE FROM BOILERS TO BRINE STORE
SEA WATER STORE TO BOILERS
BRINE FROM FACTORY TO CANAL
PIPE WITH PUMP
DIRECTION OF LIQUIDFLOW
1
2
3
4
5
6
7


SALT FACTORY FIRST FLOOR PLAN
1:100
1. RECEPTION
2. TREATMENT ROOM
3. STEAM ROOM
4. WOODEN SUNBATHING AREA
5. OPEN AIR
6. STEAM VENT FROM SALT FACTORY SUPLYING STEAM TO STEAM ROOM
7. M/F CHANGING ROOM
CANAL

Salt's effect on the wider ecosystem

In a study on salinity effect on seaweeds that thrive in high salinization waters,[31] the highest salinity water level where seaweed is found to grow was "*Acanthophora spicifera* from 15 to 55%."[32]. As designed above the canal will need to be 12.5 % salt. Only some plants and animals will be able to live in these conditions. Highly salinated environments that have sea life thriving in them are typically in much warmer climates. For example the Dead Sea, which has a salinity percentage of 33.7%[33]. The *Dead Sea* is called the *Dead* Sea as few plants or animals can survive it its harsh highly salinated conditions.

> *"The Dead Sea is roughly 8.6 times saltier than the ocean. This salinity makes for a harsh environment in which animals cannot flourish (hence its name). The high salinity prevents macroscopic aquatic organisms such as fish and aquatic plants from living in it, though minuscule quantities of bacteria and microbial fungi are present."*
>
> (Manske, 2013)

To put it into perspective The Baltic Sea has a salinity of 3.5%. My canal would be 4 times that, however half that of The Dead Sea. Considering this level of salination may be toxic for many species it is extremely important to ensure none of the water from the canal or sailing basins escape.

Once carefully lined the canal will be filled with water from the sea that will be delivered via and underground water pipe network. At the source, the Baltic Sea, and along the pipe network there will be pumps in order to propel the water up into the canal. Once the canal is full of sea water the extra anti-*freeze* salt will be added.

Image 28: large scale pond liner

31 (N. KALIAPERUMAL, 2001)
32 (N. KALIAPERUMAL, 2001)
33 40% is the maximum amount of salt soluble in water (Elizabeth Rogers, 2000)

Image 29 The Dead Sea 33.7% salinity

CHAPTER 02:
CREATING SYNTHETIC DAY LIGHT

CONCEPT DESIGN

This element of the scheme aims to provide synthetic daylight during the winter to areas of the *catalyst zone*, to encourage development and activity also to make people happier by preventing S.A.D.[34]
It will aim to provide significantly higher light levels and will introduce some of the important aspects of brighter daylight such as colour, brightness and angle of light. This will be provided in the *lighting zones* in the areas of the catalyst zones where the canal, sailing basins and beach area are located. It will make people feel as if they are in a sunny spot.
This project does not aim to recreate summer, just to make winter better.

Image 30: Helsinki new master plan: lighting zones during winter

[34] Seasonal affective disorder.
"Seasonal affective disorder (SAD) is a type of depression that has a seasonal pattern."
(www.nhs.uk, 2014)

HELSINKI NEW MASTER PLAN
LIGHTING ZONES DURING WINTER
SAILING BASINS
KAYAKING CANAL
CATALYST ZONE
DARK WINTERTIME DAYLIGHT
INNER 500 M OF THE CITRY CENTRE
LIGHTING ZONES
CATALYST ZONE 01

CHARACTERISTICS OF DAYLIGHT

Day light comprises of two different types of light, sunlight and skylight. Sunlight is the light that comes directly from the sun, skylight is the ambient light created from the rays of sun diffused by the atmosphere.

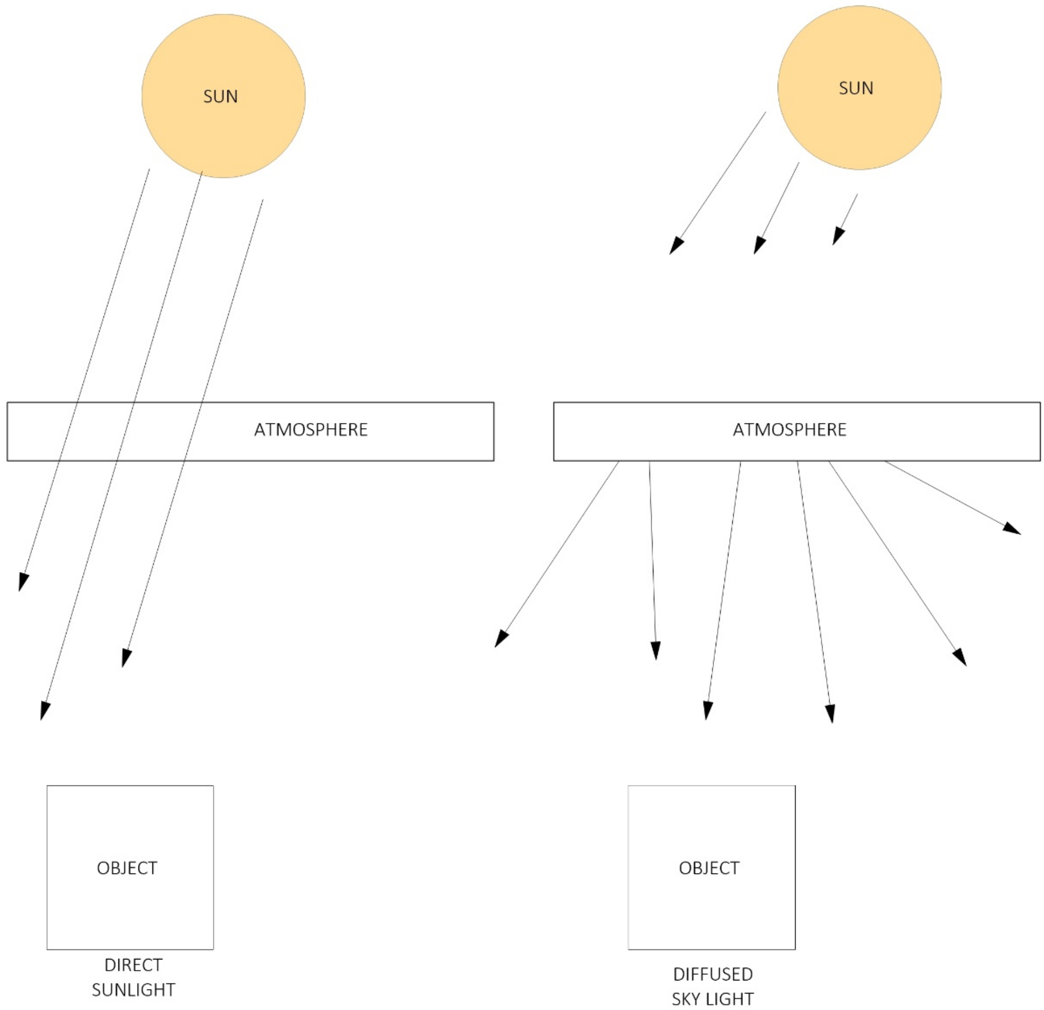
Due to the earth rotating on its axis the sun's light appears to move across the sky, and the angle of light changes. Thisis the effect that needs to be simulated.

"Sunlight
the directional beam emitted by the sun • directional • piercing and very strong, warmer in both temperature and colour • gives shape to a building • need to control its direct penetration into critical visual task areas • Spaces illuminated by the rays of eastern and western sunlight radically change on a daily, hourly-hour basis and are extremely difficult to adapt for critical visual task environments
Skylight
The diffuse reflection of light particles in the atmosphere • can be diffuse light of the clear, cloudy, or overcast sky • can be similar in all orientations • is soft, cool in both temperature and colour • Spaces illuminated with diffuse southern sunlight change on a seasonal basis and are adapt"

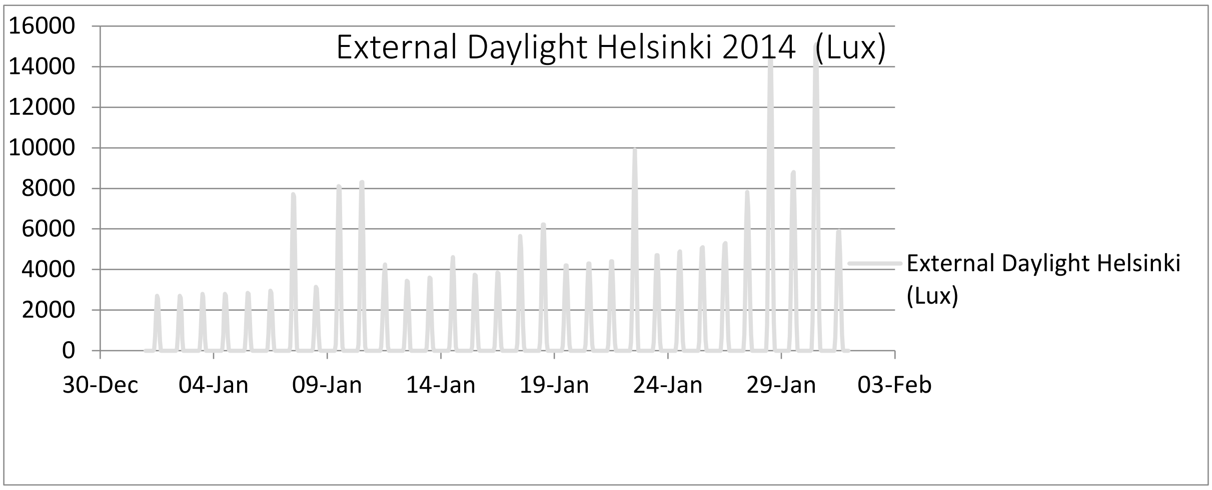
(Studio, 2013)

Daylight also changes in colour, temperature and elevation angle. The design of the synthetic sunlight will aim to mimic all of these aspects.

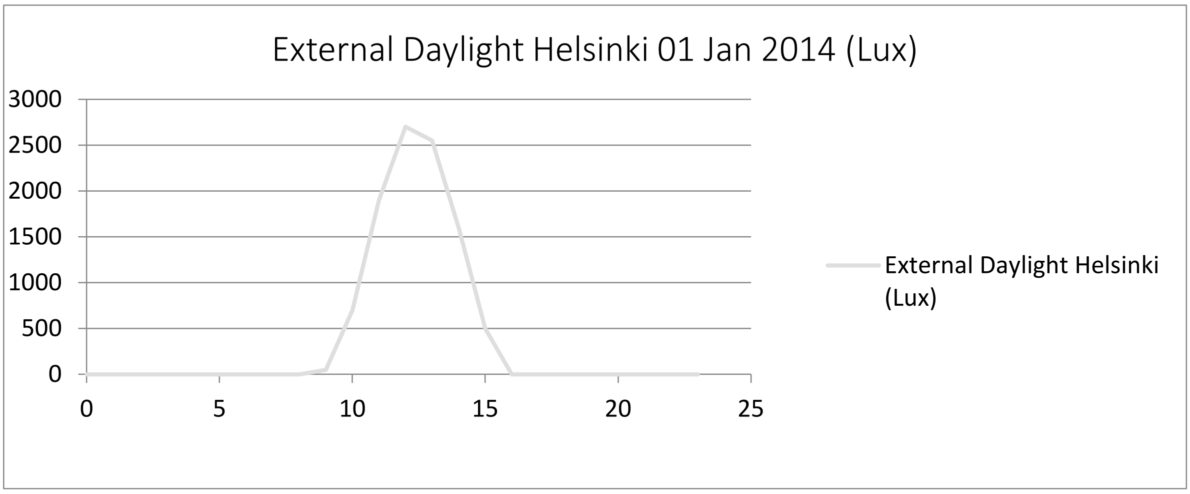
Image 31 : Day light: Sun light +Sky Light. Diagram



Daylight levels recorded at hourly internals in Helsinki 2014. [35]



Daylight levels recorded at hourly internals in Helsinki 2014. [36]

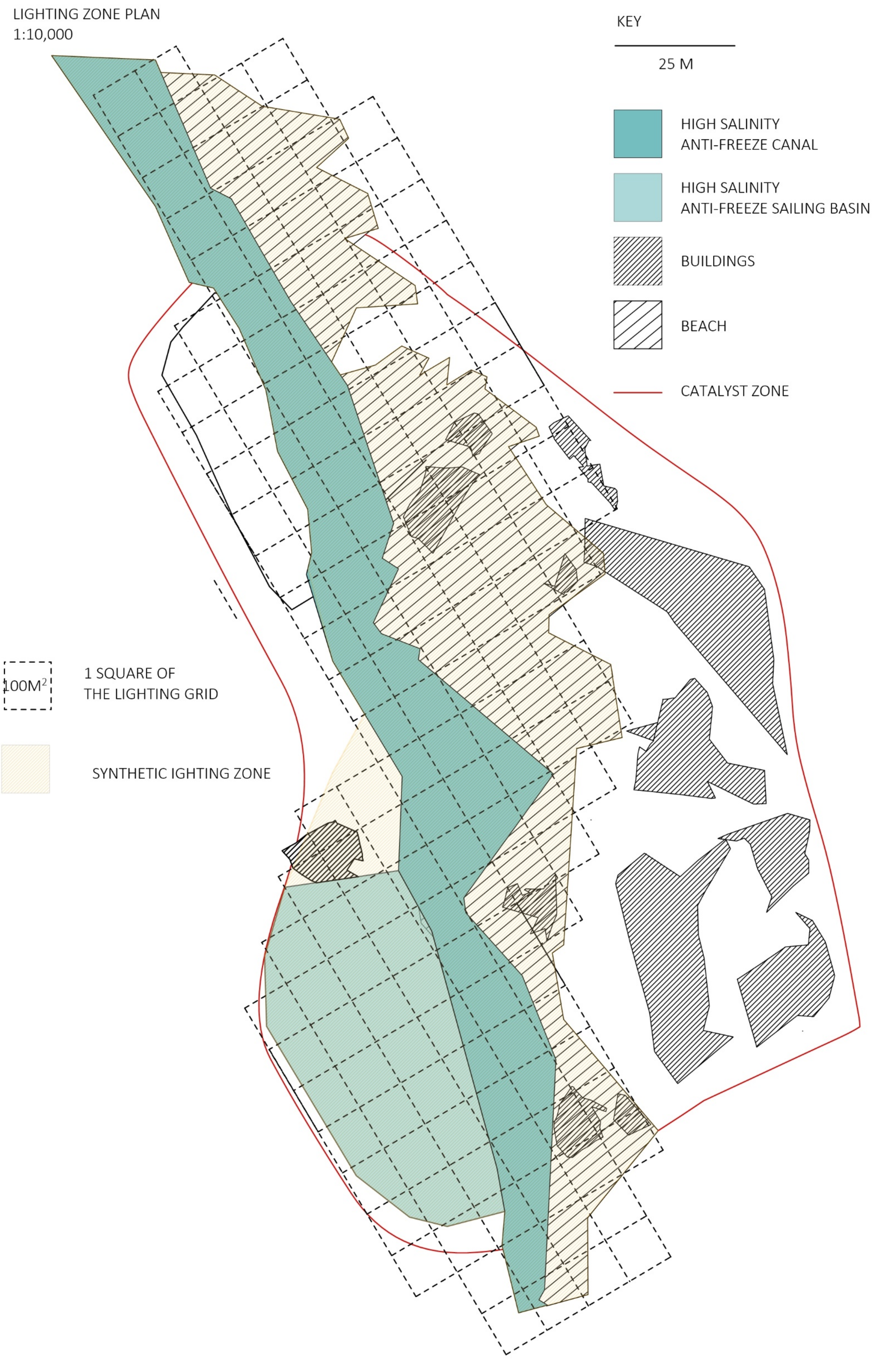


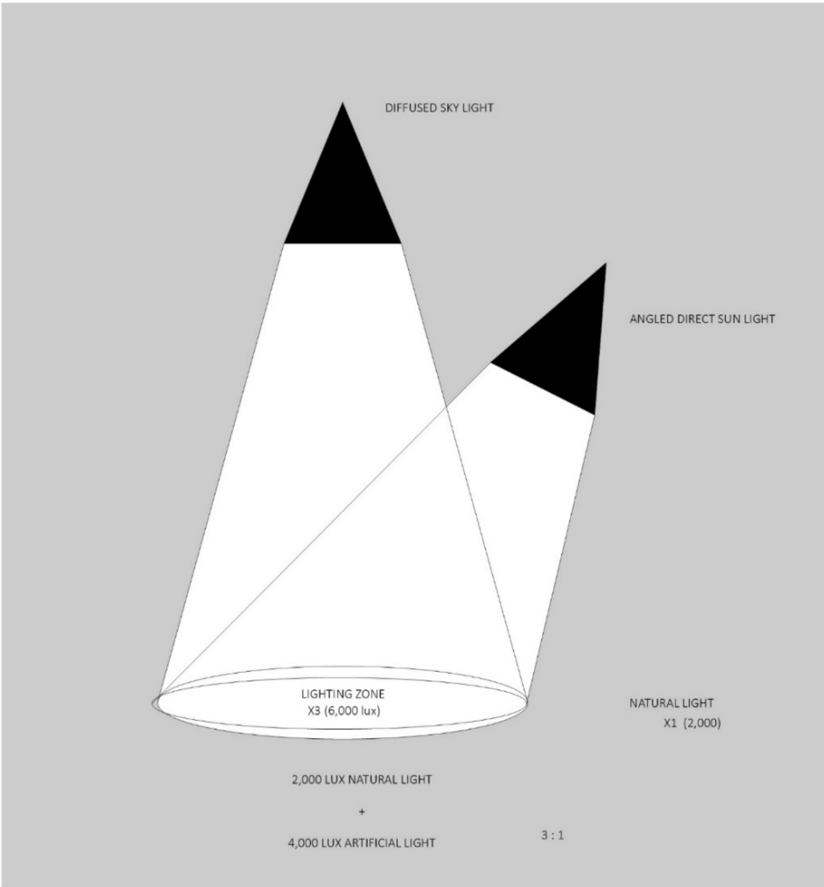
[35] Diagram by author, data source (Department of eEnergy. US Government , 2015)
[36] Diagram by author, data source (Department of eEnergy. US Government , 2015)

[37] Similar latitude positions with London at 51^0 N and Helsinki at 60^0N (Long Lat.net, 2015)

[38] The measurement pictured is in watts/ m^2

Image 33: (opposite page) lighting zone plan


LIGHTING ZONE PLAN
1:10,000
KEY
25 M
HIGH SALINITY
ANTI-FREEZE CANAL
HIGH SALINITY
ANTI-FREEZE SAILING BASIN
BUILDINGS
BEACH
CATALYST ZONE
100M2
1 SQUARE OF
THE LIGHTING GRID
SYNTHETIC IGHTING ZONE



39 Justified on page in noticeable difference experiment

Lux levels

The *Helsinki external lux level data*[40] describes the lux levels per hour for every hour for both the sunlight (referred to as *"direct radiation")* and skylight, (referred to as *"diffused radiation").*

I have used this data to select lux levels for the brief of the synthetic daylight.

The aim is to provide a sunnier winter's day, therefore, the lux levels for a mid-winter's day will be taken and then tripled to create the brief for both the sunlight and skylight.

The lux levels for sunlight and skylight from 1st February 2014 have been taken as the target brief for the synthetic lighting system.

As the 1st of February is quite a short day, I propose to double the hours of light this will give it more the feel of a summer's day with early mornings and late evenings.

This results in the target lux levels at noon for sunlight being

Sunlight target: 140, 000 lux

Skylight target: 18, 00 lux

The lux level will be programed to change throughout the day according to the table on the following page.

[40] Data from U.S. Department of Energy, which details the lux levels for every hours of the year in Helsinki.
(Department of eEnergy. US Government , 2015)

The brief shall be taken from 3 times the lux levels on the 15th January at midday.

Table 1: Light levels on 1st February 2014 per hours in Helsinki (existing)

(Department of eEnergy. US Government , 2015)

Time	Direct radiation(W/m²)[41] (SUNLIGHT)	Diffuse radiation (W/m²) (SKYLIGHT)
0:00	0	0
01:00	0	0
02:00	0	0
03:00	0	0
04:00	0	0
05:00	0	0
06:00	0	0
07:00	0	0
08:00	0	15
09:00	45	60
10:00	80	70
11:00	260	60
12:00	470	60
13:00	400	60
14:00	380	40
15:00	230	15
16:00	70	2
17:00	0	0
18:00	0	0
19:00	0	0
20:00	0	0
21:00	0	0
22:00	0	0
23:00	0	0
24:00	0	
		0

Table 2: Light levels on 1st February 2014 per hours in Helsinki x3 and x2 the hours of daylight (proposed).

Time	Direct light lux levels[42] (SUNLIGHT BREIF)	Diffuse light lux levels (SKYLIGHT BREIF)
0:00	0	0
01:00	0	0
02:00	0	0
03:00	0	0
04:00	0	0
05:00	14, 000	4, 500
06:00	14, 000	4, 500
07:00	24, 000	18, 000
08:00	24, 000	18, 000
09:00	78, 000	21, 000
10:00	78, 000	21, 000
11:00	140, 000	18, 000
12:00	140, 000	18, 000
13:00	120, 000	18, 000
14:00	120, 000	18, 000
15:00	110, 000	18, 000
16:00	110, 000	18, 000
17:00	70, 000	12, 000
18:00	70, 000	12, 000
19:00	21, 000	4, 500
20:00	21, 000	4, 500
21:00	0	0
22:00	0	0
23:00	0	0
24:00	0	0

[42] Converted into lux levels from previous page watts/m^2 using (Rapid Tables, 2015)
Answer rounded.

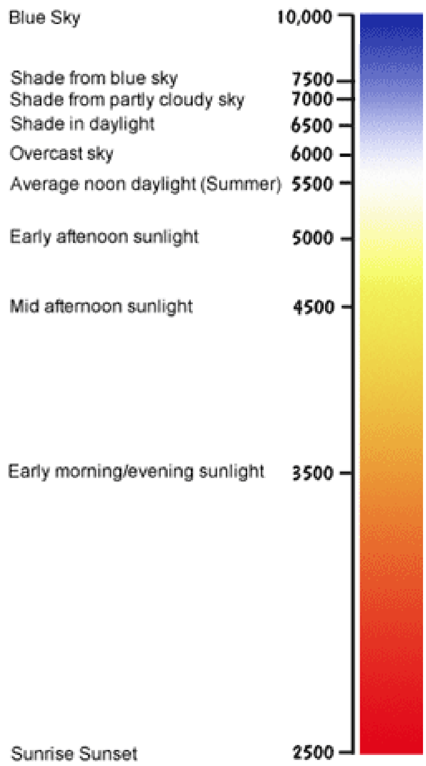
Colour of the light

Throughout the day the colour of daylight changes as follows:

Early morning	3,500 k	(orange/red)
Mid-day	5,500 K	(whitish/yellow)
Afternoon	5,000 k	(yellow)
Evening	3,500 k	(orange/red)

This colour and temperature change is measured in kelvins.
With the proposed lights it is possible to program the lux and kelvin levels, this will be employed to replicate the pattern of daylight gradual change from 1000k to 2500 k then back to 1000k.

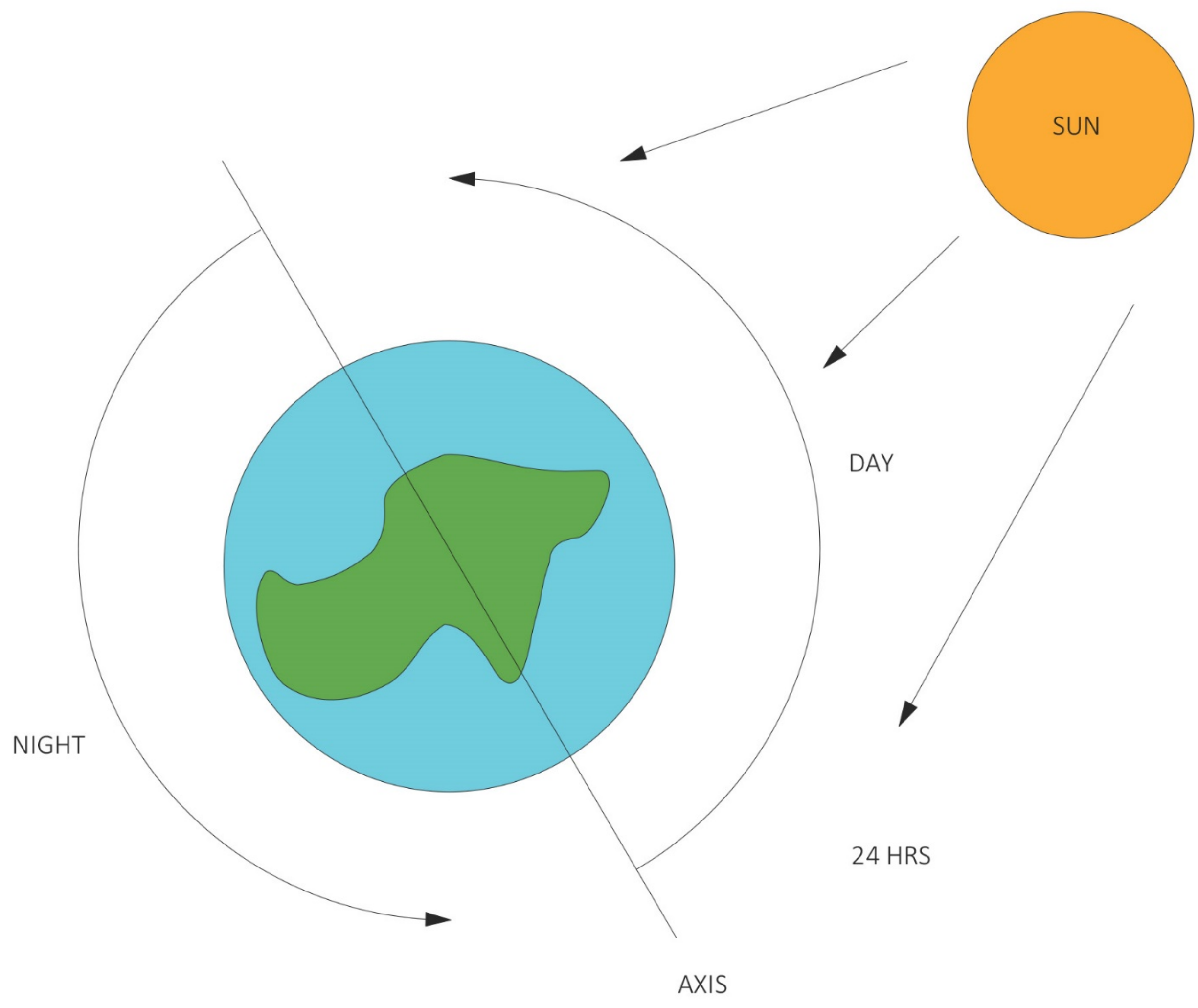
Image 35: Daylight Scale (Kelvins)



DAYLIGHT AND MOVEMENT

The earth spins on its axis as it rotates around the sun this creates the illusion of the sun moving across the sky from a low to high point. This apparent movement and change in light angle will be important to simulate in my proposal to create the illusion of real daylight.

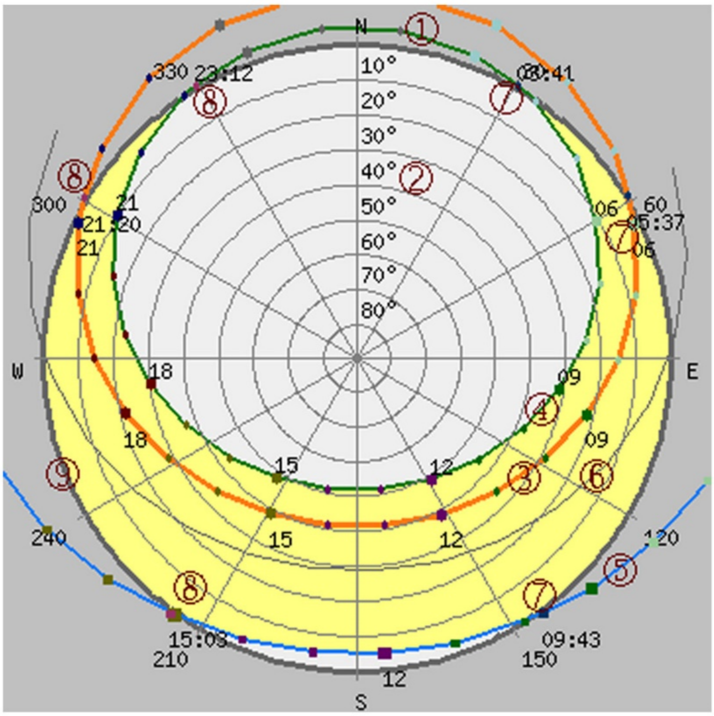
Image 36 Earth Rotating. Day and Night Diagram



ANGLE OF ELEVATION

Depicted in the diagram bellow is the movement of the sun across Helsinki on 1st February 2014. Most significantly are the angles of elevation shown. This is the angle that the sun's ray hits the ground at.
These angles will form part of the synthetic sunlight brief.

Image 37: SUN PATH DIAGRAM, HELSINKI on 1st February 2014



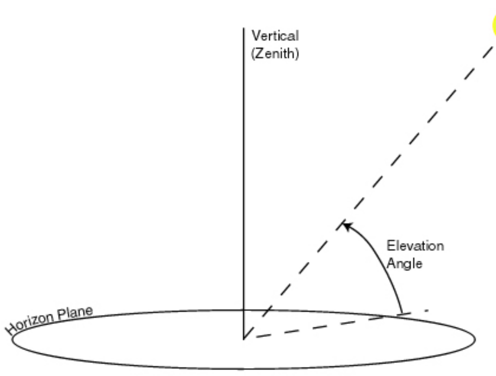
KEY

1. Azimuth angle
2. Elevation angle
3. Sun's path today
4. Sun's path on the 21st June
5. Sun's path on the 21st December
6. Sun's path during the equinox
7. Sunrise
8. Sunset
9. Horizon

ANGLE OF SYNTHETIC SUNLIGHT (SUN'S ELEVATION)

Time (24 hrs)	Proposed light angle of elevation brief (winter sun)
0:00	NO LIGHT
01:00	NO LIGHT
02:00	NO LIGHT
03:00	NO LIGHT
04:00	SKY LIGHT ONLY
05:00	80^0
06:00	70^0
07:00	60^0
08:00	50^0
09:00	40^0
10:00	30^0
11:00	20^0
12:00	10^0
13:00	10^0
14:00	20^0
15:00	30^0
16:00	40^0
17:00	50^0
18:00	60^0
19:00	70^0
20:00	80^0
21:00	SKY LIGHT ONLY
22:00	NO LIGHT
23:00	NO LIGHT
24:00	NO LIGHT

Image 38: Sun's angle of elevation
(Project Atlas, 2015)



Design criteria for synthetic daylighting

LIGHTS

Bright enough to reach 140,000 lux.
Not too heavy to be angled/moved.

Direct light holder

Must be able to tilt light to different angles and create the sensation of the light source moving across the sky.

Diffused light holder

High enough to project diffused light or have a light diffuser attached.

BATTERIES

Enough power to supply lights

THE LIGHTS

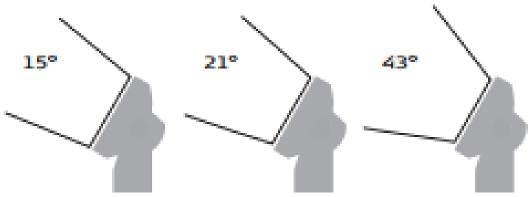
The proposed lighting design has been based on are the ISGM P-5 LED Wash lights[43] which are possible to program for both lux and kelvin levels.
The principals of this light will be used for both the design of the sunlight and skylight.

Image 39 + 40: ISGM P-5 LED Wash lights

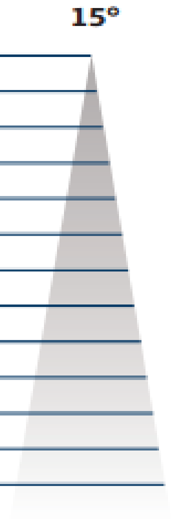
[43] (ISGM Lighting, 2015) Data sheet

LUX DIAGRAM

Narrow spread lens of 15°
Medium spread lens of 21°
Wide spread lens of 43°

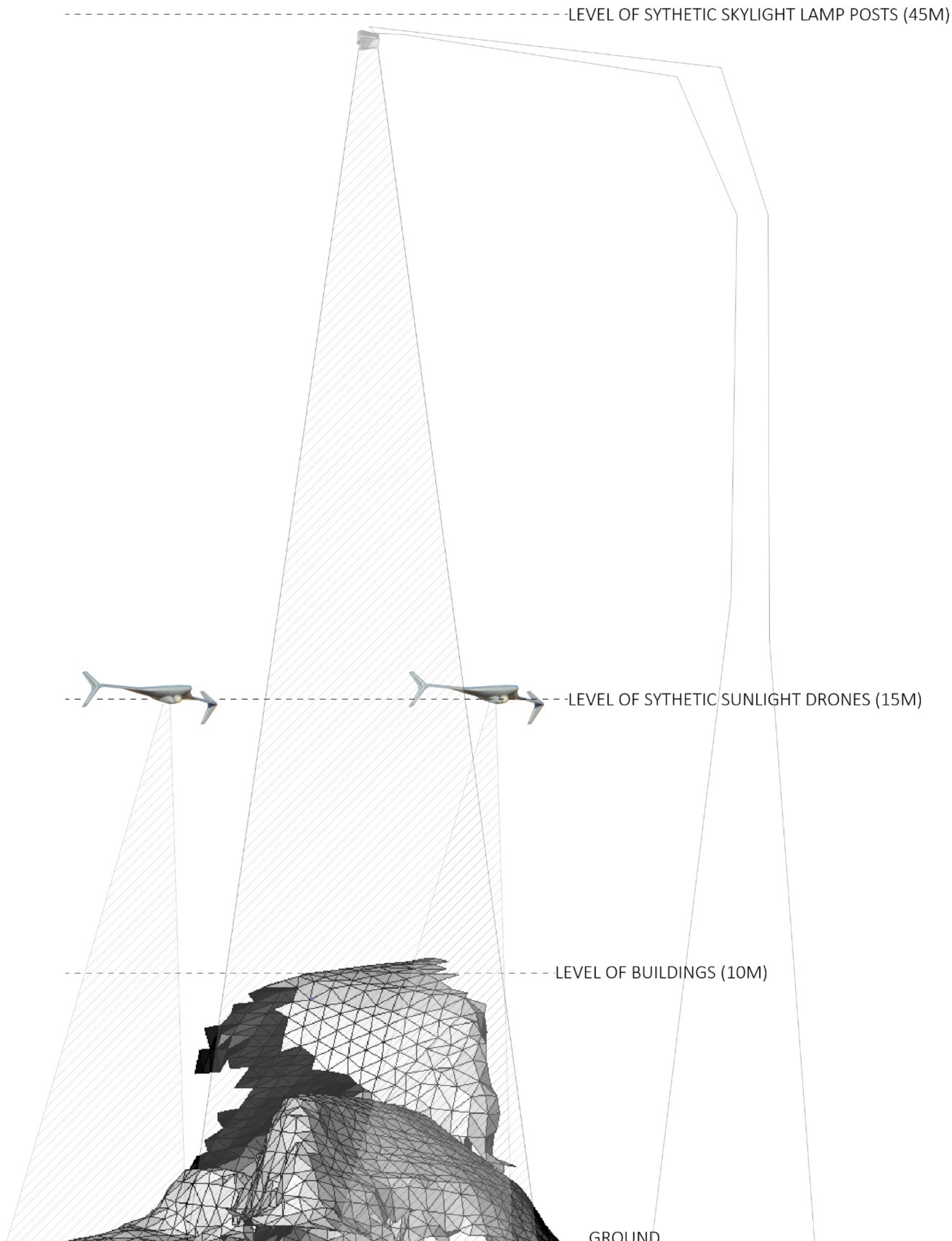


Distance (m)	Illumination (Lux)	Beam width, (m)
1	92500	0,3
2	23100	0,5
3	10300	0,8
5	3700	1,3
10	930	2,6
15	410	3,9
20	230	5,3
25	147	6,6
30	103	7,9
35	75	9,2
40	58	10,5
45	46	11,8
50	37	13,2



HEIGHTS

It is important that we consider the levels of the site and buildings when designing the lighting scheme.
There are no obstacles such as very large trees in the way, however there are buildings. The building in the lighting zone have no more than 3 stories. This mean they would be around 10m tall. The lighting must be located above the buildings.
The synthetic sky lighting design must be above the synthetic sun lighting.


LEVEL OF SYTHETIC SKYLIGHT LAMP POSTS (45M)
LEVEL OF SYTHETIC SUNLIGHT DRONES (15M)
LEVEL OF BUILDINGS (10M)
GROUND

LEDS OF THE FUTURE

The aim for the design objective for the light is to be as small, light and produce as many lux as possible. Research into future production of LEDs shows that in a few years' time, when this project would be realised, LEDs would produce up to 5 times more lux for the same size light.

(Eric Bretschneider, 2008)

The lights at 15m high at 15^0 produce a 3.5m wide beam at[44], 410 lux (now).
This does not meet our 140, 000[45] lux target.

If we had access to LEDs of the future and 65 lights per drone we would reach our target for synthetic sunlight.

[44] (ISGM Lighting, 2015)

[45] See sunlight brief , 140 000 lux

Batteries for lights

There is a need for small, light batteries to enable the drone to lift them.

In an article by The Oak Ridge national laboratory they discuss the development of a new type of battery that has the potential to last longer than what is currently available on the market. [46]The article shows that the theoretical maximum battery energy density is approximately 1000 $mAhg^{-1}$.

To get this into W hrs / kg I multiply by the potential voltage by 1000.

1.7V x 1000= 1700Whr/kg

Each light uses 420W[47] and there are 65 of them.

65 x 420W

= 27,300 W.[48]

They're in use for 8 hrs

27,300 W x 8hrs

= 218 000 Watts

At 600 watts per kilo together the batteries will all weigh

218 000 / 600

= 365 kg.

[46] (Oak ridge national laboratory, 2014)
[47] (ISGM Lighting, 2015)
[48] (All about batteries , 2010)

PAYLOAD

The drone will need to be able to carry 65 of the lights (585 kg) + 65 of the batteries (365kg), totalling 950kg.

TOTAL SUN LIGHT = SYNTHETIC SUN LIGHT + NATURAL SUN LIGHT

The target lux level is 140 000 lux, the natural daylight is 47 000 lux.
Therefore 93 000 lux is needed from the synthetic lights.

THE DRONE

Model: Northrop Grumman unmanned bat drone [49]

Payload:	1,000 kg Target 950kg.
Flight height:	91 m Target 15 m
Flight time:	12 hours Target 16 hours[50], Which means the day will have to be divided into 2 x 8 hours shifts, with 2 sets of drones.

Image 43: drone to produce synthetic sunlight design diagram (opposite page)

[49] (Northrop Grumman Capabilities, 2015)

DRONE TO PRODUCE SYTHETIC SUN LIGHT DESIGN DIAGRAM

KEY

1. unmaned BAT drone
(northropgrumman)

Payload: 1, 000kg
Length: 2 m
Height: 0.9 m
Endurance: 12 hours

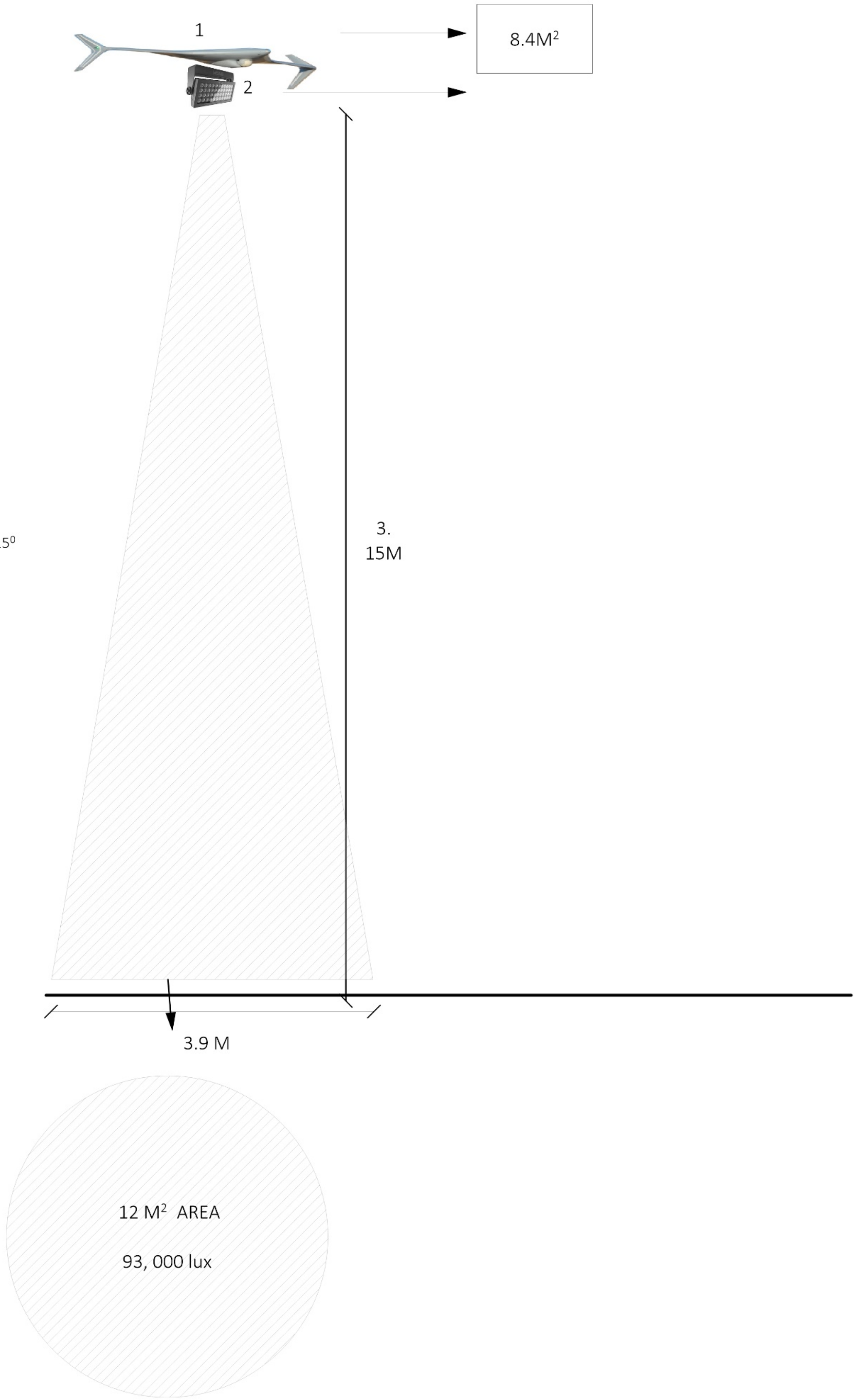
2. ISGM P-5 9 kgx 65 (585kg)

LED Wash Light with future LEDs
(lux and kelvin controlable)

+ Lithium battery x 65 (365kg)

3. 15m distance from the ground

4. 93,000 lux in a beam 3.9m wide 15^0



REPLICATING SKY LIGHT ANGLE OF ELEVATION

The drones can be programed to fly and hover at specific angles. This feature will be employed in order to point the lights to simulate the sun's angle of elevation discussed in the brief.

Image 44: (opposite page) synthetic light: colour shape and drone path across one square of the lighting grid

Table 3: Angle of synthetic sunlight brief

Time (24 hrs)	Proposed light angle of elevation brief
0:00	NO LIGHT
01:00	NO LIGHT
02:00	NO LIGHT
03:00	NO LIGHT
04:00	SKY LIGHT ONLY
05:00	80^0
06:00	70^0
07:00	60^0
08:00	50^0
09:00	40^0
10:00	30^0
11:00	20^0
12:00	10^0
13:00	10^0
14:00	20^0
15:00	30^0
16:00	40^0
17:00	50^0
18:00	60^0
19:00	70^0
20:00	80^0
21:00	SKY LIGHT ONLY
22:00	NO LIGHT
23:00	NO LIGHT
24:00	NO LIGHT

DRONE FLIGHT PATH THROUGHOUT THE DAY

ELEVATION

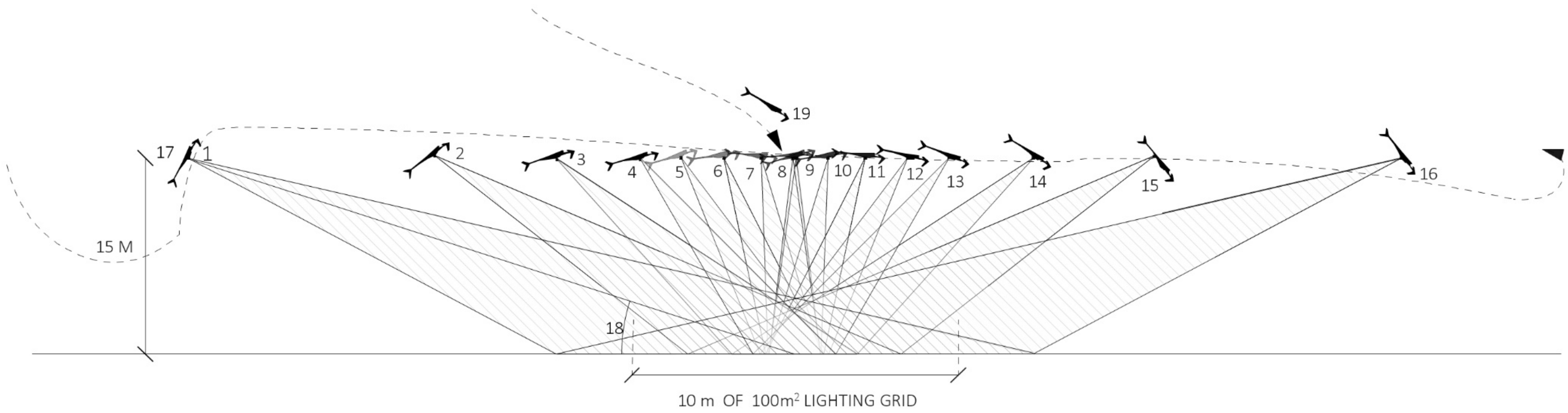
CREATING LIGHT AT THE ANGLES OF ELEVATION USING DRONES

1. 5AM 80^0
2. 6AM 70^0
3. 7AM 60^0
4. 8AM 50^0
5. 9AM 40^0
6. 10AM 30^0
7. 11AM 20^0
8. NOON 10^0
9. 1PM 10^0
10. 2PM 20^0
11. 3PM 30^0
12. 4PM 40^0
13. 5PM 50^0
14. 6PM 60^0
15. 7PM 70^0
16. 8PM 80^0

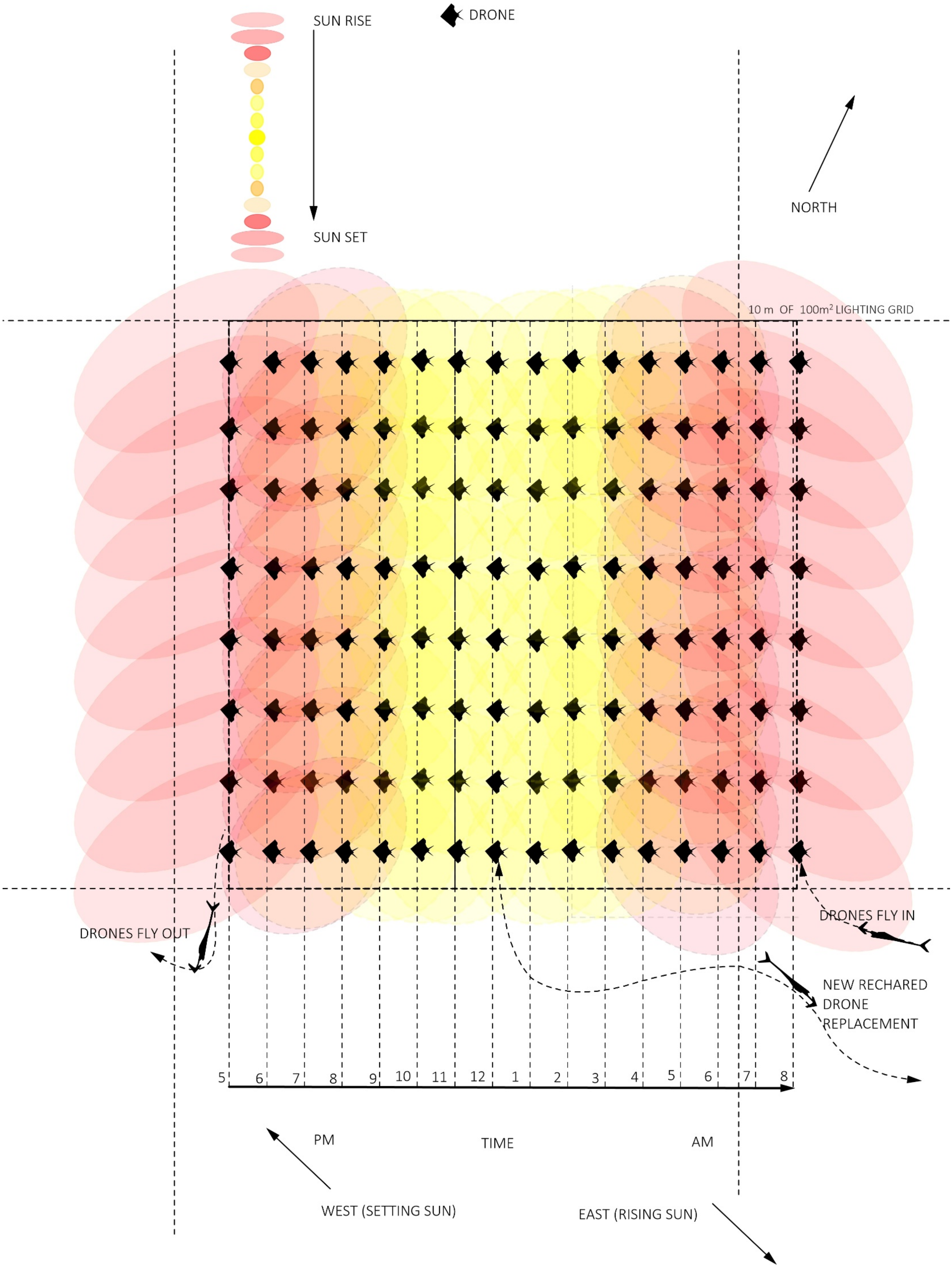
17. DRONE

18. POINT ANGLE OF ELEVATION MEASURED FROM

19. FULLY CHARGED DRONE FLIES IN TO REPLACE OUT OF BATTERY DRONE



SYNTHRTIC LIGHT: COLOUR, SHAPE AND DRONE PATH ACROSS ONE SQUARE OF LIGHTING GRID



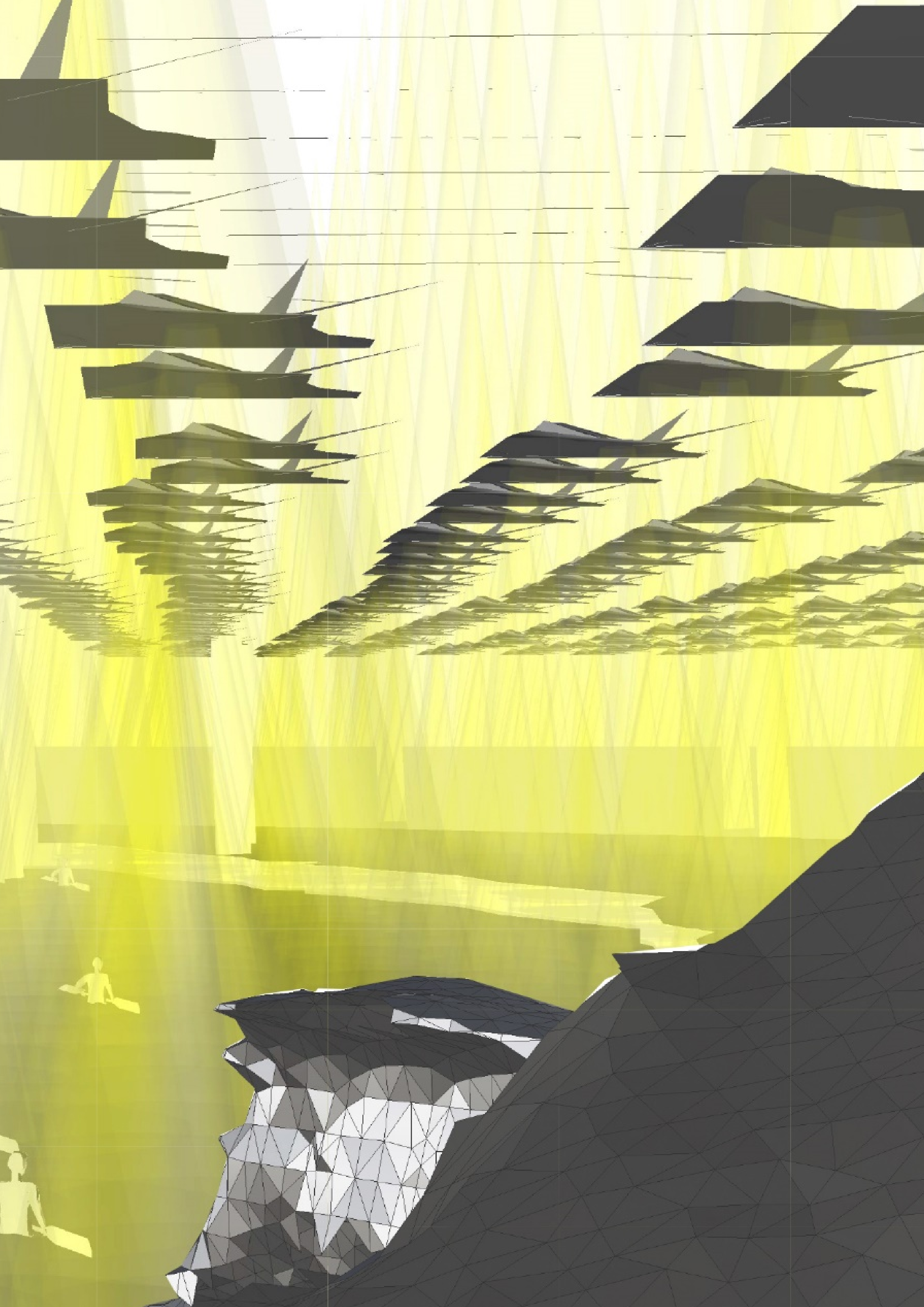
SUN LIGHTING ZONE PLAN

1:10,000

ANTI FRREEZE WATER

12 M^2 — DRONE CARRYING x 65 LIGHTS (15^0)AT 15 M HIGH

$100M^2$ — 1 SQUARE OF THE LIGHTING GRID



TOTAL SKY LIGHT = SYNTHETIC SKY LIGHT + NATURAL SKYLIGHT

The target lux level is 18 000 lux, the natural daylight is 6 000 lux. Therefore 12 000 lux is needed from the synthetic lights.

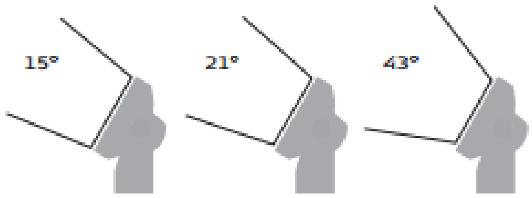
SKY LIGHT DESIGN

The sky lighting design will be achieved by mounting 52 of the p-5 lighting on a 45m high lampposts with mains electricity. At this height the lights will produce a beam 11.8m wide with an area of c. 100m2, giving 34 000 lux using LEDs of the future. Given this we will require one lamp post per square of our lighting grid.

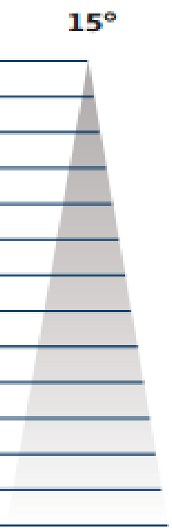
Image 47: Beam width v lux levels of the P 5 light

LUX DIAGRAM

Narrow spread lens of 15°
Medium spread lens of 21°
Wide spread lens of 43°



Distance (m)	Illumination (Lux)	Beam width, (m)
1	92500	0,3
2	23100	0,5
3	10300	0,8
5	3700	1,3
10	930	2,6
15	410	3,9
20	230	5,3
25	147	6,6
30	103	7,9
35	75	9,2
40	58	10,5
45	46	11,8
50	37	13,2

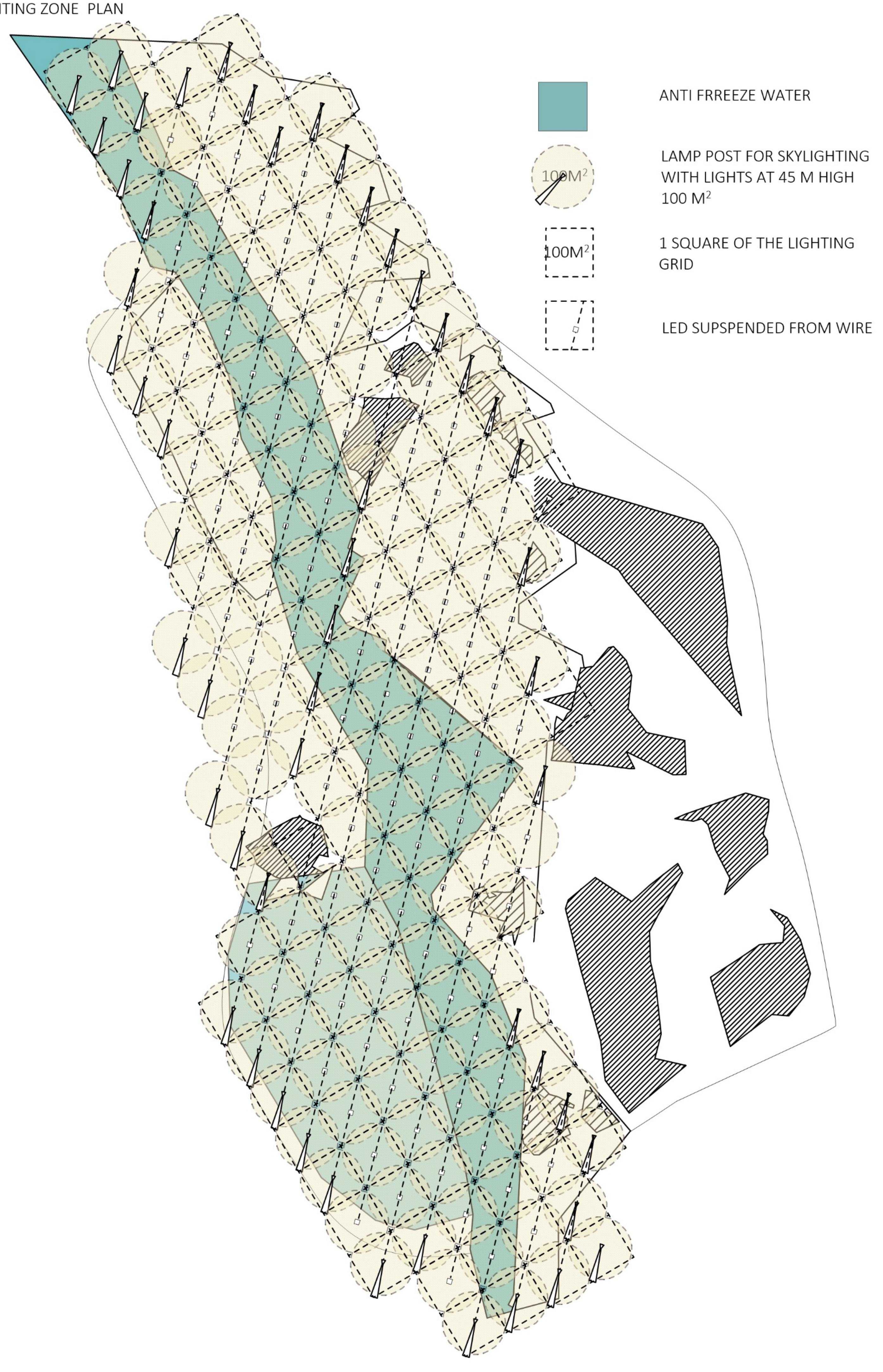


LAMP POST AMENDMENT

Initially the design required each individual square of the lighting zone having a lamp post. However I quickly discovered that this was very restrictive when moving around the site. I amended the deign to include the mesh of wires holding up the lights to the center of the lighting zone. This enabled me to remove the central lamp posts.

Image 48: (opposite page) sky lighting zone plan

SKY LIGHTING ZONE PLAN
1:10,000



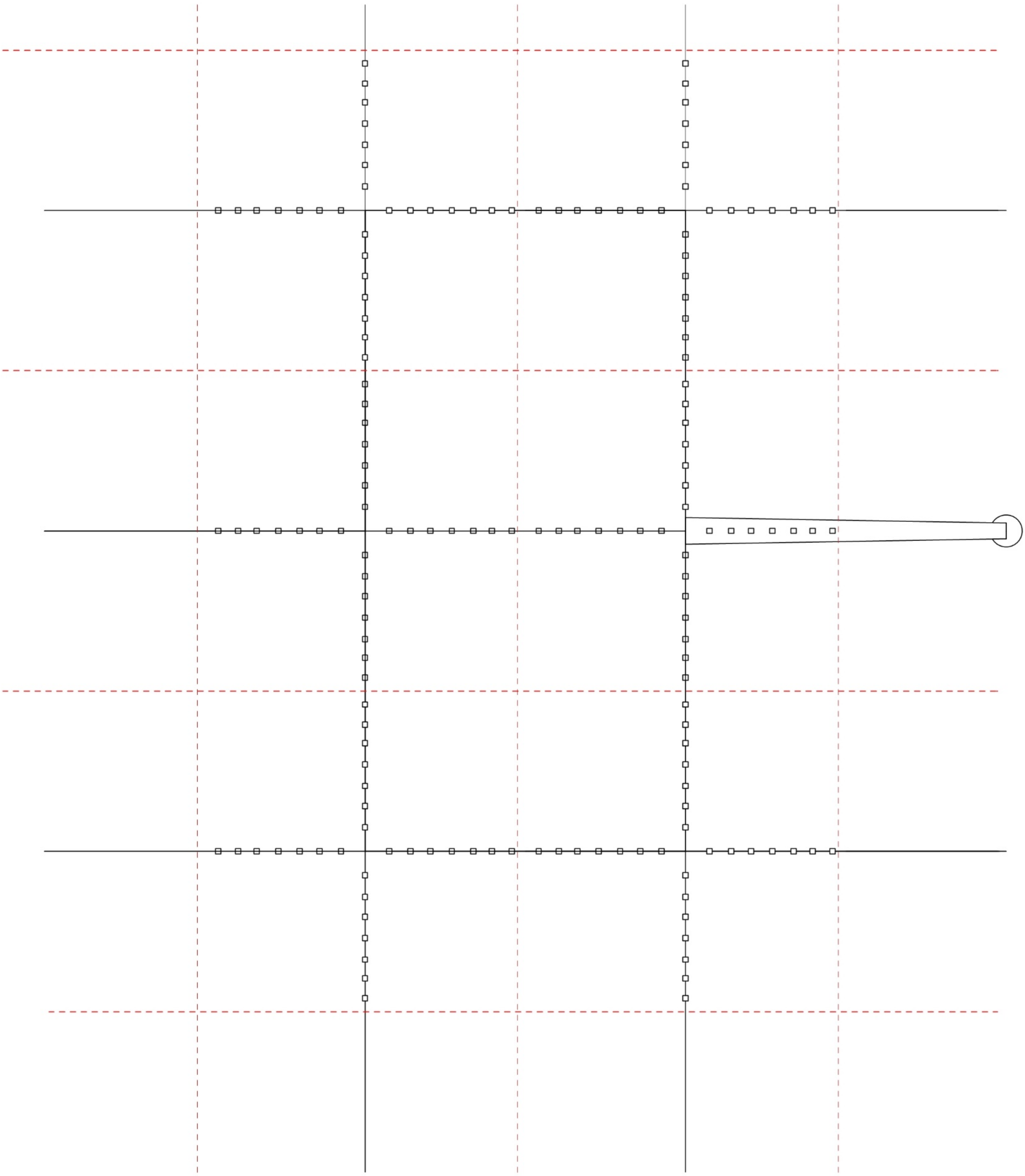
SNYTHETIC SKY LIGHTS: LED LIGHT CONFIGURATION

SUSPENSION WIRE

LIGHTING ZONE GRID (10M X 10M)

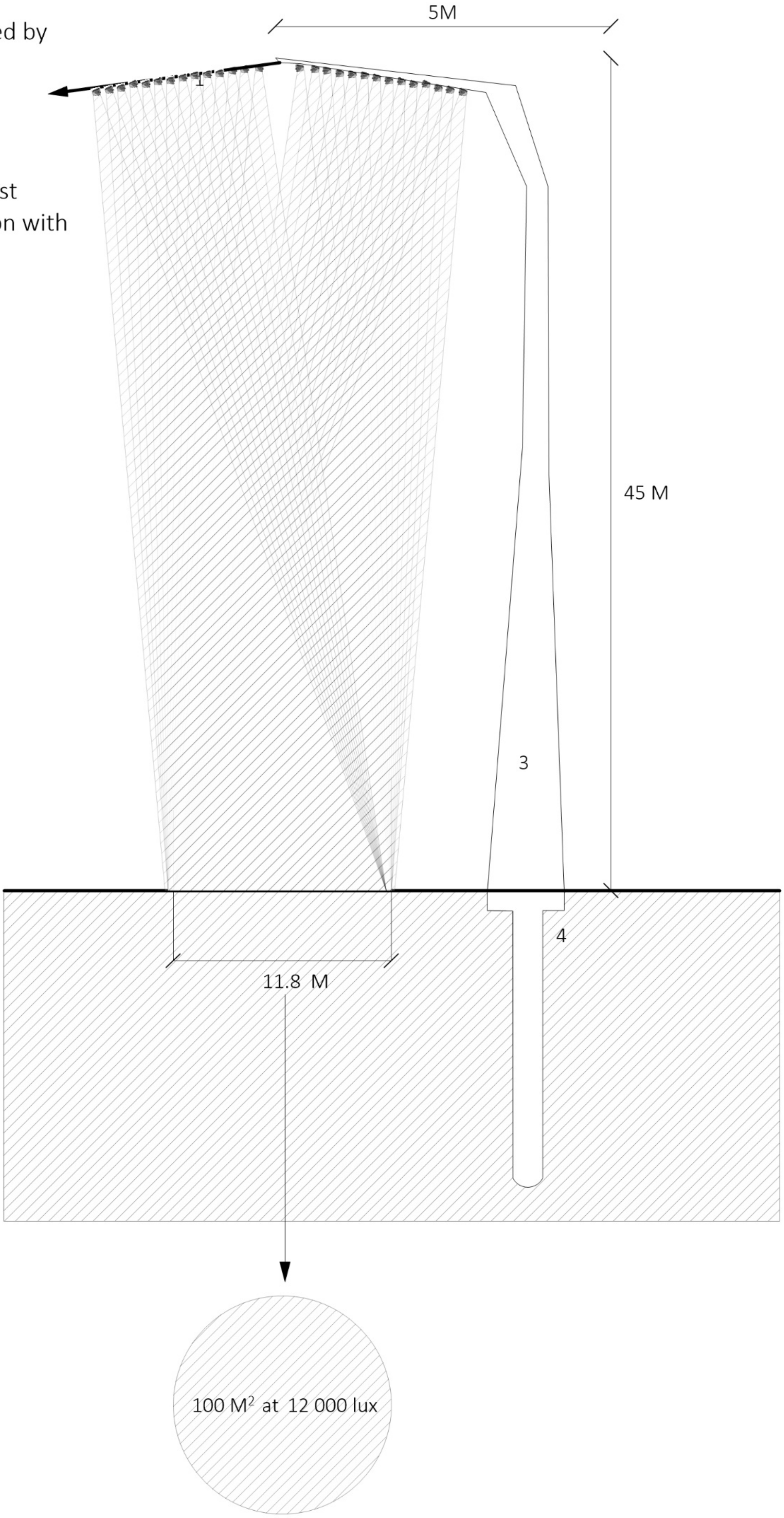
LAMP POST (5MX 0.2M)

LED LIGHT (0.1M X 0.1M - 52 LIGHT PER SQUARE OF THE GRID)



SKY LIGHT LAMP POST AND
WIRE MESH

1. X52 LED light powered by mains electricity
2. Light cone produce at 45 M high 11.8m wide
3. Corten steel lamp post
4. c. 15m pile foundation with pile cap



SHADOWS

SYNTHETIC SUN LIGHTING

The synthetic sun light is comprised of natural daylighting (947 000 lux) and the synthetic sunlight from the lights the drones carry (93 000 lux). The drone itself will has an area of $8m^2$. There will be 4 drones per 100m3 of the lighting zone grid, therefore 32% of the natural daylight will be blocked. As this is only 11% of the lighting total, making me 11% away from the target this is acceptable.

SYNTHETIC SKY LIGHTING

The daylighting comprises of natural daylight (6 000 lux) and the synthetic LED daylighting (12 000 lux). The drone shadow with block out 32% of both the natural and synthetic day light resulting in 78 000 lux of sky light. This deficit is too large. To counterbalance the loss of lux from the shadows 16 further LED lights, will be added to each square of the lighting grid in the skylight lamp posts and wires. Resulting in 68 LEDs in total reaching the target of 18, 000 lux.

Image 50: revised synthetic sky lights: LED light configuration

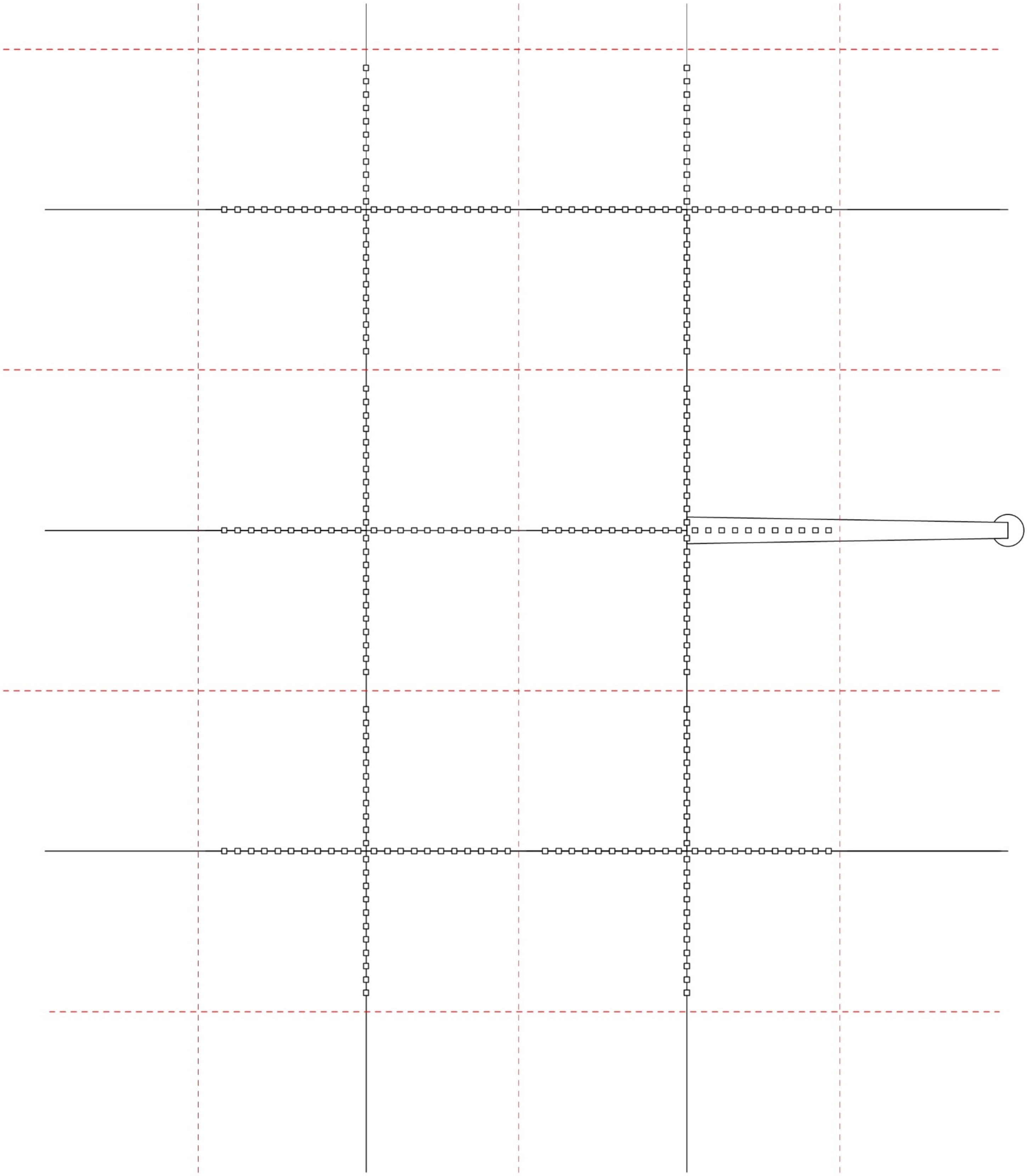
REVISED SNYTHETIC SKY LIGHTS: LED LIGHT CONFIGURATION (16 MORE LEDs PER $100M^2$)

SUSPENSION WIRE

LIGHTING ZONE GRID (10M X 10M)

LAMP POST (5MX 0.2M)

LED LIGHT (0.1M X 0.1M - 68 LIGHT PER SQUARE OF THE GRID)



ADDITIONAL DAY LIGHTING AND ITS EFFECT ON THE LIGHTING ZONE ENVIRONMENT

The building cladding materials

Glazed building without shading devices should be avoided in this area to minimise solar gain[51]. Although due to the LEDs low heat transmitting nature [52] I would expect any solar gain to be minimal.

---

[51] "Solar gain is short wave radiation from the sun that heats a building, either directly through an opening or indirectly through the fabric of the building." (Building Designs wiki, 2014)
[52] "The invention of the blue LED was the final key to using light emitting diodes – low power, long-lasting sources of light." (The Guardian newspaper online, 2014)

Plant and animals in the Lighting zone

As the water is too highly salinated to allow most known plants or animals to survive we can assume that there will be no issues with overgrown water plants. On the other hand the plant life on land is likely to thrive with the synthetic day light.

An article written by H. Kim and R.M. Wheeler and C.A> Mitchell, discusses the issue.

"Plant productivity in response to LED lighting"

(Wheeler, 2010)

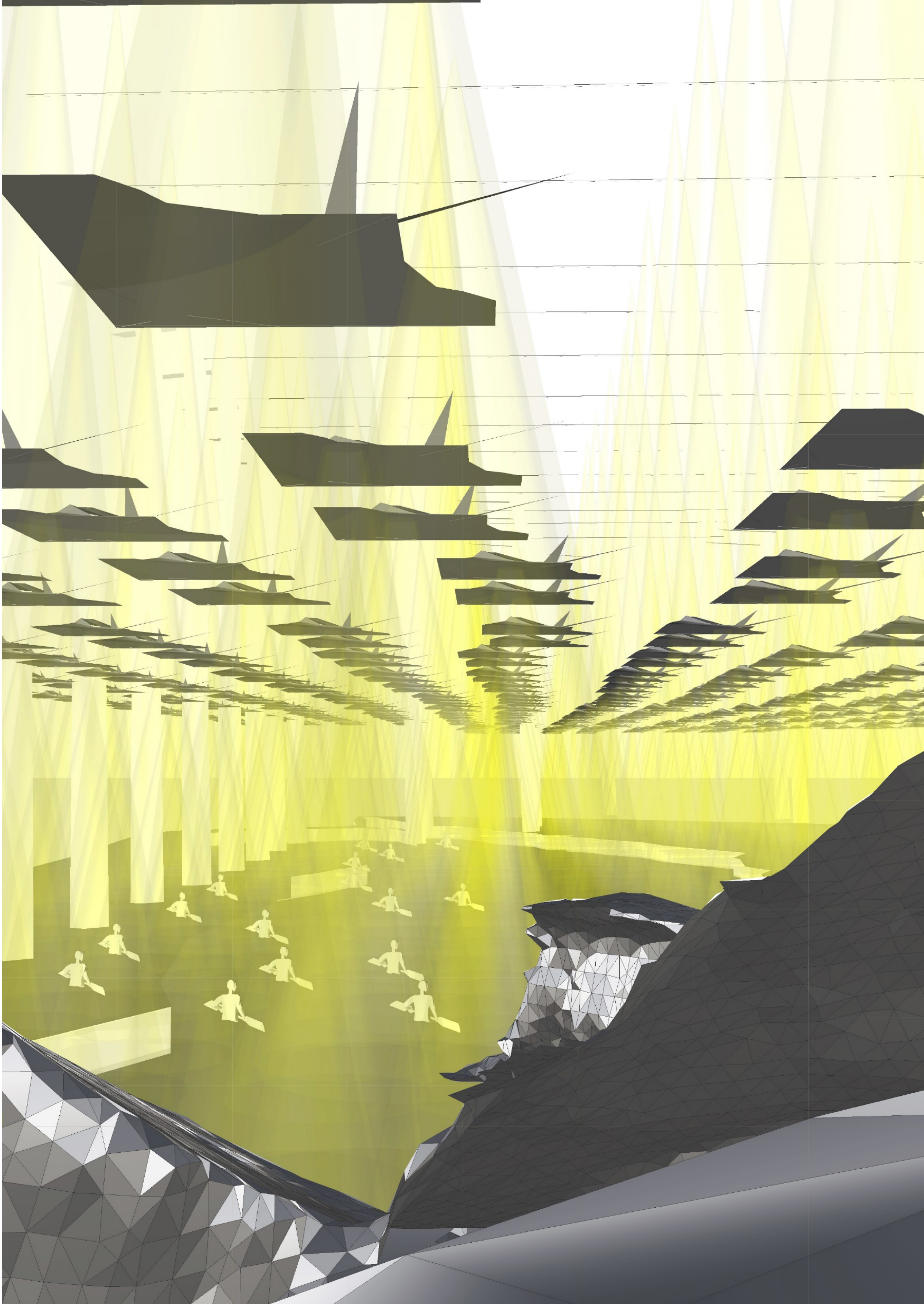
The authors describe the positive effect of being able to control the colour of the light when growing plants using LEDs and their overall successful usage of growing plants using LEDs.

"Light-emitting diodes (LEDs) have tremendous potential as supplemental or sole-source lighting systems for crop production"

(Wheeler, 2010)

We can therefore assume that the various non water dwelling plant species will thrive. There must be adequate provisions designed in to control their growth for example appropriate maintenance access for pruning.

Image on the following pages 51 + 52 + 53



CONCLUSION

Following the research and development carried out in this thesis many findings have been noted and used to inform the masterplan and building design.

SALINATED WATERS

To reinvent winter in Helsinki I have proposed interventions of liquid state water during winter achieved by adding salt to the canal, also synthetic daylight to the lighting zones.

The quantity of salt required has been calculated at 69 300 tones (32 x 32 x 32m).
To make the canal we must first, dig and line to prevent the salt seeping into other waters and poisoning other sea life. There it will be filled with sea water from the Baltic Sea and the salt added. The salt required will be made from boiling sea water which will be piped into 33 factories across the masterplan in 14cm diameter pipes. In each factory it will be boiled and then mixed with a small amount of water to produce brine that can be transported by a network of pipes, spouts and turbines across the canal evenly. To ensure the canal does not overflow from the 650mm rainfall per month will be piped back into the salt factories and boiled to produce salt. The salt factory will also house a steam room which will be filled with steam produced as a by-product in the salt production boiling. Salt will be sold in a shop area and used in beauty and relaxation tremens in the spa. The cavity in the walls will be 20 cm in order to hold the 14 cm diameter pipes required, access panels must also be incorporated into the design. The canal water will be maintained at 12.5% salinity which is lower than the maximum of 40% salt soluble in water.
In summary the anti-freeze canal is possible, enhancing winter by enabling water activities.
In summer the water temperature will be warm enough to swim. The high salt content of the water will increase the buoyance of objects submerged causing them to float[53]. This will create an enjoyable environment for the Fins to relax and have fun in.

SYNTHETIC LIGHTING ZONES

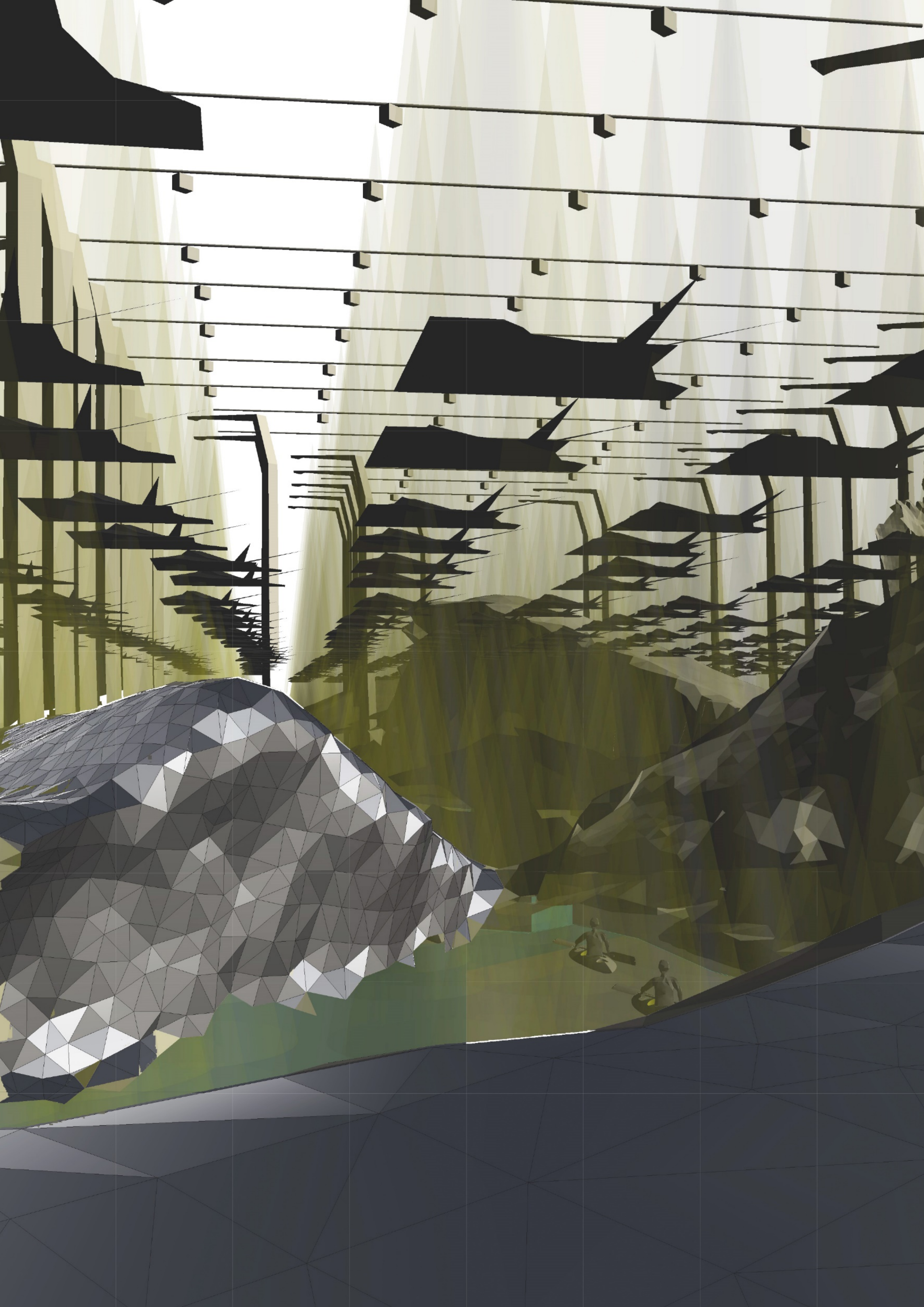
The Helsinki winter has only $6^{1/2}$ hours of daylight in winter, which causes high levels of S.A.D. in the population. Daylight has been analysed and concluded that it comprises of sunlight, direct angled light, sky light and diffused scattered light. It has different lux and kelvin levels throughout the year and day. I propose to recreate a mid-winters day, however 3 times brighter which I concluded would be enough to provide a noticeable difference between the lighting zone and the rest of the catalyst zone. Lux

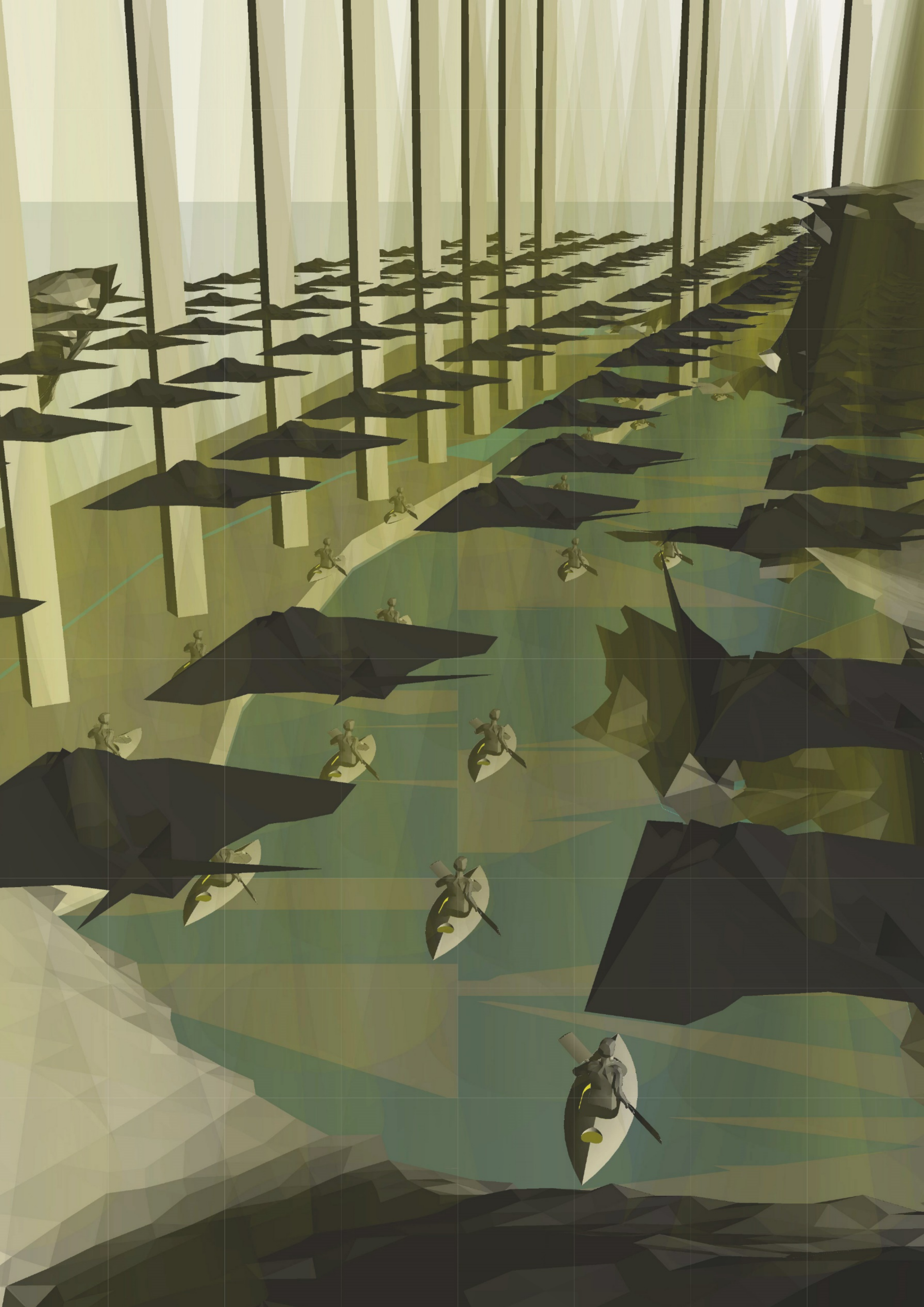
[53] "Because salt water is denser than freshwater, some things float more easily in the ocean—or extremely salty bodies of the water, such as the Dead Sea." (Science Buddies, 2014)

level data was taken for both sun and sky light and timed by 3 to create the brief. At midday at the sunlight brief is 140, 000 lux and the sky light brief is 18, 000. The LED lights chose can be programed by both lux levels and kelvin levels.
Throughout the day the kelvin levels will change from morning 3, 500 k orange/red, mid-day 5,500 k white/ yellow, afternoon 5,000 yellow, evening 3, 5000 orange/red. The hours of daylight will be doubled to improve the short days of winter. The drones carrying the sunlight will be programed to tilt and hovel projecting the lights at angles mimicking those of sunlight on a mid-winter's day, ranging from 80^0 at 6am to 10^0 at noon and back to 80^0 at 8pm. The synthetic daylight will be divided into a grid system with $100M^2$ grid. Per square there will be 4 drones carrying 65 LED lights at 15 m high with a beam width of 3.9m and illuminated area of 12m2 with 93,000 lux. Along with the 47, 000 lux from the natural day light we come within 10% of our target of 40,000lux taking into account the drones show. The drones have a battery life of 16 hours so will need to split the day into2 8 hour shifts.
The skylight will be produced by lamp posts and wires holding up the LEDs. Per 100m2 the wires and lamp posts will support 78 LEDs lights at 45M high emitting 12, 000 lux which in conjunction with the background daylight reaches our target of 18, 00 lux.

The combination of the background synthetic skylight, the direct angled synthetic sunlight the change in light temperature or colour should create a realistic and enjoyable environment for Helsinkiers. The synthetic daylight will give the illusion of being in a sunny spot, improving people moods, and reducing S.A.D. in sufferers[54].
It will also have a positive effect on plant growth providing a lush environment. This could provide many interesting design opportunities. The environments of small corners of Helsinki (catalyst zones) will be significantly altered in feel, activity type, ecology and winter will be reinvented in Helsinki.

[54] "Researchers from the University of Maryland's School of Medicine have determined that just one hour of bright light therapy significantly reduces depression and depressed moods." (Adams, 2013)





IMAGES

IMAGES

Image 01
The new Helsinki master plan catalyst zone 01 drone synthetic daylighting system and anti-freeze canal , by author

Image 02
Finland the land of 1000 lakes
Geosnap, 2013. *Geosnap*
www.eosnap.com
Accessed 02 April 2015

Image 03
Rjukan's mirror installation on site
Johanso, M
Rjukan, Norway, Sees Winter Sun For First Time Thanks To Mountain Mirrors, international Business Times Newspaper

Image 04
Myers, Russell, *Giant MIRRORS brighten the winter darkness for town which gets NO sunlight*, the mirror Newspaper

Image 05
Myers, Russell, *Giant MIRRORS brighten the winter darkness for town which gets NO sunlight*, the mirror Newspaper

Image 06
Helsinki archipelago, Salo, Jaakko, discovering Finland
http://www.discoveringfinland.com/travel/regions-cities/aland-archipelago/#

Image 07
Water activities in and around Helsinki, by author
Images from www.googleimages.com

Image 08
Sea ice in the Gulf of Finland over the months, by author

Image 09

Helsinki Cruises map showing winter time closures
Helsinkicruises, 2012. *Helsinkicruises*
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Image 10

Finland frozen
Geosnap, 2013. *Geosnap*
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Image 11
One of the Helsinki governments fleet of ice breakers, used to create routes that boats can use through the wintertime sea ice

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Image 12
Annual hours of daylight in Helsinki per month, Diagram by author, information from climatemps, 2009. *climatemps*
www.helsinki.climatemps.com
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Image 13
The new Helsinki master plan: water ways, by author

Image 14
Water ways in catalyst zone 01, by author

Image 15
Salt production process, by author

Image 16
Average monthly temperature in Helsinki (^{0}C, by author
Information source
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Image 17
High salinity anti-freeze waters plan, by author

Image 18
Anti-freeze waters concept, by author

Image19
Volume of sea water in canal v salt required, by author

Image 20
Sea water boiling at the Maldon salt factory,
Maldoon Salt Company, 2014. *Maldoon Salt Company*
http://www.maldonsalt.co.uk/The-Story-How-Maldon-Salt-is-made.html
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Image 21
Salt production process, by author

Image 22
High salinity water stages, by author

Image 23
New Helsinki master plan: brine distribution system, by author

Image 24
Extracted steam from boiling pans to steam room, by author

Image 25
Salt factory ground floor plan, by author

Image 27
Salt factory first floor plan, by author

Image 28
Large scale pond liner
http://garciarockandwaterdesign.com/blog/?paged=2

Image 29
The Dead Sea 33.7% sainity
Manske, D., 2013. *Twisted Sifter*
http://twistedsifter.com/2012/06/10-things-you-didnt-know-about-the-dead-sea/
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Image 30
Helsinki new master plan: lighting zones during winter, by author

Image 31
Day light: Sun light +Sky Light. Diagram, by author,
Information by http://electrical-engineering-portal.com/difference-between-diffuse-and-directed-light

Image 32
Noticeable difference between light levels experiment London, by author

Image 33
Lighting zone plan, by author

Image 34:
- *Lighting concept,* by author

Image 35
Daylight Scale (Kelvins) ,
Ephotozine, 2002. *Guide to colour temperatures*
http://www.ephotozine.com/article/guide-to-colour-temperature-4804
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Image 36
Earth Rotating. Day and Night Diagram, image by author, information by
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http://www.bbc.co.uk/education/clips/z6vfb9q
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Image 37
S*UN PATH DIAGRAM, HELSINKI on 1st February 2014*
GAISMA , 2015. *GAISMA*
http://www.gaisma.com/en/location/helsinki.html
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Image 38
Sun's angle of elevation
Project Atlas, 2015. *Project Atlas (Harvard)*
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Image 39 + 40
Beam width v lux levels of the P 5 light
ISGM Lighting, 2015. *ISGM Lighting*
http://sgmlight.com/media/94388/P_2_15degrees_Datasheet.pdf
Accessed 29 March 2015

Image 41
Master plan heights, by author

Image 42
Northrop Grumman Unmanned Bat drone
Northrop Grumman Capabilities, 2015. *Northrop Grumman Capabilities*
http://www.northropgrumman.com/Capabilities/BATUAS/Documents/pageDocuments/BAT_Datasheet.pdf
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Image 43
Drone to produce synthetic sunlight design diagram, by author

Image 44
Drone to produce synthetic sunlight design diagram, by author

Image 45
*Sun lighting zone pla*n, by author

Image 46
View of synthetic sunlight drones, by author

Image 47
Beam width v lux levels of the P 5 light
ISGM Lighting, 2015. *ISGM Lighting*
http://sgmlight.com/media/94388/P_2_15degrees_Datasheet.pdf
Accessed 29 March 2015

Image 48
Sky lighting zone plan, by author

Image 49
Synthetic sky lights: LED light configuration

Image 50
Revised synthetic sky lights: LED light configuration

Image 51
View of synthetic daylight system, by author

Image 52
View of synthetic daylight system, by author

Image 53
View of synthetic daylight system, by author

TABLES

Table 1

Light levels on 1st February (2014) per hours in Helsinki (existing)
Information from Department of eEnergy. US Government , (2015).
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Table 2

Light levels on 1st February 2014 per hours in Helsinki x3 lux levels and x2 the hours of daylight (proposed)

Table 3

Angle of synthetic sunlight brief

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