MARITIME GRAVEYARD

BENV GA08: DESIGN REALISATION
STEVEN DANIEL GRAVES
U21 YEAR 4 2017

CONTENTS

0.01 STOCKHOLM, AN INTRODUCTION
BRIEF: THE MARITIME GRAVEYARD

SITE
Land Adjacent Biskopsvägen 19, 115 21, Djurgarden, Stockholm, Sweden

PROJECT SYNOPSIS: THE MARITIME GRAVEYARD
The project brief is a 'live' museum displaying shipwrecks that have been preserved in stockholms archapelago. The submerged wrecks are to be brought on land to help reduce their environmental impact on the landscape and the new Architecture will be used to salvage these sunken wrecks and displaying them as artifacts. This architecture should question the notion of 'a musem' as a civic monument and critique the way that these cultural destinations can become disconnected from their localities. This proposal should therefore act as a piece of social infrastructure.

The project should have a responsivity to its environment and dynamically evolve throughout time to empower the artifacts it houses and create momentary conditions reflective of its environment.

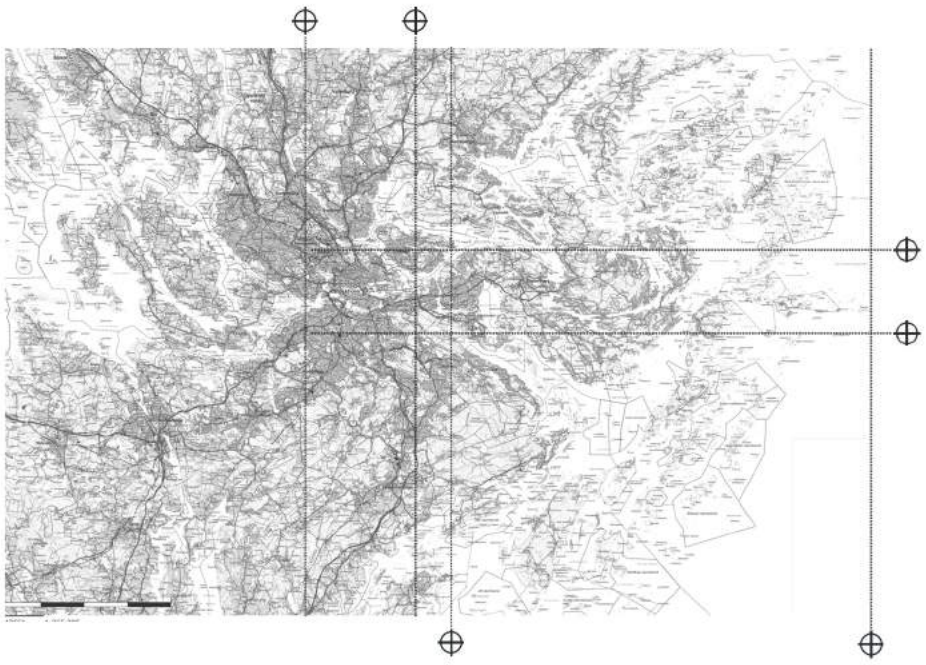
SCOPE OF WORKS
The proposal acts as an extension of Stockholms Archipelago, habitating the south coast at Biskopsvägen, on 'the museum island' Djurgarden. The littoral zone is extended North-Easterly onto the site and spreads through Djurgarden carving the landscape to form an organic network of channels and docks.

CONSULTANTS
Andrew Porter, Abigail Ashton and Tom Holberton - Unit 21 Design Tutors: The Bartlett School of Architecture UCL
Brian Eckersley - Structural Consultant: Eckersley

0.02 PROJECT RESEARCH +BACKGROUND

CONTEXT: *An Introduction to Stockholm*

Stockholm, the capital city of Sweden is a city with a strong connection to water. The city is built across fourteen islands that are connected between fifty-seven bridges giving it the name the 'city between the bridges'. Located on the threshold between lake Malaren, the third largest *freshwater* lake in Sweden and the Baltic sea the cities ties to the water are incredibly strong. The secularised city becomes interconnected through bridge links. These bridges are incredibly important vessels to provide physical connectivity. However the fragmented nature of Stockholm and its Archipelago, *despite this framework of infrastructure* has lead to boating at the forefront of transport between the islands.



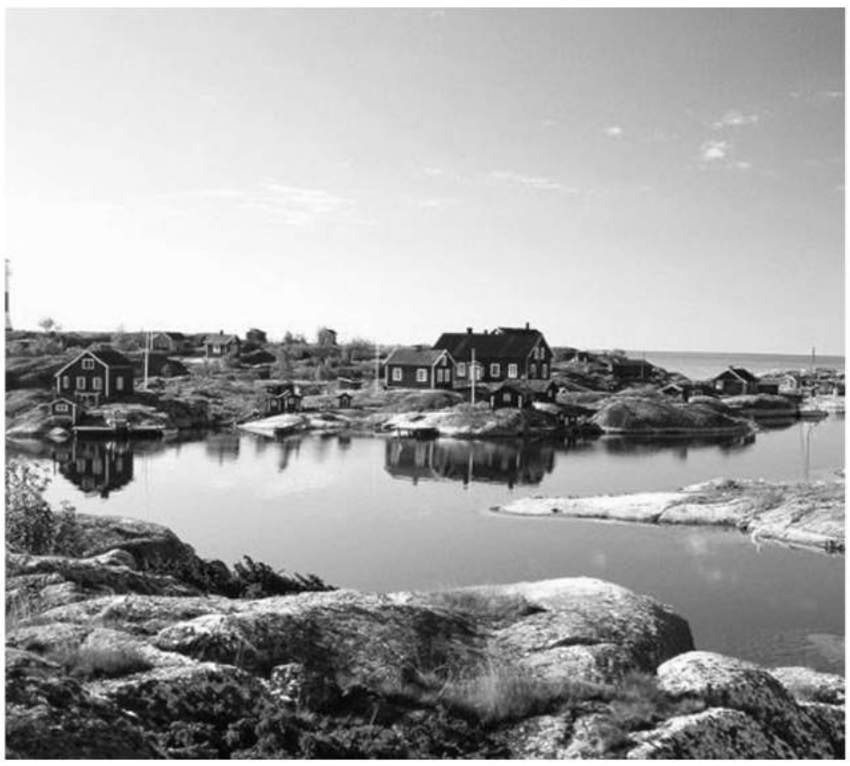
Prologue

Stockholms Archipelago, is a collection of over thirty thousand islands and rock outcrops that form the largest chain of islands in sweden and the second largest in the baltic sea. The islands are located just a few minutes by boat from stockholm forming a beautiful and breathtaking panoramic landscape. This fragmented landscape is home to an abundance of wildlife, cultivating a very rich and diverse ecosystem.

This fragmented maritime landscape has led to boats and boating, being increasingly popular with swedish people and being an important part of swedish culture. Boating is one of the largest activities in the country, with one third of the country's population taking part in boating at least once per season and the number of pleasure boats per capita being one of the highest in the world. As well as this, sweden has a highly developed boat building industry which generates export income and provides an abundance of jobs. This means boating has become a way of life for swedish people and has helped to define Swedens identity as a boating nation.

Throughout history shipwrecks have sat beneath the Baltic preserved almost perfectly on the seafloor. Making the baltic an Archaeological paradise of undiscovered maritime treasures. Historically political issues and nature have conspired to keep these secrets of the Baltic hidden with warships and submarines preserved perfectly in the sea water because of the low salt content of the water. Throughout history, it has also been tradition amongst Swedish people to take their old boats out onto Stockholms Archipelago during winter months and bed them on ice, drill holes in their hull and as the ice melts let them sink below the water. This is however creating large environmental issues, as the chemical content of the boats paint (and oil) is leaking into the archipelago, killing wildlife and damaging the enironment.

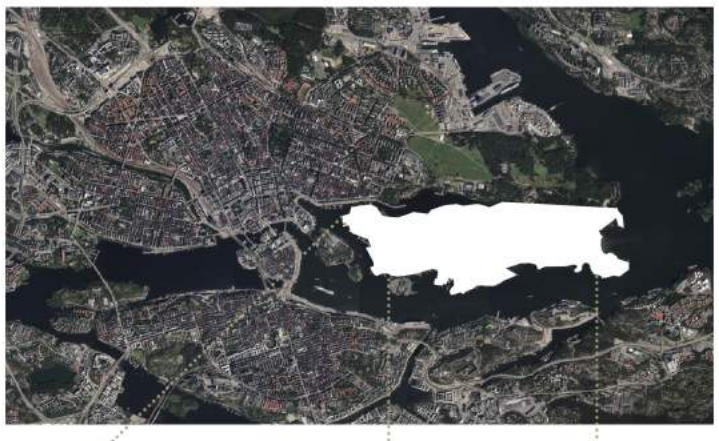
This maritime environment and the inherent nature is engrained into the swedish culture and this connection between land and sea remains important to the swedish identity.



In Sweden, materials and components from 200,000 scrapped cars are recovered and reused each year. It is part of a well-established recycling system. However the same systems are not available for boats, and due to Swedens strong national maritime interest this poses a problem.. Around 60,000 boats per year in Sweden get old, are damaged or otherwise breakdown never to see water again. The Maritime Graveyard serves primarily to recover parts from disused boats and boat wreckages and store the unsalvagable boats away from the water where they pose a threat to the environment.

Djurgarden

Djurgården is an island in central Stockholm, Sweden. It is home to many historical buildings, monuments, museums and galleries. The island is home to the open-air museum Skansen as well as a small residential area Djurgårdsstaden. There are many yacht harbours, and extensive stretches of forest and meadows. It is one of the Stockholmers' favourite recreation areas and tourist destinations. It has as a consequence, adopted the name ' the museum sialnd' attracting over 10 million visitors per year to its attractions.



Museums on the Island

The museums on the Island stand as disconnected elements. They house artifacts within galleries and as a result isolate them.

The buildings themselves act as cultural destinations and therefore isolated entities with the space between them acting as spaces of transition. The Maritime Graveyard will act as a piece of social infrastructure, spreading across the landscape retaining a strong connection to the waters edge and inviting people to learn about the countrys strong maritime cultural history.

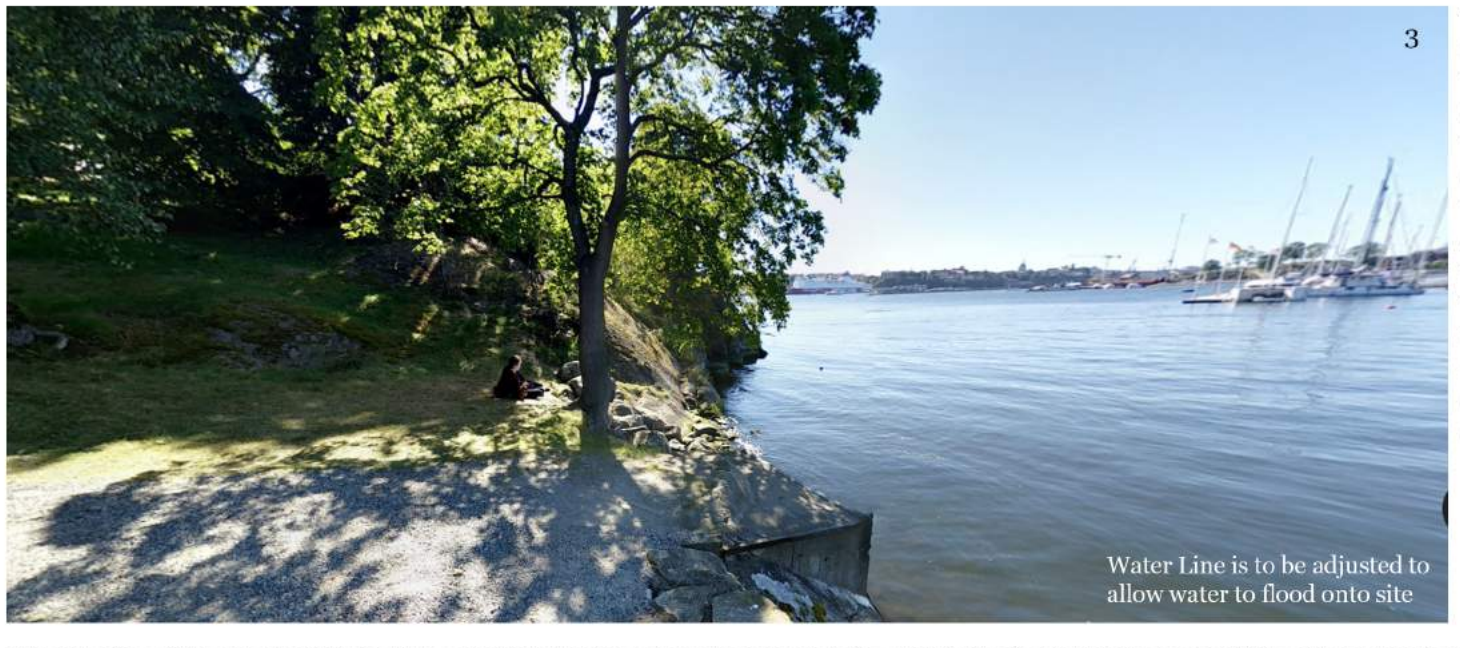
1.03, Site Restrictions

TO LAKE MALAREN

←

TO BALTIC SEA

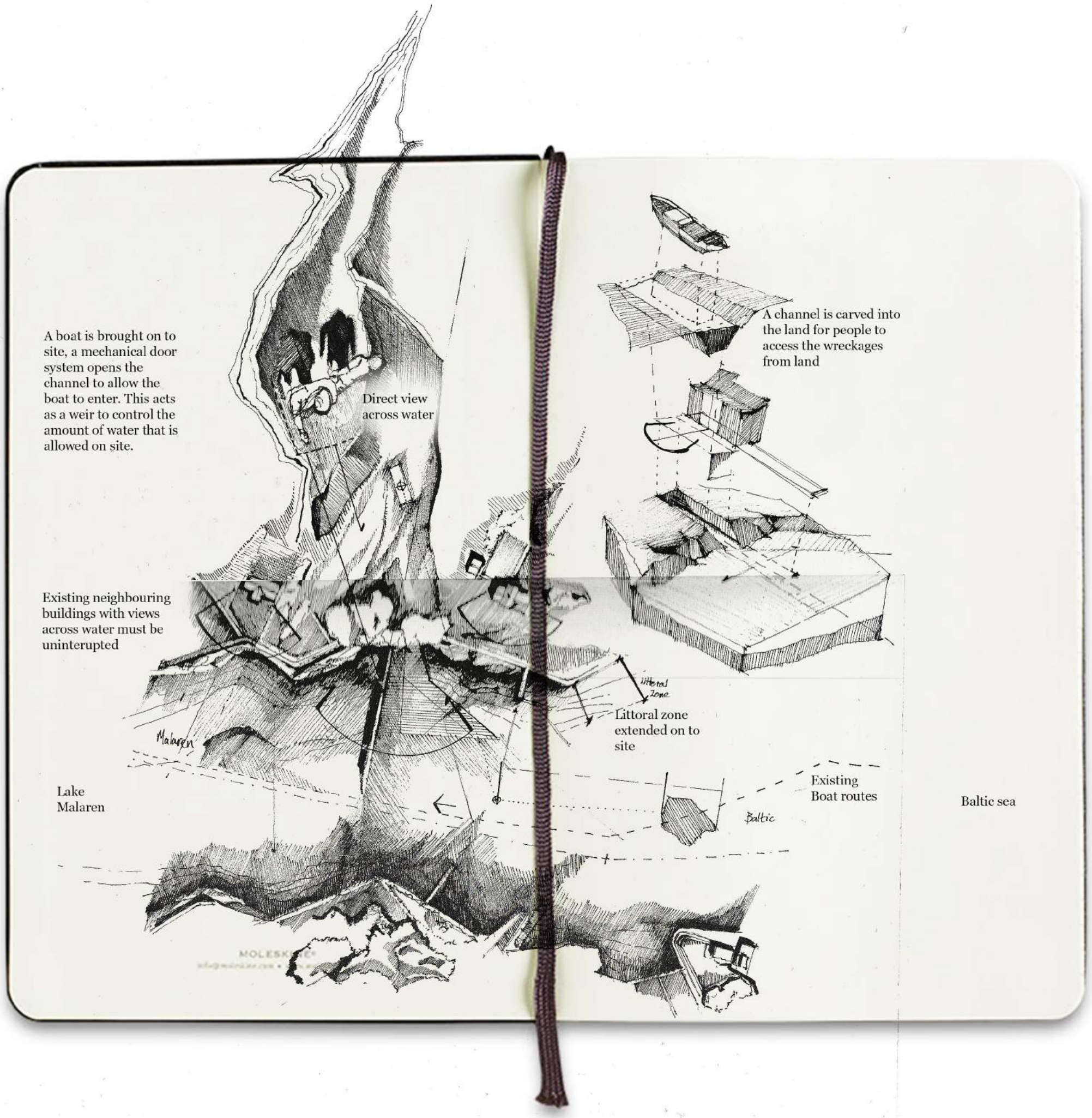
→



There is currently little interation between the waters edge and the site. The only instance where a connection occurs is shown in view 3. People here are utilising rock faces for site seeing out onto the water. This is an important vista to retain a visual connection to the opposite islands.

The massing of the site should take in to consideration the connection through the corridor to the water. Boats should be able to travel on to the site and the vidual link out on to the water must be retained.

The role of the water within the scheme is vital. The Archipelago is to be extended onto the site, spaces are to be created beneath the water and the depth of the water is to determine the intensity of light that enters the building.



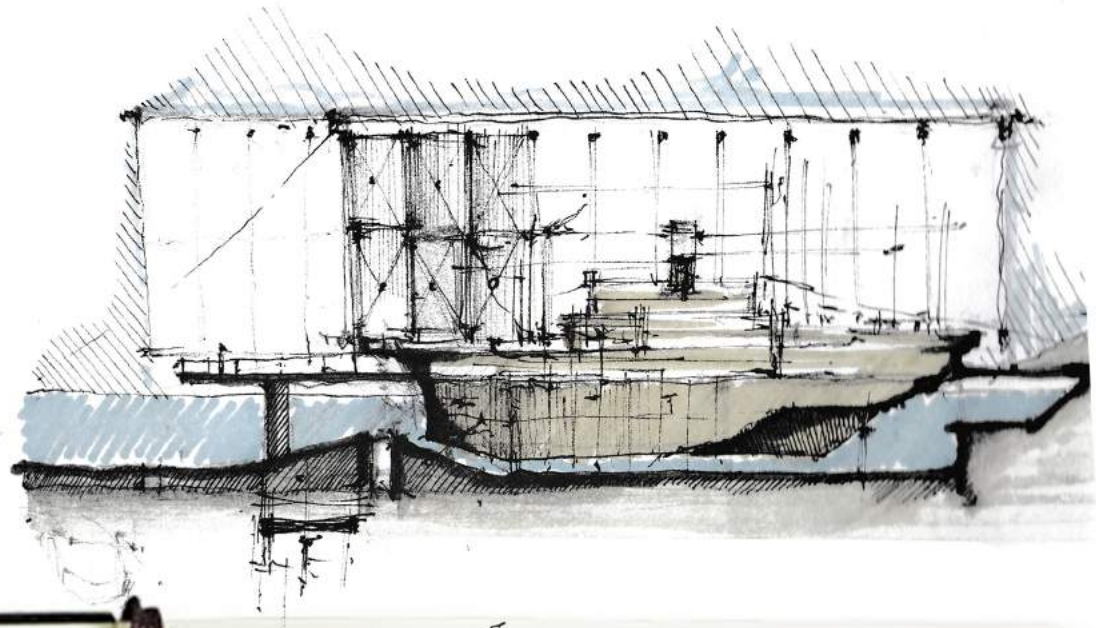
The Graveyard for Maritime wreckages

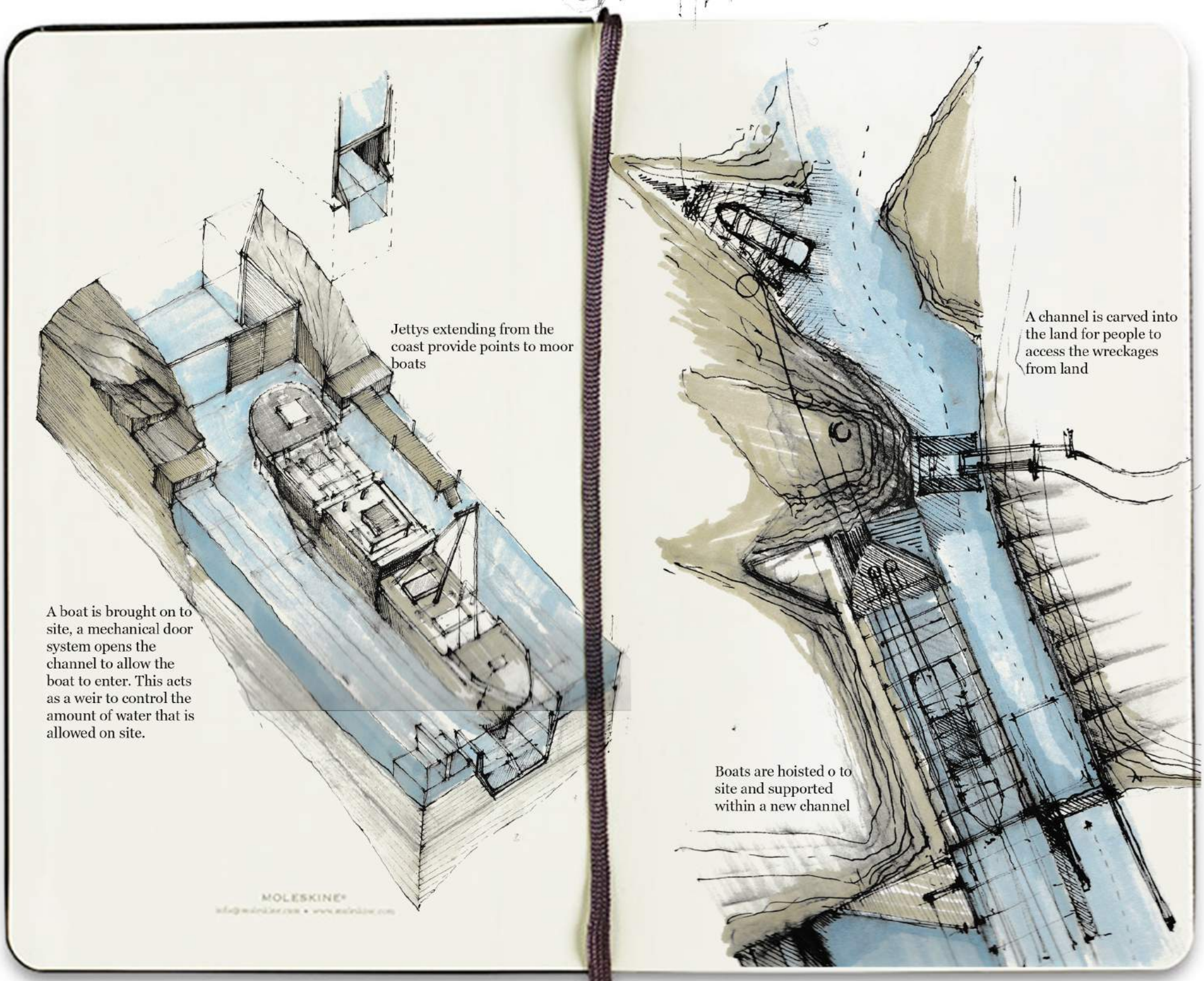
-

Existing Site Sketch analysis

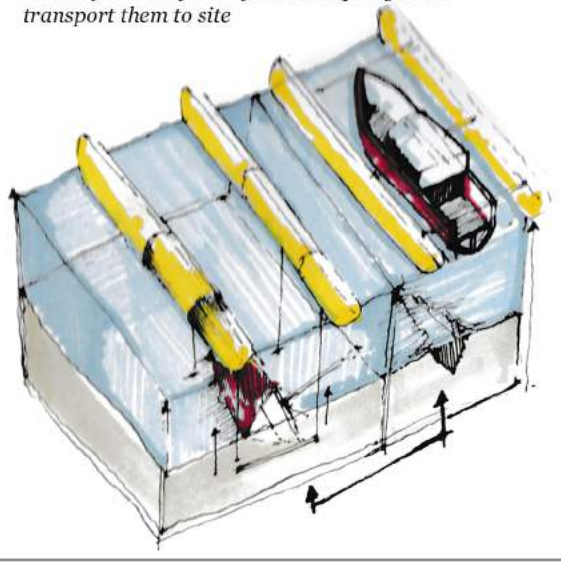
1.06 Concept + Form development

Conceptual section through the site showing theboat being brought into a new channel provided for boat wreckages to be viewed as Maritime Artifacts.





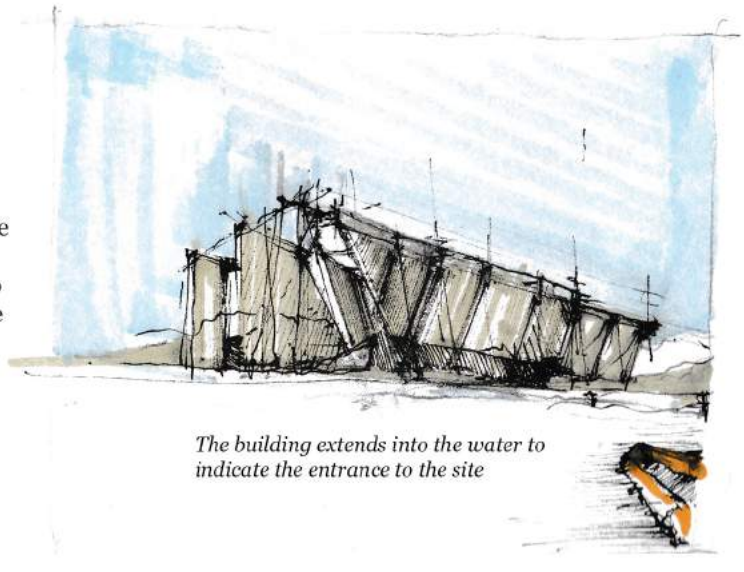
Floatation devices are used to hoist submerged wrecks from the floor of the Archipelago and transport them to site



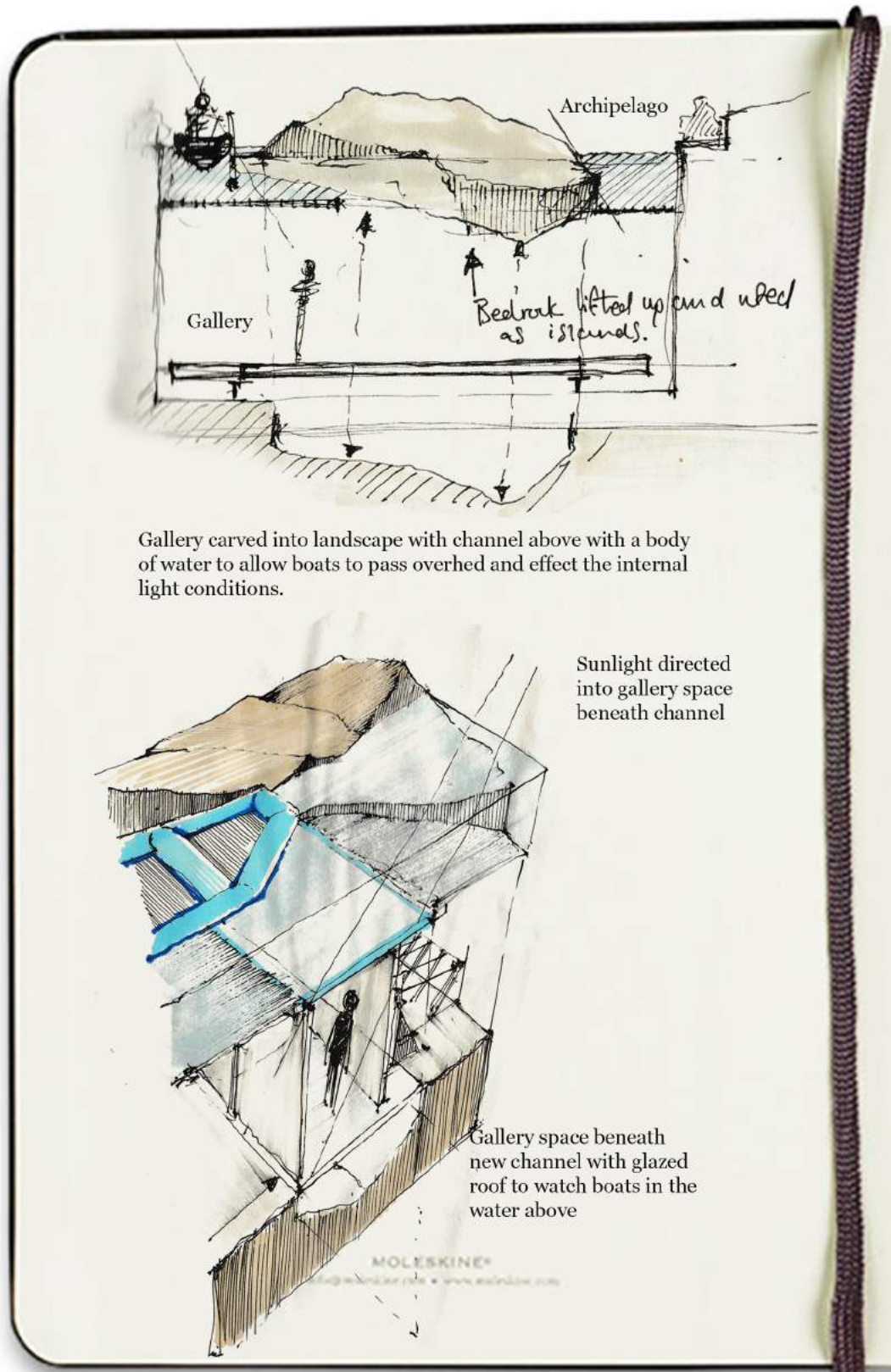
The Graveyard for Maritime wreckages

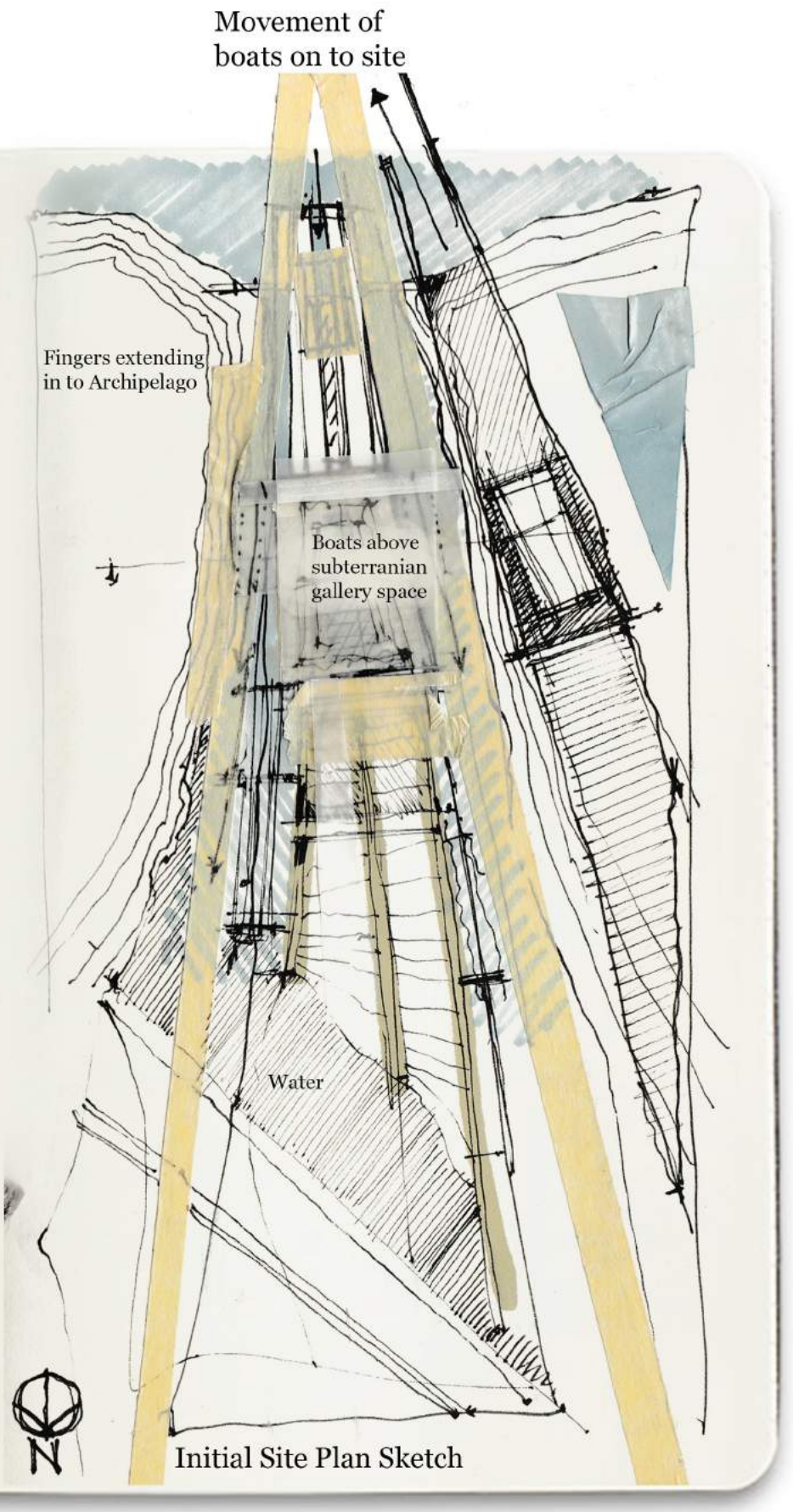
-

Stockholms fragmented landscape is scattered with maritime wreckages, these wreckages are to be lifted from the Archipelago where they are causing damage and pollution to the environment. These boats are then brought on to the site at Djurgarden which will act as an extension of the Archipelago where these boats will become artifacts of swedens rich Maritime history.



The building extends into the water to indicate the entrance to the site



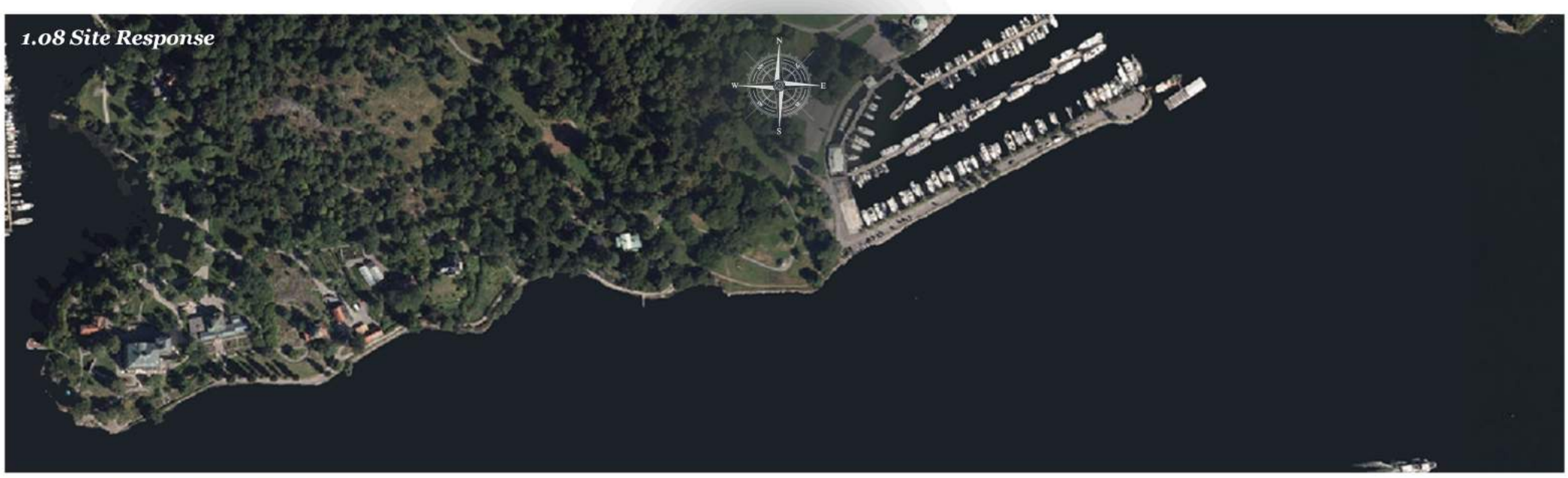


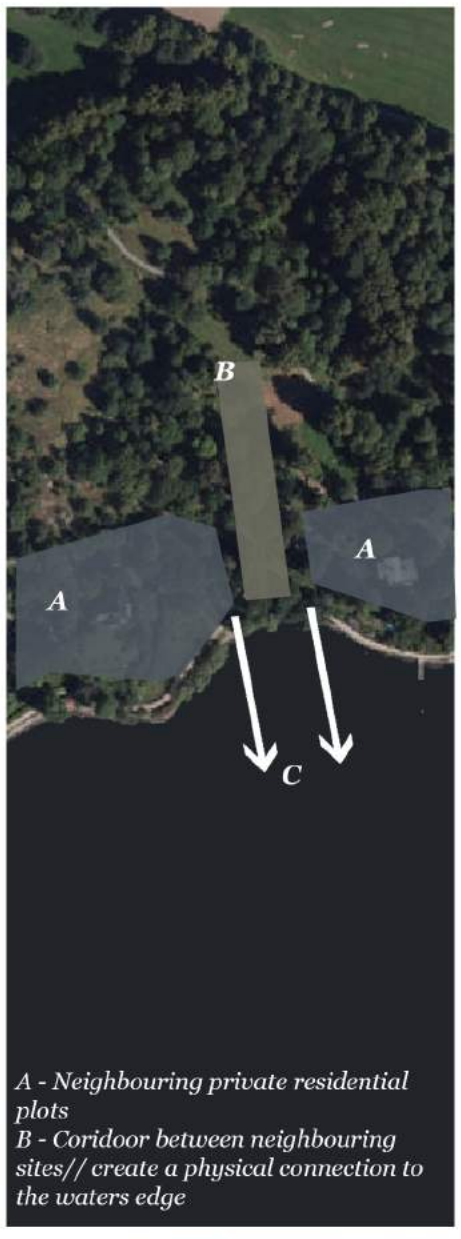
The Graveyard for Maritime wreckages

-

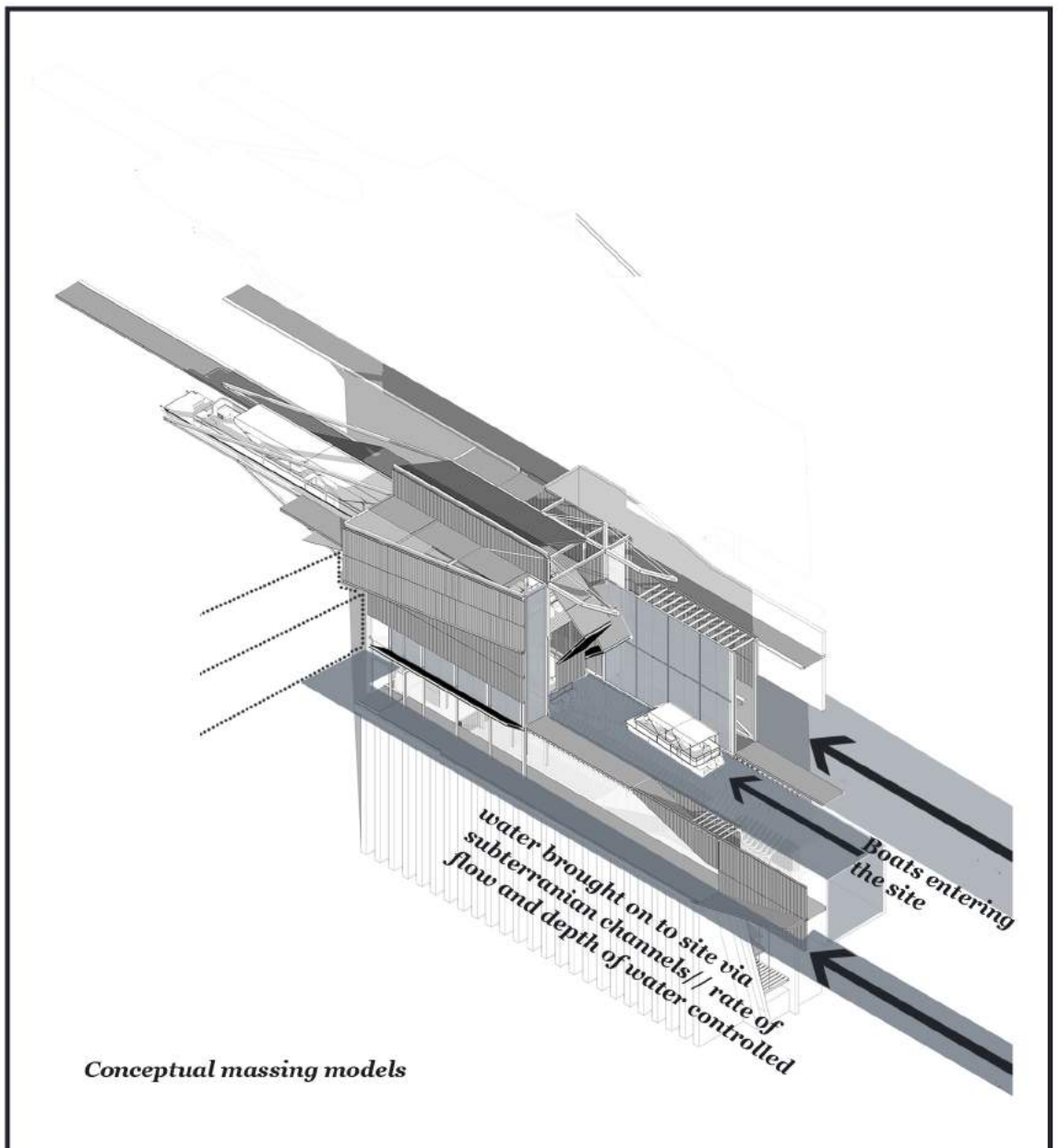
Initial Conceptual Gallery drawings

1.08 Site Response

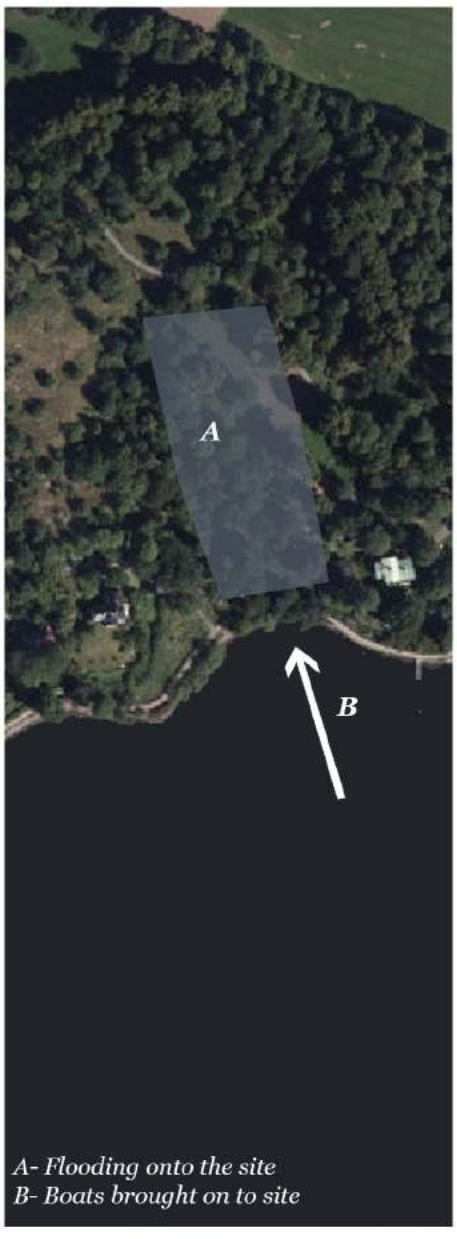




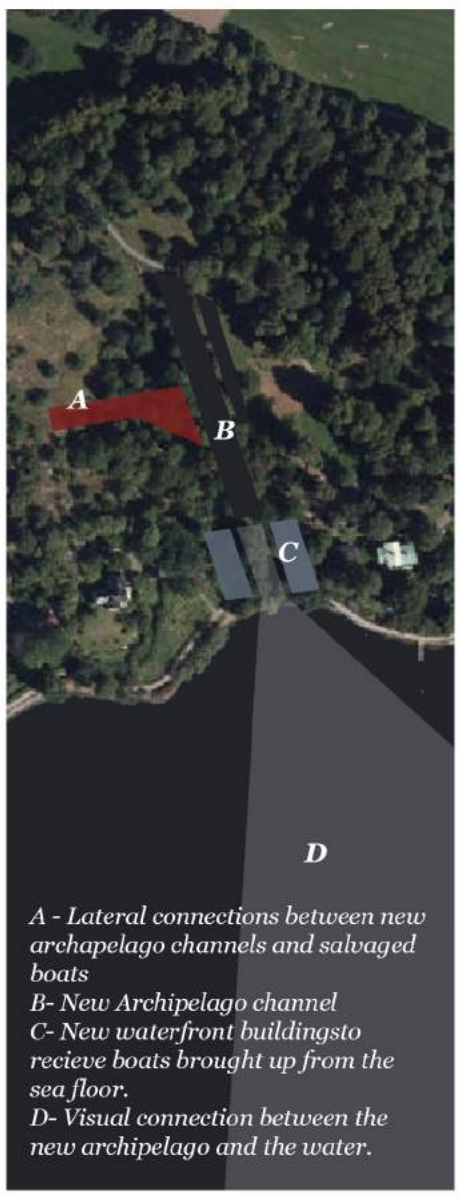
A - Neighbouring private residential plots
B - Coridoor between neighbouring sites// create a physical connection to the waters edge



Conceptual massing models

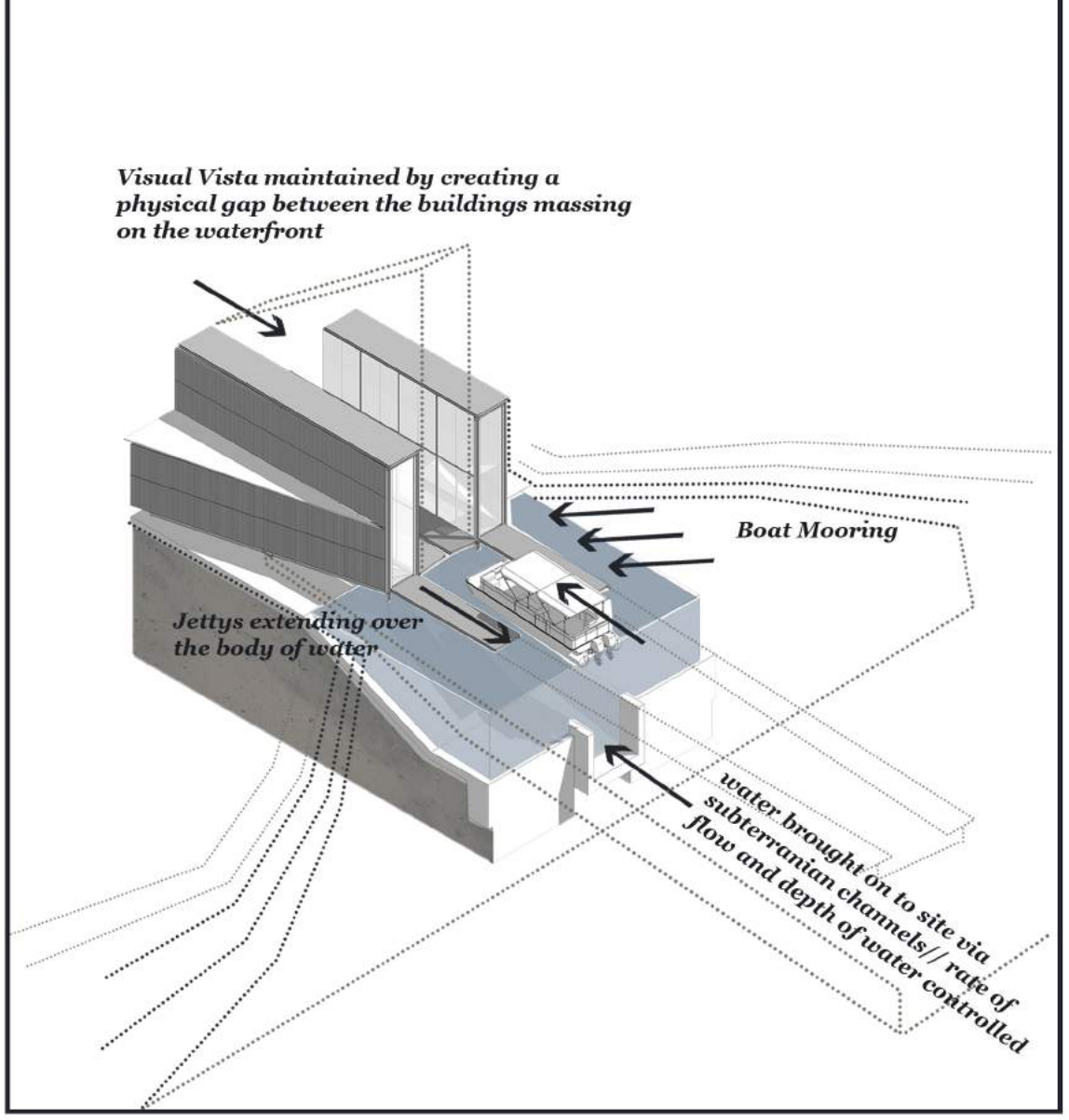


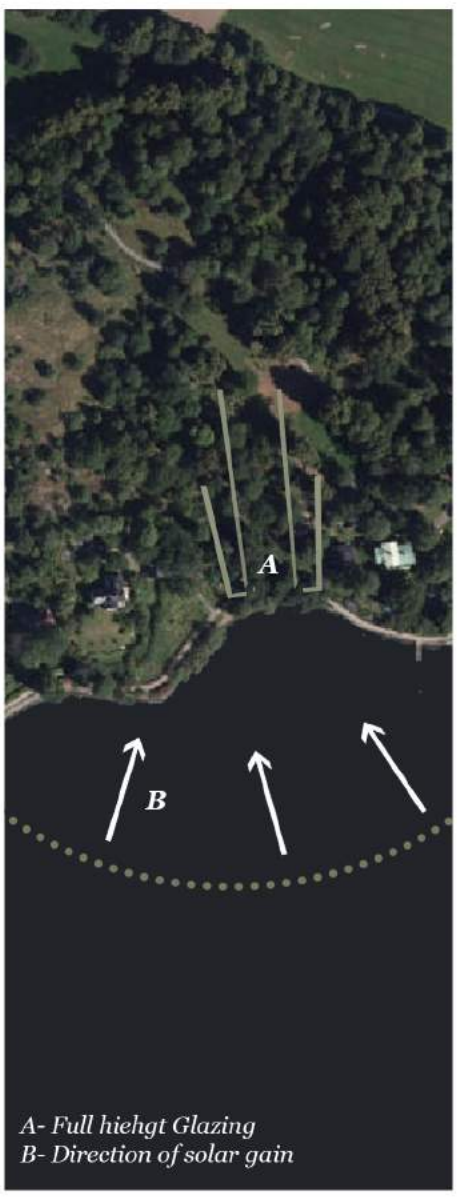
A- Flooding onto the site
B- Boats brought on to site



A - Lateral connections between new archapelago channels and salvaged boats
B- New Archipelago channel
C- New waterfront buildingsto recieve boats brought up from the sea floor.
D- Visual connection between the new archipelago and the water.

Visual Vista maintained by creating a physical gap between the buildings massing on the waterfront





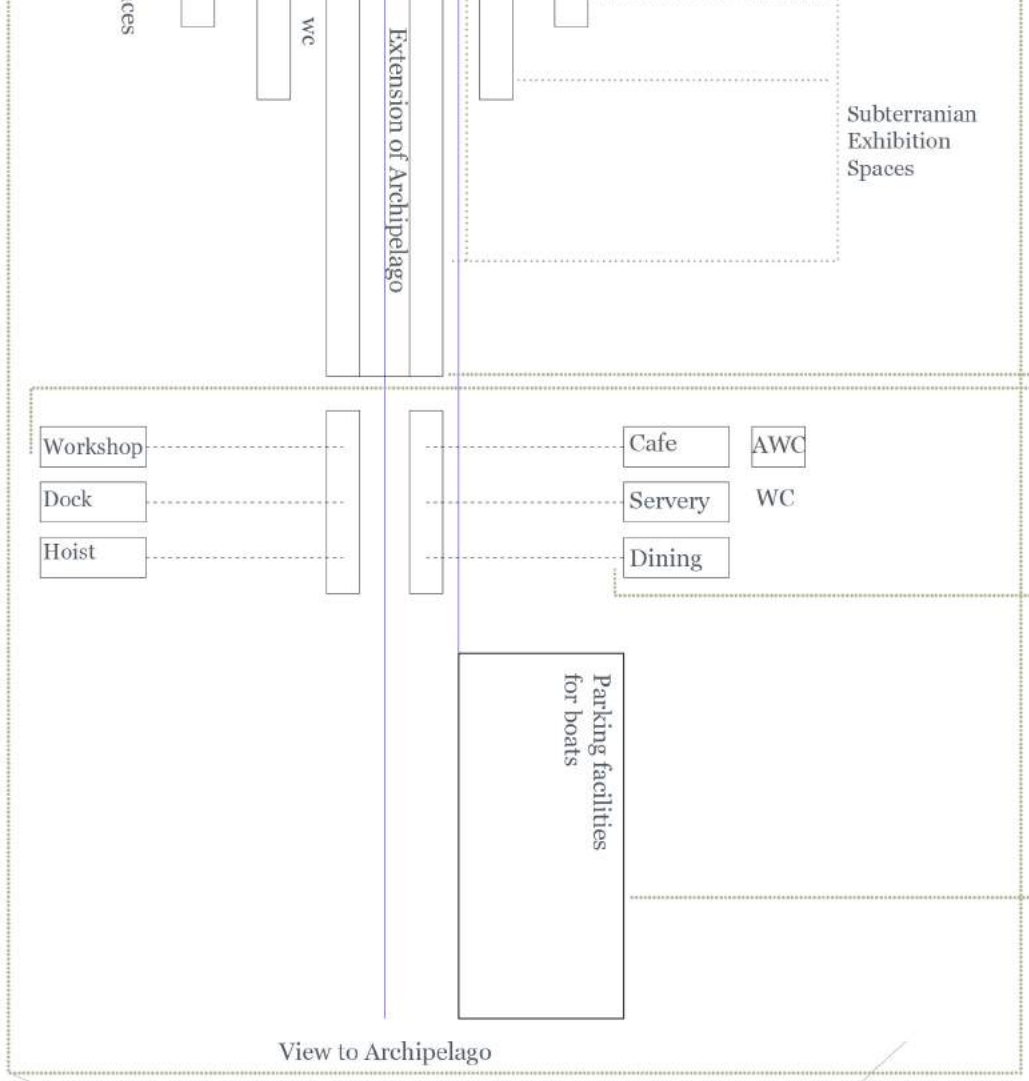
A- Full hiehgt Glazing
B- Direction of solar gain

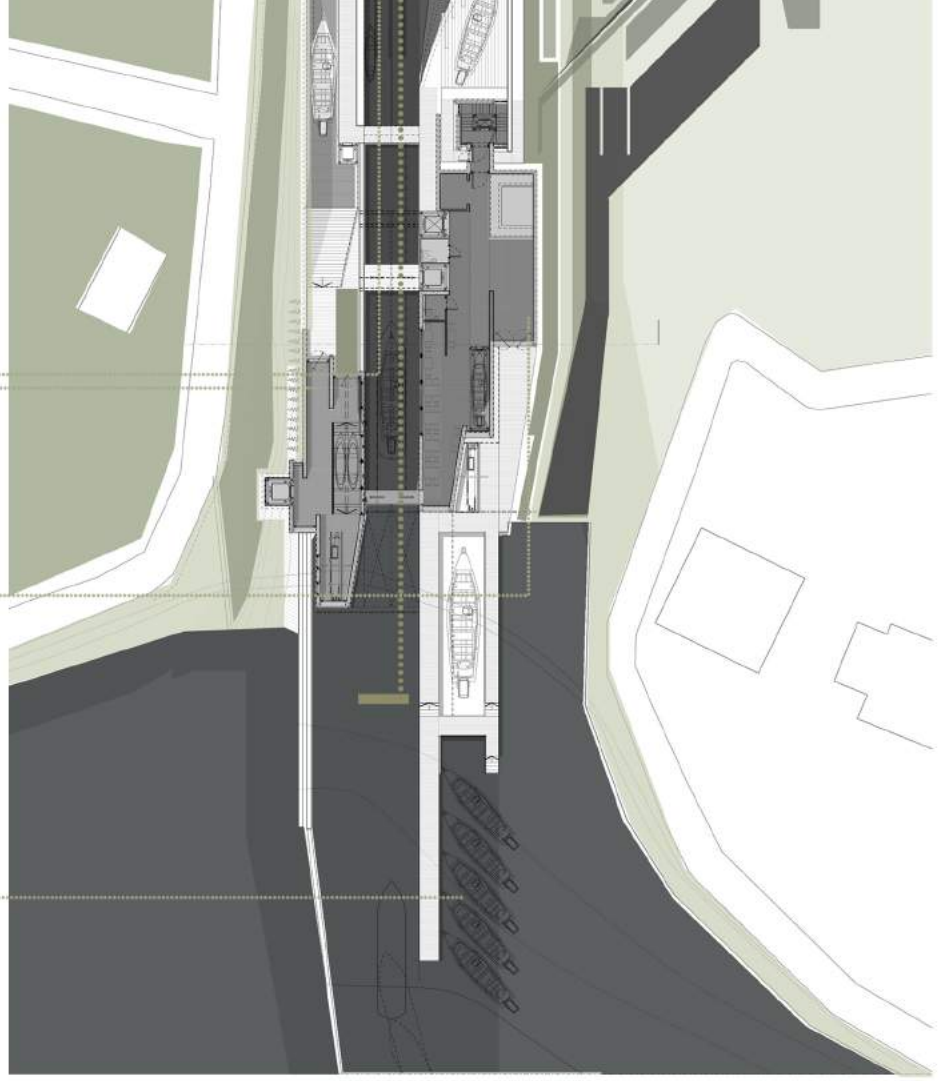
1.09 Programme + Organisation

The proposed building is conceived as a cultural artefact of the Maritime history of Stockholms Archipelago. It reinforces and completes the historic identity of Stockholm. It is designed as a flexible landscape and the spaces within the scheme are to respond to programmatic adjustments in the short and long term and which could be reinterpreted in the future.

The brief for the site on the Djurgarden has been largely prescribed by the environmental crisis affecting the Archipelago. The intention is that this is a project acts as a museum of the Archipelagos lost maritime treasures, whilst also helping the environment by removing the toxic artifacts and filtering their damaging effects on the environment.

The spaces that would be incorporated into the design are:
01 Exhibition / gallery spaces
02 Shipwreck salvage workshops
03 Boathouse
04 Kayak rental shop
05 Plant rooms
06 Retail / restaurants / rental studios
07 Outdoor space
The adjacency diagram below describes the intention to extend the Archipelago on land and salvage the shipwrecks from beneath the Baltic.

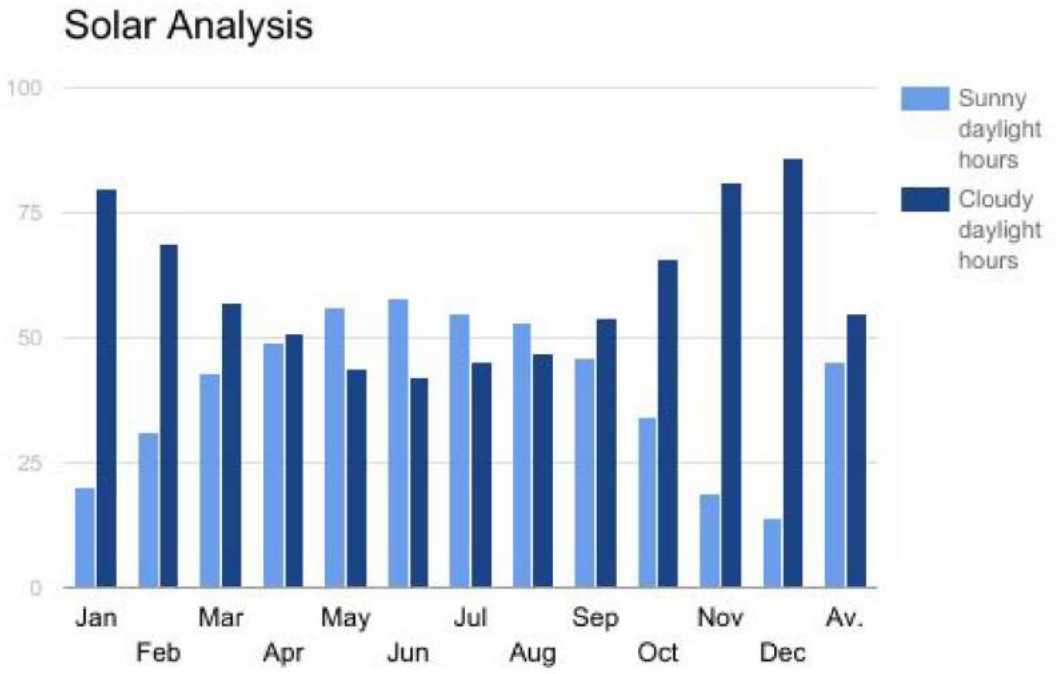


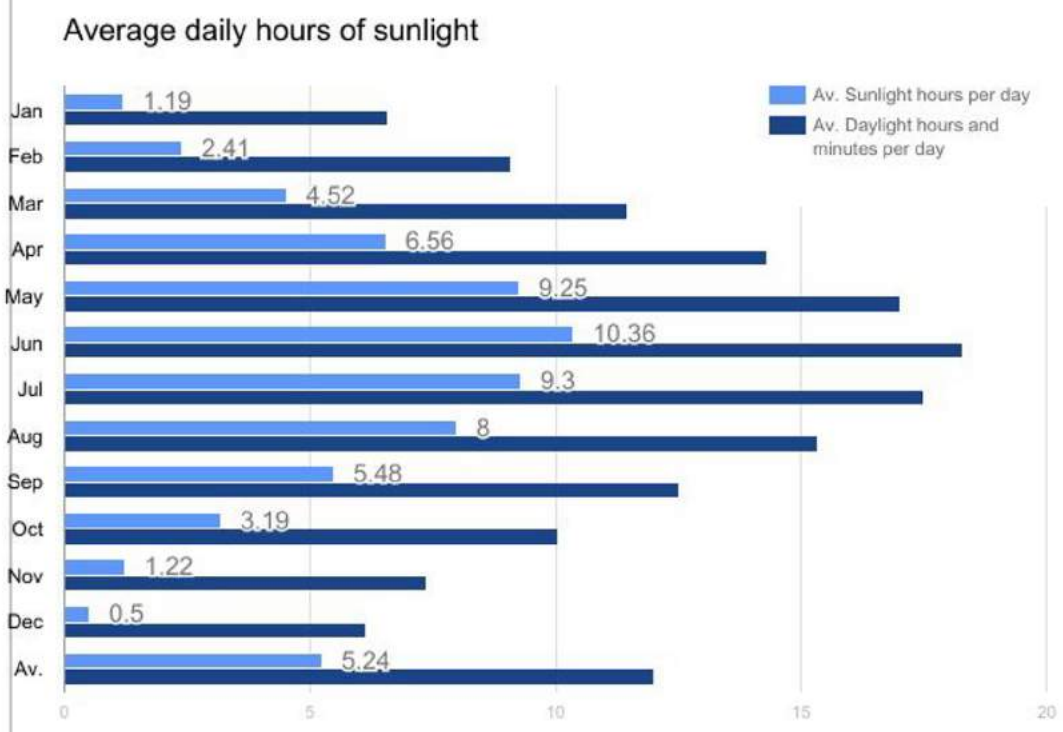


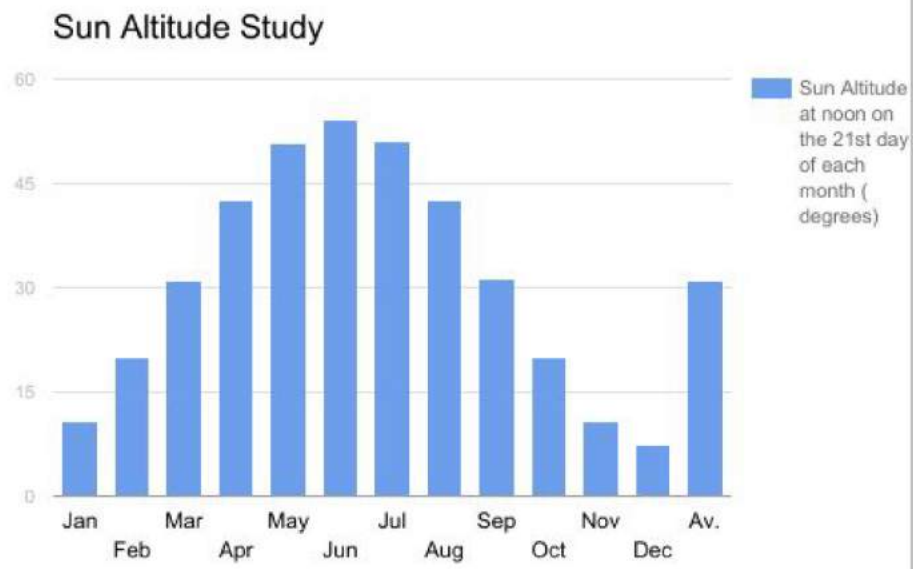
1.10 SITE OVERVIEW Climate

Due to stockholms northerly geographical location, its climate is maritime temperate. The biome it belongs to is the Temperate Deciduous Forest. The North Atlantic Current makes the air temprature rise which is brought up from the South-West by low pressured winds. Due to high pressure zones in the East Stockholm recieves warm summers and cold winters.

The quality of sunlight Stockholm recieves is considerably restricted due to the amount of daylight throughout the year and also due to the intensity of this light which can often be hindered by weather. During the winter the amount of daylight Stockholm recieves drops to as little as six hours per day. During the summer however the longest day lasts for over 20 hours. aylight throughout the year and also due to the







Traditonal design considerations of the Provence evolved for the climate:

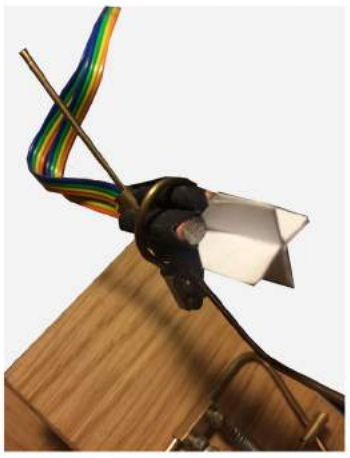
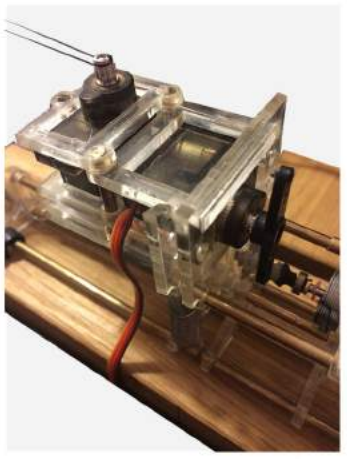
- Strong and compact, retaining warmth in winter and staying cool in summer.
- Healthy, dry indoor climate for inhabitants
- Durability in a maritime climate with driving rain.
- High number of windows - allowing maximum levels of natural light indoors.
- The building's insulation levels.
- The buildings capacity to withstand freque

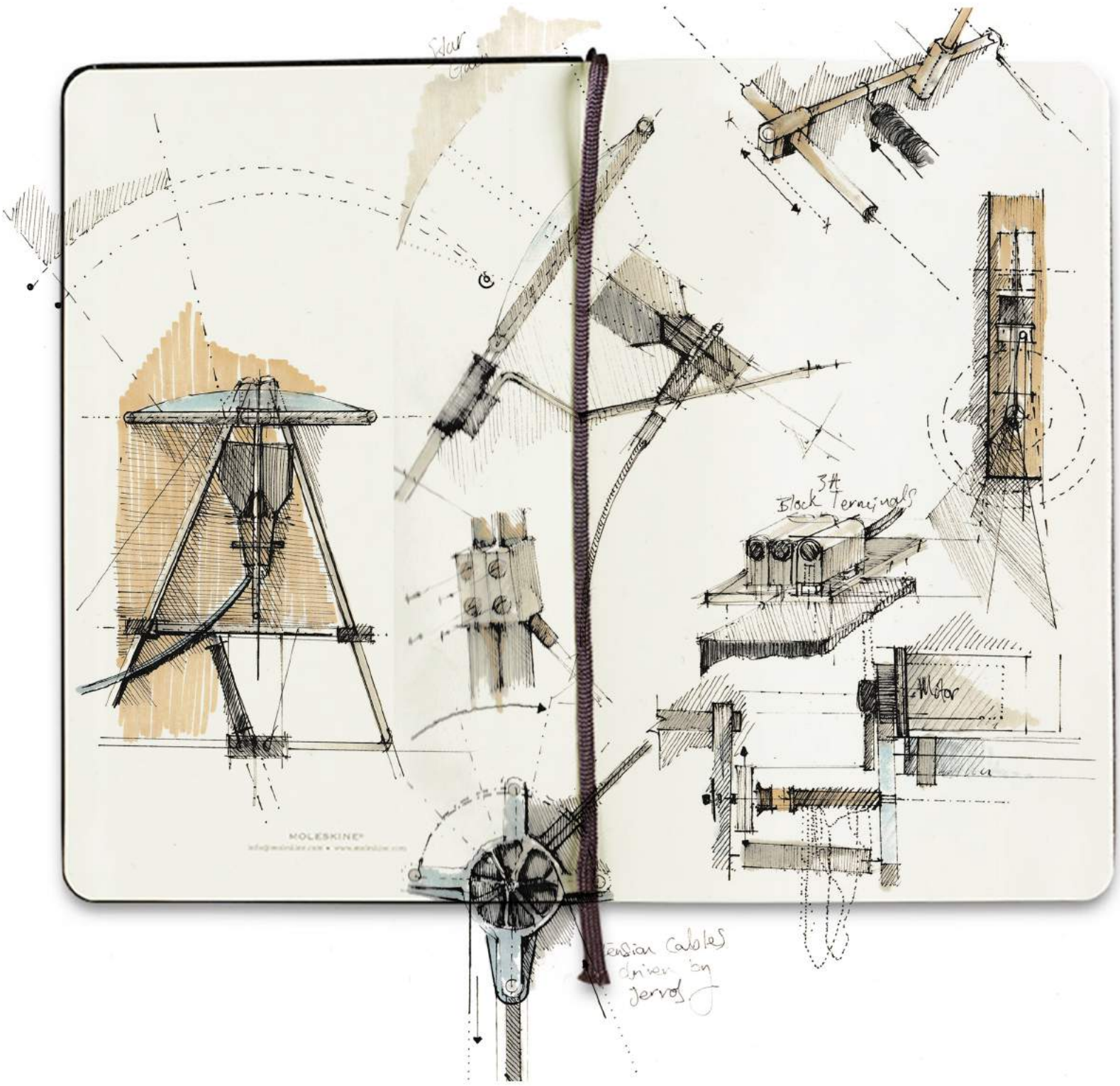
nt driving rain.

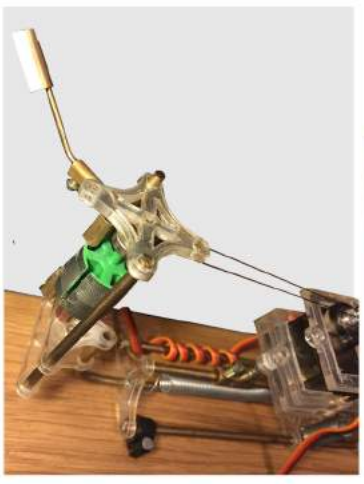
Historically, the Scandinavian built as much as possible out of wood. A lack of forest forced them initially to build partly underground with only the top part of the walls and roof being made of wood.

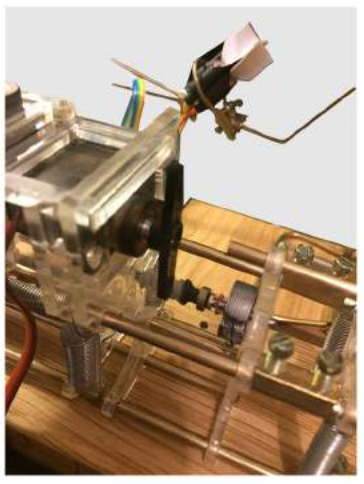
All available timber was used, such as salvaged parts of boats and driftwood. Most dwellings were made with a timber post-frame filled in with stones and mortar. Where timber was available it was always the preferred building material.

1.11 Evironmental Strategy
Environmentally Responsive Device



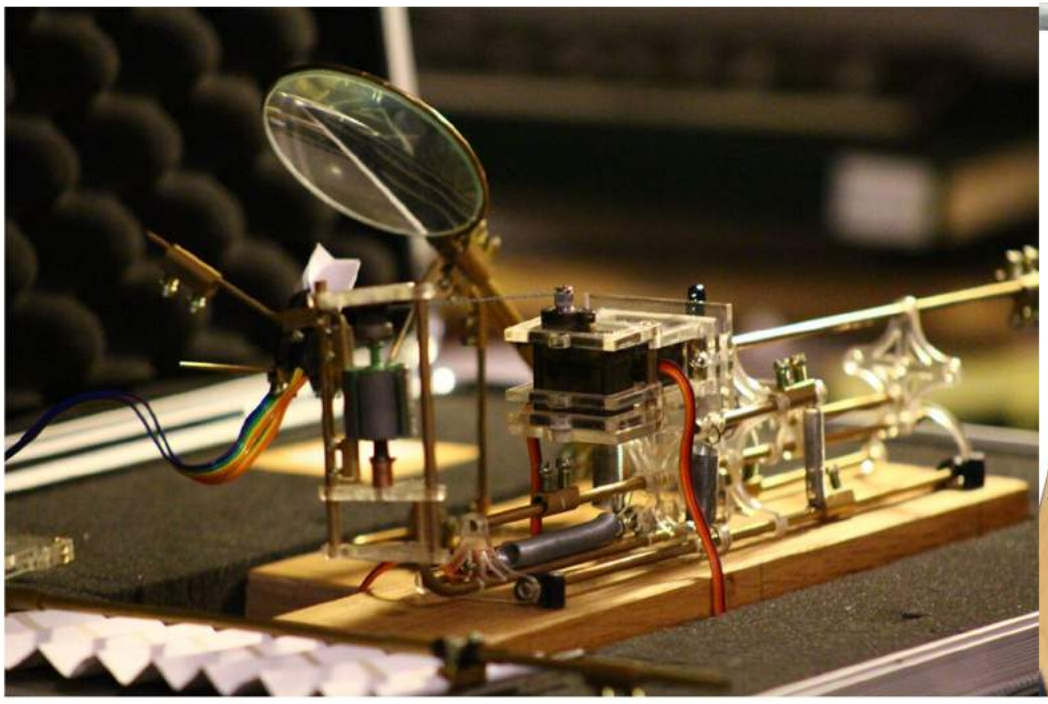



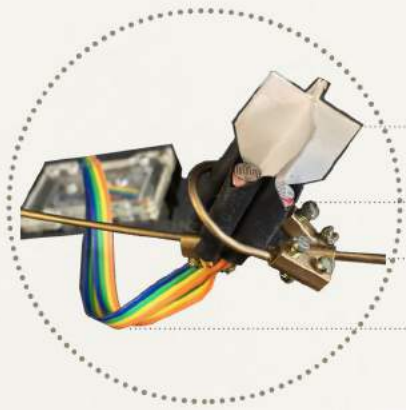


Solar Tracking Apparatus

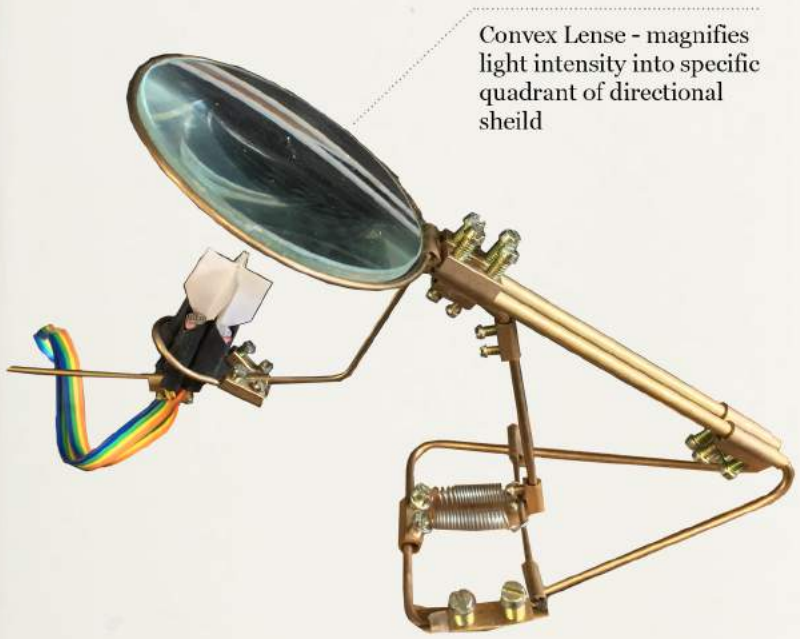
Planning sketches for Solar Tracking device. The apparatus takes directional light readings and through an Arduino circuit board, translates this information to drive two 9g metal gear servo motors, the directional light readings drives the motors in a corresponding direction. This movement is then translated to the architectural componants via a series of cables in tension. This apparatus is to act as a starting point for a piece of infrastructure that will span the landscape and translate solar activity on both a long and short term basis. This means the apparatus will respond to immediate changes in its surroundings effectively, this will allow the corresponding architecture to adapt to the slightest of changes in light. This includes momentary overshadowing from cloud formations, passing traffic, etc.

1.12 Evironmental Strategy
Environmentally Responsive Device

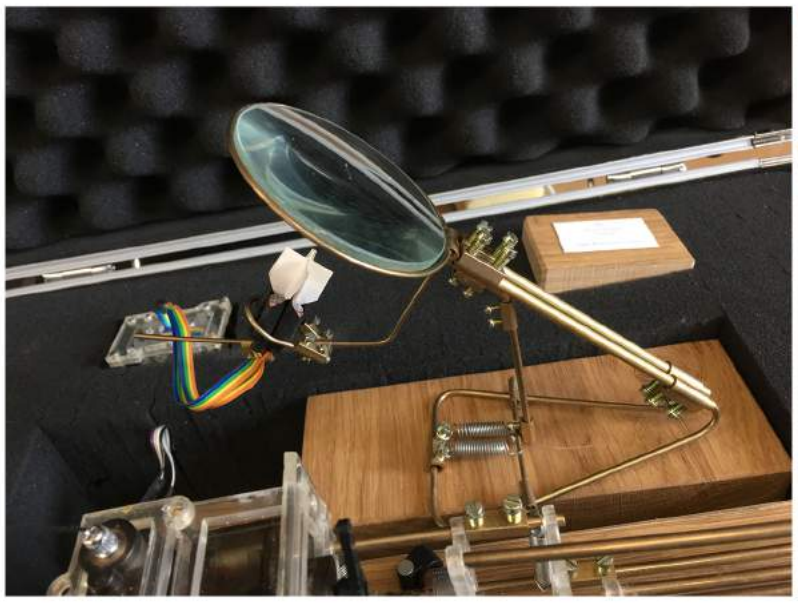


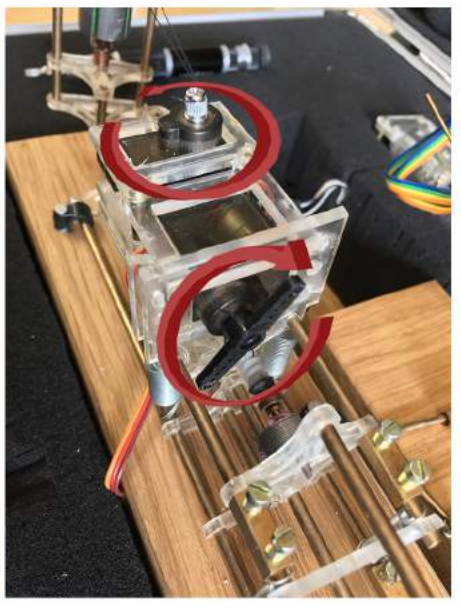


The top left light sensor is triggered, this is translated into anti-clockwise movement in the vertical motor, and lateral motor. The degree to which the motor turns is dependant on whether a stronger light source is triggered by another sensor which will change the direction and degree of movement.

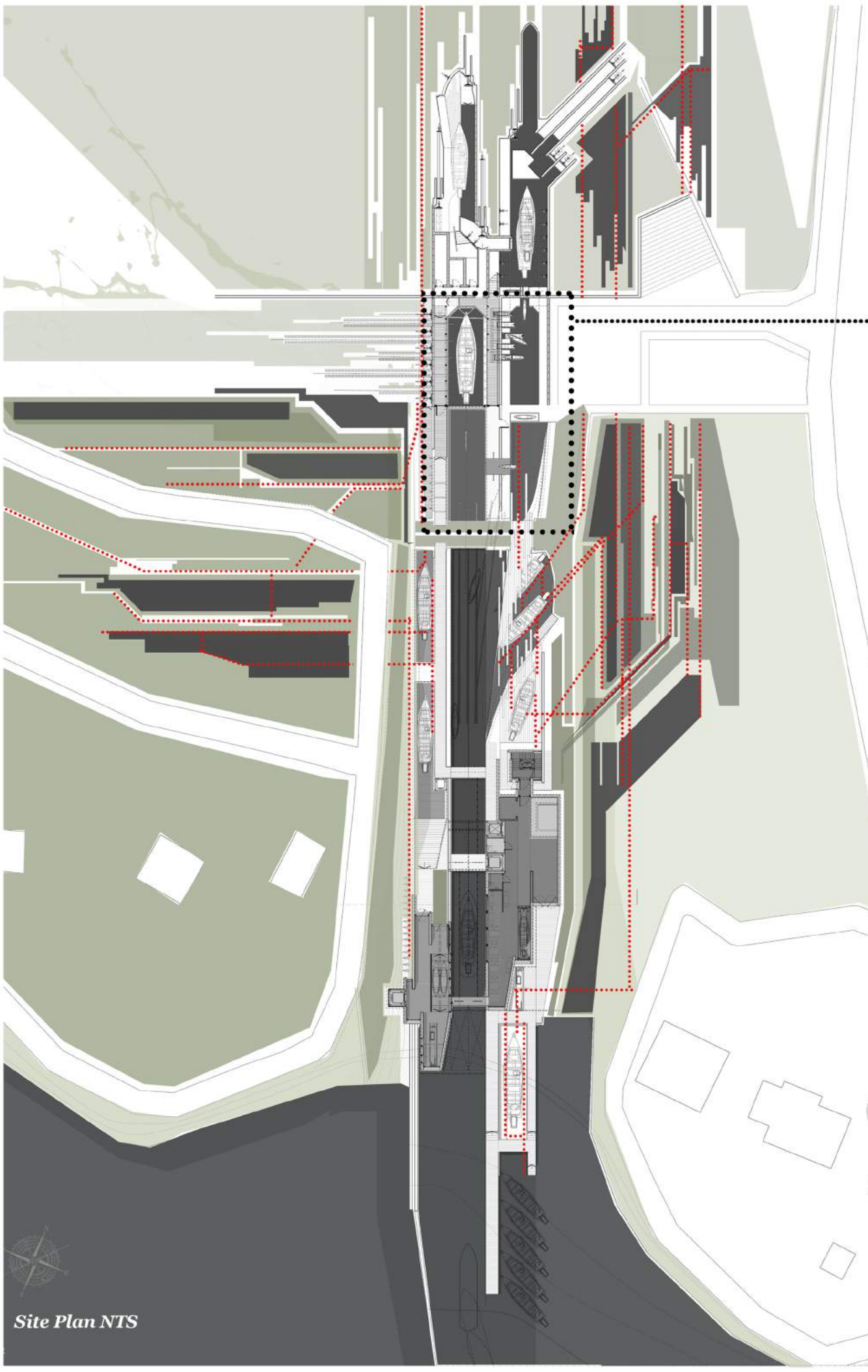


The bottom left light sensor is triggered, this is translated into clockwise movement in the vertical motor, and lateral motor. The degree to which the motor turns is dependant on whether a stronger light source is triggered by another sensor which will change the direction and degree of movement.

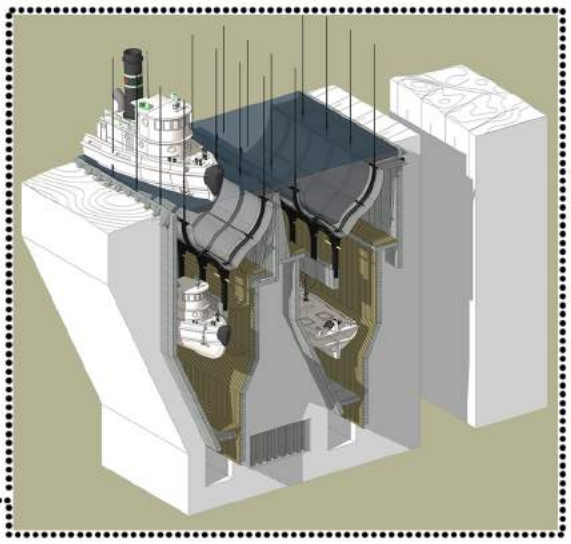




1.13 Structural Strategy
Structural Overview

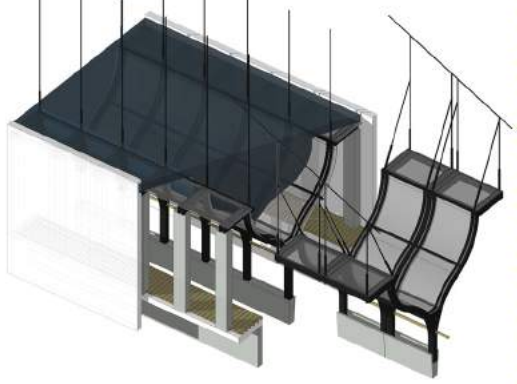


Site Plan NTS

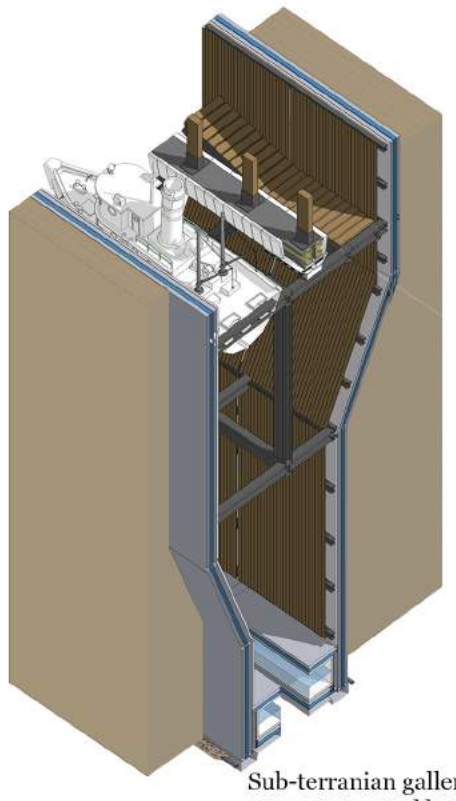


Sub terranian Gallery Space - DR focus

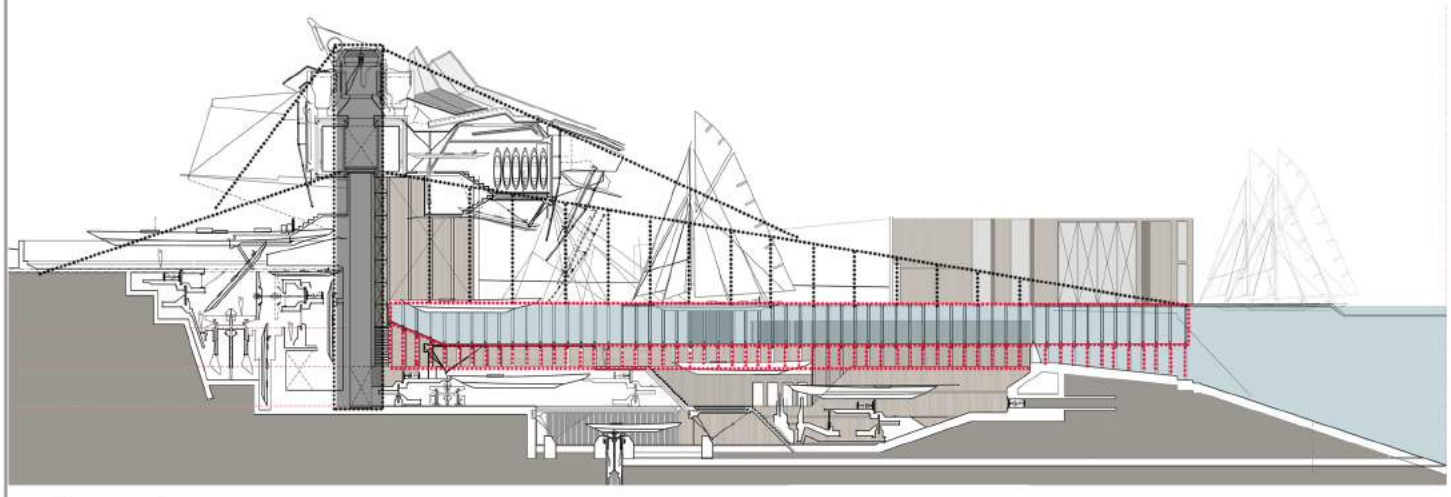
Tension cables supported from a precast concrete structural core



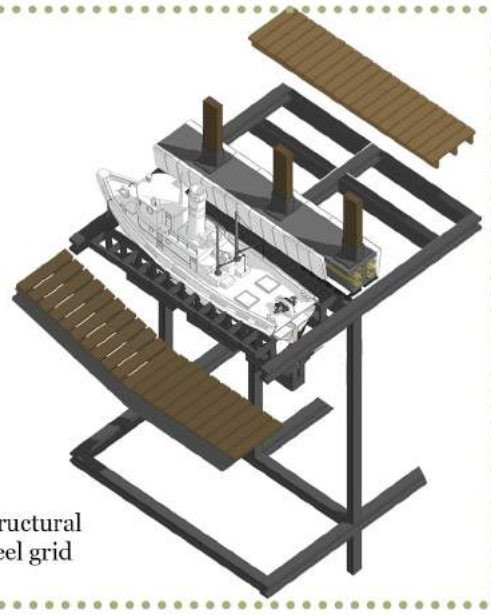
Water Channel above gallery space - Glulam ribs with structural glass



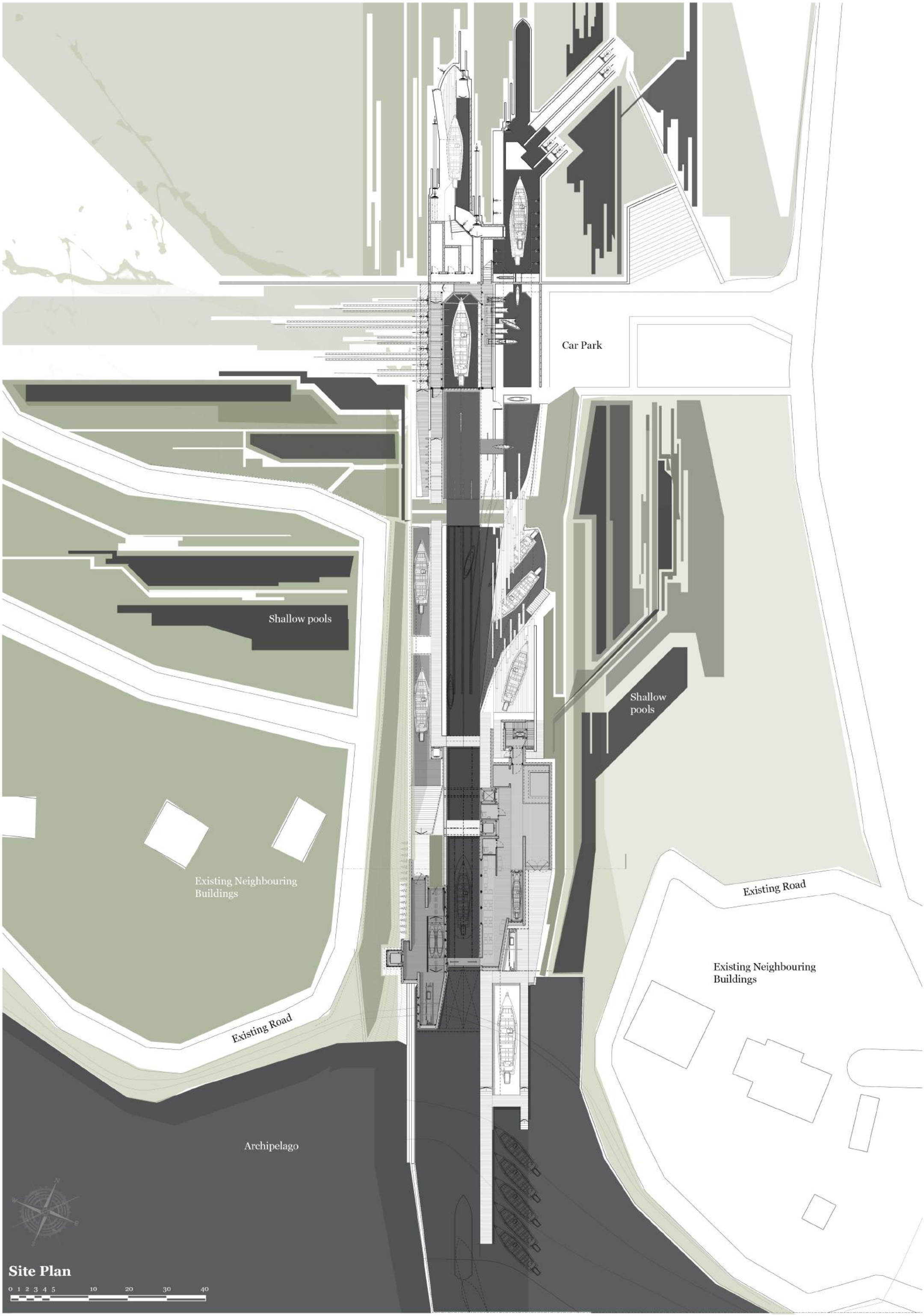
Sub-terranian gallery space supported by concrete retaining walls



Site Section NTS



Structural steel grid


Car Park
Shallow pools
Existing Neighbouring Buildings
Existing Road
Archipelago
Shallow pools
Existing Road
Existing Neighbouring Buildings
N
Site Plan
0 1 2 3 4 5 10 20 30 40

1.15 Fire Strategy
Floor Plans

Fire assembly point

Fire exit

Ground Floor Plan
1:500

-1 Floor Plan
1:500

Gallery Space

Entrance

Awcs

-2 Floor Plan
1:500

Lift

Gallery Space

Entrance

Female Wcs

Male Wcs

Plant room/Store

Key

Fire Exit

Ramp access - all level changes are ramped 1.20 falls

WC

AWC

Lift

Fire Extinguisher

Fire Assembly

2.01 Construction Process

Construction Sequence(1) - Showing construction sequence of key structural elements and infrastructure

Waste Disposal Site

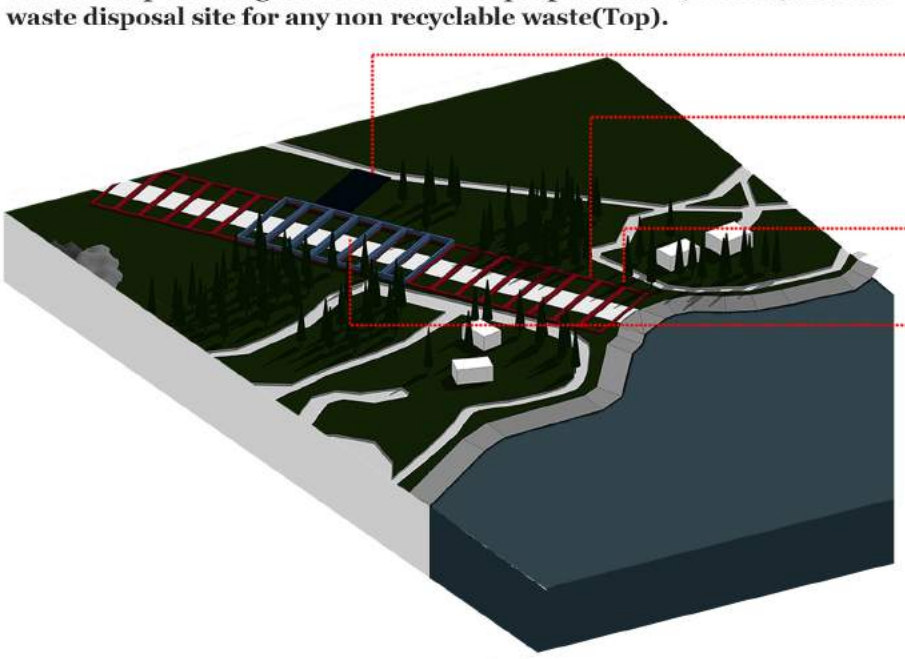
Satelite map showing the location of the proposed site (Bottom) and the waste disposal site for any non recyclable waste(Top).

Construction Sequence Key

1 Vehicular access for works traffic established. The Existing site is cleared of debris, the debris is cleared up and disposed of. The Existing trees within proposed building envelope are removed and stored on site to be prepared for use within the building. Area of rock outcrop removed and stored on site. Section of wall removed.

2 Sections of earth excavated, material removed and stored onsite for later use. Some areas excavated for temporary access to new lower ground level. New sheet piling installed to provide dry zone for new pile foundations to be formed.

3 New piling extending in to temporary dry zone to be submerged in water at completion. Sheet piling provides dry access for works. Mechanical pump systems prevent water ingress. Temporary sheet flooring laid out for storage of construction materials, vehicles and amenities.

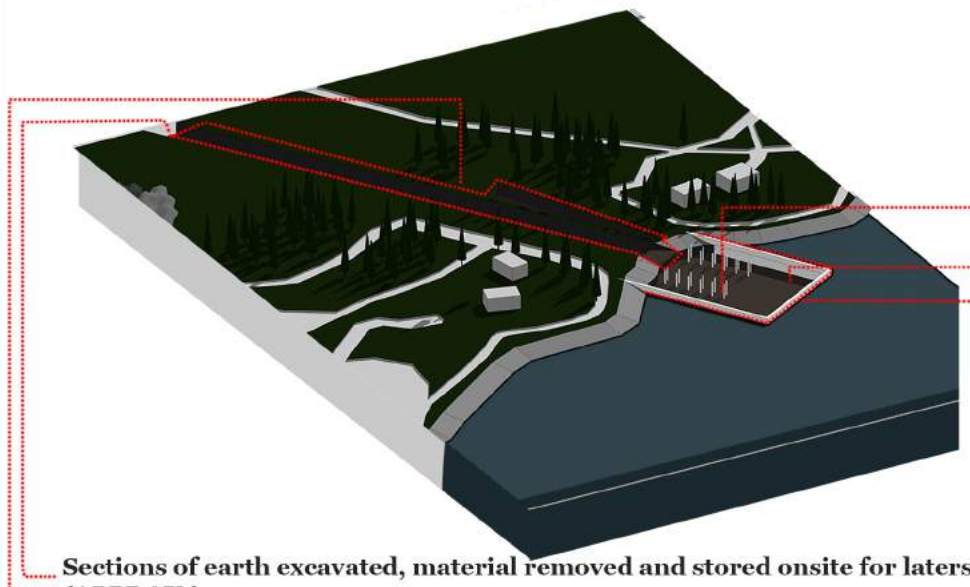


Vehicular access for works traffic established.

The Existing site is cleared of debris, the debris is cleared up and disposed of.

The Existing trees within proposed building envelope are removed and stored on site to be prepared for use within the building.

Area of rock outcrop removed and stored on site. Section of wall removed.



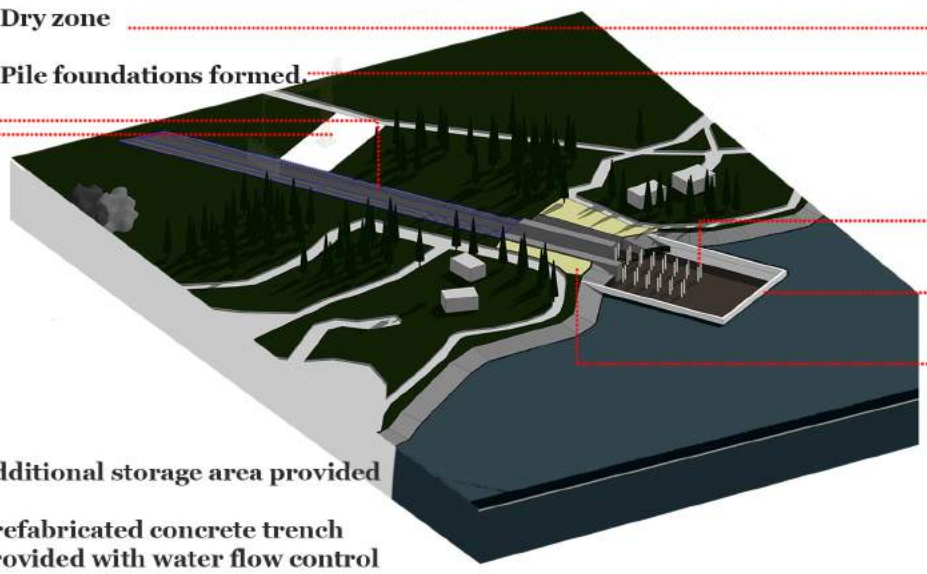
Sections of earth excavated, material removed and stored onsite for laters use (APPROX.)

Excavated for temporary access to new lower ground level.

New sheet piling

Dry zone

Pile foundations formed



Additional storage area provided

Prefabricated concrete trench provided with water flow control

New piling

Mechanical pump systems prevent water ingress

Temporary sheet flooring

2.10 Construction
Cross Section

Coping stone to fall away from channel

Insulated Cavity Closer

Channel with adjustable depths of water

Location for Services

for more information of structural systems see section 2 material strategies

Gallery Space

25mm cedar cladding on trated battons on steel frame

75mm screed (incl. heating matrix)

200mm concrete slab

200mm Kingspan Styrozone

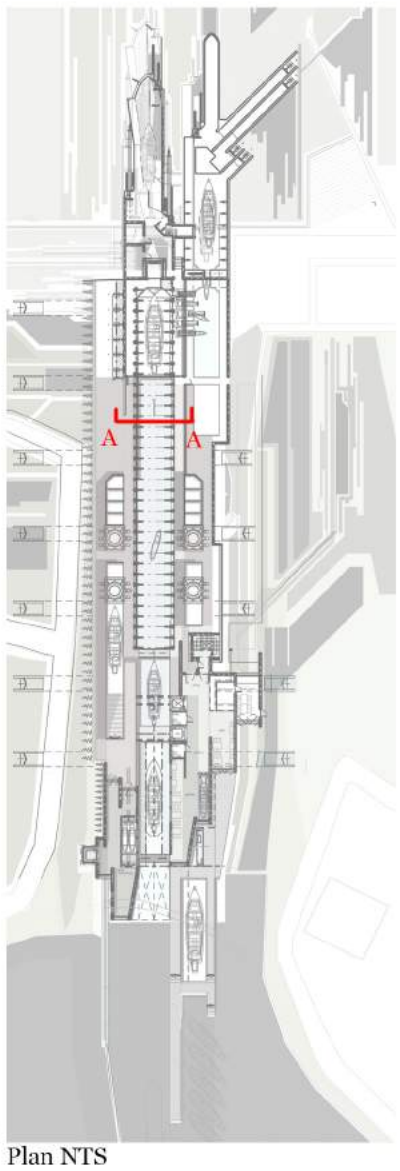
separation layer

250mm concrete slab

damp proof membrane

hardcore

Section AA 1.50

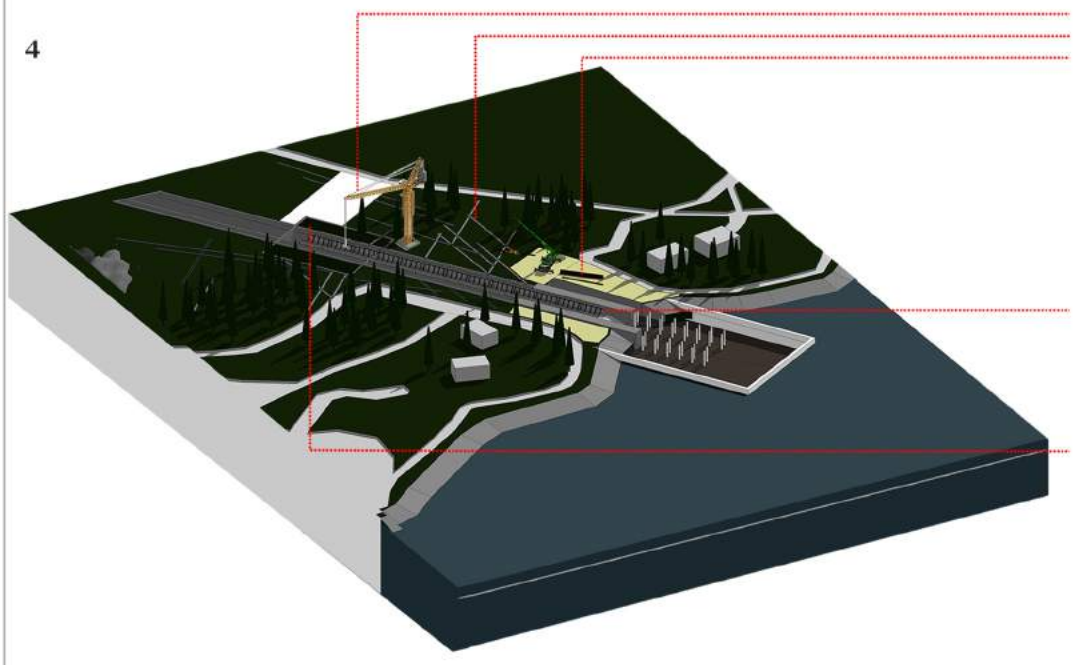


Plan NTS

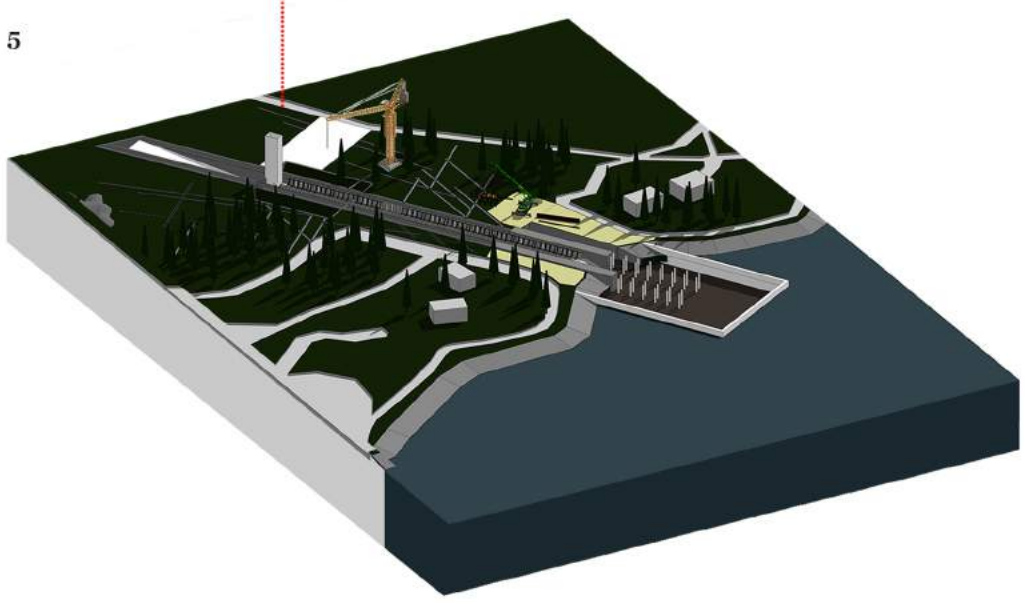
2.02 Construction Process

Construction Sequence(2) - Showing construction sequence of key structural elements and infrastructure

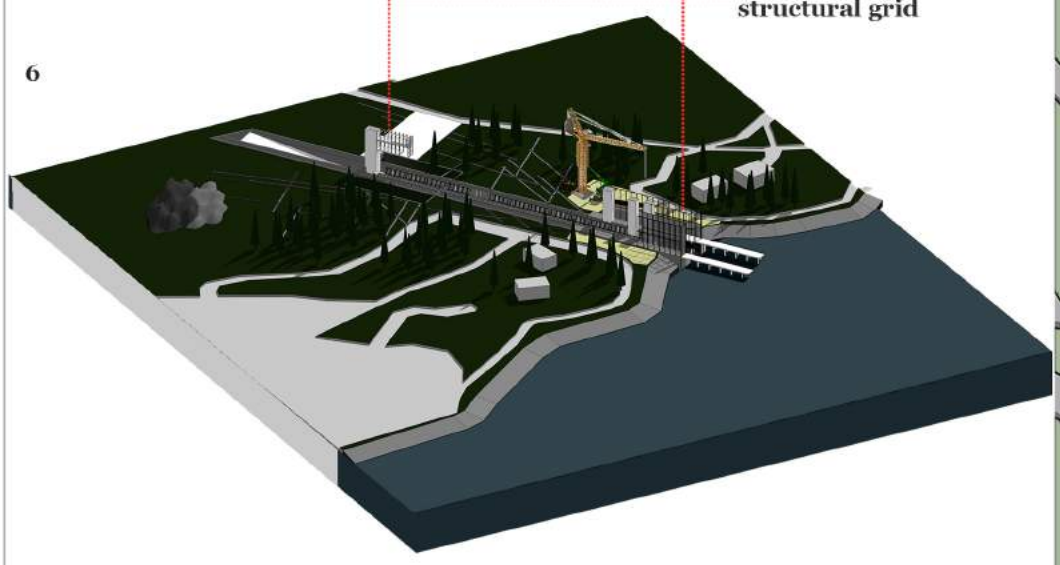
4



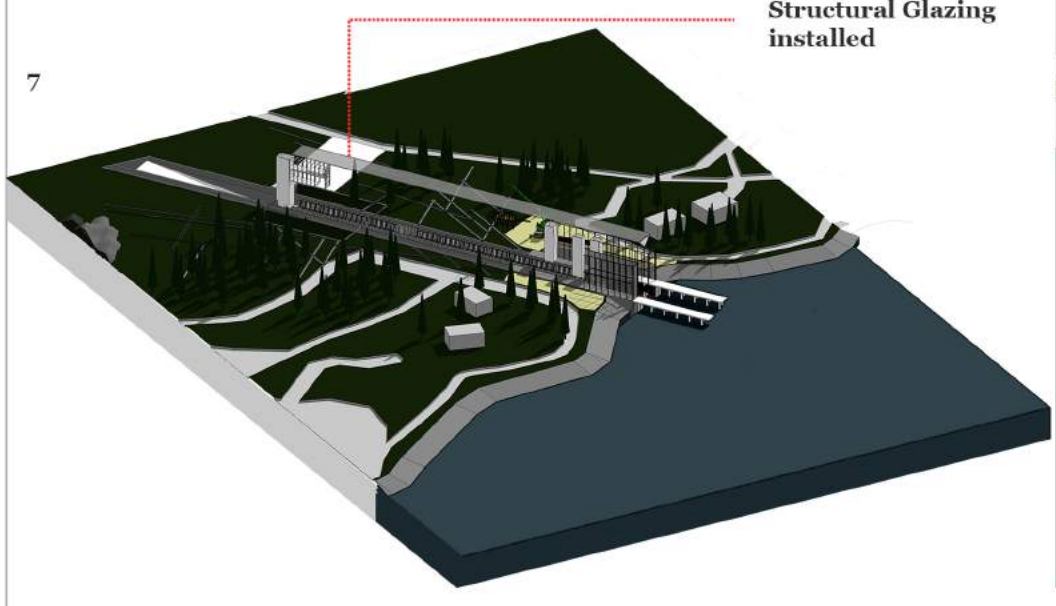
5



6



7



Construction Sequence Key

4 Trenches for steelwork across site are to be created and steel componants are installed. Structural elements within the excavated trench are installed in sections and covered to prevent water ingress during heavy rain.

5 Precast structural cores are shipped to site and constructed

6 Remaining external steel grids are constructed. Jetty elements extending into Archipelago are built. Trench walls are tested for whater tightness. Dry zone is removed.

7 Floors are cast. Precast facade elements and glazing are brought to site and installed. Channel tested for water tightness. Channel to be filled for a period of 1 month to ensure no water ingress damages the internal evironments. Internal spaces are created.

Week Number

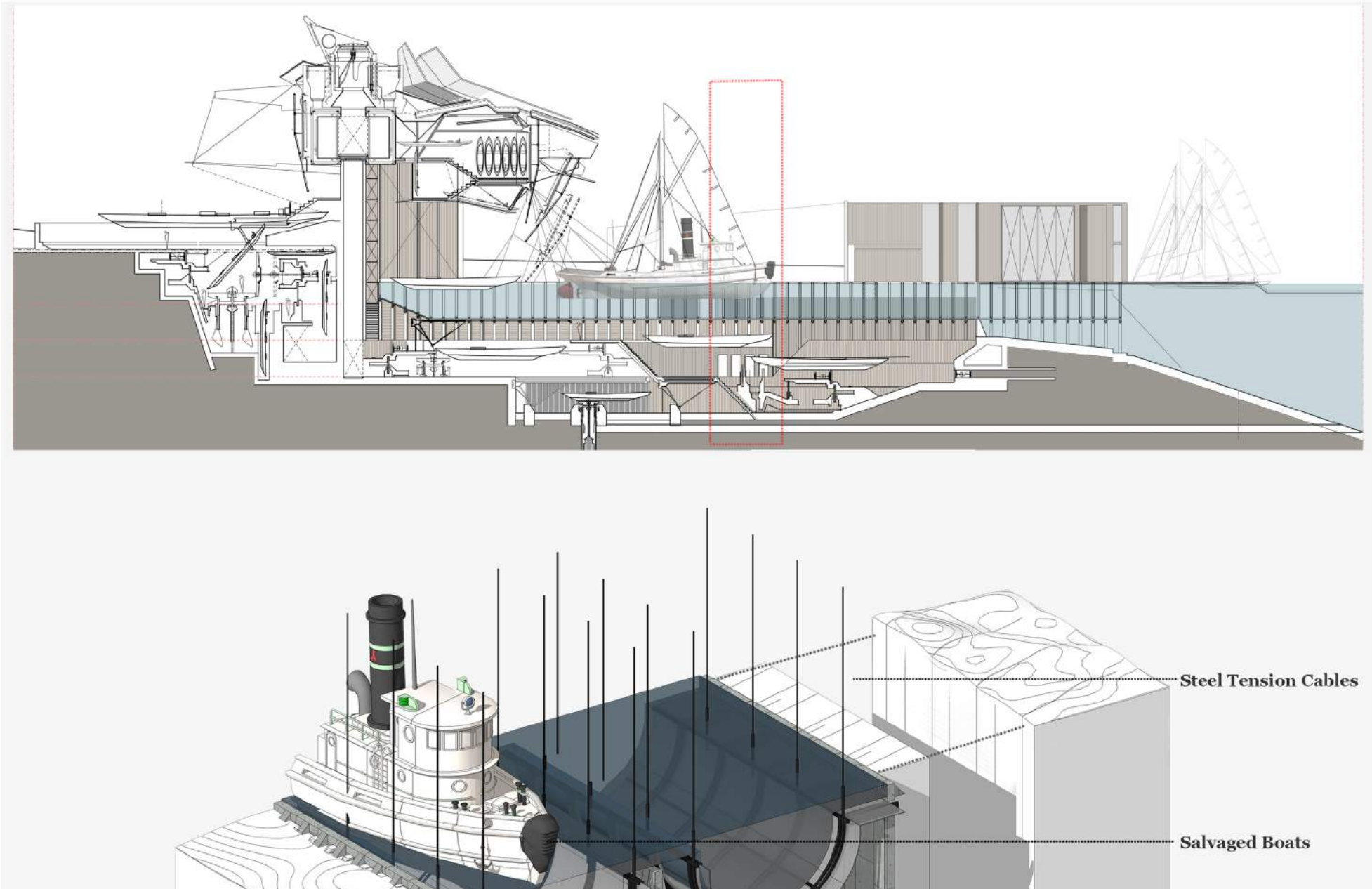
	Year 1												Year 2												Year 3											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	
ENABLING / STRIP OUT WORKS																																				
Removal of debris																																				
Existing trees removed and stored on site																																				
Creation of vehicular access route																																				
FIRST PHASE OF WORKS																																				
Sections of earth excavated and used elsewhere for levelling out (excess stored onsite)																																				
Sections of existing concrete decks excavated and recycled for use elsewhere onsite																																				
Excavated land supported with temporary structure for casting to take place																																				
Temporary roofing installed																																				
Casting of Subterranian base and inbuilt channels																																				
Casting of retaining walls(including waterproofing), butresses and concrete bearing elements																																				
Sheet piling and pump installed																																				
Second phase of excavation at existing line of coast with temporary structure																																				
Installation of reinforcement																																				
Casting of base for ground level buildings																																				
Steel basework installed																																				
New deck installed over piling																																				
Water flow system installed at coastline and sealed closed for works to be carried out																																				
Concrete apron cast at coastline																																				
Sheet piling removed																																				
Precast concrete cores erected																																				
Steelwork installed on structural cores																																				
Steelwork for internal linings and walkways installed																																				
Wall linings including waterproofng works																																				
Temporary roofing partially removed for glulam roof structure to be installed																																				
Steel tension suspension cables installed																																				
Partition walls erected																																				
Prefrabricated glazing installed																																				
Joinery installed																																				
SECOND PHASE OF WORKS																																				
New ground level steel framed structures erected																																				
Structural walls and cores erected																																				
Second floor installed																																				
Roofing works (complete envelope)																																				
Ground works build up of pathways and planting																																				
Glazing installed																																				
Joinery installed																																				
Channel flooded																																				
Exhibitions internal environment checked for water ingress																																				
INTERNAL FIT OUTS																																				
Specialist exhibition pieces installed																																				
Internal Furniture installed																																				
OFF SITE PREPARATORY WORKS																																				
Fabrication of concrete structural cores																																				
Fabrication of steel elements and fixings																																				
Fabrication of Glulam elements																																				
Fabrication of structural and non structural glazing																																				
SPECIALIST WORKS																																				
3D Scanning of internal environment																																				
Calibration of environmental control systems																																				

2.03 Construction Process

Construction Sequence(3)

2.04 Structural Sytsems
Structural Focus Overview

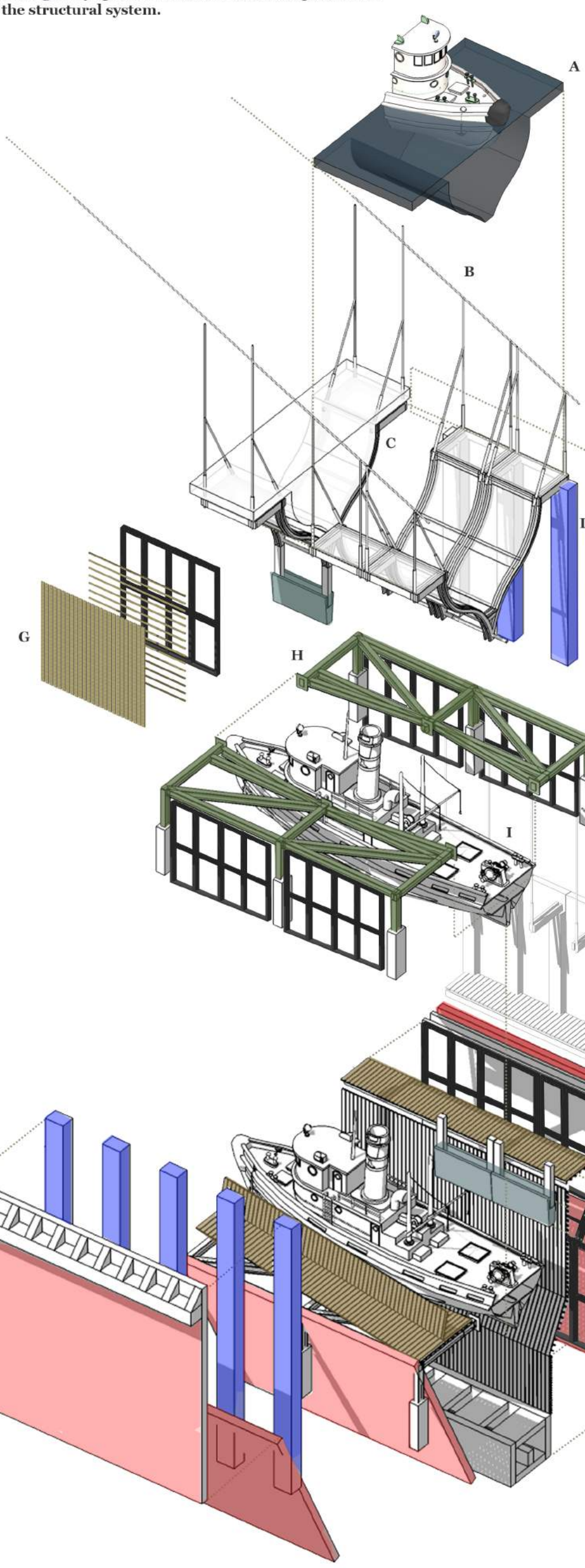
Within Section 2 I will focus on the structural system involved in the subterranian gallery space. I will show the development and detailing of the structural system.

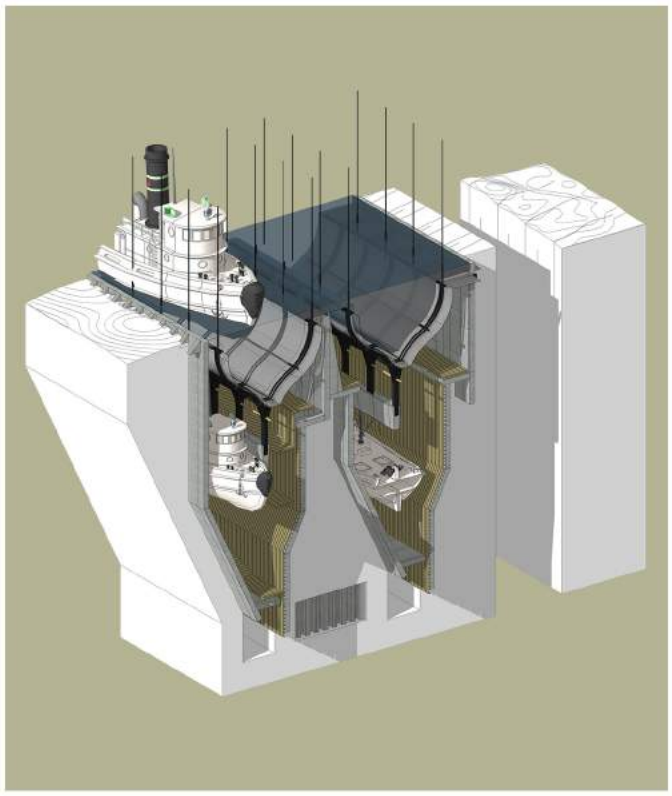


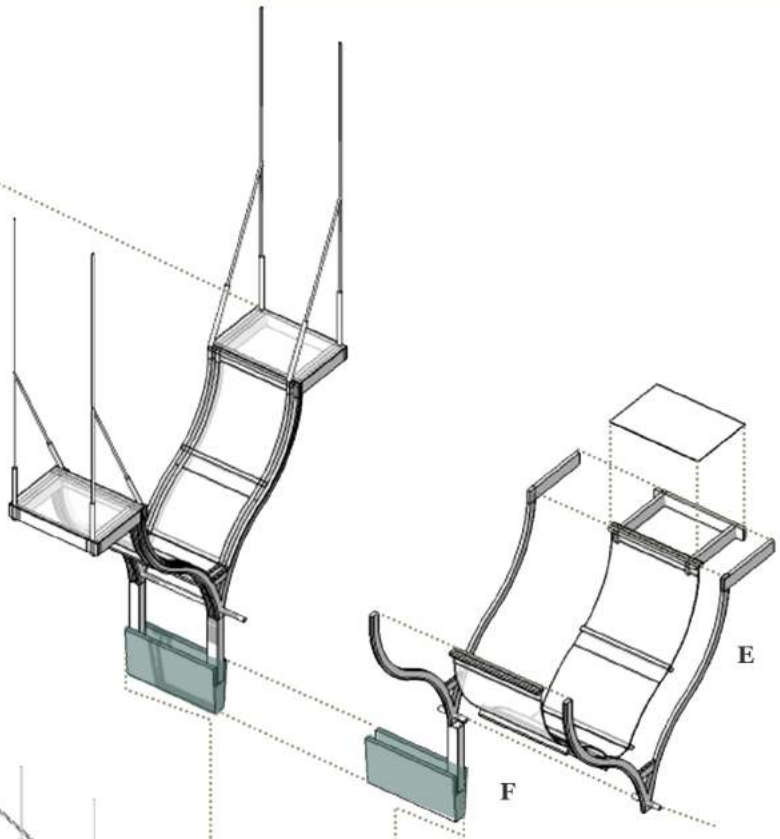
This section through the subteranian gallery sits within a trench beneath ground level and so will require retaining structures and weatherproofing. The space is situated beneath a body of water which transports boats above. The body of water is controlled so the depth can be adjusted to alter the amount and quality of natural light that enters the gallery space. In order to support this body of water as well as the boats above I have developed a structural system be replicated across the site in museum spaces where the same conditions are required.

2.05 Structural Sytsems
Structural Component Heirarchy

Within Section 2 I will focus on the structural system involved in the subterranian gallery space. I will show the development and detailing of the structural system.







A Salvaged boats in body of water

B Steel tension support cables

C Water Carrier

D Concrete bearing elements

E Glulam structural ribs

F Concrete-clad Steel beam

G internal Cedar cladding on treated battons fixed to steel grid

H Steel boat support matrix

I Exhibited Salvaged Boat

J Gallery walkway

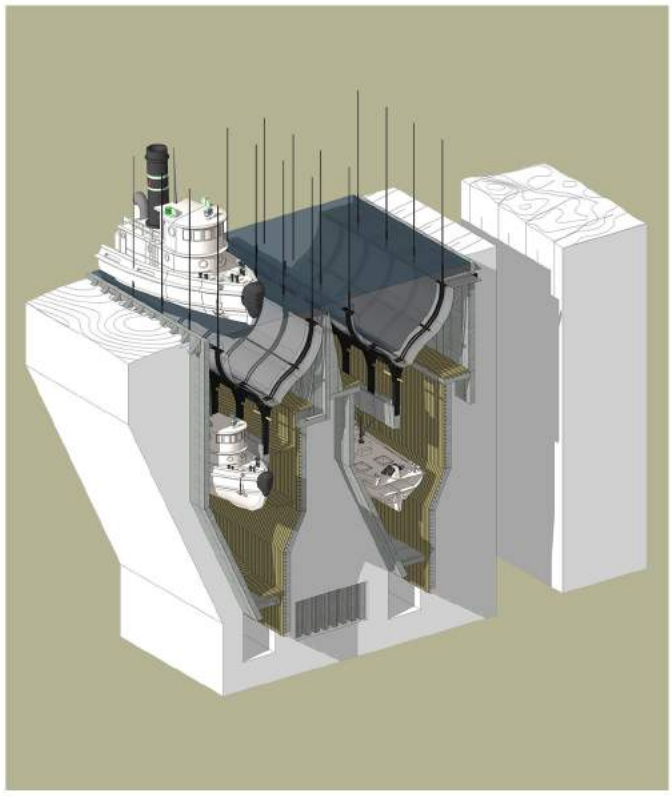
K Retaining walls

I Subterranian water channels

2.06 Structural Sytsems
Structural Stress Diagram

Within Section 2 I will focus on the structural system involved in the subterranian gallery space. I will show the development and detailing of the structural system.

DETAIL OF STEEL ABUTMENT WITH SHIP



A Salvaged boat being transporte on to site

B Body of water flooding the site from stockholms Archapelago

C Timber Clad ramped walkway and handrail

D Timber clad walkway through the exhibition space

E Salvaged boat suspended and exhibited within the museum

F Steel grid framework supporting suspended boat and walkway above

G Structural grid tied back to retaining walls with ertical loads being distributed vertically into pad foundations

H Body of water shown in situ

I Steel suspension cables vertically suporting the glulam ribbed hull structure, tied back to concrete structural core

J Marine grade triple glazed armoured glass unit supportin boady of water above - cladding glulam ribbed hull structure

K Glulam Ribbed hull structure braced horizontally by timber mullions and tensional steel element

L Tensional steel element fixed to each structural rib

M Timber column transferring vertical loads from ribbed structure above

N Steel beam clad in precast concrete sections transferring loads horizontally to pad foundations

O Concrete bearers transferring loads from ribbed structure vertically through the retaining wal to pad foundations below - also acting as butresses

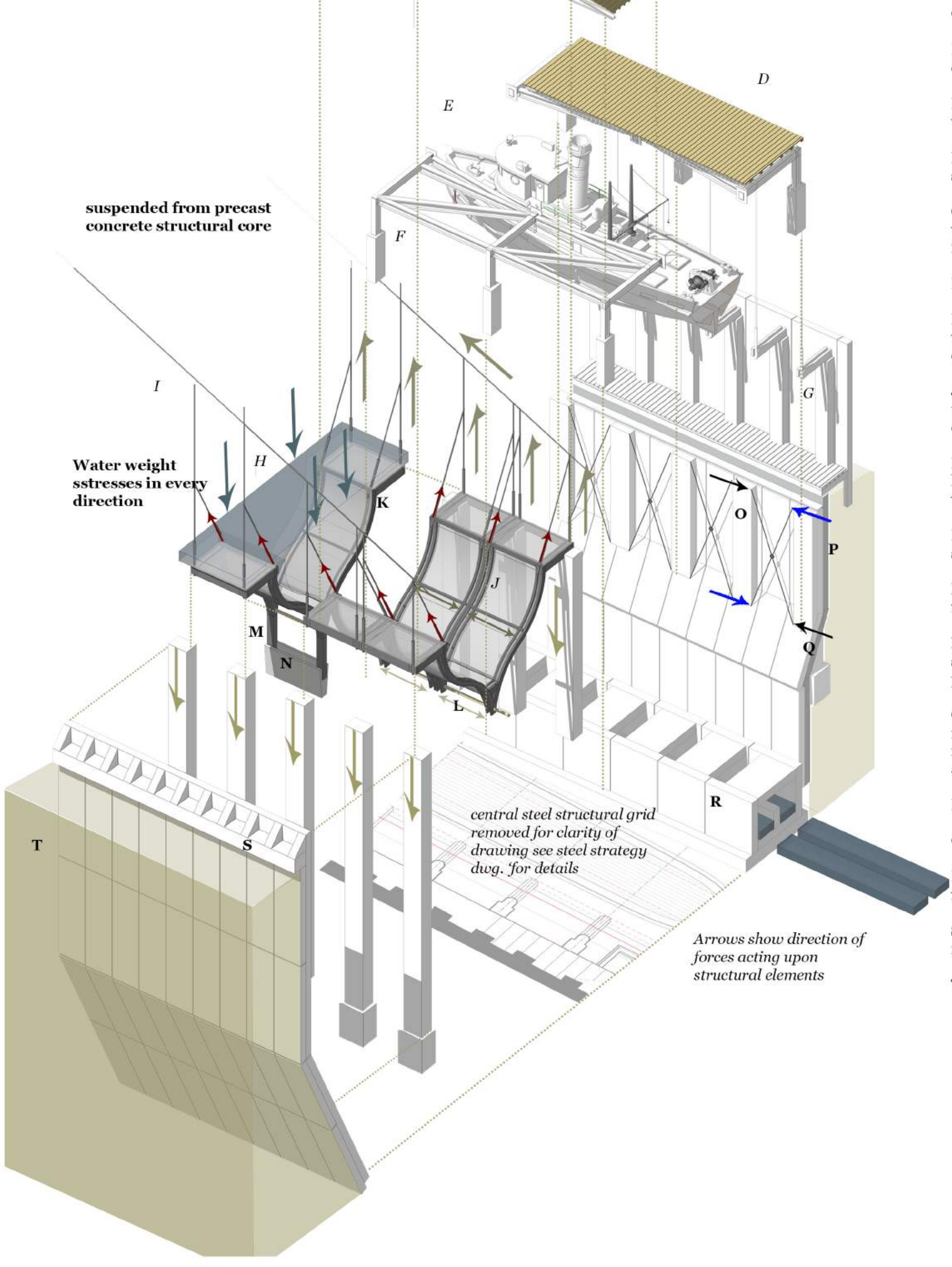
P Concrete retaining wall

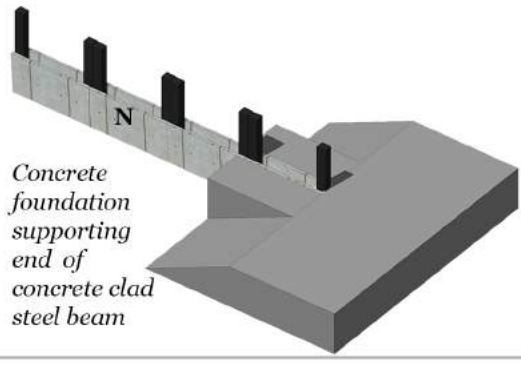
Q Step in retaining wall (degree of step)

R Retaining wall housing water depth and flow channels

S Retaining wall heel to counter rotational movement

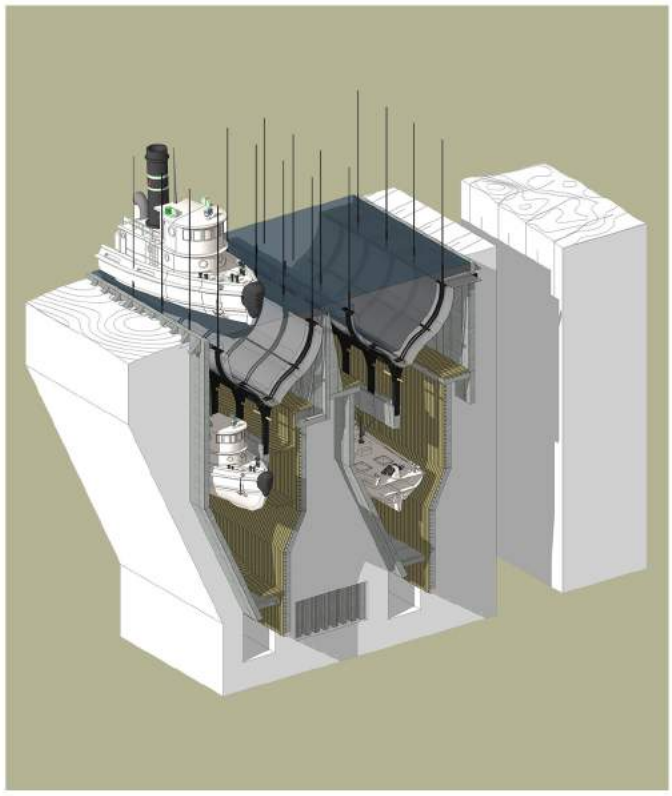
T Body of earth



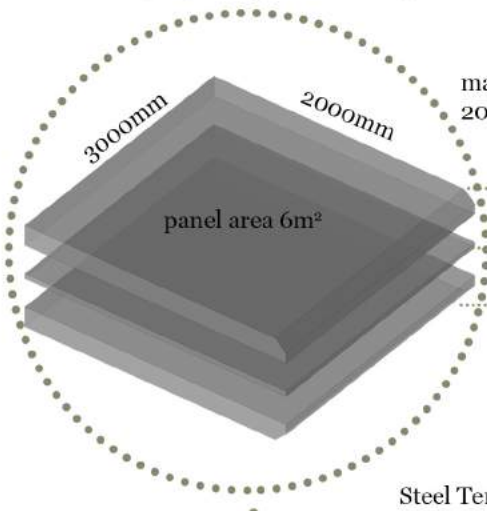


2.07 Structural Sytsems
Material Strategy - Glass

Tempered glass is often used in marine environments due to its increased strength which is created through its manufacturing process. The tempering process is either a controlled thermal or chemical process which places the outer surfaces in compression and the inner surfaces into tension. This process means that if for some reason a panel of glass was damaged the panel would still hold itself in place so that any water in the channel above can be drained and the panel can be replaced.



Triple glazed panels build up



max. size of panel
2000 x 3000mm

1 Toughened pane
2 Laminated pane
3 Toughened pane

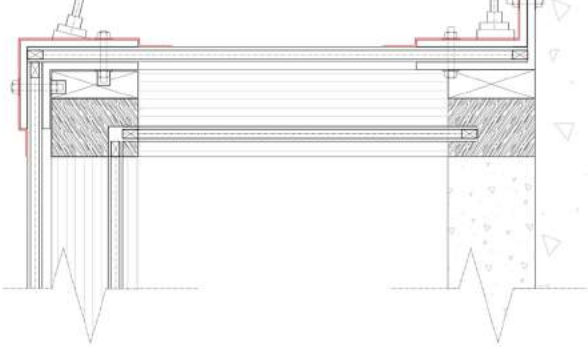
Glass configuration
Pane 1 25mm Toughened
Pane 2 13.5mm Laminated
Pane 3 25mm Lamainated

Weights
Pane 1 375kg
Pane 2 180kg
Pane 3 375kg

Tempered laminated marine grade glass used in preference to acrylic despite it being harder to form curved surfaces it has many benefits which will help with the longevity of the surface and the overall cost and ease of construction. It isn't as easily scratched and will not discolour with age. The material however has a few draw backs as it refracts light different to its counterpart - Acryllic. Clarity is somewhat distorted with glass however the play of scale and distortion will add intrigue when looking through into the water above.

Distortion - Glasses refraction index is different from that of water. So as the light passes through the air, glass and then water to get reflected back from the hull of a ship through them both a second time, the light is bent four times. Each time the light is bent it is distorted. This can play with the colour, position and scale of the origional image.

Total volume of water each rib section carries is max. 38 Meters Cubed which equates to 38000 KG wt. This weight is the absolute maximum water weight and mechanical systems control this to ensure the loads do not pass the structural loading threshold. The load is distributed across 6 panes.



Glass is easier to ship and requires fewer specialized tools to work with, so glass tanks tend to be less expensive than acrylic tanks.

Table showing typical properties of the interlayer between toughened panes

Property	Units (Metric)	Value
Youngs Modulus (elastic properties)	Megapascal (MPa)	300.00
Tensile Strength	Megapascal (MPa)	34.50
Elongation	%	400.00
Density	g/cm^3	0.95
Flex Modulus	Megapascal (MPa)	345.00
Heat Deflection	°C	43.00
Melting Point	°C	94.00
Coefficient of Thermal Expansion (-20 C to 32 C)	10^-5 cm/cm °C	10 to 15

2.08 Structural Sytsems
Material Strategy - Steel

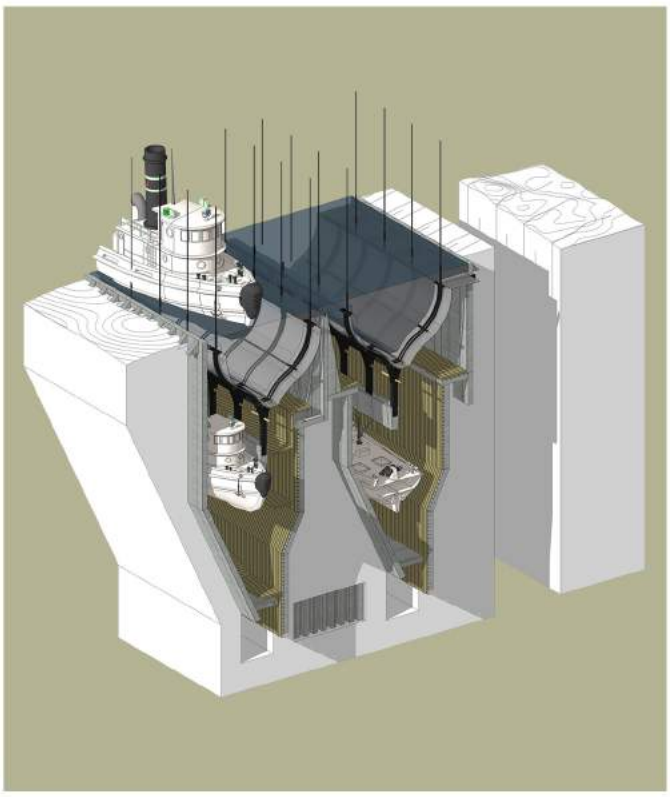
Steel is used in construction as it has many advantages. Mainly its strength to weight ratio. Steel componants for the Martime Graveyard will be made offsite and transported to be utilised within the scheme. Bespoke componants and connections will be created by specialist steel fabricators who are employed to produce these elements offsite. One delievered to site the contractors will assemble the finished componants. Each steel connection is to be designed by the Architect and consuting Engineer. This is critical to the project as most structural failures happen at connections. Its is because of this that the consulting engineer, steel fabricator and Arcitect work closely together to give accurate design drawings to the fabricator for the connections and within the drawing package, clear assembly guidelines are given to the contractors to follow.

The fabrication of the steel structure can be done entirely at the construction site, however this is labour-intensive. By fabricating finished componants offsite in a workshop, better working conditions are provided and the time spent producing the structure is reduced. The contractors are challenged with simply lifting the componants in to position and bolting them together to form the structure. If the componants were produced on-site, the quality of the compinants might suffer with the poorer lighting conditions and availability of specialist equipment.

The length of the componants are goverened by the size of truck and trailer that is available to transport them onsite. The steel componants that make up the gallery space have been designed so they are never longer than 6m. This means they can be transported to site easily. (Standard transport lorry trailers can transport up to 12m)

As the on-site work is limited to lifting the members into place and bolting them together. The construction process is extremely fast.

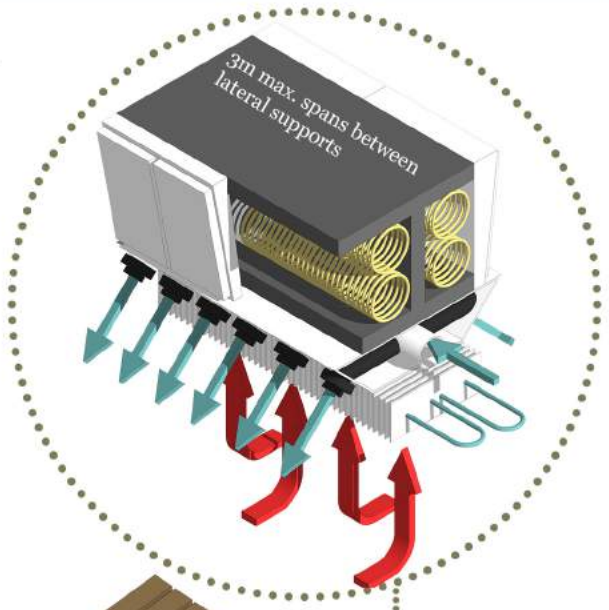
Multiple Spider Cranes will be used to lift the steel elements in to place during construction within the gallery space only. This will be used as its easily manouvered into tight spaces and as the max. length of the steel componants is never greater 6m they are able to support this weight with ease.

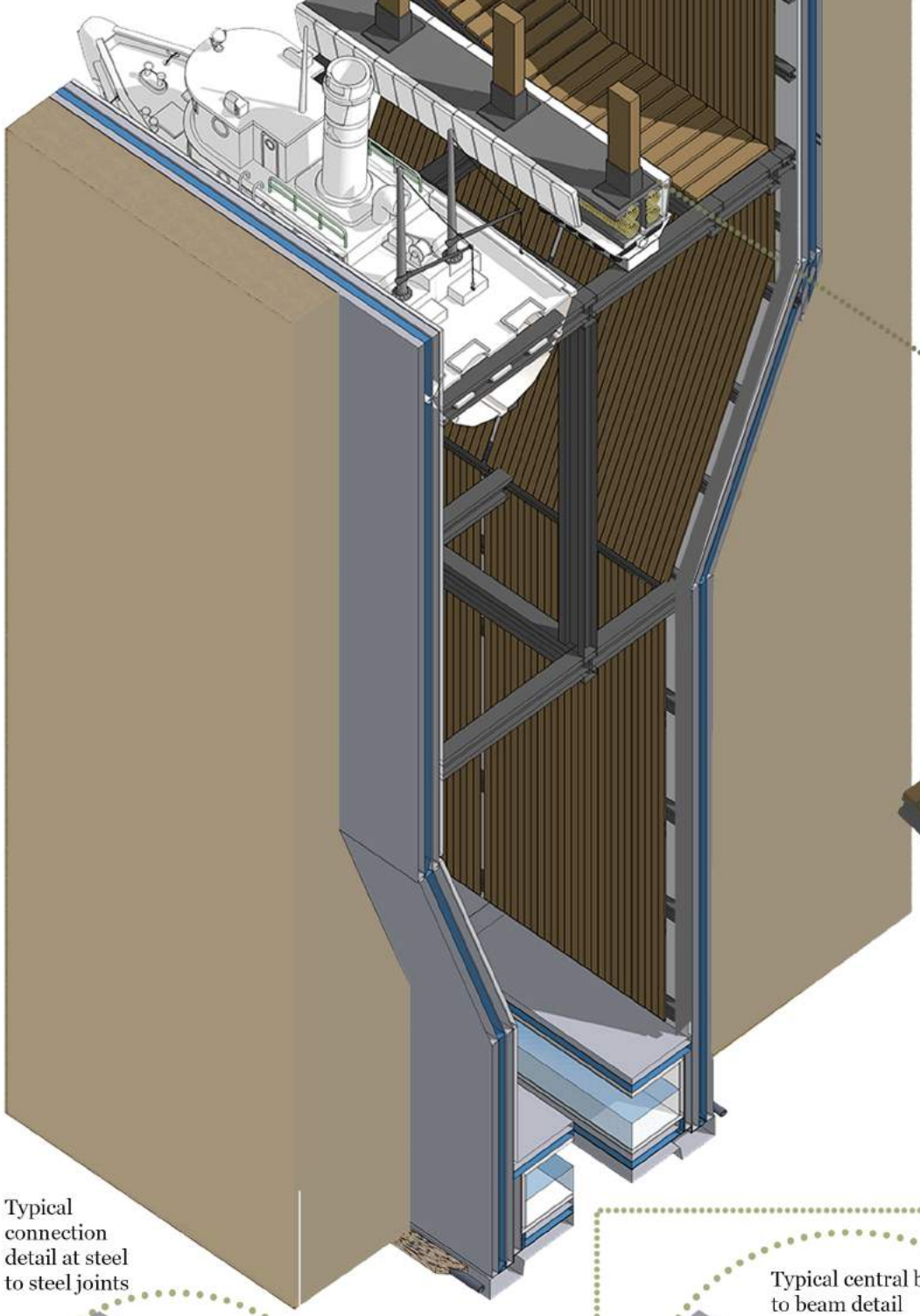


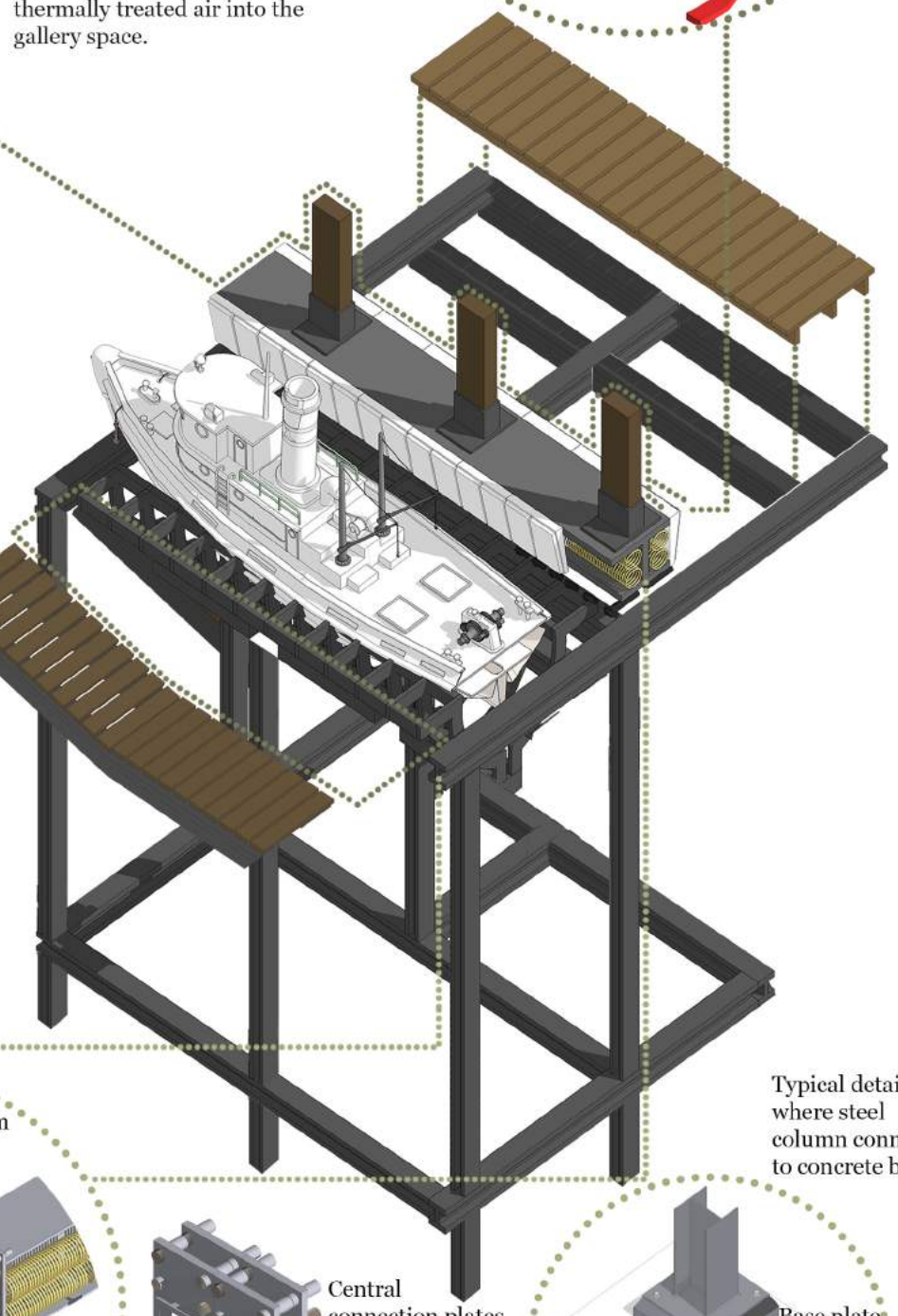
The central structural steel beam is visually continuous which spans the gallery space, is supported by horizontal members at 3m intervals.

Due to the length restrictions beam to beam connections allow this componant to be built up of 6m steel lengths.

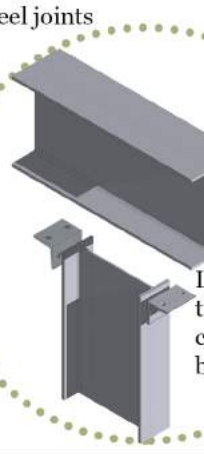
The beam is clad for fireprotection, this also conceals the flanges of the beam where services are provided discreetly for the gallery. The beam also acts as a temperature controlling element provided fresh thermally treated air into the gallery space.





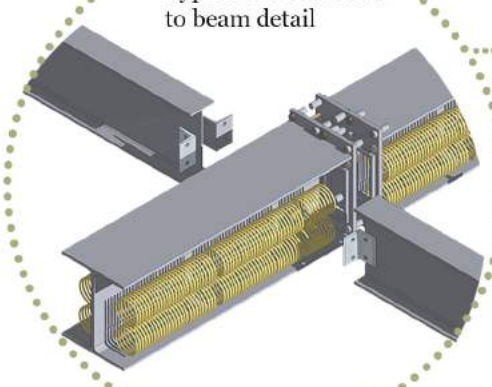


Typical connection detail at steel to steel joints



L brackets tied to steel column and beam

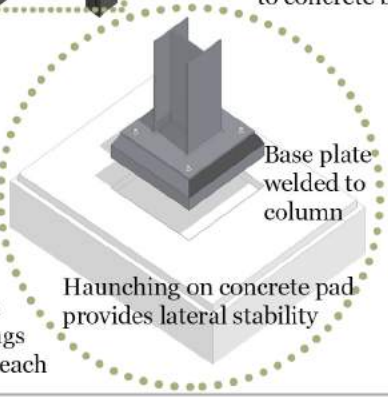
Typical central beam to beam detail



Central connection plates are welded to the beam and bolted to eah other

Connections contain strengthened openings for the services to breach

Typical detail where steel column connects to concrete base



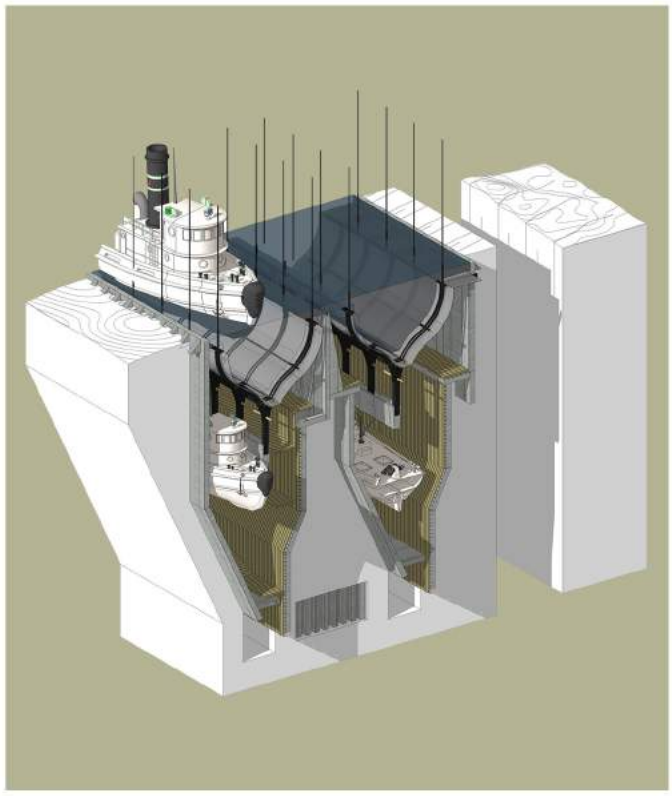
Base plate welded to column

Haunching on concrete pad provides lateral stability

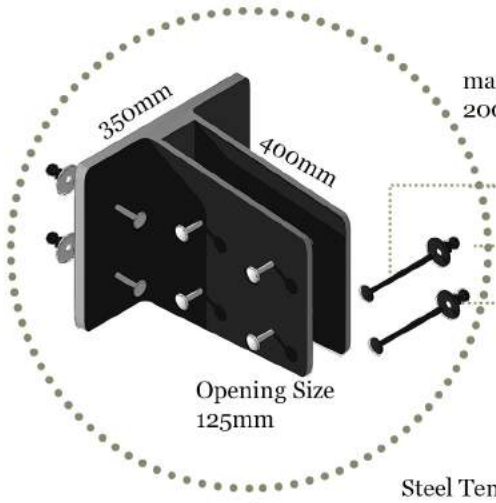
2.09 Structural Sytsems
Material Strategy - Timber

Glulam, is a type of structural engineered wood product comprising a number of layers of dimensioned timber bonded together with durable, moisture-resistant structural adhesives.

The process of laminating a number of smaller componants, produces a singe stronger structural member. These structural members are used as vertical columns or horizontal beams, as well as curved shapes. The connecting elements are usually made with bolts and steel plates.



Steel Mullion Hangar Detail



max. size of panel
2000 x 3000mm

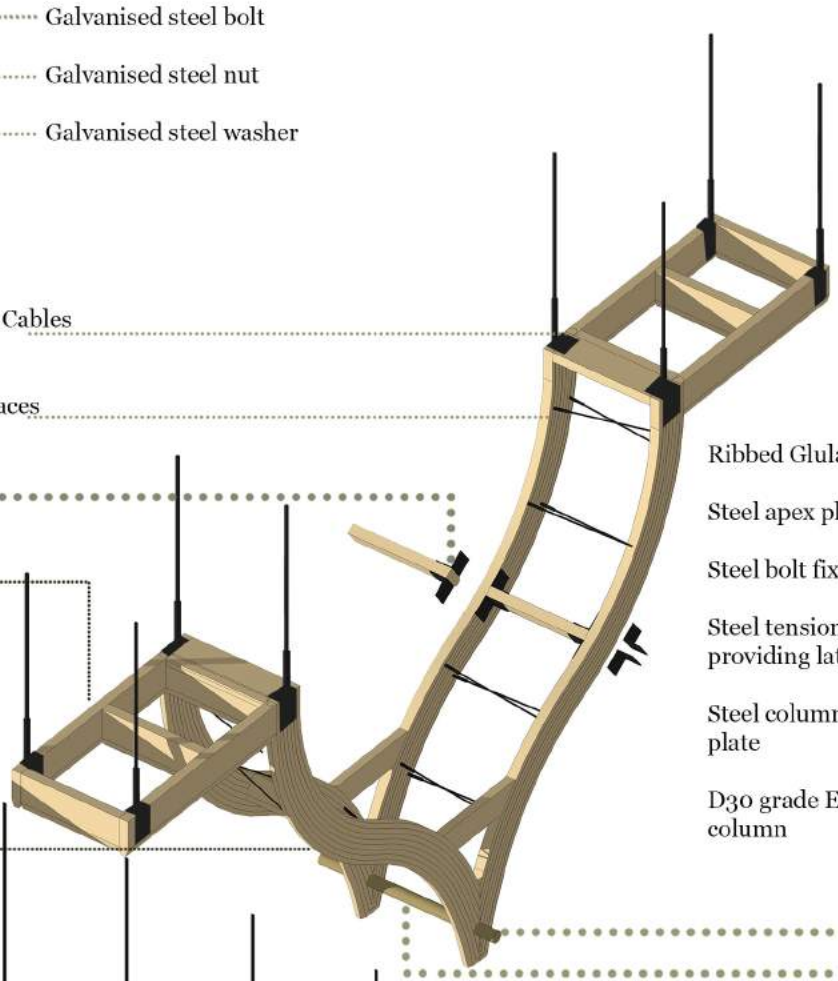
Galvanised steel bolt

Galvanised steel nut

Galvanised steel washer

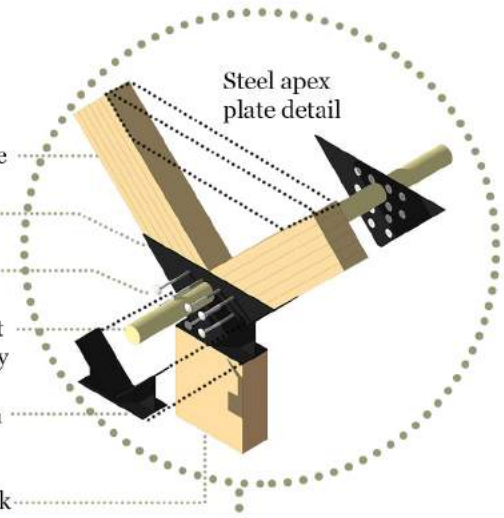
Steel Tension Cables

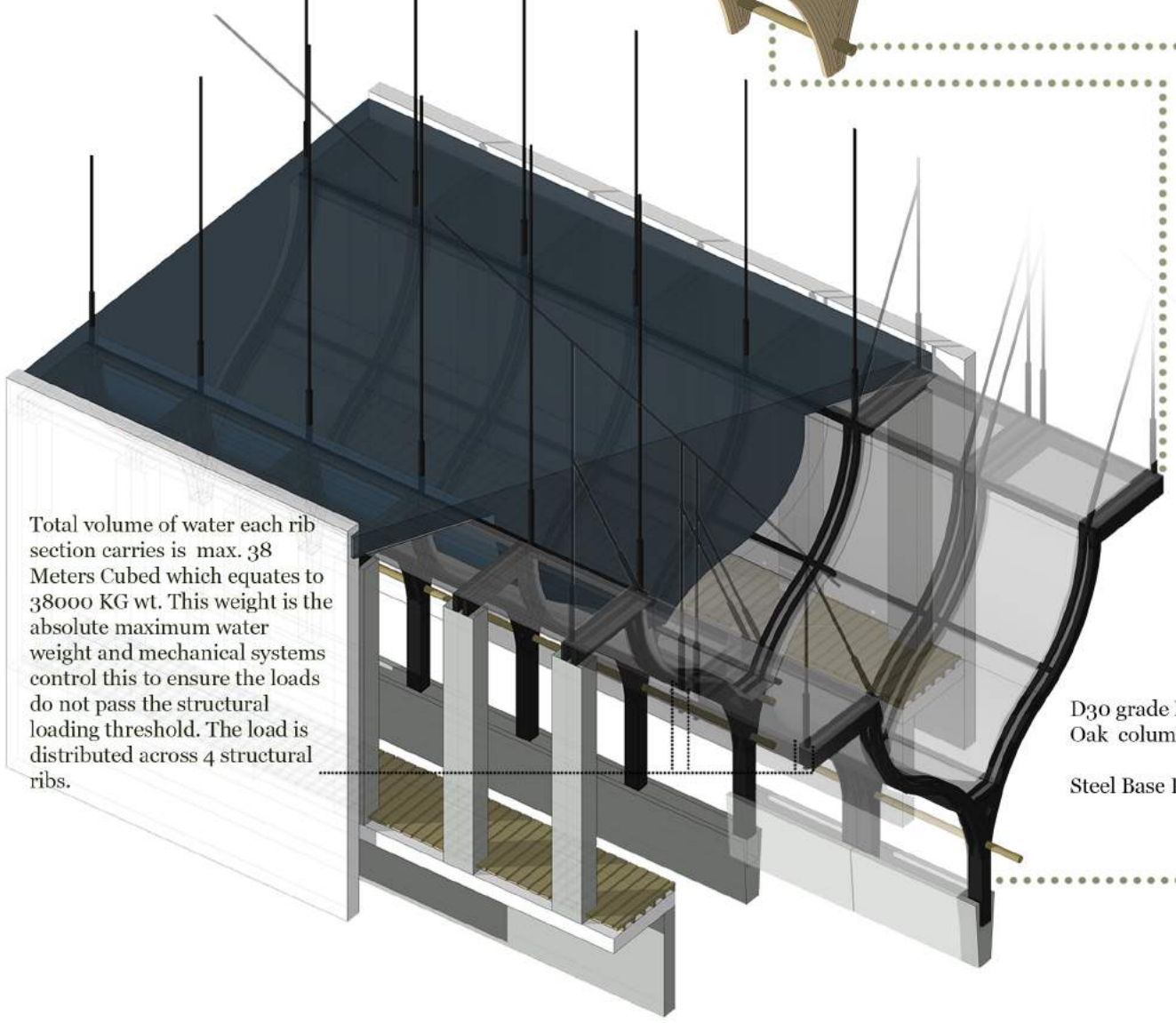
Steel cross braces



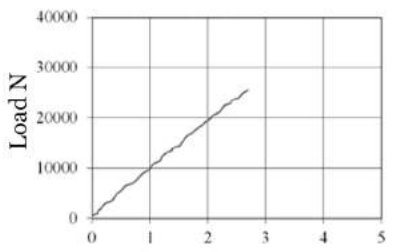
Timber spans
Span 2m - Thickness 150mm
Span 4m - Thickness 150mm

Glulam has much lower embodied energy than reinforced concrete and steel, although higher than solid sawn-timber. The laminating process allows timber to be used for much longer spans, heavier loads, and complex shapes.

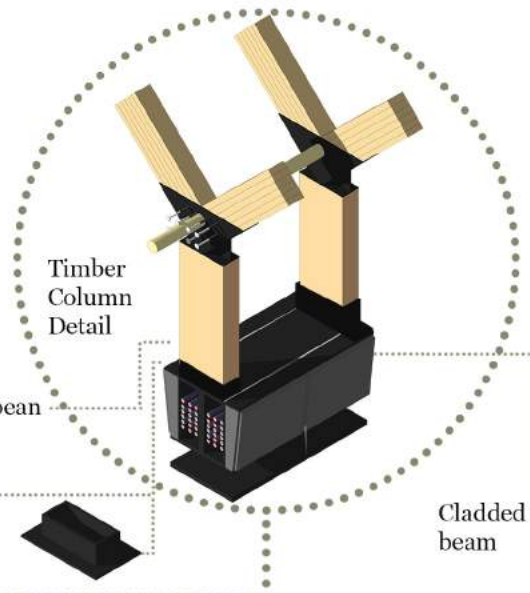




Total volume of water each rib section carries is max. 38 Meters Cubed which equates to 38000 KG wt. This weight is the absolute maximum water weight and mechanical systems control this to ensure the loads do not pass the structural loading threshold. The load is distributed across 4 structural ribs.



Load - Displacement curve for typical glulam componants

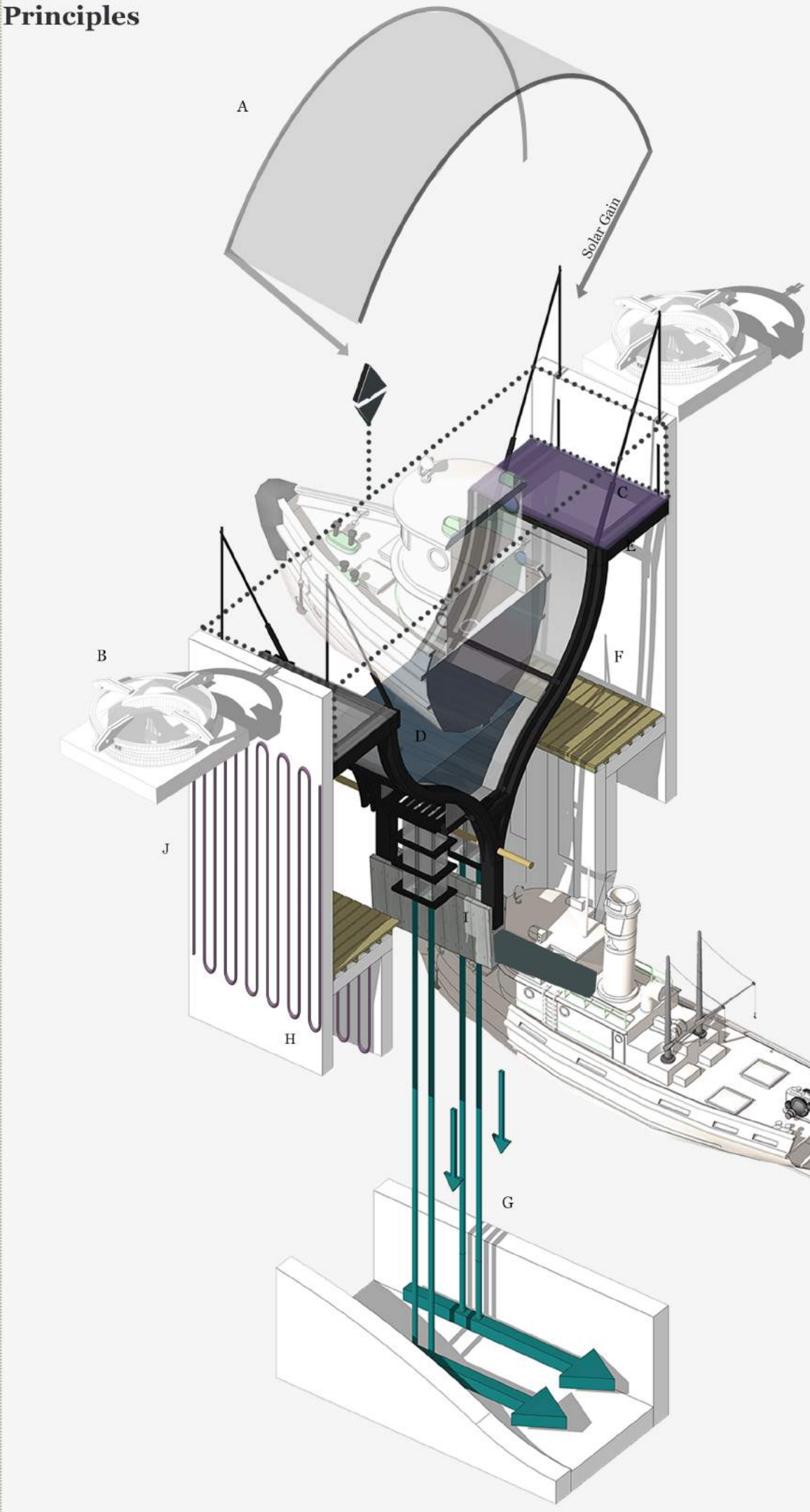


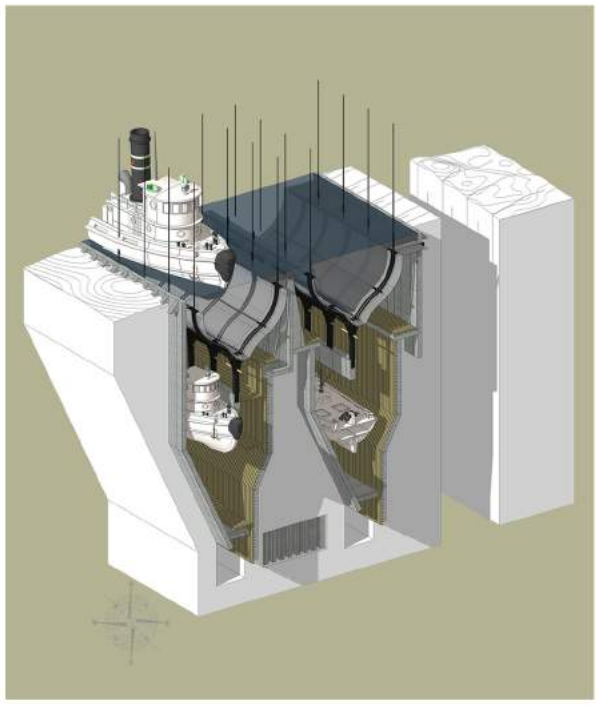
The high strength and stiffness of laminated timbers enable glulam beams and arches to span large distances without intermediate columns, allowing more design flexibility than with traditional timber construction. The size is limited only by transportation and handling constraints.

Glulam as a material optimises the structural potential of a renewable material resource. Large members can be constructed off site and shaped easily which lends itself to the unusually shaped channel. The process of making glulam means there is significantly lower amounts of waste material compared to solid sawn members. The negative impact of knots within each board that build up the beam is significatly less also.

The weight of Glulam is two-thirds of that of the weight of steel and one sixth the weight of concrete – the embodied energy to produce it however is six times less than the same suitable strength of steel.

3.01 Environmental Strategies
Principles





Environmental principles

A Solar gain/exposure to natural light

B Low perimeter walls to allow maximum solar light

C Triple Glazing

D Body of water - Depth and Terbidity are adjustable

E Responsive Automated Louvre System

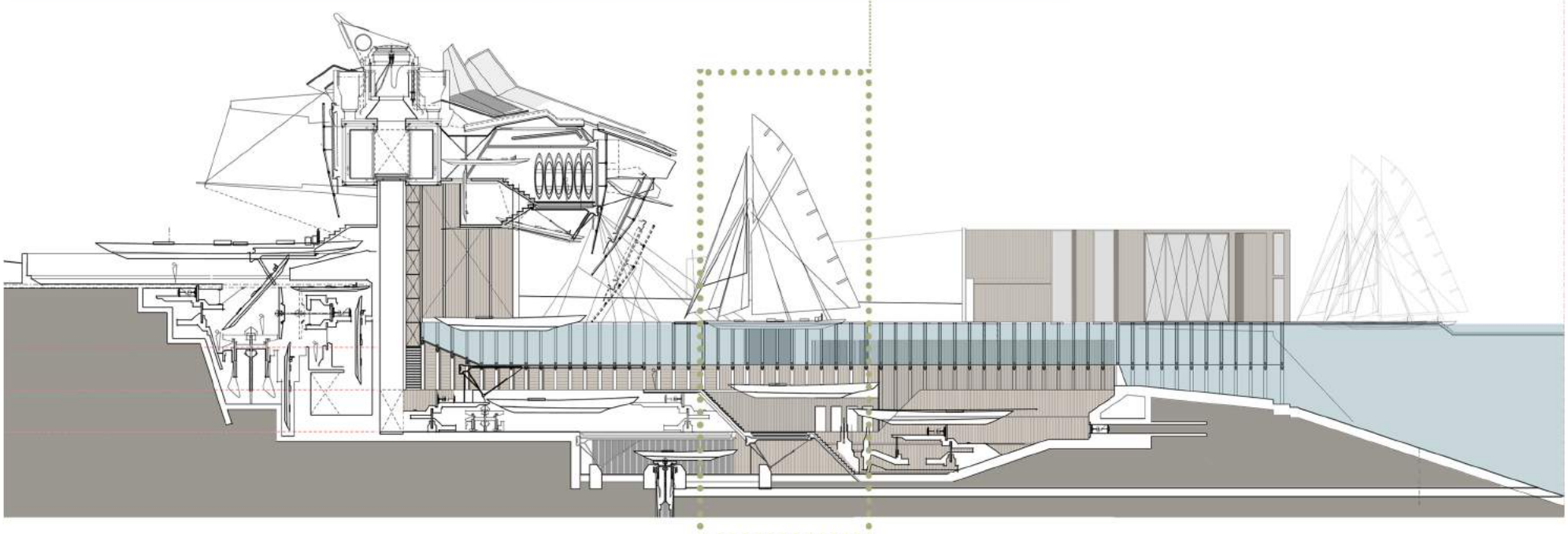
F Internal Gallery Space

G Draining filtered water and transporting it back to the Archapelago

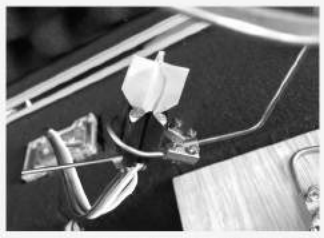
H Concrete elements add thermal mass which regulate temperature

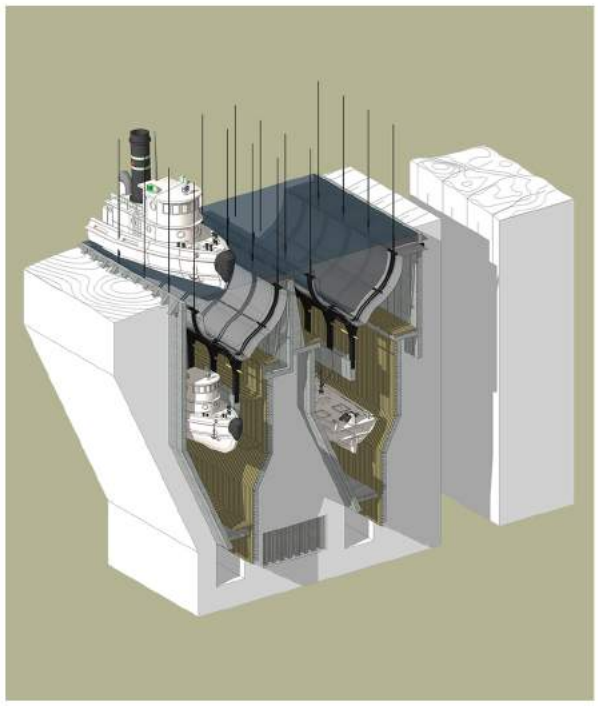
I Temperature regulating beam

J Heating matrix within walls



3.02 Environmental Strategies
Solar Gain





A

Solar Gain

Water levels rise and fall to control light levels

Low perimiter walls to maximise solar gain into trench

B

C

D

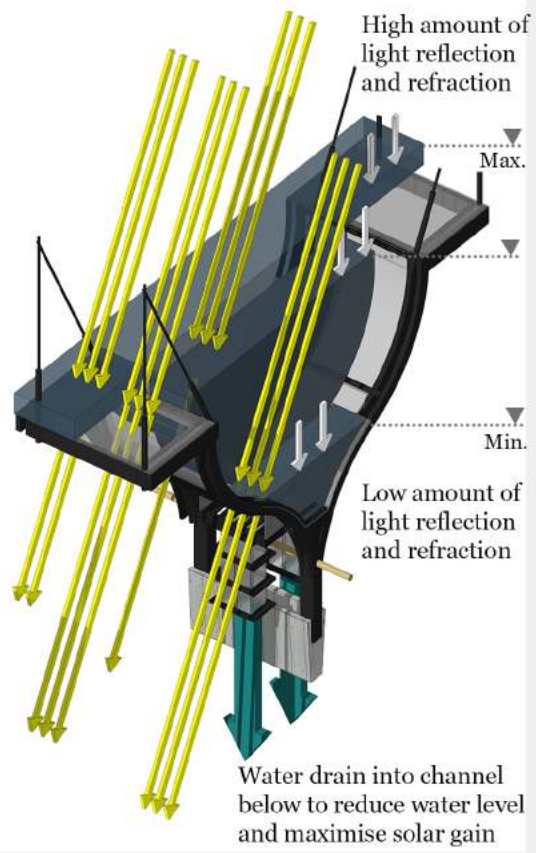
E

F

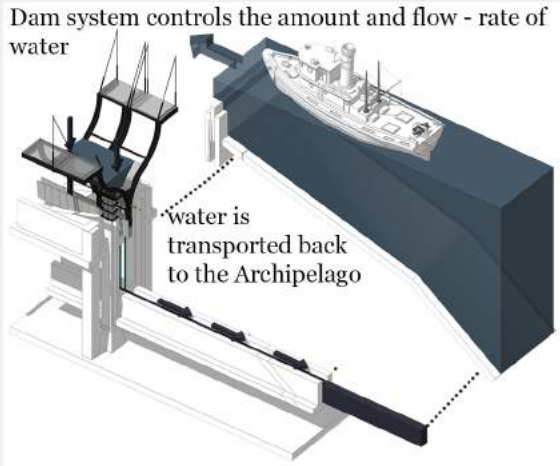
G

Arduino system controls automated directional louvre system to control light intensity at shallowest part of channel

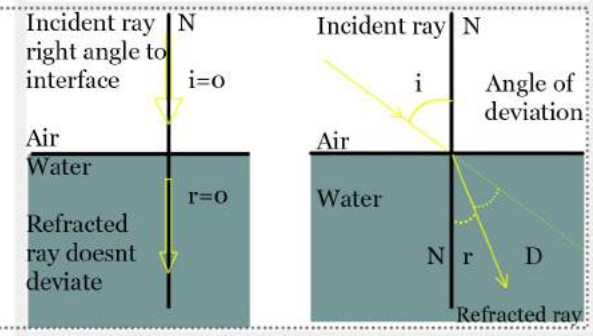
FIXED TO U/S OF GLAZING



Dam system controls the amount and flow - rate of water



Flow of water is controlled so that the surface of water can be adjusted and therefore the refracted suns rays cean create a sense of movement within the gallery space beneath



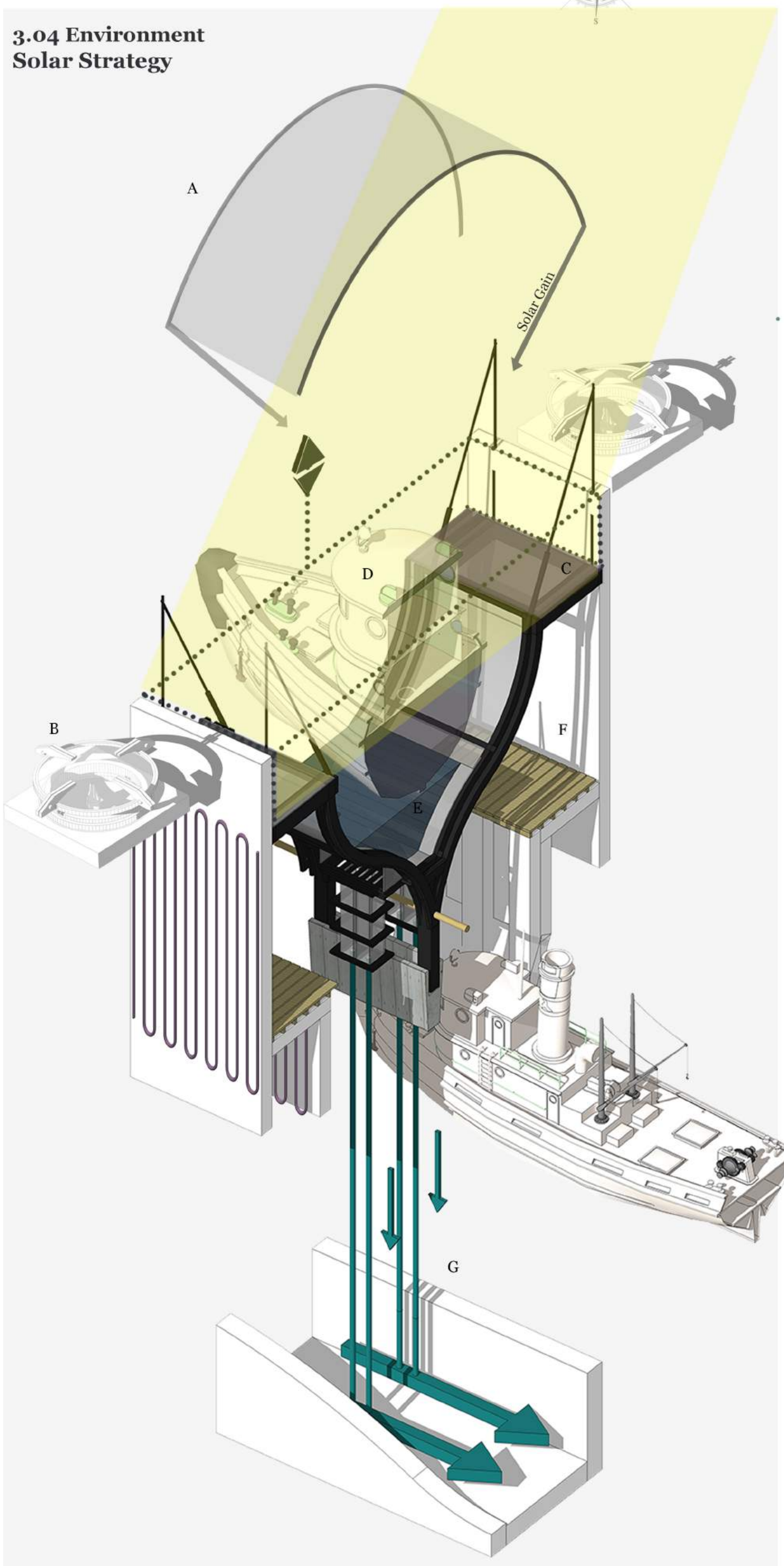
Subterranian channel trasporting water back to the Archapelago.

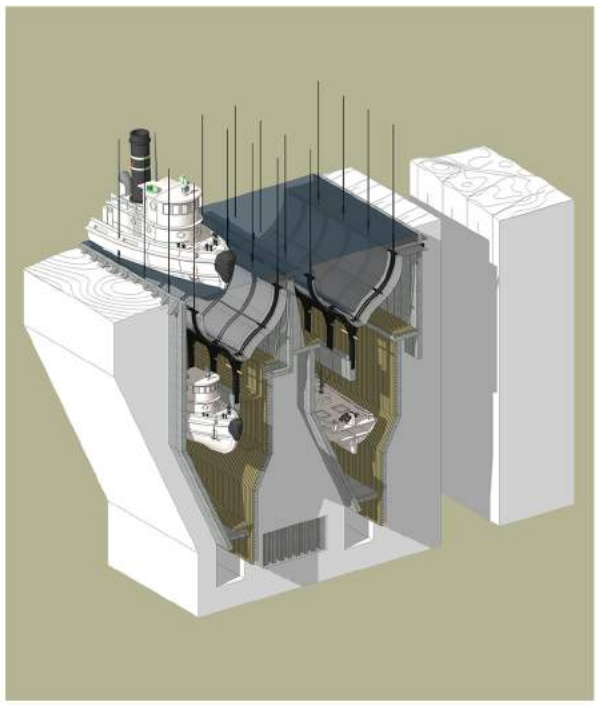
The depth of water is controlled by the light sensors. When there are low external light levels the body of water above the gallery space is reduced. This is done by partly draining the channel and pumping the water back into the archapelago. This means the light does not have to travel through the body of water and instead enters the space with a higher level of intensity.

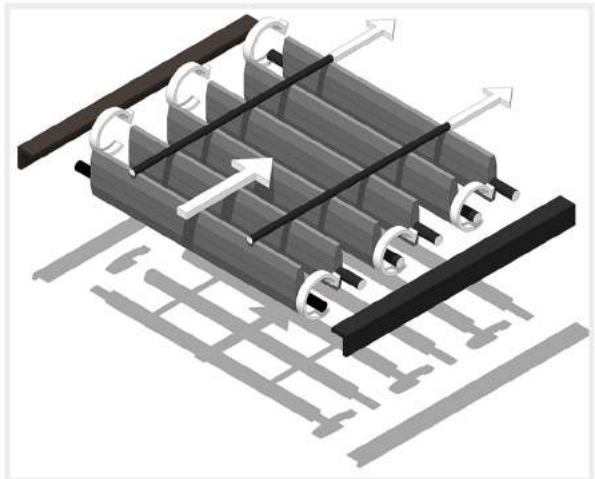
Physical tesing

I have developed a responsive device using arduino technology. Programming a basic circuit board to respond to changes in sunlight to incorporate into the schemes funadmental environment strategy. The device is responsive in realtime to changes in sunlight, taking in light intensity readings and translating this data to kinetic componants. These are designed to drive architectural elements to adjust the environment within the building.

3.04 Environment
Solar Strategy







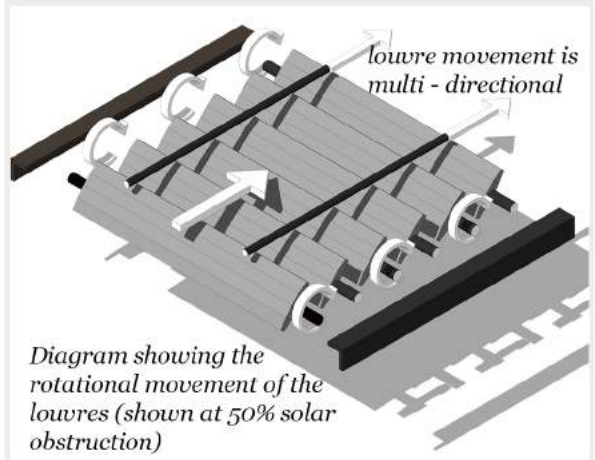
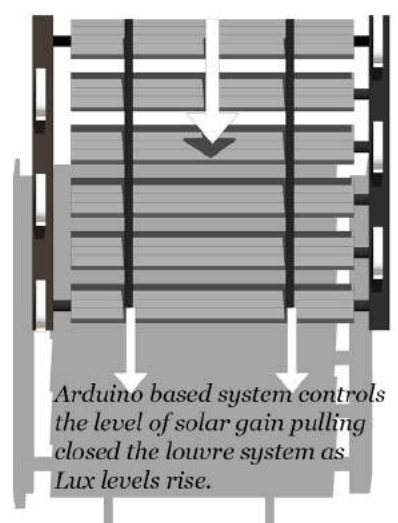
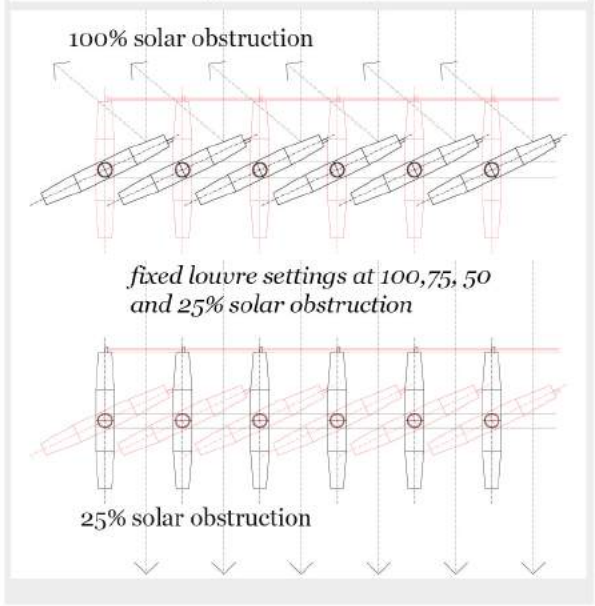


Diagram showing the rotational movement of the louvres (shown at 50% solar obstruction)

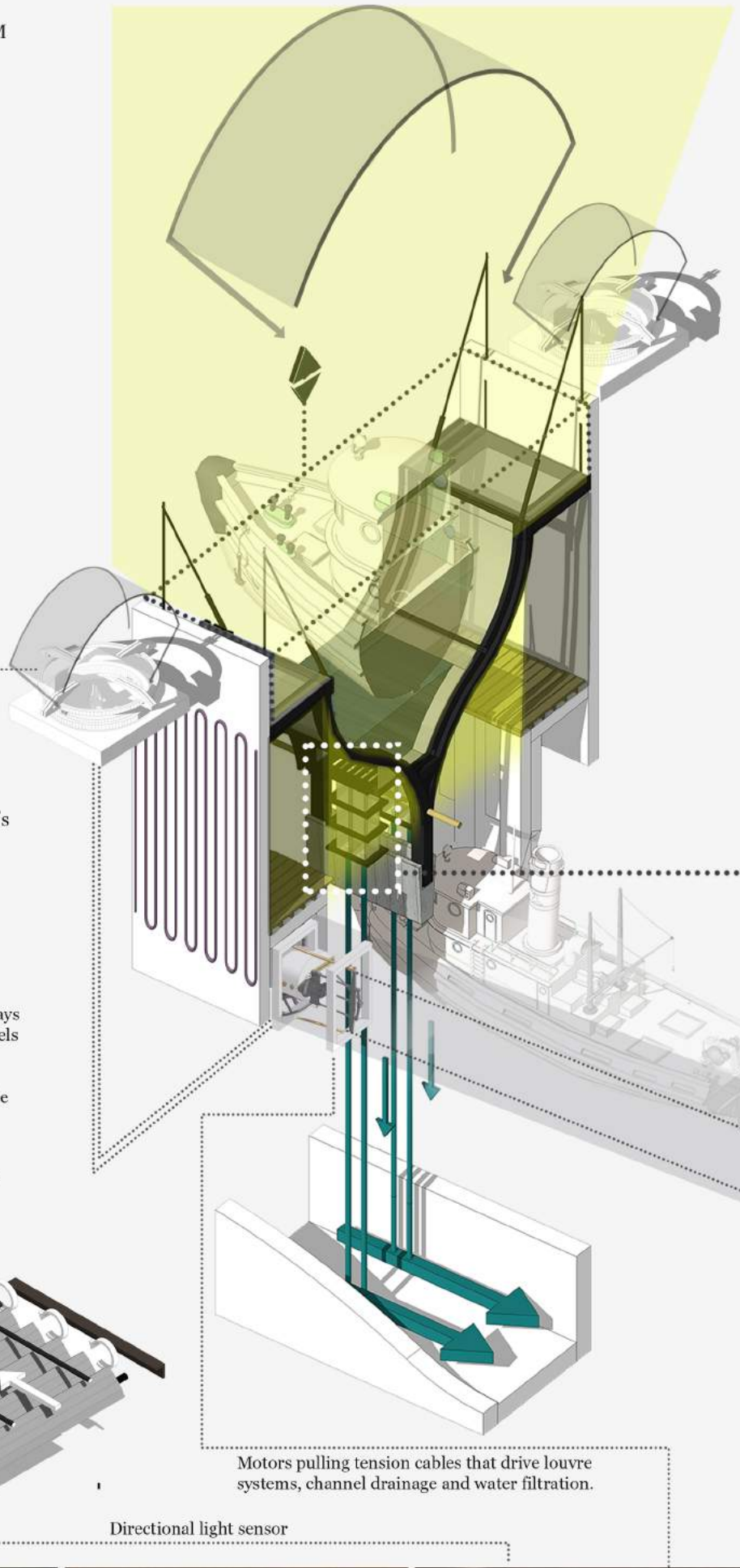


Arduino based system controls the level of solar gain pulling closed the louvre system as Lux levels rise.



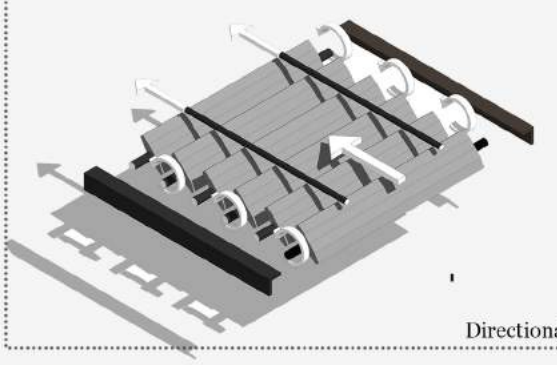
3.04 Environment
Solar Strategy

SOLAR RESPONSIVE SYSTEM
Physical development



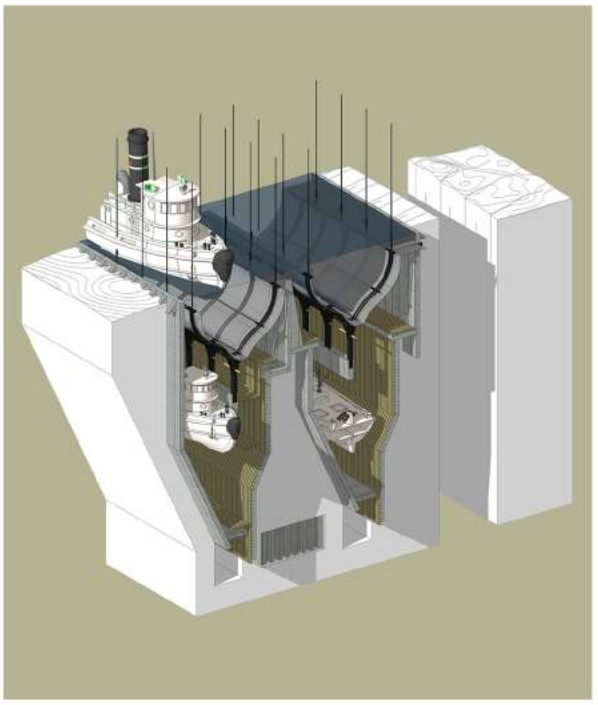
Louvre system fixed to u/s of parallel sections of glazing (directly above walkways)

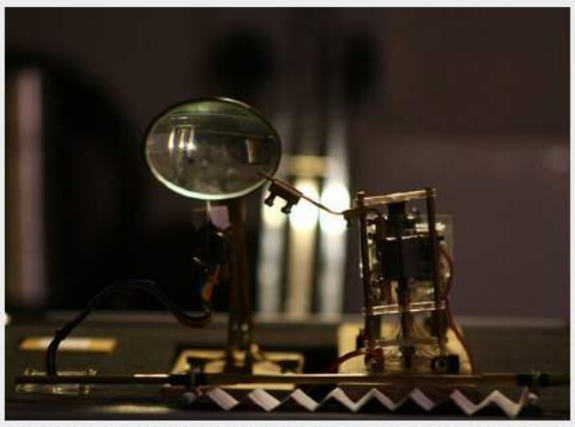
If internal Lux levels raise above 300 Lux. the Louvre system closes completely blocking 100% of the solar rays through the flat glazed pannels above the walkways. When they drop below 50 Lux the Louvres are fully opened. The percentage of solar gain blocked between these extremes is incremental to keep glare and temperatures within the space steady.



Motors pulling tension cables that drive louvre systems, channel drainage and water filtration.

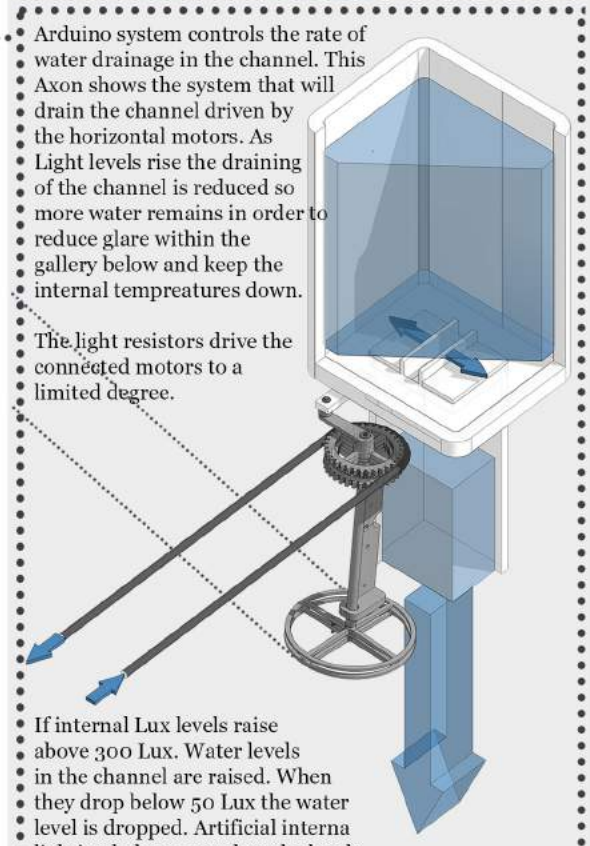
Directional light sensor



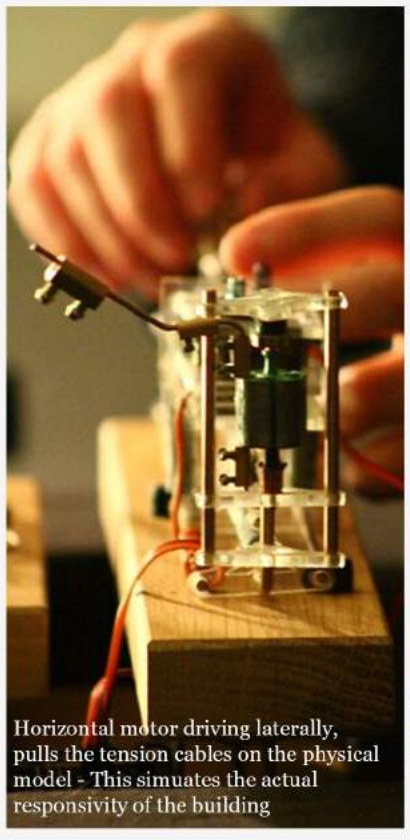


Arduino system controls the rate of water drainage in the channel. This Axon shows the system that will drain the channel driven by the horizontal motors. As Light levels rise the draining of the channel is reduced so more water remains in order to reduce glare within the gallery below and keep the internal tempreatures down.

The light resistors drive the connected motors to a limited degree.

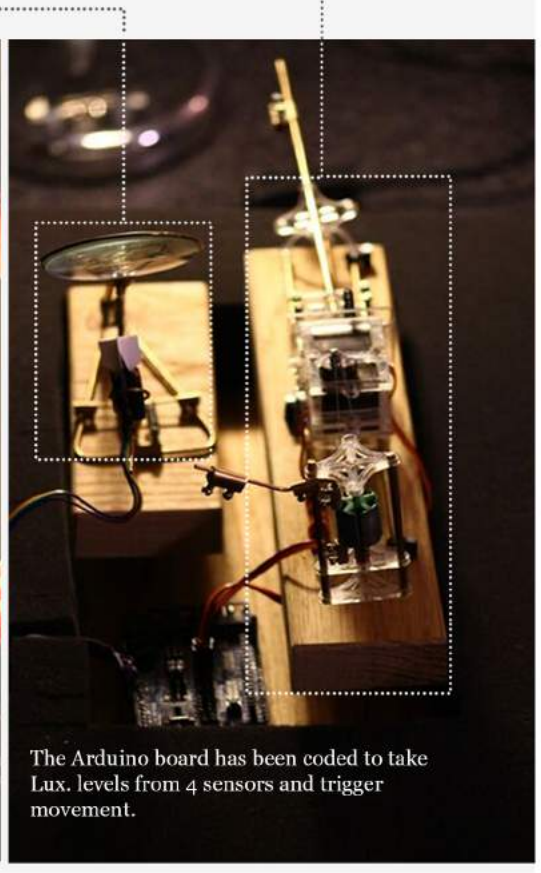


If internal Lux levels raise above 300 Lux. Water levels in the channel are raised. When they drop below 50 Lux the water level is dropped. Artificial interna lighting helps to regulate the levels.



Horizontal motor driving laterally, pulls the tension cables on the physical model - This simuates the actual responsivity of the building

The direction of the strongest light source is picked up by the sensor and the architecture moves to respond to this.

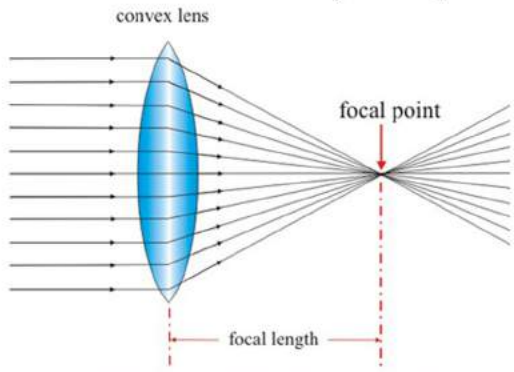


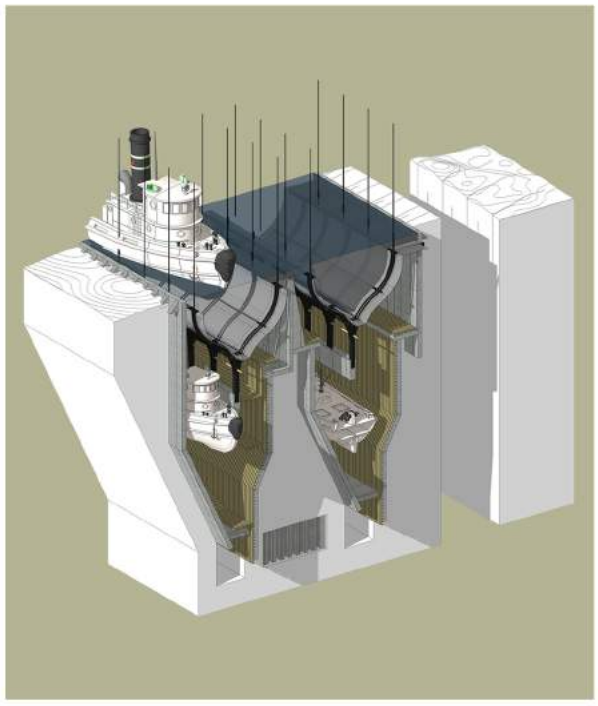
The Arduino board has been coded to take Lux. levels from 4 sensors and trigger movement.

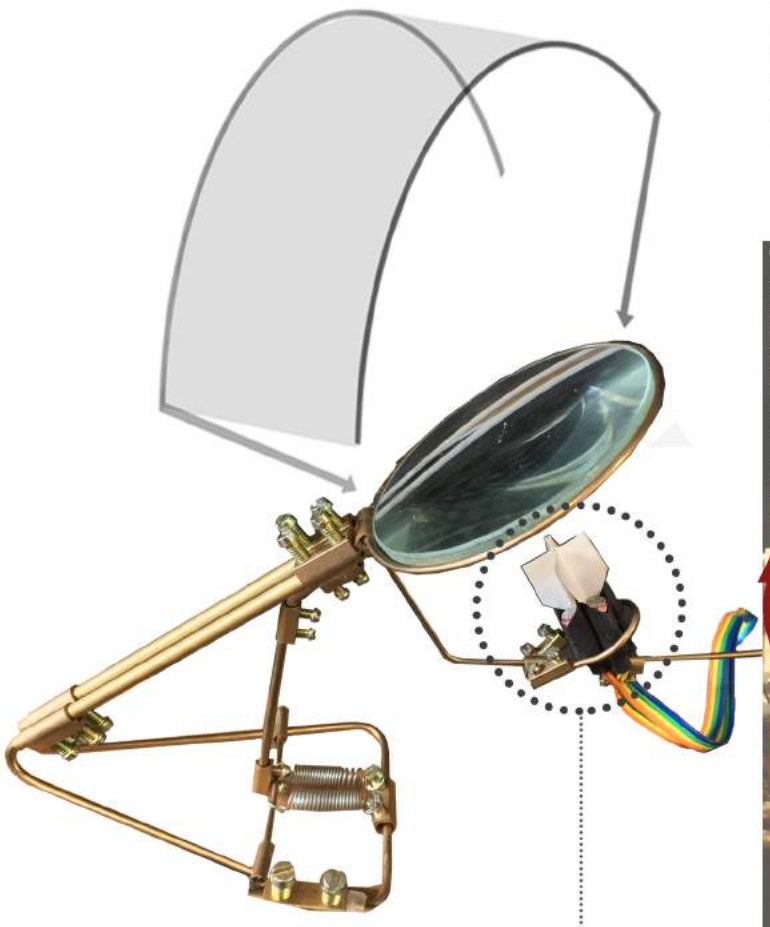
See Appendix. for Arduino Coding document.

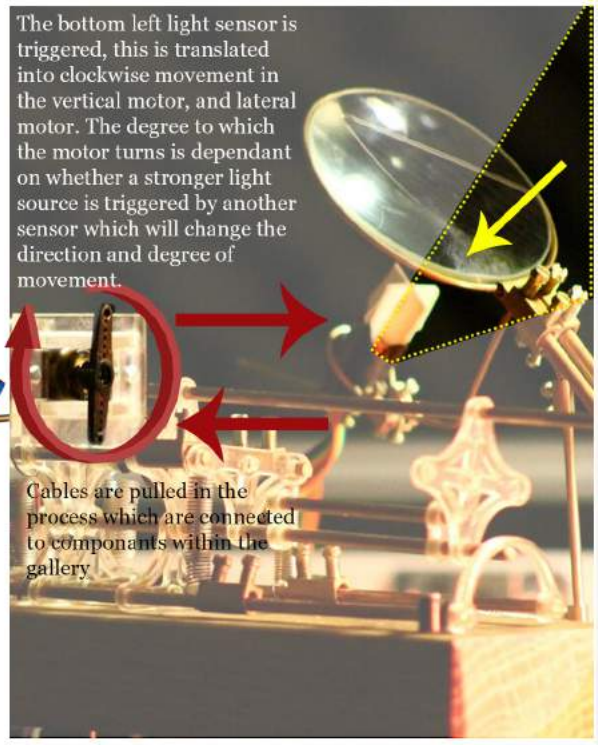
3.05 Environment
Solar Strategy - Solar Responsive Device

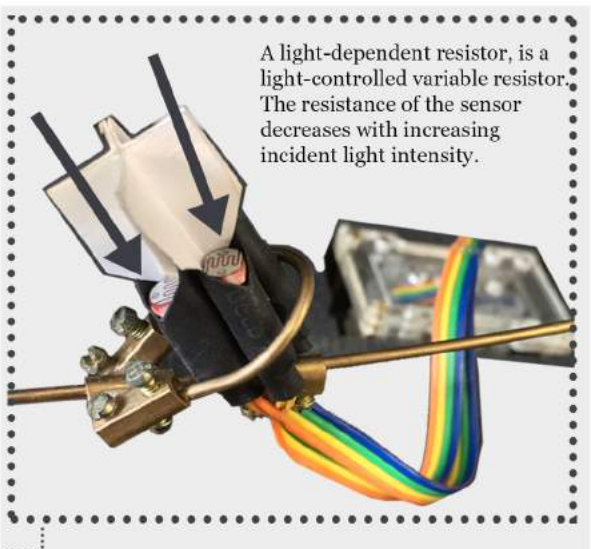
The incoming light energy is concentrated on the light depending resistors by the convex lense. This is then broken into directional data by the x shaped divider

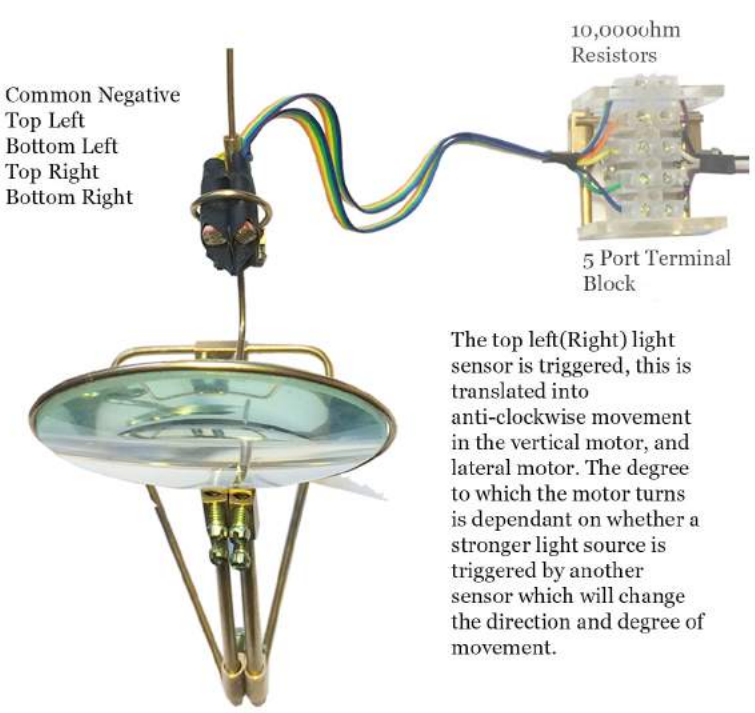




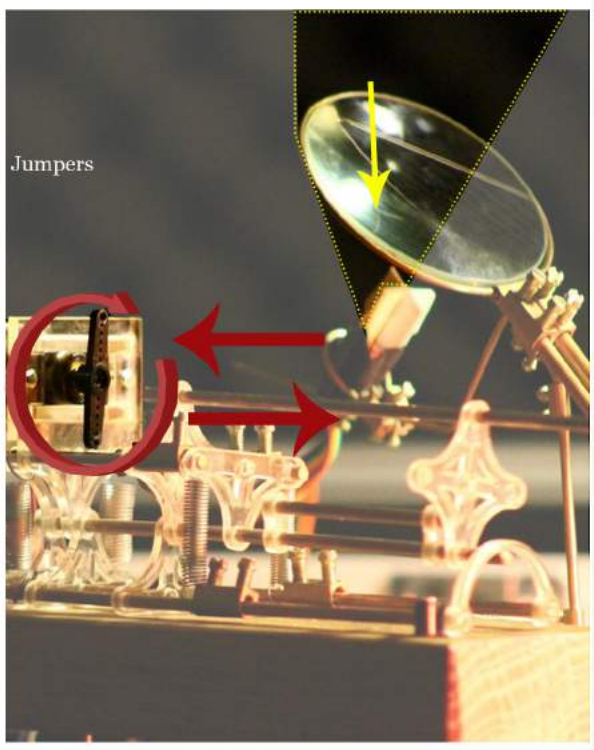


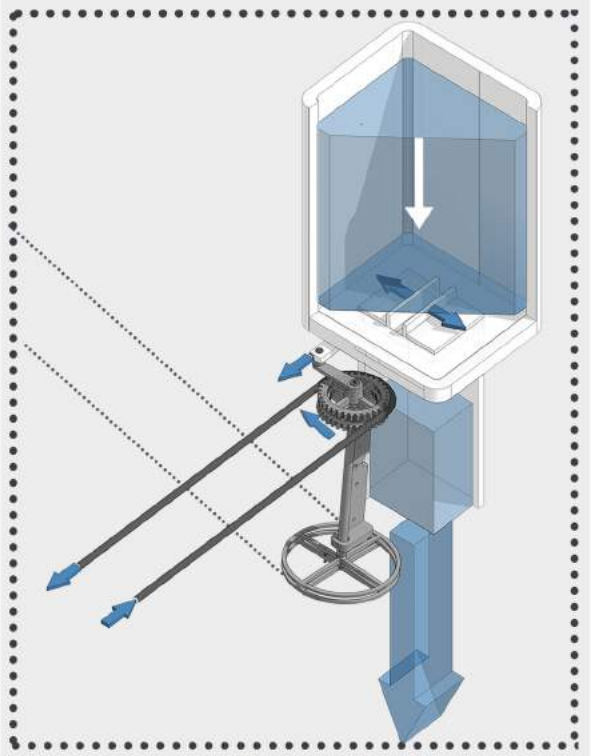


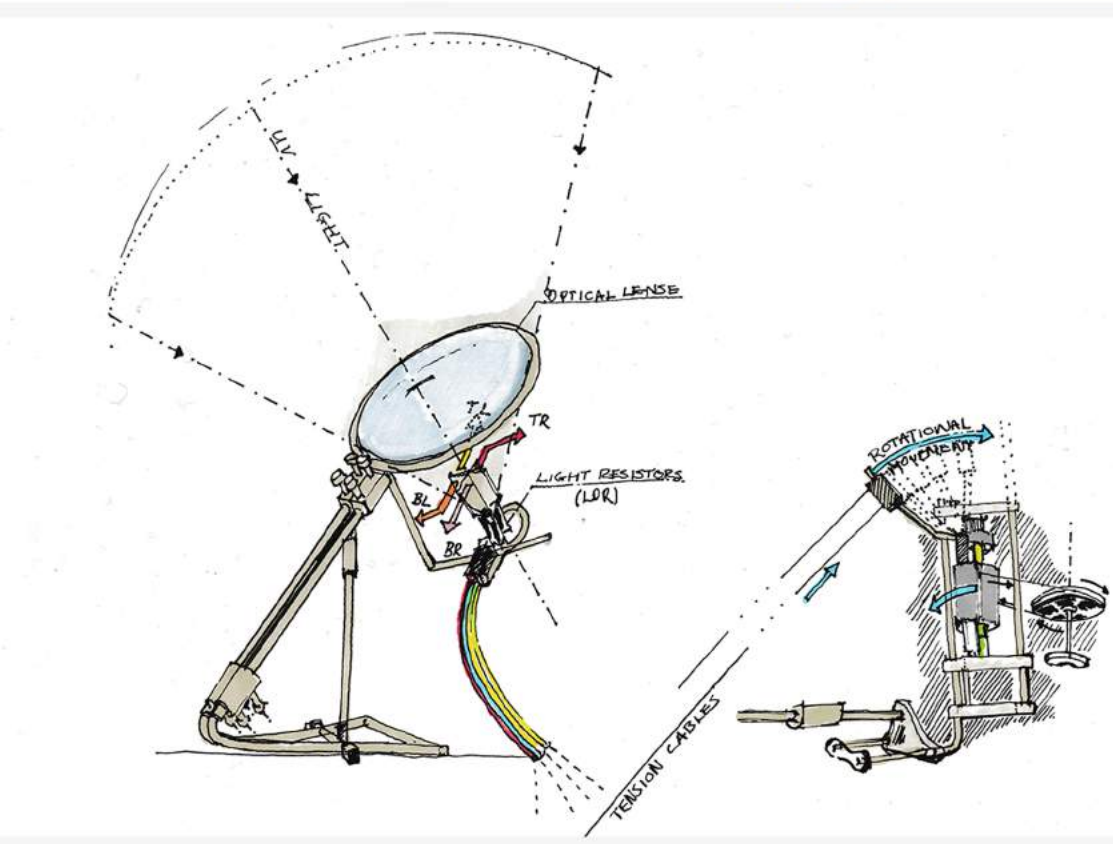


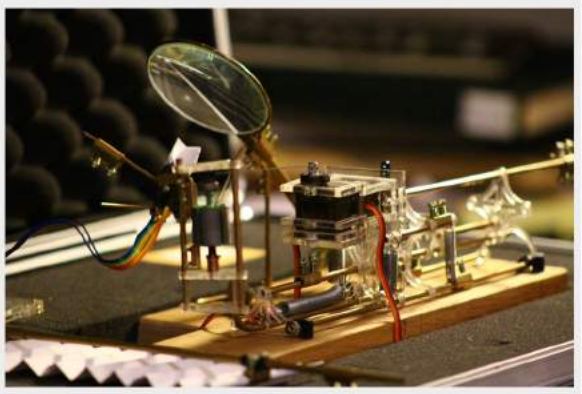


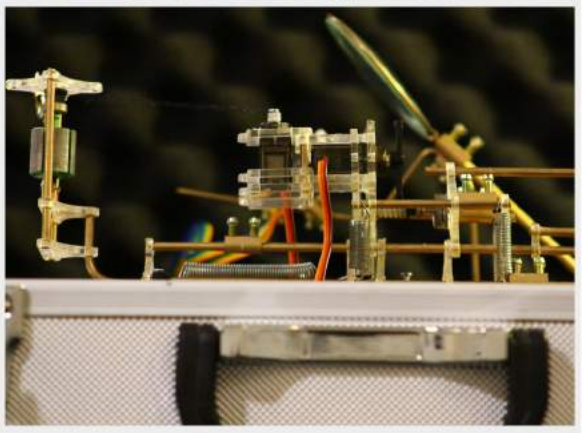
The top left(Right) light sensor is triggered, this is translated into anti-clockwise movement in the vertical motor, and lateral motor. The degree to which the motor turns is dependant on whether a stronger light source is triggered by another sensor which will change the direction and degree of movement.



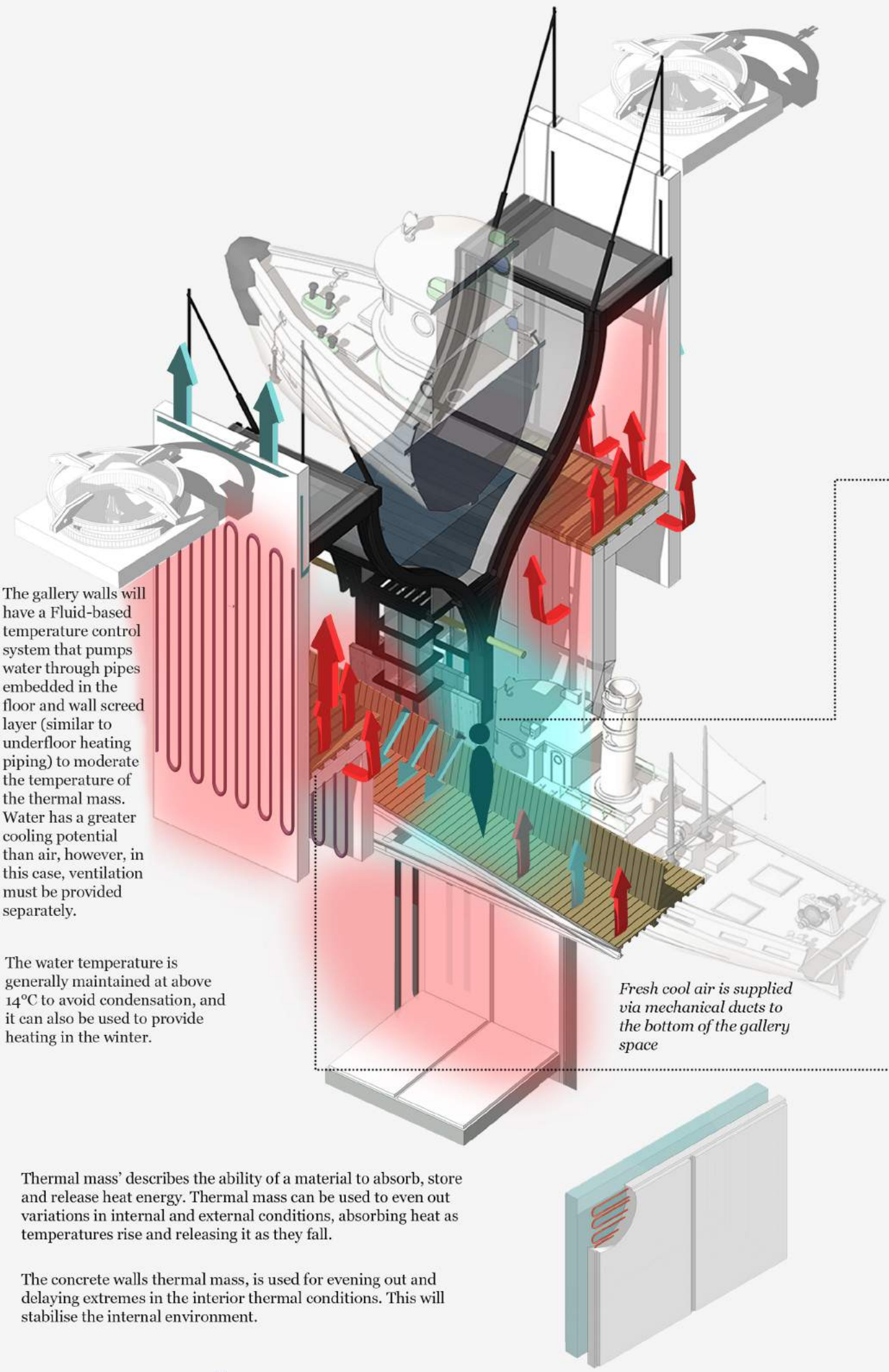








3.06 Environment
Temperature control



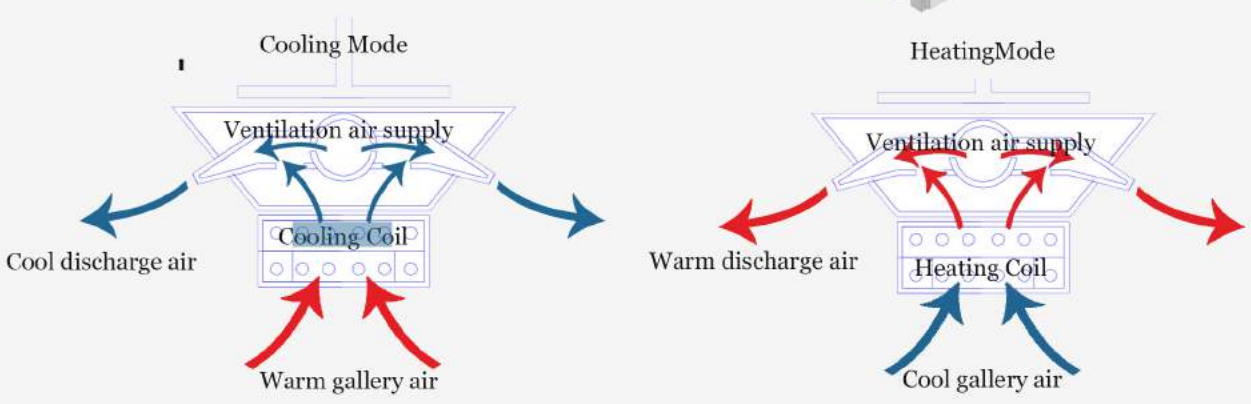
The gallery walls will have a Fluid-based temperature control system that pumps water through pipes embedded in the floor and wall screed layer (similar to underfloor heating piping) to moderate the temperature of the thermal mass. Water has a greater cooling potential than air, however, in this case, ventilation must be provided separately.

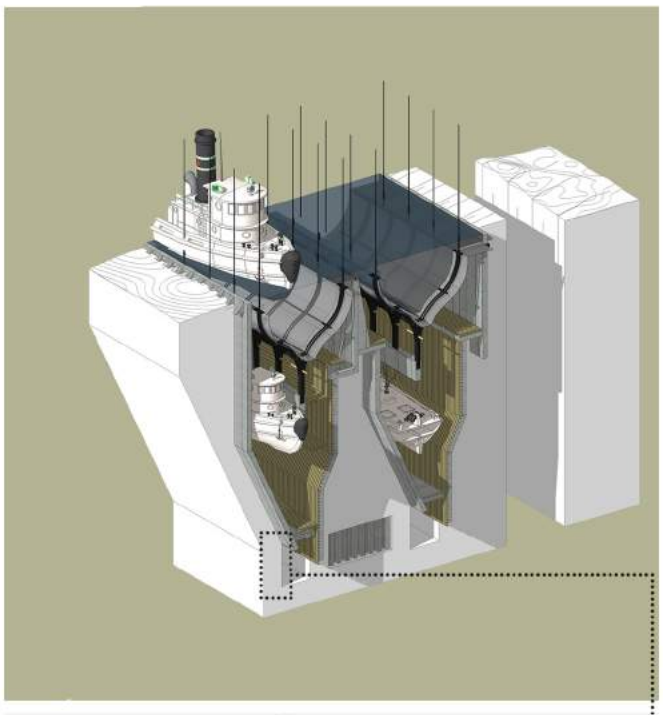
The water temperature is generally maintained at above 14°C to avoid condensation, and it can also be used to provide heating in the winter.

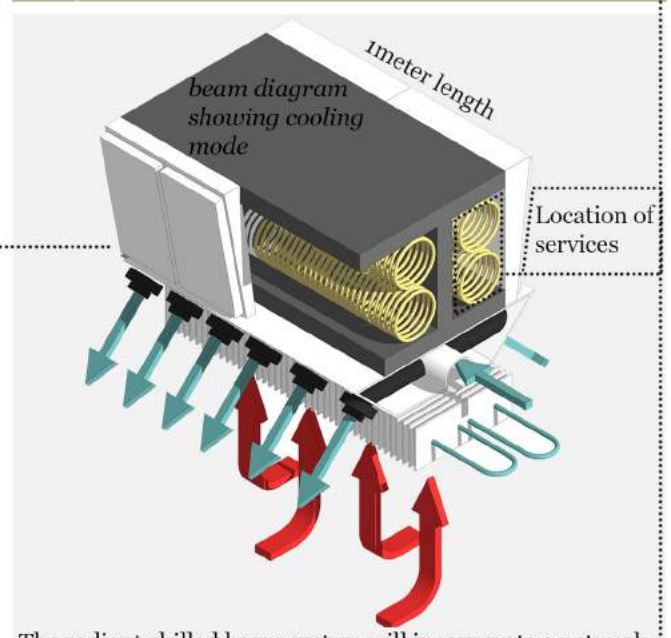
Fresh cool air is supplied via mechanical ducts to the bottom of the gallery space

Thermal mass' describes the ability of a material to absorb, store and release heat energy. Thermal mass can be used to even out variations in internal and external conditions, absorbing heat as temperatures rise and releasing it as they fall.

The concrete walls thermal mass, is used for evening out and delaying extremes in the interior thermal conditions. This will stabilise the internal environment.

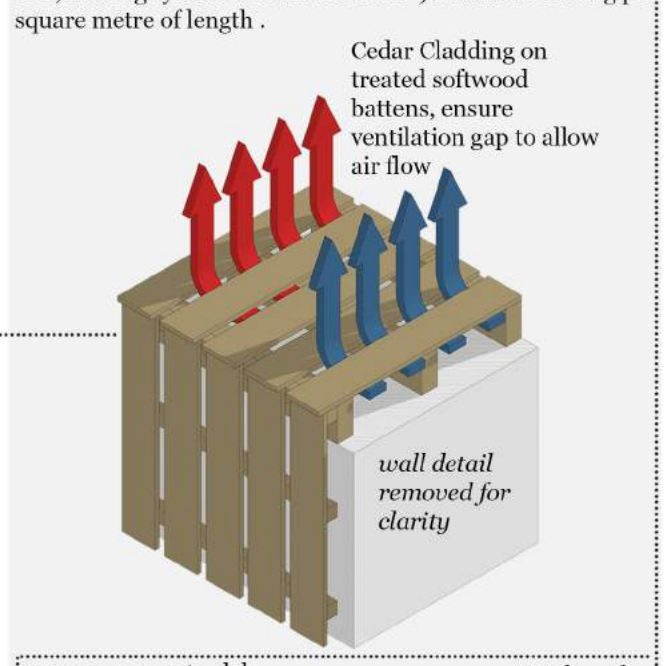


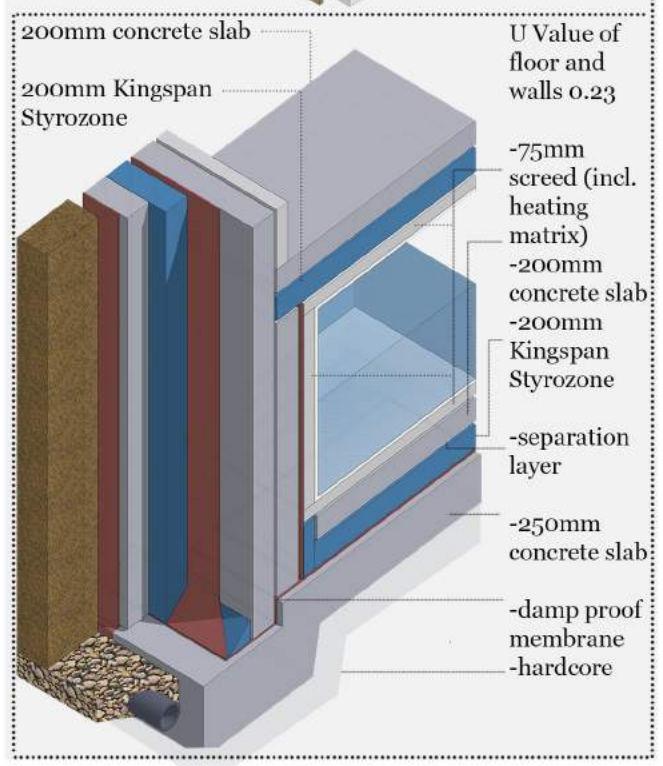




The radiant chilled beam system will incorporate a network of chilled water. The beam then cools the occupied space by both radiation and convection. This provides even temperatures throughout the space and avoids draughts.

The, chilling system will deliver 60 to 90 watts of cooling per square metre of length .

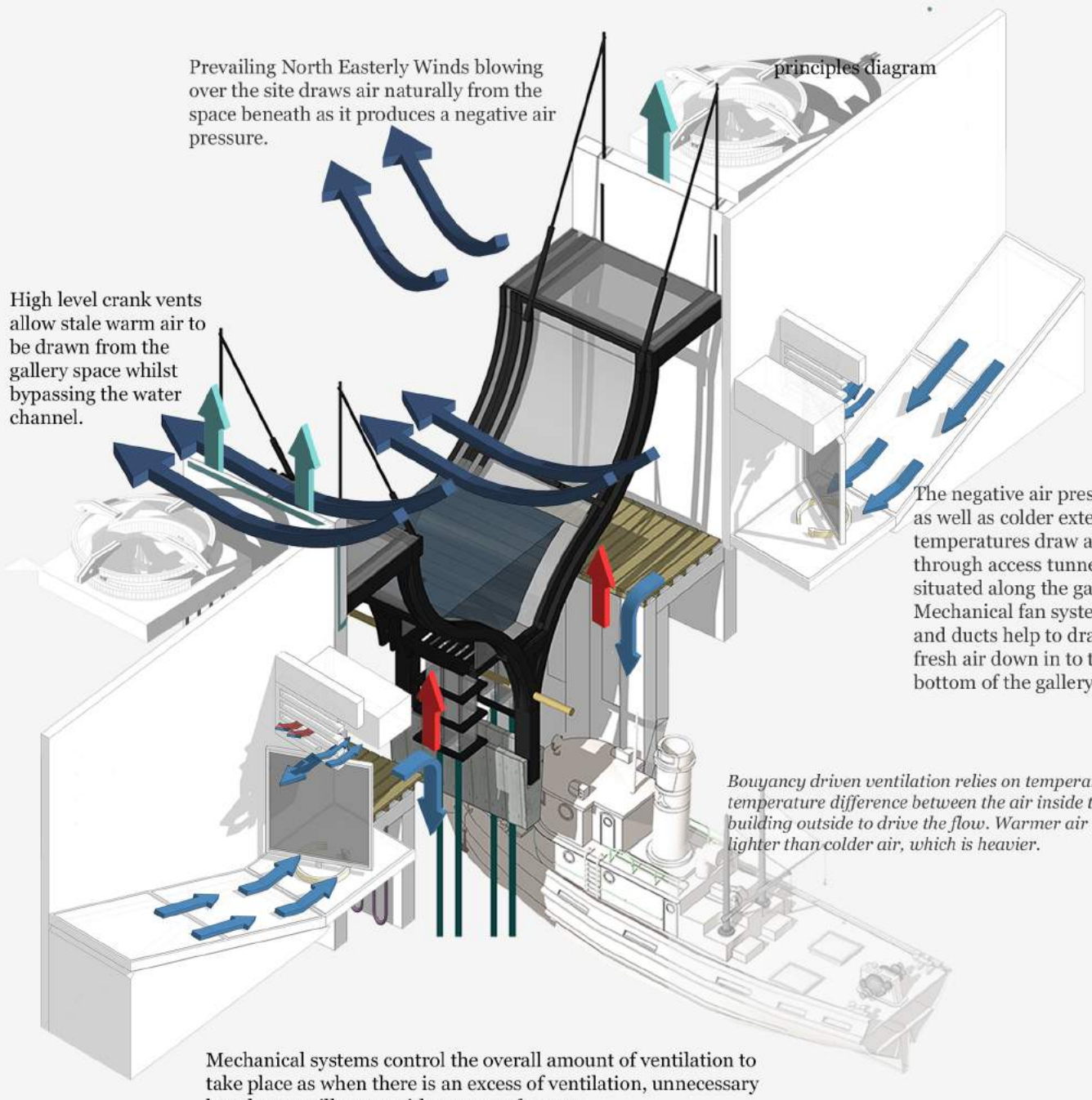




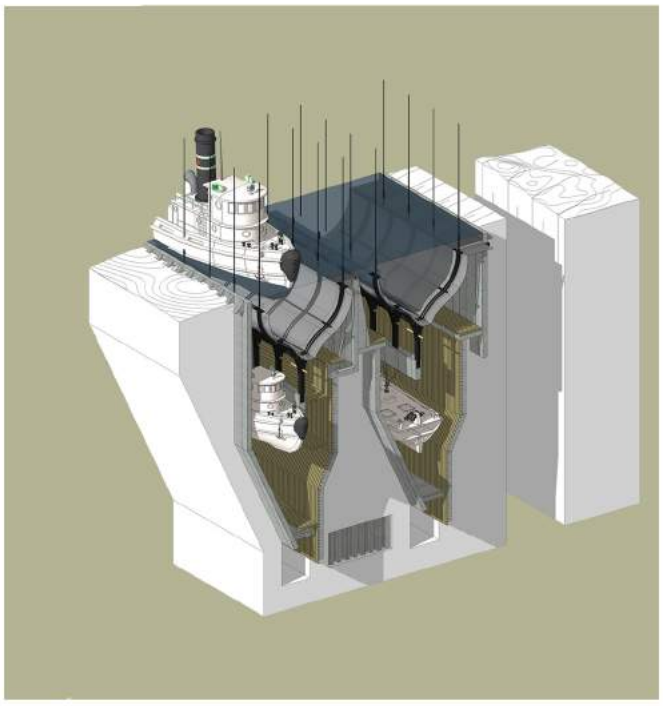
U Value calculations

Lambda value of insulation 0.038 Thickness/Lambda = R value (Thermal Resistance) 0.2/0.038 =5.26	Lambda value of concrete 0.8 Thickness/Lambda = R value (Thermal Resistance) 0.2 / 0.8 = 0.25	0.25 + 5.26 1 / 5.51=0.18

3.07 Temperature and ventilation



Mechanical systems control the overall amount of ventilation to take place as when there is an excess of ventilation, unnecessary heat losses will occur with a waste of energy.



principles diagram

Disadvantages of mechanical ventilation

The disadvantage of mechanical ventilation is that it consumes electricity and cools the air. Therefore, mechanical ventilation should be kept to a minimum of the acceptable levels of indoor air quality.

Providing more ventilation than is really required increases costs. This is because internal 'conditioned' (heated or cooled) air that is removed from a building has to be replaced with the same amount of air from outside. This also needs to be heated or cooled to match the temperature of the building. Besides, moving air around mechanically, using fans uses electricity.

Indoor air quality is important to the occupants of the buildings, comfort. To provide a safe, healthy and comfortable indoor environment, minimum ventilation standards must be provided. This is dependent on the occupancy and functionality of the space. Ventilation provides the following;

Fresh air for respiration, Control of humidity (excess humidity occurs from water vapour in the air – issues arise when there are delicate exhibitions) Provides thermal comfort to occupants, Dilution and removal of airborne pollutants.
The basic standards of ventilation as defined by local authorities are Min. required fresh air – 5l/s per person with a recommended rate of 8l/s per person.

The space will be partly mechanically ventilated as opposed to relying entirely on natural ventilation because of the subterranean position of the gallery which makes it more difficult to draw fresh air into the space. There is however an opportunity to open windows or doors in the case of temperatures rising at a higher capacity.

Ventilation Calculations

Gallery Area 720.00sqm

Total Gallery capacity during peak times will be approximately 100 people at any time.

The Gallery will have 100 people present at any time each producing approx. 100 Watts of energy (most of which is expended as heat). Therefore;

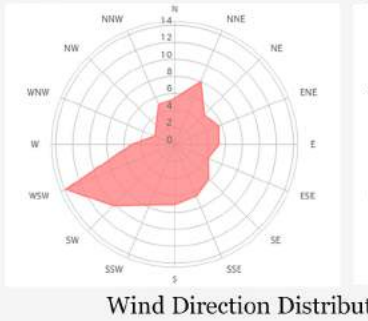
10,000 Watts / 720 sqm = 13.8 Watts per sqm

In order for a room to be cooled solely by natural ventlaton, the space requires openings that cover 5% of the total foor area, on opposite sides. For the restaurant area, the opening will need to be a minimum of 36sqm
Current area of openings = 16.00 sqm (8 access tunnels)

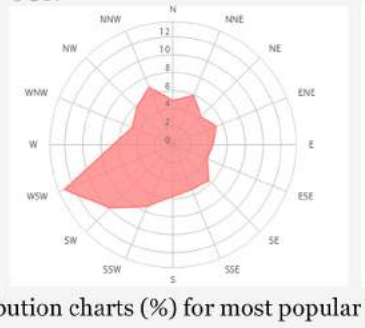
The capacity of 100 people will therefore mean the space will need to rely on suplementary ventilation to produce a comfortable environment.

Month of year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
	01	02	03	04	05	06	07	08	09	10	11	12	1-12
Dominant wind direction													
Wind probability >= 4 Beaufort (%)	31	31	39	43	44	39	35	32	34	32	31	35	35
Average Wind speed (kts)	9	9	10	11	11	10	10	9	10	9	9	10	9
Average air temp. (°C)	-2	0	3	9	14	18	21	20	15	8	4	0	11

MAY

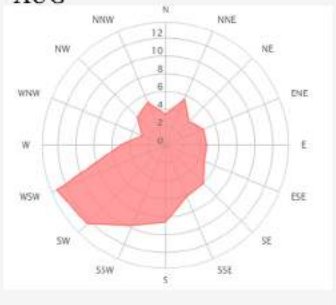


JUN



JUL

AUG

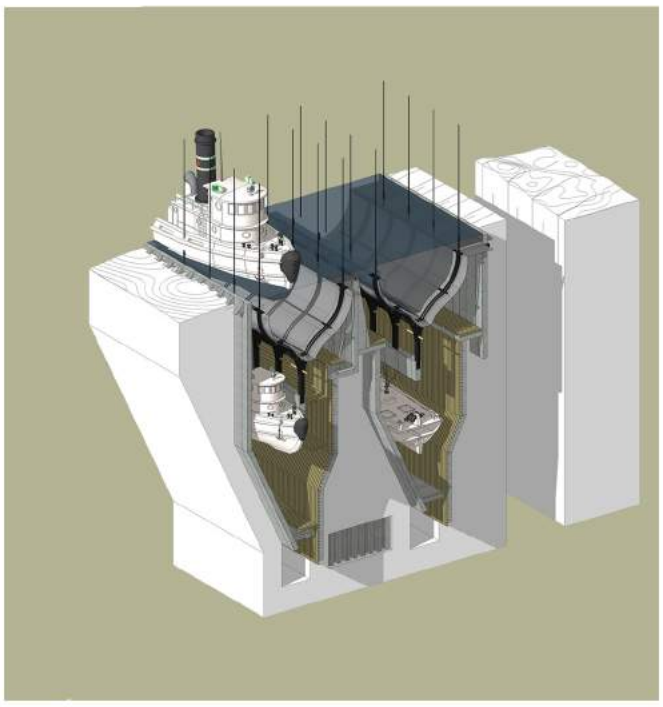


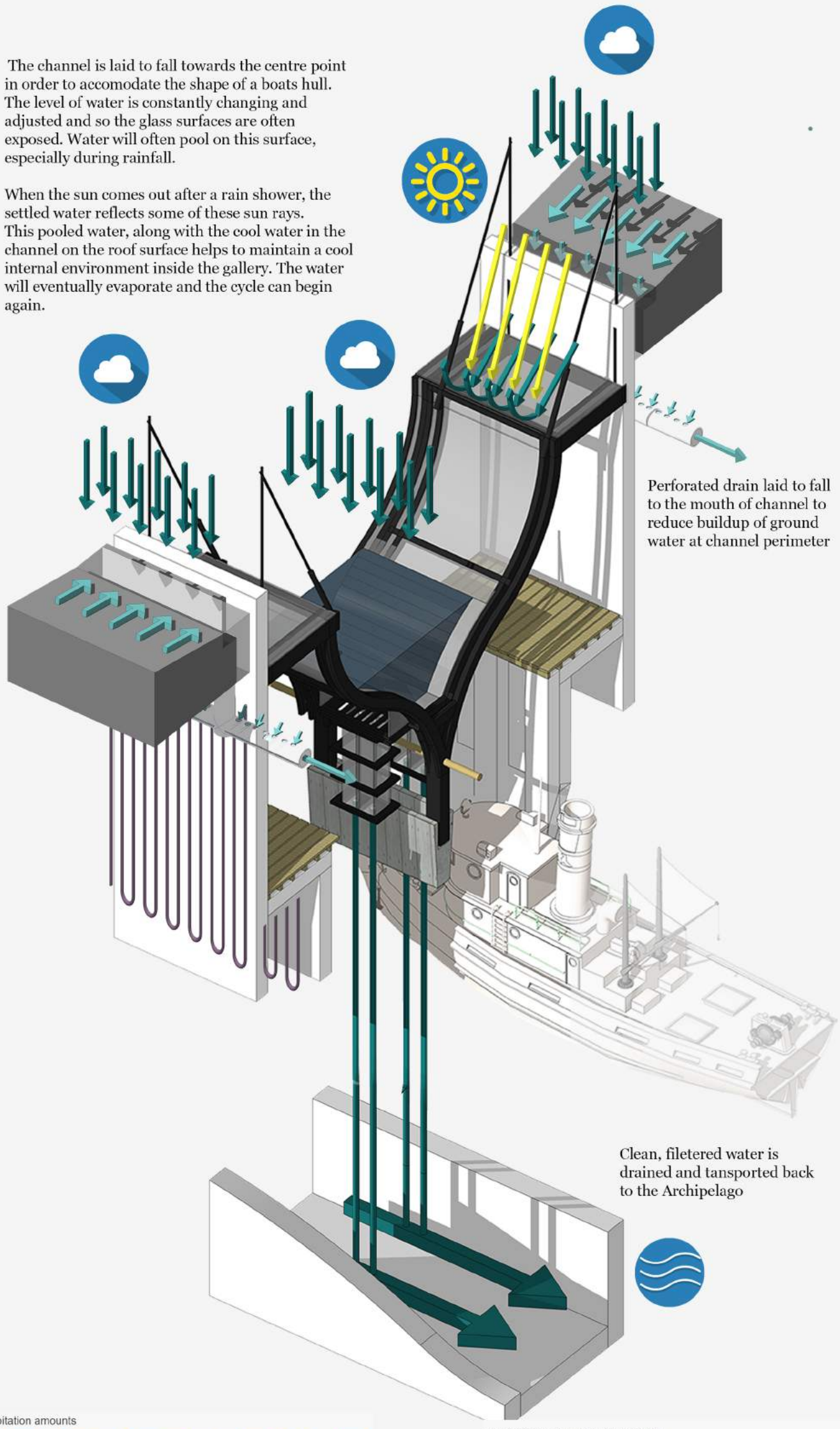
Wind Direction Distribution charts (%) for most popular visitor months

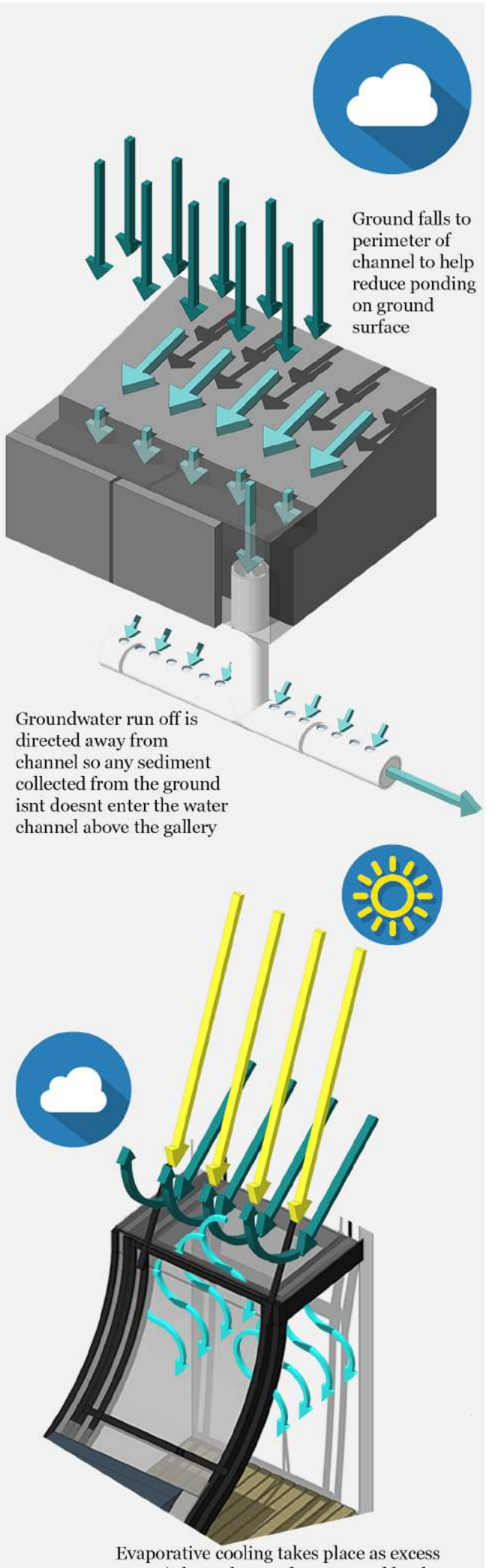
3.08 Environment Rainwater Strategy

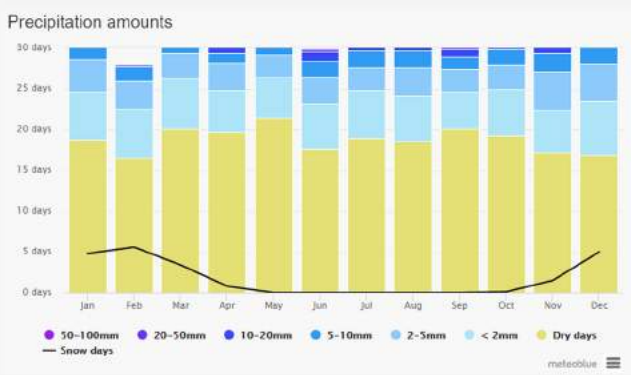
The channel is laid to fall towards the centre point in order to accomodate the shape of a boats hull. The level of water is constantly changing and adjusted and so the glass surfaces are often exposed. Water will often pool on this surface, especially during rainfall.

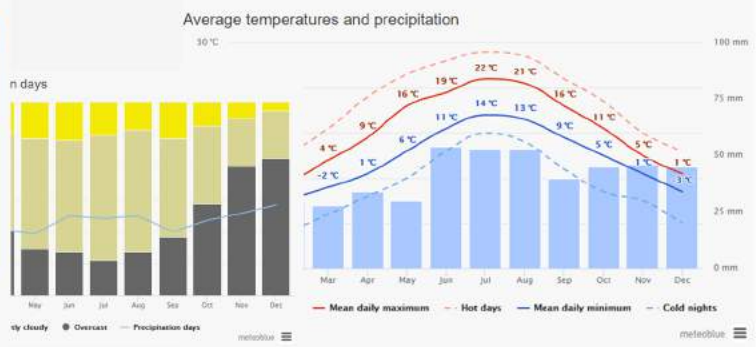
When the sun comes out after a rain shower, the settled water reflects some of these sun rays. This pooled water, along with the cool water in the channel on the roof surface helps to maintain a cool internal environment inside the gallery. The water will eventually evaporate and the cycle can begin again.





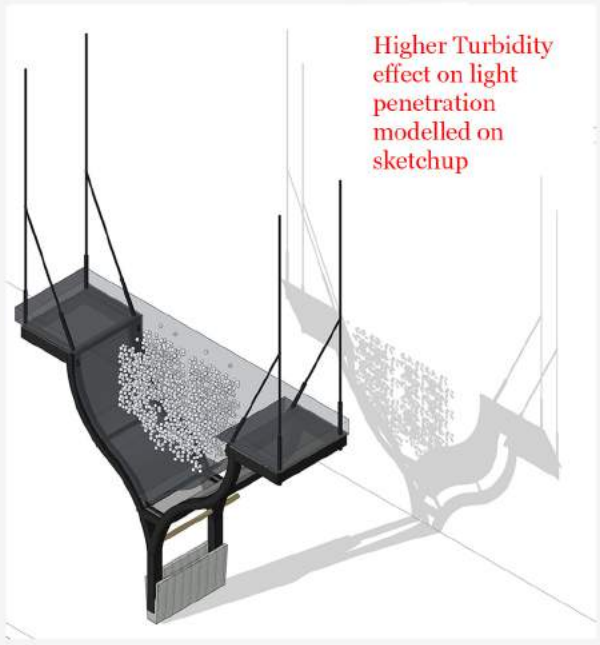




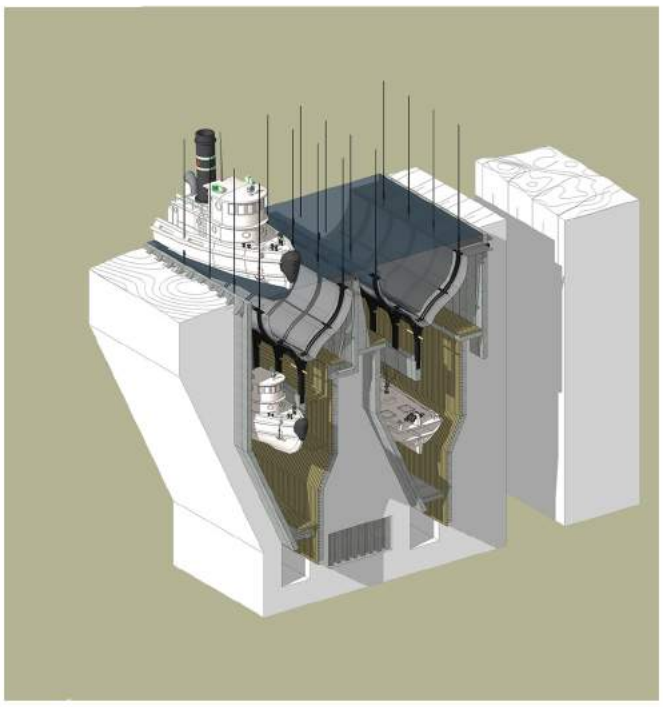


3.09 Environment
Solar Strategy Water Filtration

Lower Turbidity effect on light penetration modelled on sketchup

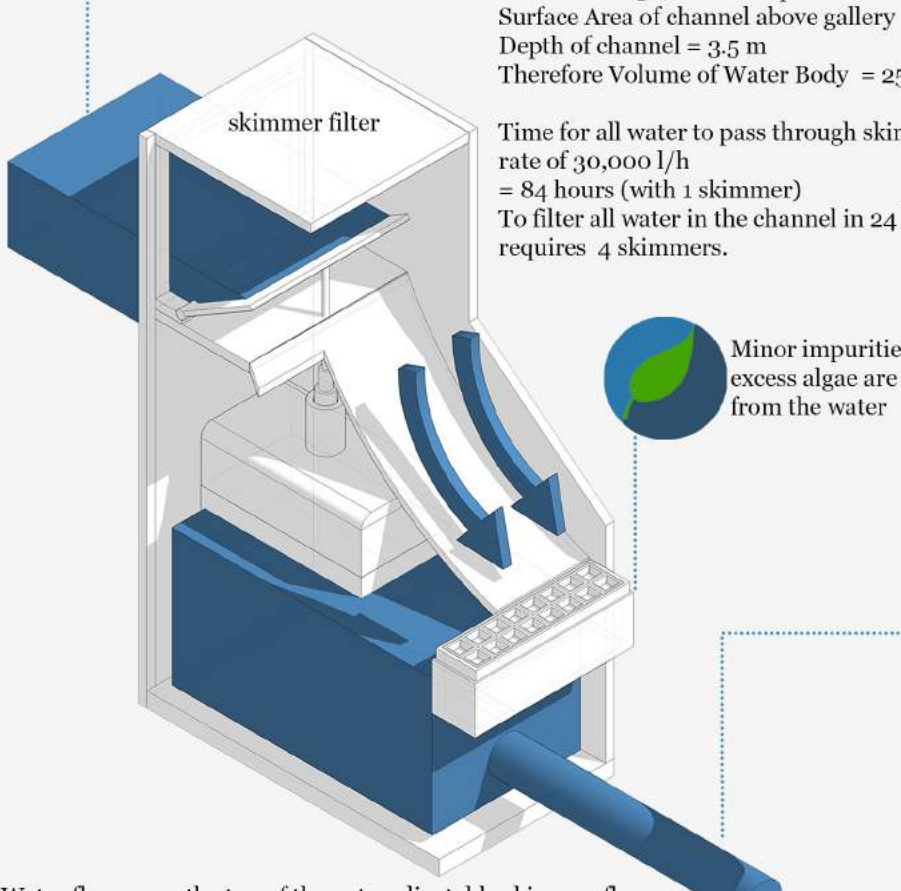


Higher Turbidity effect on light penetration modelled on sketchup



Dimensions, 75mm x 50mm x 100 mm
Max. flow of 30,000 litres per hour
Surface Area of channel above gallery = 720 sqm
Depth of channel = 3.5 m
Therefore Volume of Water Body = 2520m3

Time for all water to pass through skimmer with rate of 30,000 l/h
= 84 hours (with 1 skimmer)
To filter all water in the channel in 24 hours requires 4 skimmers.



Minor impurities and excess algae are removed from the water

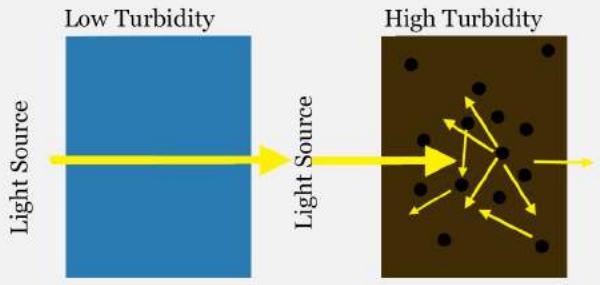
Water flows over the top of the auto-adjustable skimmer flap. This flap is connected to the float guage so its height is automatically adjusted.
The system will only allow the exact amount of water that is pumped out of the filter to enter the filter on the inlet.

Water contaminated with Oil and rust are to be filtered at varying rates during the year. A higher filtration rate will result in the colour of light penetrating into the gallery space to be clearer and the colour balance will deviate towards the blue end of the light spectrum.

During winter a higher rate of filtration will allow more direct sunlight into the space. This will result in a rise in internal temperature and light levels within the spwill be higher and therefore less reliant on artificial lighting.

During the summer the levels of natural daylight are higher and therefore naturally more light will penetrate the gallery space. In order to control internal temperatures and reduce glare within the space the turbidity will be adjusted so a higher amount of solids are suspended within the water. Which in turn will affect the colour.

Rust from the salvaged boats can contaminate the water giving it a Brown, Red, Orange or Yellow appearance. Depending on the varying chemical oxidation states of the metals used and the varying concentrations of the rust in the water. This also will affect the colour of light.



The colour of water is greatly affected by the suspension of particles in it. Its colour is directly affected by the type of solids that are suspended. When a body of water is completely free of suspended solids its clarity would allow light to pass freely through the water. The only limiting factor in this case would be the ability of the water itself to allow light to pass through.

Light wavelengths would be able to penetrate roughly 300ft into a body of completely pure water and the waters appearance would be blue. This is because the last colour of the light spectrum is blue.

In shallower and more turbid water the light at the blue end of the light spectrum is not absorbed into the water very far giving the water a blue appearance. However as the body of water is at its deepest in the channel is 3.5 meters the type of silt within the the water has the greatest effect on the colour of light that passes through.

The differences in colour are therefore based on the depth that specific light can penetrate without being fully absorbed but also the type of silt the water carries. These are both aspects that can be adjusted wthin the scheme to control colour of light in the gallery space beneath.

Typical water colour dependant on the type of solids within water

Green - abundance of algae

Yellow - due to clayey turbidity

Brown - abundance of diatoms

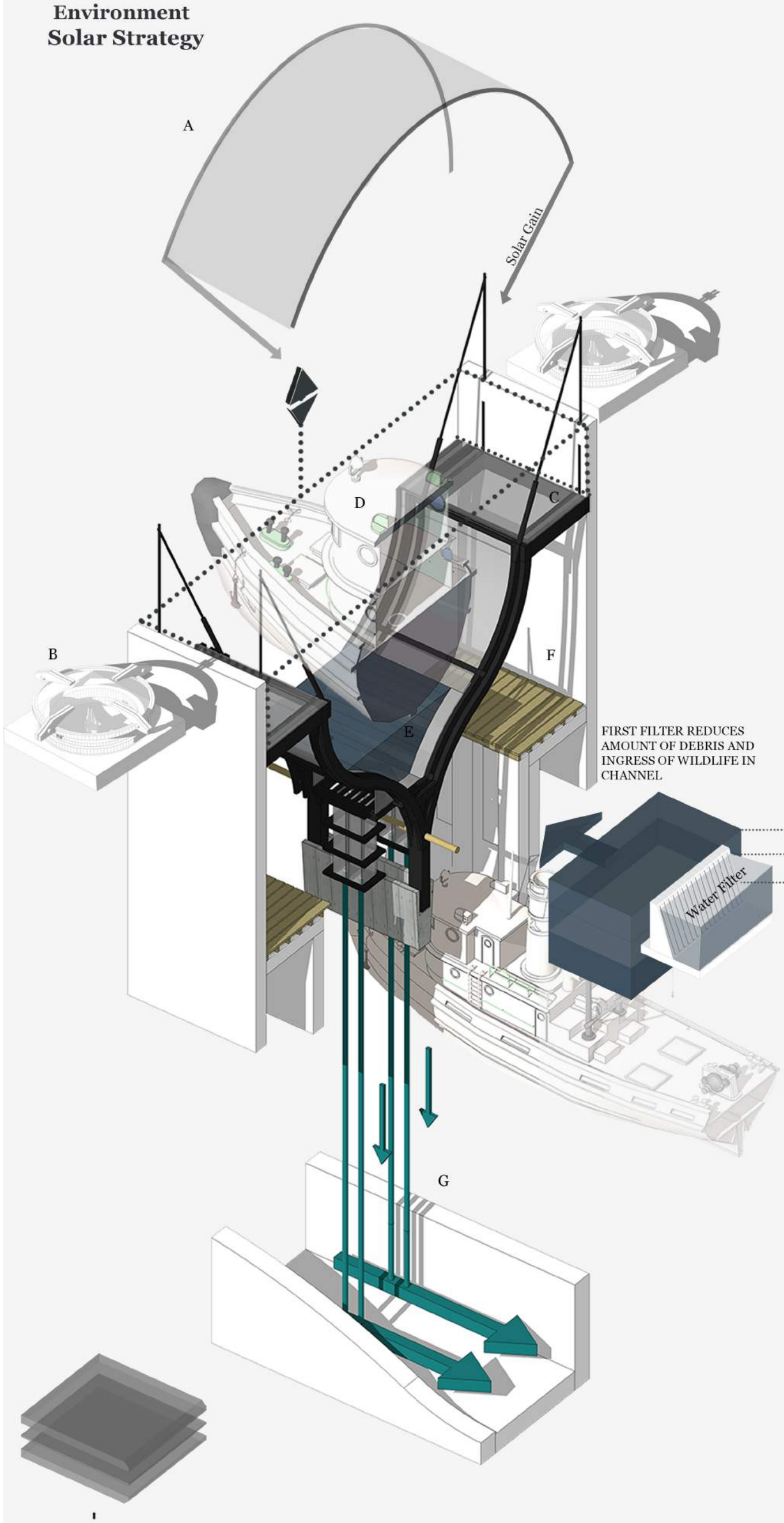
Ferrous metals -

The colour of turbid water (based on type of suspended matter rather then water depth) can therefore be adjusted through different levels of filtration.

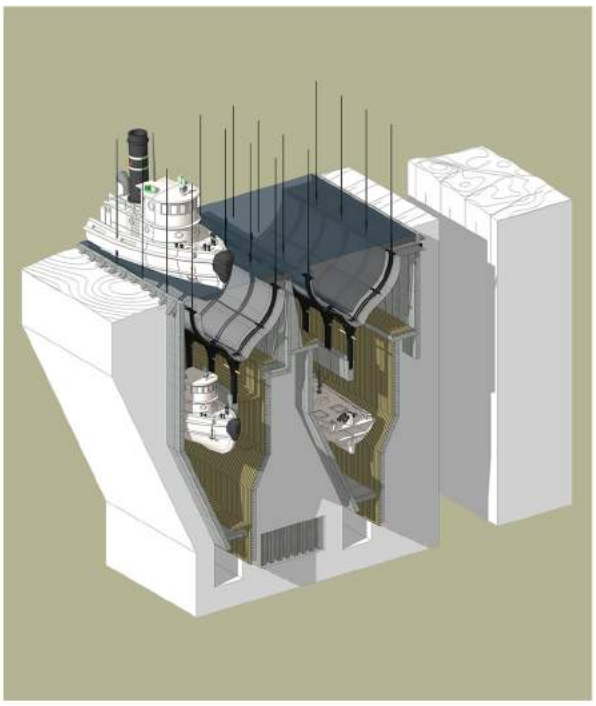
As salvaged boats are leaking oil into the body of water oil is to be considered as it will affect the ability of the light to penetrate the water.

With oil - a thick film is produced on the water surface. This is because oil is hydrophobic and therefore floats above water. So the lightin this instance reflects upwards from the top of the film and also the underlying interface between the oil and the water. Stopping almost all of the light penetration into the water. This is therefore also to be filtered in order to control light penetration.

3.10 Environment Solar Strategy



Distortion - Glasses refraction index is different from that of water. So as the light passes through the air, glass and then water to get reflected back from the hull of a ship through them both a second time, the light is bent four times. Each time the light is bent it is distorted. This can play with the colour, position and scale of the origional image.



Turbidity is the cloudiness of a fluid caused by the suspension of particles within the fluid. These particles are generally invisible to the naked eye however they can cause the opacity of water to decrease, this will directly affect the amount of light that is able to pass through the water. Turbidity is usually used as a test of water quality. The existing turbidity of the Archapeagos water is utilised in the scheme throughout different times of the year depending on the strength of the natural daylight.

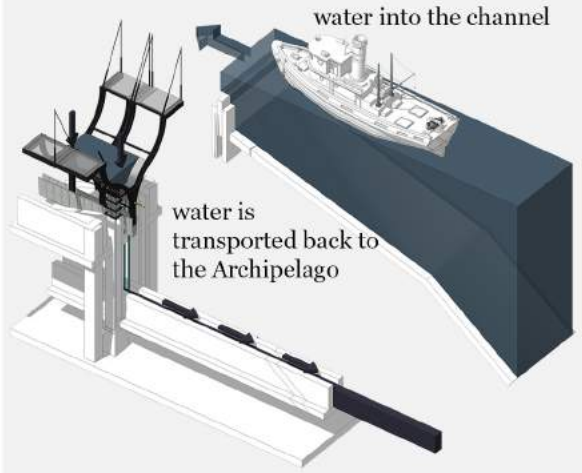
This is controlled initially by the light sensing device that controlls the level of water in the water channel. By draining water along the channel water can be drawn in at the channel source and the rate at which this water is drawn in effects the rate of filtration. So this rate is adjusted throughout the year to maintain a stable level of glare and heat within the space below counteracting the changing nature of the seasons.

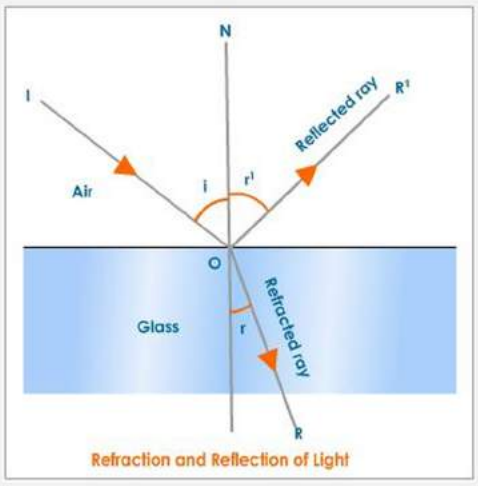
Low Turbidity - Clearer water - More Solar Gain
Useful in winter months

High Turbidity - Darker/Cloudier water - Less Solar Gain
Useful in summer months

Turbidity is used to determine the concentration of suspended particles in a sample of water by measuring the incident light scattered at right angles from the sample.

Dam system controls the amount and flow - rate of water into the channel





3.11 Environment
Solar Strategy Water Filtration

Despite light being essential for viewing exhibits, it can also damage sensitive items within the gallery. Light can damage pigments within materials causing fading in the exhibited boats or change of appearance. It can even cause damage to already sensitive materials. Light is expressed in wavelengths, with natural light starting with a wavelength of 300nanometers(this is the minimum wavelength able to penetrate the atmousphere. The light spectrum can be divided into 3 main groups (see the table below)

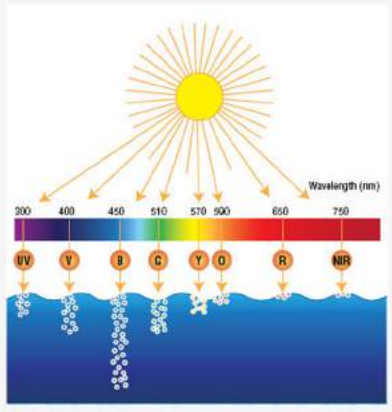
The light between 400 and 760nanometers is visible light that our eyes are able to see as the spectrum of colours visible in a rainbow.

Wavelengths shorter than 400nanometers are UV radiation. This radiation is not visible to the human eye, this shortest wavelength is the most damaging.

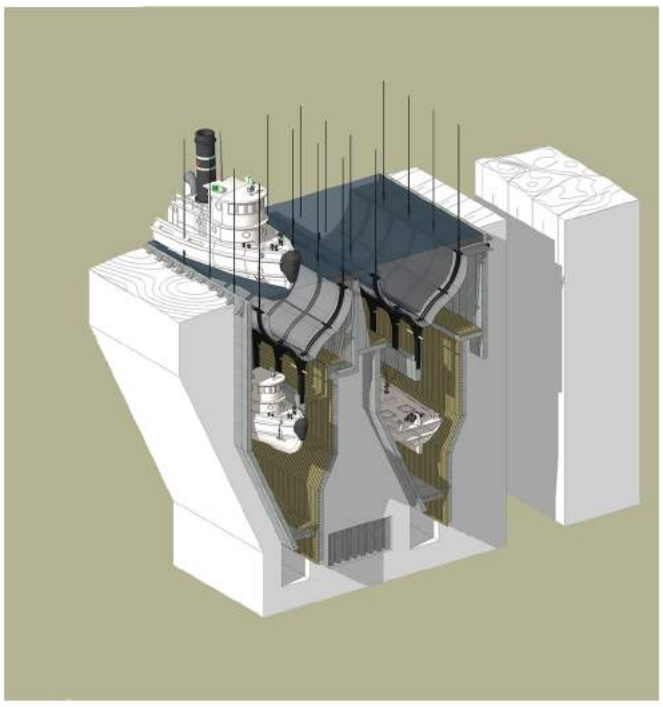
Wavelengths longer than 760 are classed as Infa-red radiation and is felt as heat.

It is therefore important to reduce non visible light - particularly UV light. This is the job of the body of water as UV and Infared lights penatrative ability of water is lesser than that of light with different wavelengths.

So to eliminate non visible radiation the body of water is kept at a depth during times where light levels are highest - to a maximum. Giving the Gallery a blue hue (blue light having the highest penatrative ability in water.

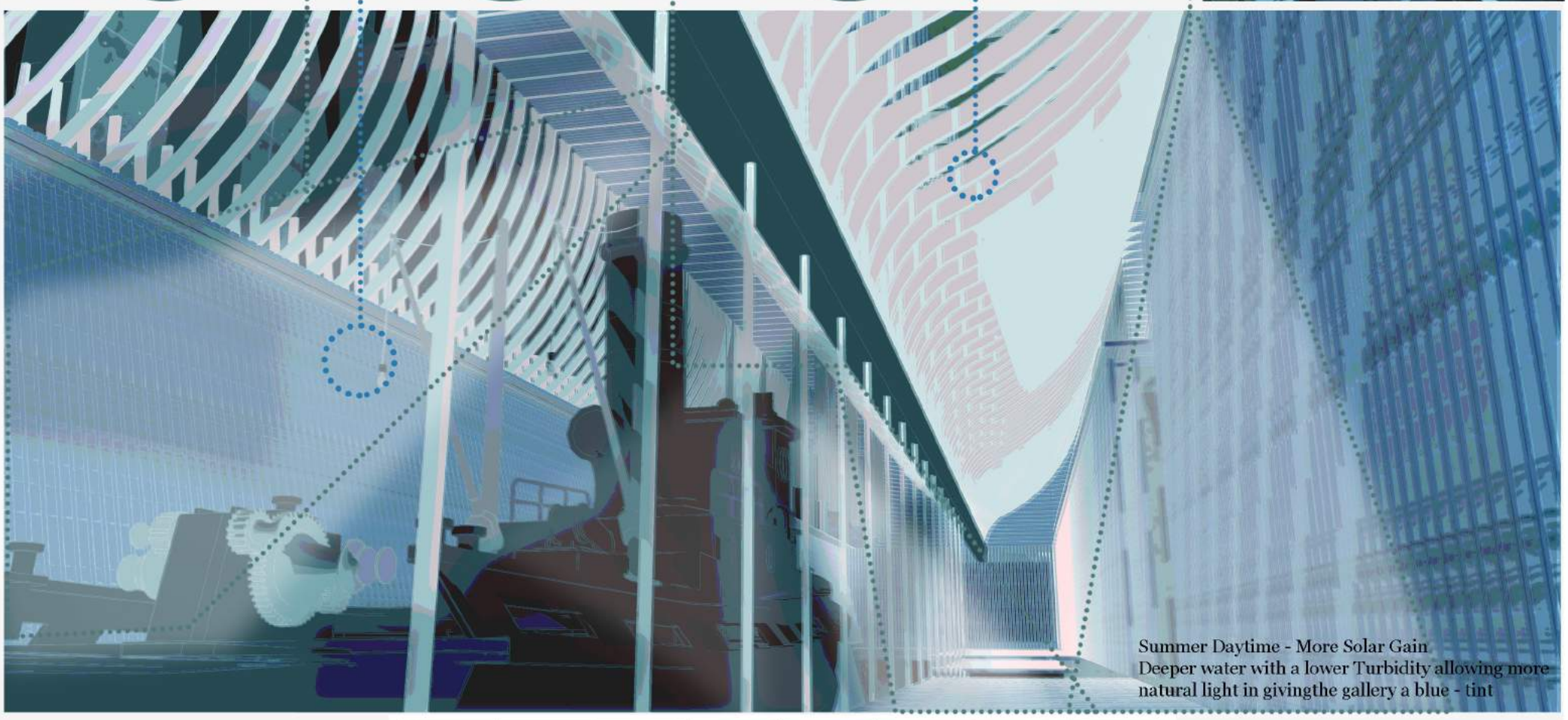


This shows the spectrum of light and its penatrative ability in water. This will be relevant within the channel above the gallery space as the penatrative depths will be reduced with Turbidity. Making the 3.5m deep channel have a strong effect on the internal environment.

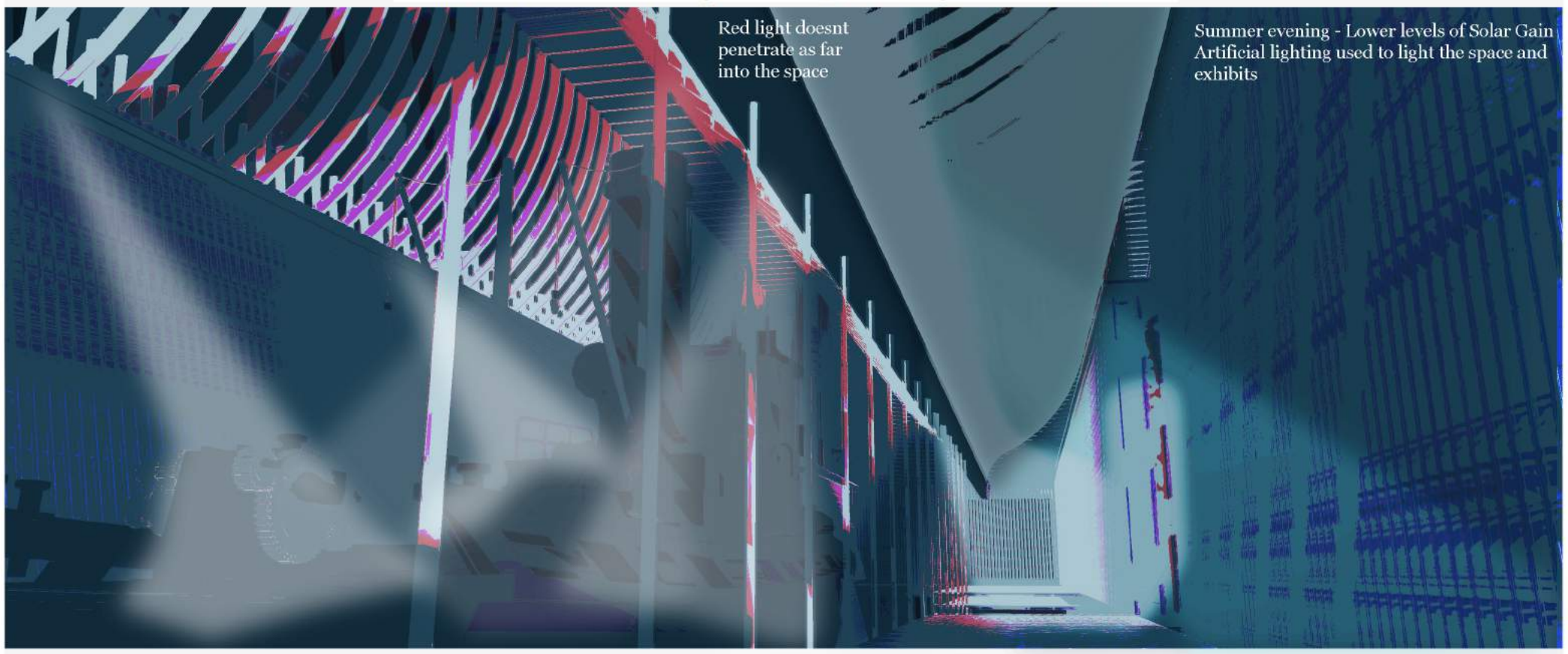


Artificial lighting supplementing the overall lighting making a comfortable environment. Focusing on the exhibitions to provide visual focal points.

High levells of solar gain



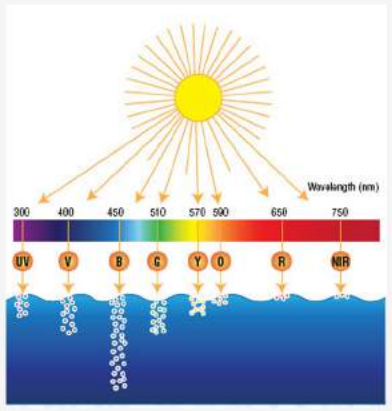
Summer Daytime - More Solar Gain
Deeper water with a lower Turbidity allowing more natural light in givingthe gallery a blue - tint



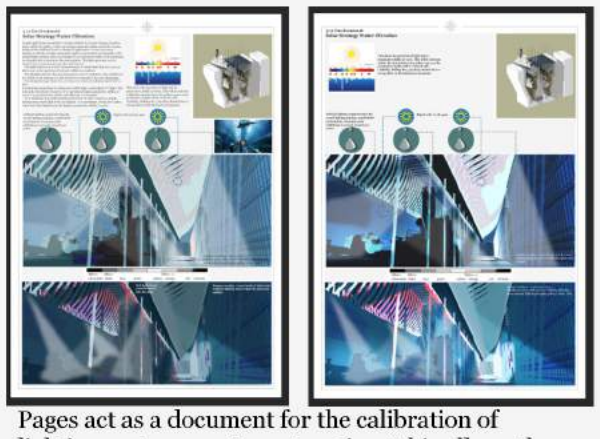
Red light doesnt penetrate as far into the space

Summer evening - Lower levels of Solar Gain
Artificial lighting used to light the space and exhibits

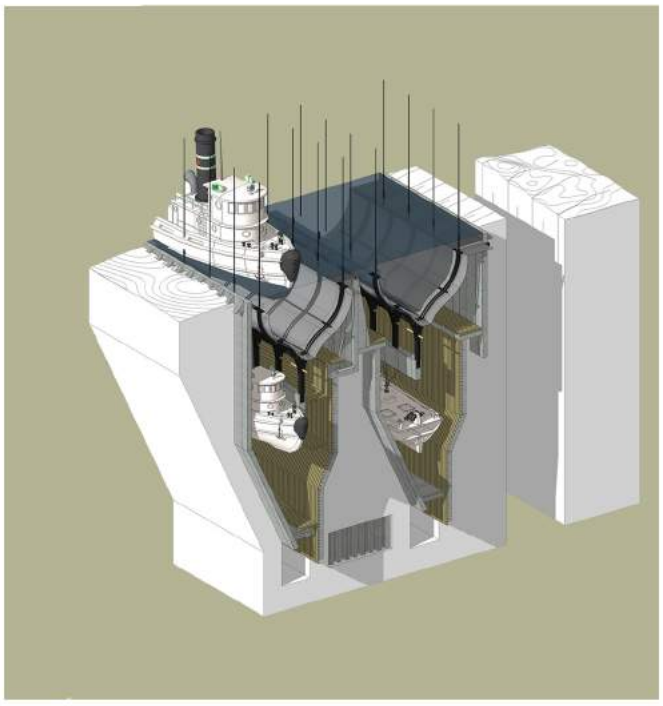
3.12 Environment
Solar Strategy Water Filtration



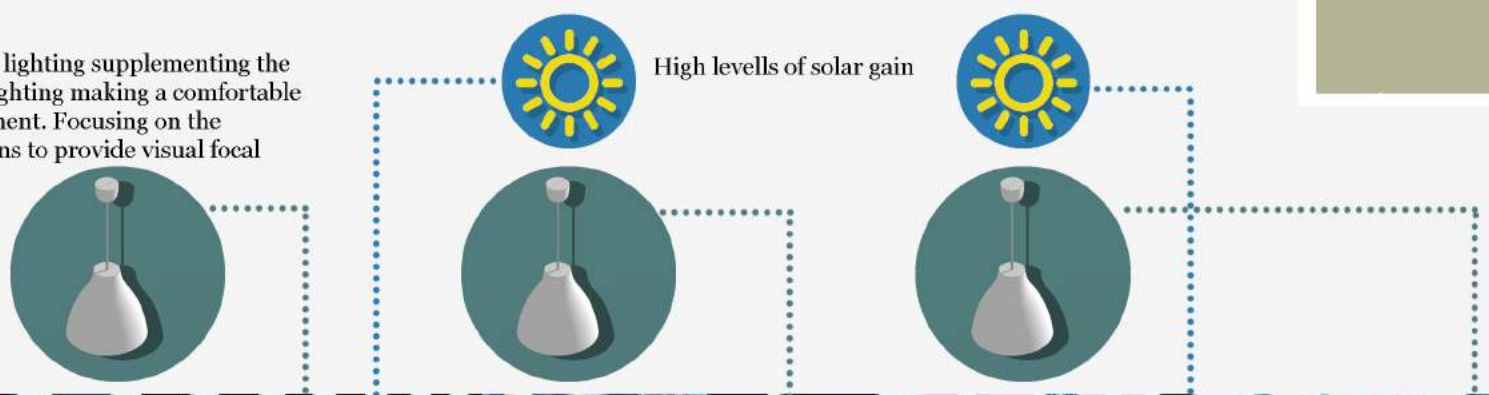
This shows the spectrum of light and its penatrative ability in water. This will be relevant within the channel above the gallery space as the penatrative depths will be reduced with Turbidity. Making the 3.5m deep channel have a strong effect on the internal environment.



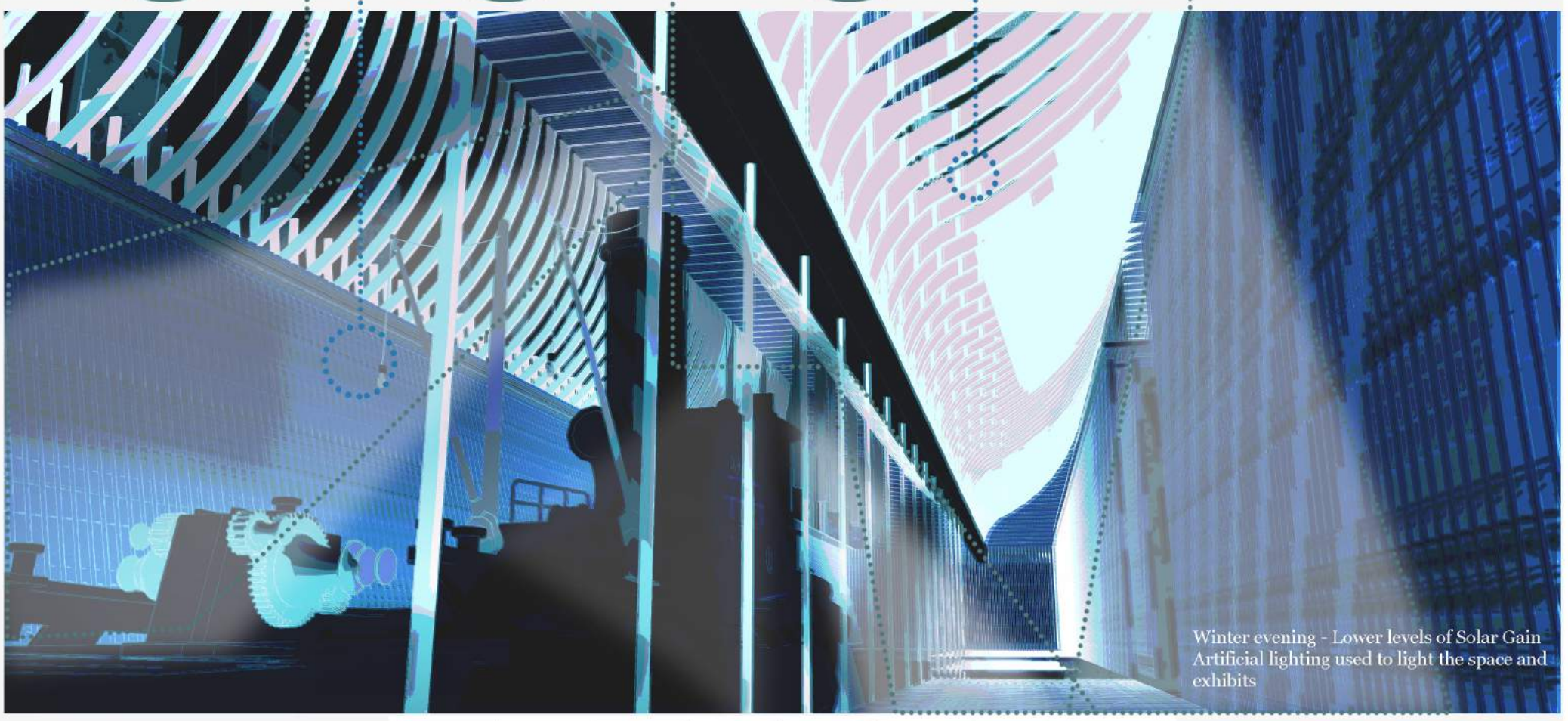
Pages act as a document for the calibration of lighting systems post construction. This allows the internal spaces to be tweaked to optimise the internal environment as per the visual mock up.



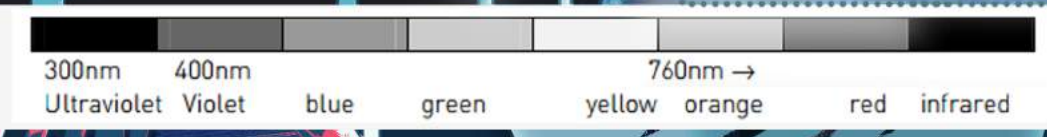
Artificial lighting supplementing the overall lighting making a comfortable environment. Focusing on the exhibitions to provide visual focal points.

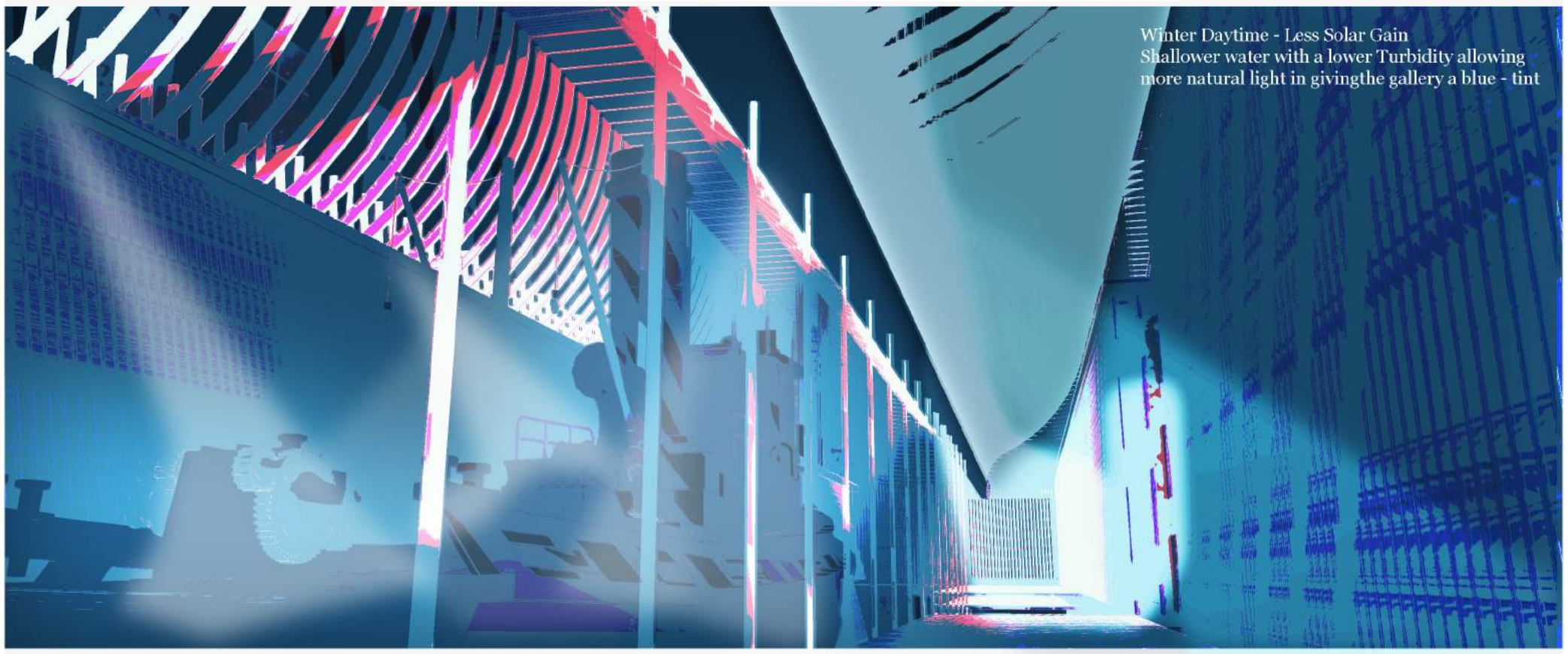


High levells of solar gain



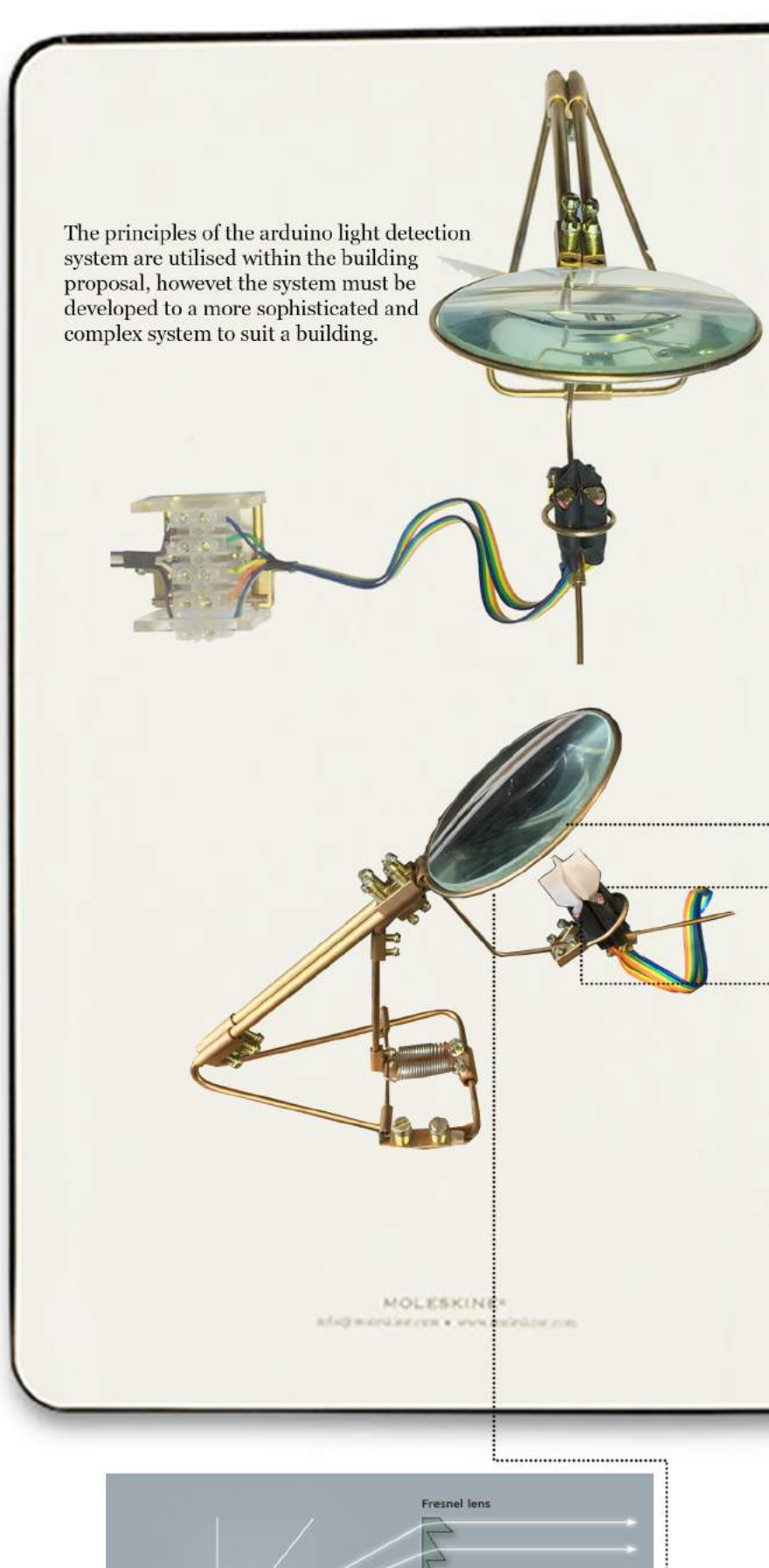
Winter evening - Lower levels of Solar Gain
Artificial lighting used to light the space and exhibits



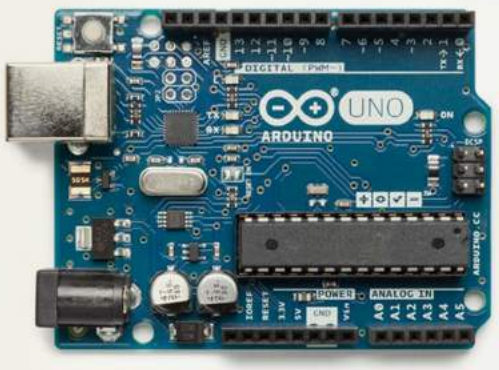


Winter Daytime - Less Solar Gain
Shallower water with a lower Turbidity allowing more natural light in givingthe gallery a blue - tint

3.13 Environment
Arduino Development



The principles of the arduino light detection system are utilised within the building proposal, howevet the system must be developed to a more sophisticated and complex system to suit a building.



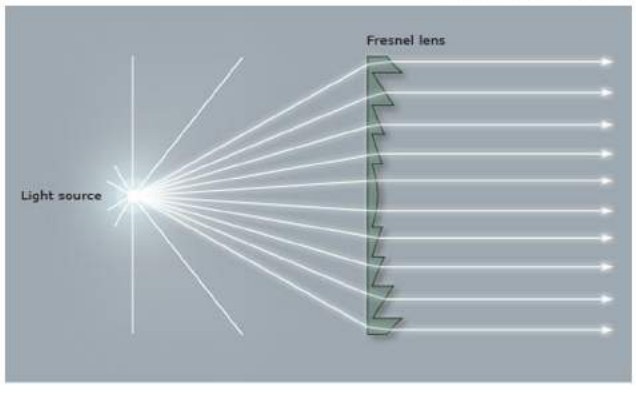
The Arduino board is a simple way of producing a set of commands used in the physical testing. The application of the system within the building would need a system that is more sophisticated and reliable. The system wouldn't necessarily be entirely digital as the analogue nature of the system produces movement within the gallery space that effects the experience of the museum guests.

Issues with scaling up the solar tracking device.

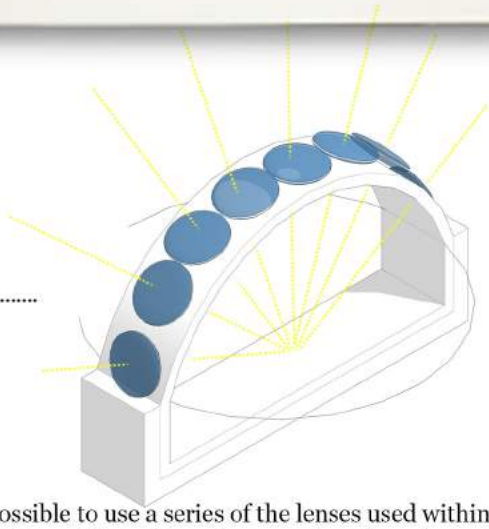
As the lense is scaled up the strength of the lense needs to be restricted in order to not damage the solar resistors

The LDRs will need to be replaced with a more sophisticated and reliable light sensor

The number of light sensors will increase, which will provide a more accurate reading of light direction (compared to the current responsivity in 4 directions)

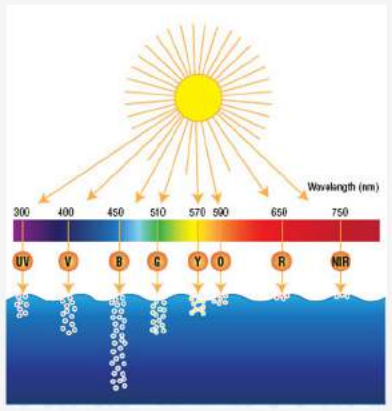


By reversing a fresnal lense directional light can be focused on a specific point. These lenses can be positioned in different directions and so the highest lux. levels recorded will be picked up by the smart system and the building will respond accordingly.

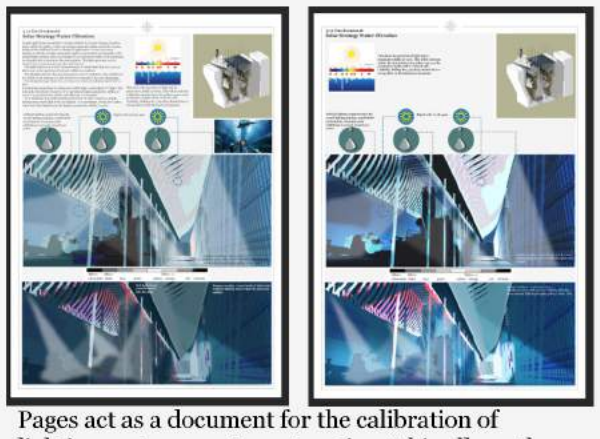


It is possible to use a series of the lenses used within the physical testing. They will need to make up larger network as shown below. This proposal shows a section through a domed configuration of lenses which focuses the natural daylight in the center.

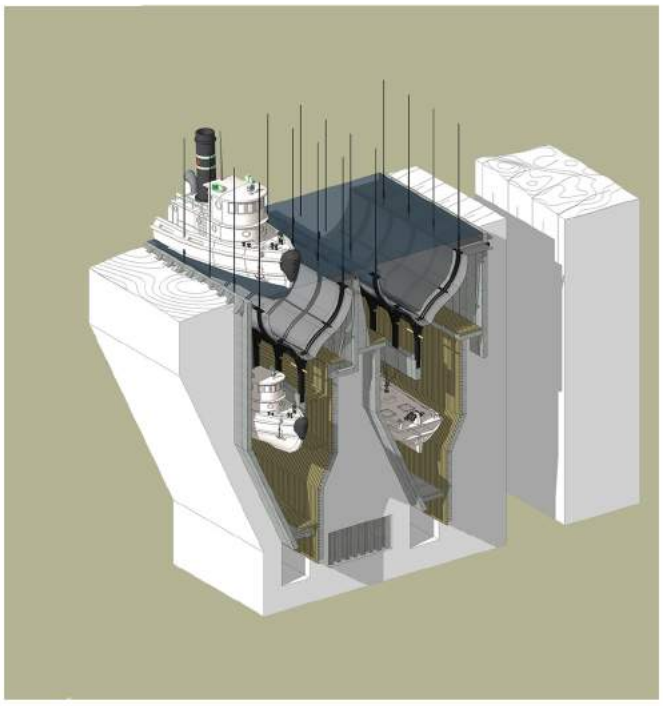
3.12 Environment
Solar Strategy Water Filtration



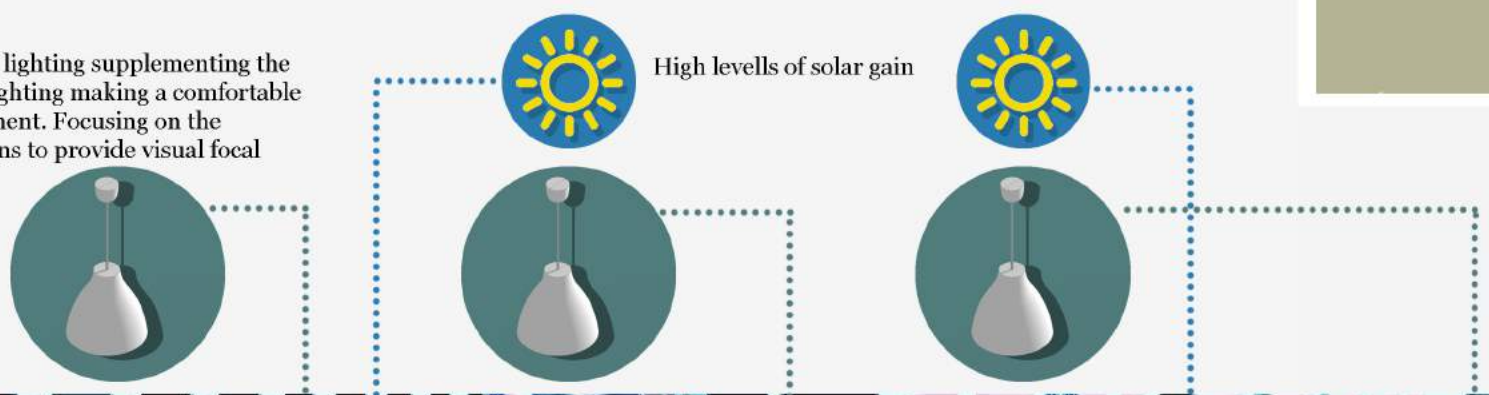
This shows the spectrum of light and its penatrative ability in water. This will be relevant within the channel above the gallery space as the penatrative depths will be reduced with Turbidity. Making the 3.5m deep channel have a strong effect on the internal environment.



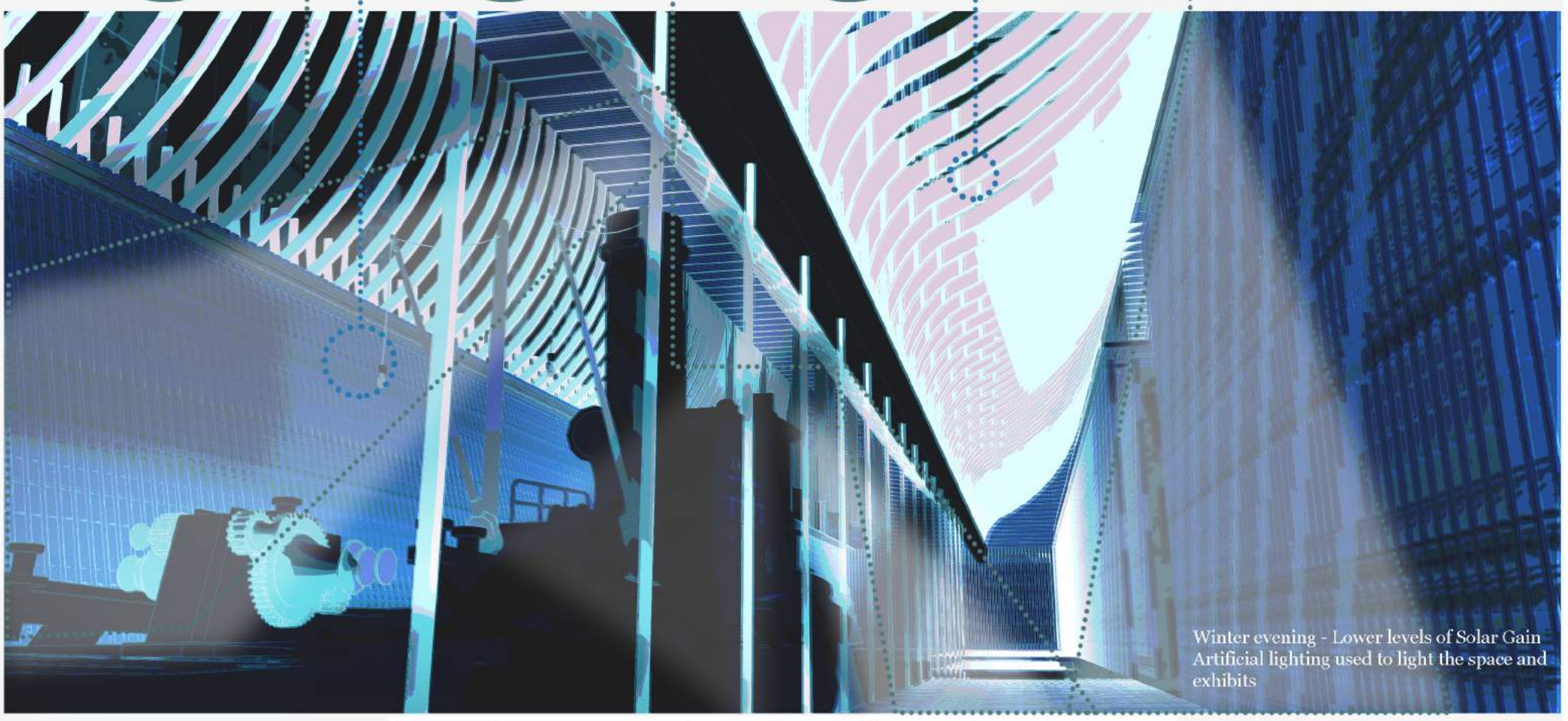
Pages act as a document for the calibration of lighting systems post construction. This allows the internal spaces to be tweaked to optimise the internal environment as per the visual mock up.



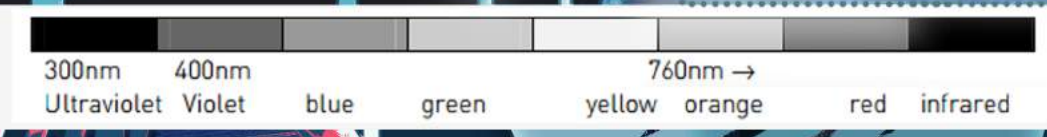
Artificial lighting supplementing the overall lighting making a comfortable environment. Focusing on the exhibitions to provide visual focal points.

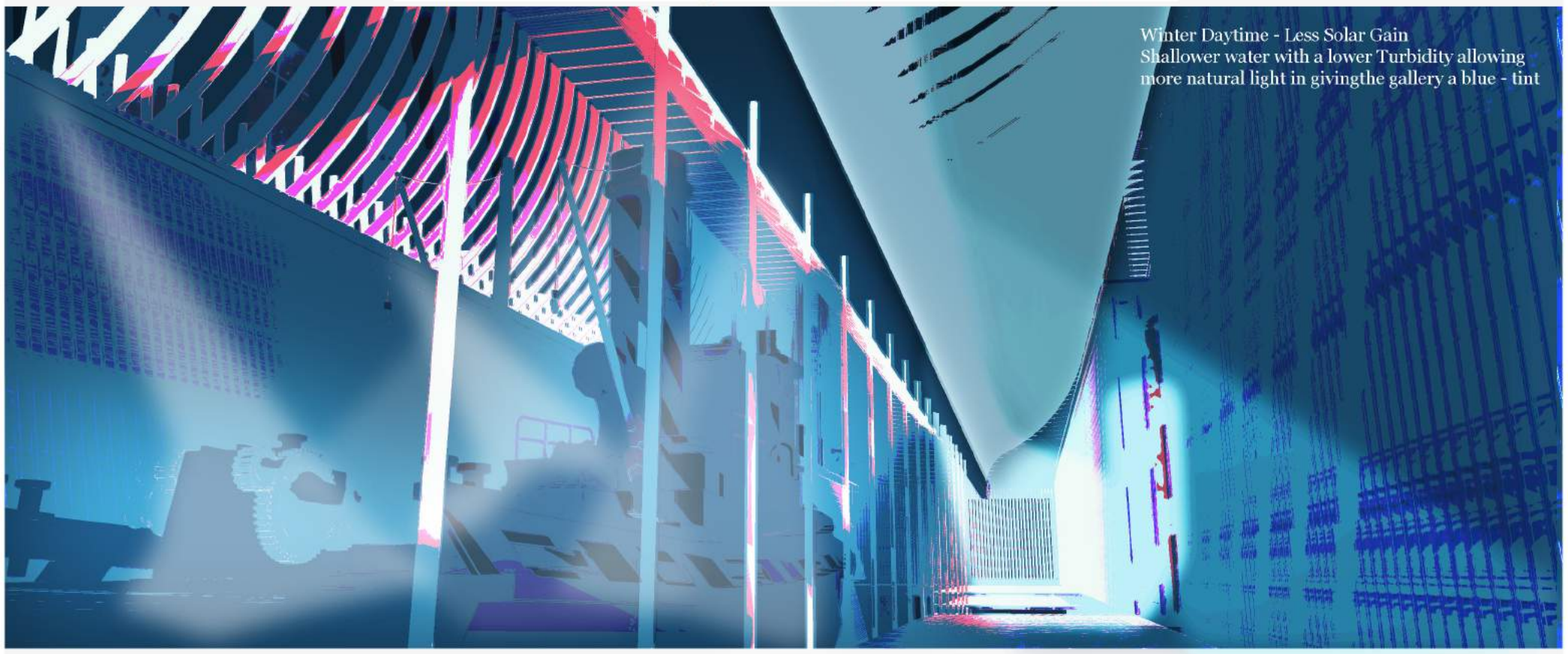


High levells of solar gain



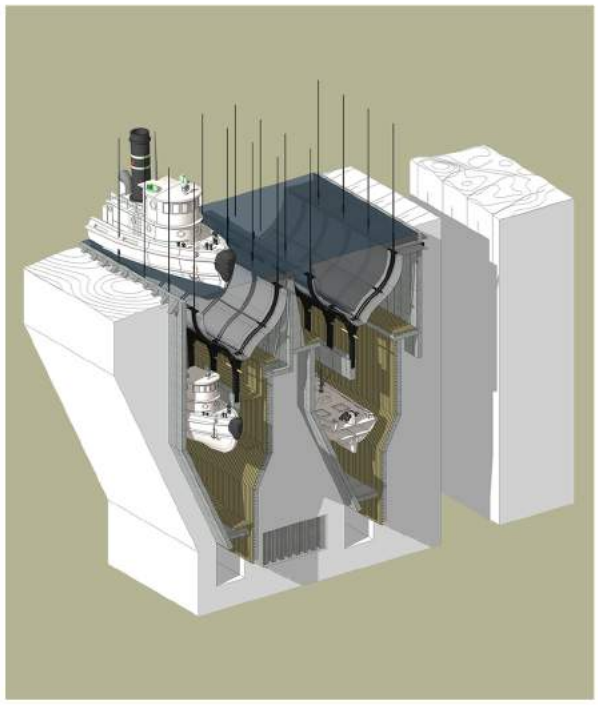
Winter evening - Lower levels of Solar Gain
Artificial lighting used to light the space and exhibits





Winter Daytime - Less Solar Gain
Shallower water with a lower Turbidity allowing more natural light in givingthe gallery a blue - tint

4.01 BUILDING DELIVERY
Delivery and Building Parameters



LOCAL CONTEXT OUTLINE, DELIVERY + BUILDING PARAMETERS
CLIENT ORGANISATION

The Swedish National Maritime Museums (SNMM) will be the client. A government agency under the directive of the Swedish Ministry of Culture who will approve the project and budget. SNMM also runs the Vasa Museum, Maritime Museum and Naval Museum. A supervisory board of elected individuals from the SNMM group and representatives from the Ministry of Culture and Swedish environmental protection agency will approve the development. Ensuring the project addresses and meets the national environmental and cultural objectives.

PROJECT Environmental AIMS + cultural GOALS

The project aims to preserve Sweden's rich national maritime cultural heritage and to provide a platform for people to appreciate its legacy. The environmental issues remain core to the ethos of the museum, and the proposal will help with the governments environmental objectives to preserve Stockholm's marine environment and create a flourishing coastal area.
It will aim to do this by providing a facility to dispose of old boats and remove toxic wrecks from the archipelago that are contaminating the natural environment and causing harm to biodiversity. The wrecks will be salvaged and then placed in the museum to exhibit otherwise lost treasures of Sweden's rich maritime heritage.

ROLE OF THE ARCHITECT

- Formally advise client of their duties/responsibilities
- Take on role of Principle Designer
- Advise client on specialist contractors
- Development of brief advising the client on the proposed scheme design
- Consulting with maritime specialists to define scheme parameters.
- Examining the site conditions and Coordinating Consultants
- Collate specialists' documents and reports
- Undertaking a feasibility study within parameters defined from measured survey drawings and specialists reports
- Preparing sketch plans for approval from local authority
- Applying for Planning Permission
- Provide services in connection with any planning appeals that may arise
- Preparing preliminary specifications
- Work up drawings to a standard required to meet building regulations requirements
- Provide the contractors with construction drawings and specification
- Upon completion provide as built and health and safety documentation to the client

ROLE OF THE CLIENT

- Ensure suitable management arrangements are in place for the project
- Select and appoint a competent Principal Designer (Architect)
- Select and appoint a competent Principal Contractor and Specialist Contractors
- Oversee budget and brief concerns
- Notify the relevant authorities of the project
- Ensure provisions of time and resources are provided for each stage of the project
- Provide suitable welfare facilities prior to construction
- ensure that contractors are provided with the necessary

The Design Team + Specialist contractors
The consultants necessary for the project will include

- Cost consultant.
- Mechanical and electrical engineer
- Structural engineer.
- Access consultant
- Approved building inspector
- Archaeologist
- Civil engineer
- Construction manager
- Contract administrator
- Ecologist
- Environmental consultant
- Fire engineering consultant
- Fixtures and equipment consultant
- Health and safety consultant
- Hydrologist
- Landscape architect
- Local consultants with specialist knowledge of local practices and procedures
- Lighting designer
- Planning consultant
- Public health consultant
- Quantity Surveyor
- Security consultant
- Site inspector
- Specialist contractor for excavation and building envelope
- Specialist contractor for sensitive interior spaces
- Surveyor
- Transport engineer

Prior to the project starting it is vital that the design teams are well coordinated and structured. The design team may change throughout the project however the structure of the project will remain in line with

Appointment of the Architect

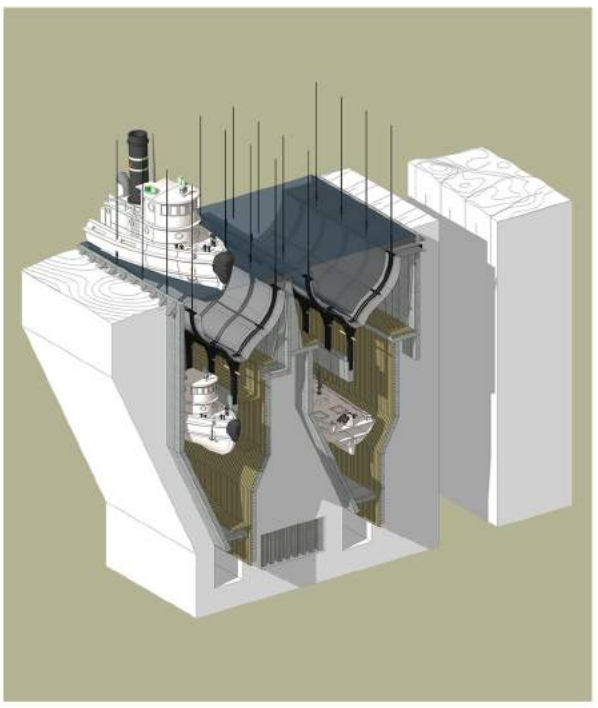
As the project is Government funded, the architect would be appointed following a tender procedure. The successful design and construction team would be chosen from a pre-qualified short listing process. They would need to meet European Union requirements and be the successful candidate in a design competition with a competitive tender price. The architect is responsible for ensuring the design team and expert specialist consultants work within local building regulations professional practice. The architect will provide onsite supervision at every stage of the project.

STAKEHOLDERS

The major stakeholders will provide the funding for each stage of the project. These are the Swedish Ministry of Culture and Swedish environmental protection agency who provide funding for projects that work towards the environmental objectives that the government wish to address by 2020.

Governments Environmental objectives

4.02 BUILDING DELIVERY
Health and Safety



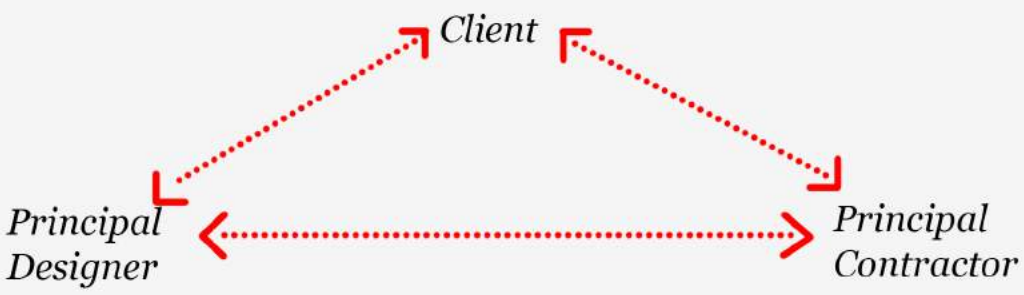
Building Delivery/Health and safety
CDM REGULATIONS - DESIGNING OUT RISK
The Construction (Design and Management) Regulations 2015 are a set of legal documents outlined by HSE (health and safety Executive). They are designed to govern the way all building projects are planned and undertaken irrespective of size to ensure the health and safety of those involved in the construction industry. The document aims to improve health and safety by helping plan the works so risks are identified and managed from start to finish.

RISKS MANAGEMENT – NEW ROLE OF THE ARCHITECT

As previously mentioned, the Architect will take on the role of Principle designer. The principal designer has control over the pre construction phase of the project. This will be the case because the Architect has
- a sound technical knowledge of the construction industry
- understands the skills to manage and coordinate the preconstruction phase

Although the client has overall responsibility for the successful execution of the project, the principal designer and principal contractor will take lead on different phases of the project.

The principal designer and contractor are key in coordinating health and safety so its important a good working relationship is established.



The project will require a summary of potential risks to the construction crew for the entire duration of the project and its use afterwards. The following list identifies risks and defines the control methods that are to be undertaken.

Identify the Hazard(s):
Using the list of hazards supplied tick all those that apply to your design specification; remember to include any potential risks to construction workers, setting crews, production staff, performers, audiences or members of the general public.

Assess and Control the Risk:
Complete the full risk assessment by adding in the control methods needed for each hazard identified. If you have additional hazards which are not identified in the list of hazards supplied, add these together with the control measures needed onto the last page of this document

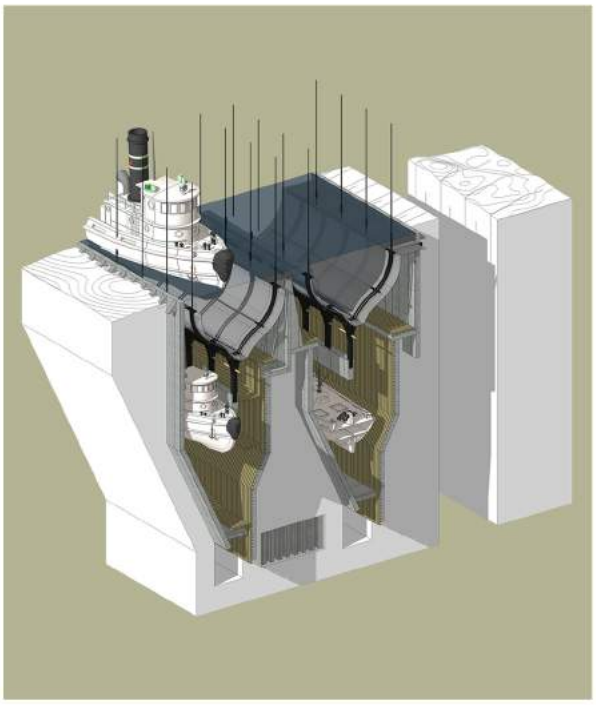
Existing Site

Task/Activity	Identify Hazard	Control Measures undertaken
Investigation Work	Risk of drowning – As site is located on waters edge	Anyone undertaking investigations by boat or at water's edge must be supervised by experienced professionals in suitable weather conditions.
		The coastguard is notified of the work and correct PPE is provided and worn correctly.
	Collapse of unstable Rock outcrops	No one can walk on areas of unstable ground. If its necessary correct ppe is provided and worn correctly.
Excavation	Collapse of Excavated earth	Unstable ground will be temporarily reinforced
	Persons/Material falling in to excavation	Excavations are clearly marked. Stop blocks are placed around the perimeter of excavated areas. Correct PPE is provided and worn correctly.
	Water Ingress/flooding	Dry Zones established and mechanical pump systems used to counteract ingress of water. Escape routes are defined and clearly marked.

4.03 BUILDING DELIVERY
Health and Safety

continued

	Undermining of existing adjacent structures	Existing foundations are identified prior to construction Dig test holes to determine the location of existing foundations.
	Compromising existing services	Dig test holes to determine the location of existing services. A specialist contractor is employed who is fully trained with experience
Construction		
Constructing formwork in-situ	Falling into excavations	A specialist contractor is employed who is fully trained with experience
	Collapse of formwork	Correct formwork edge protection is provided
Pouring Concrete in-situ	Eye, skin and respiratory tract irritation from exposure to cement dust	Use correct PPE and provide washing stations and separate eating/drinking locations in dust free areas.
	Overexertion and awkward postures	Workers are to take regular breaks and rotate in shifts
	Slips, trips and falls	Identify and fix all slippery surfaces, damaged ladders, loose walkways and unsteady hand/footholds.
	Chemical burns from wet concrete	Wear correct PPE and clothing
	Injury from equipment	Adequate lock out systems and guards provided on all machinery
		Use respirator
Lifting heavy building components with large machinery	Workers may be struck by machinery or elements being moved	Site Work is to be coordinated so workers are aware of elements being lifted.
		Number of elements onsite being lifted is restricted to one at any time.
		Correct PPE is worn correctly at all times.
		Specific training is provided for all workers.
		Maintain a safe working distance between co-workers
	Damage to existing powerlines	There are designated spotters to ensure no machinery of building components enter within 20 feet of the services
Working at height	Falling	Working at heights will be avoided wherever it is possible
		Safe working platforms are provided and barriers/handrails are constructed
		Ladders are only used in areas where a secure hand hold is available
		All workers are to have received specific training
Movement of vehicles	Collision of vehicles	Designated areas and strategic planning are defined for the movement of vehicles around site
	Being hit by a moving vehicle	Reversing is kept to a minimum Construction site and welfare facilities are separated
Risks in building use	Risk of drowning in channels and pools of water	All children under the age of 14 must be accompanied and supervised by an adult at all times
	Slippery Surfaces	Railings (min. 1000mm) high to be provided along edges of all pathways
	Tripping on steps and ramps	Non slip surfaces are provided around all water edges
	Falling into subterranean gallery spaces	
	Cleaning windows at height	Extension poles used in preference of ladders
	Cleaning guttering at height	Safe platforms are provided with access routes and handrails



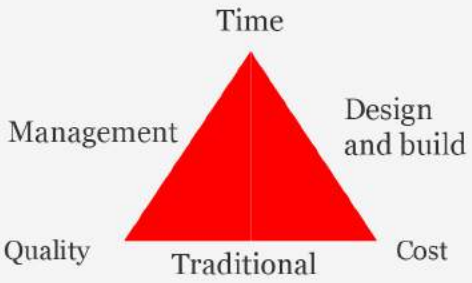
4.04 Procurement Form, Effect upon Design and design information

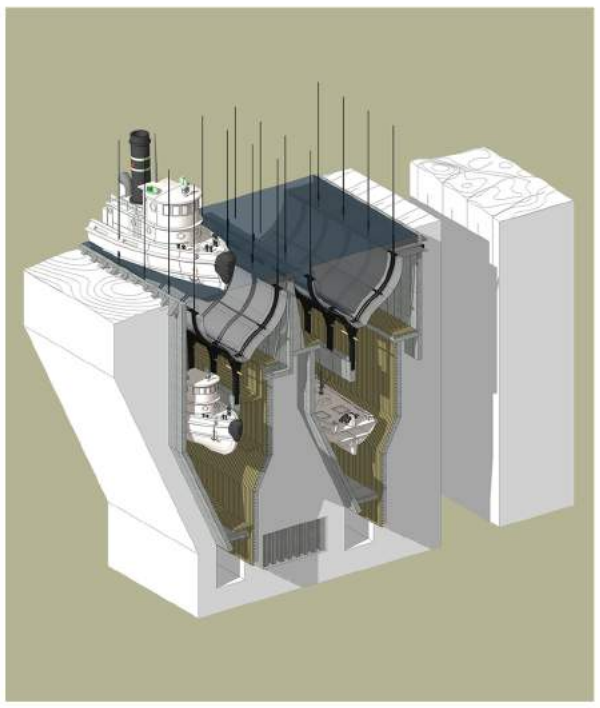
Procurement Form, Effect upon Design and design information

Deciding on Procurement Method
Quality – This is incredibly important within the scheme as the Maritime graveyard holds sensitive and delicate exhibits.

Cost – The budget can be stretched and overspend is less of an issue as the proposal is helping towards the governments aims of enhancing and preserving the natural environment and cultural heritage of Sweden.

Time – The proposal will cause little interference with the surrounding landscape due to its geographical location therefore this is less of a factor within the project.





The choice of procurement method is vital to the project, choosing the best solution for the project will help to optimise the relationship between time, quality and cost. In such a large scale project a comparative study will provide an indication of the suitability of different procurement methods.

The project will be holding sensitive exhibits so quality of construction is essential, for this reason I will compare and contrast management and traditional procurement methods as these have a degree of build quality assurance. This in contrast to a design and build procurement method which is focused mainly on a trade-off between time and cost.

Traditional Procurement
The traditional procurement route, is possibly the most commonly used method of producing building works. This method is often referred to as the Design-Bid-Build method. The client initially appoints consultants to design the project in detail > prepare tender documentation (incl. Drawings schedules and quantities). > Contractors are then invited to submit tenders for the construction phase, this is done on a competitive basis.

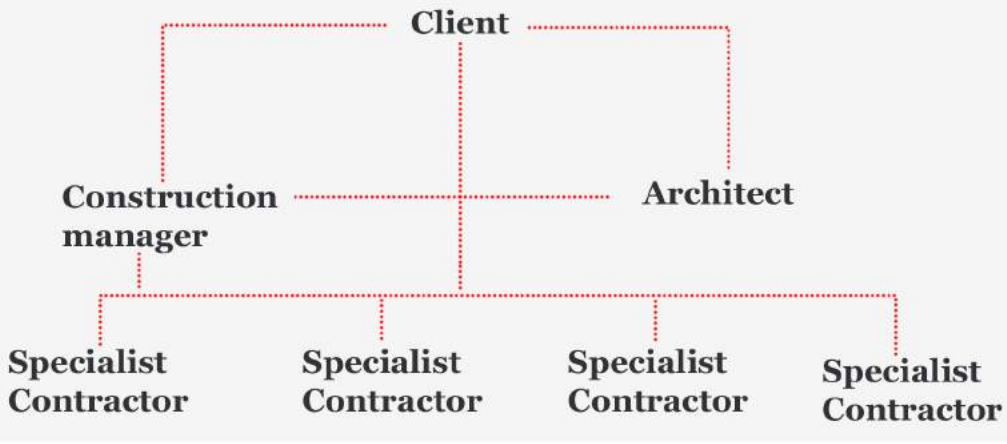
In this type of contract the contractor is not usually responsible for the design (besides temporary works) However in this instance specialist contractors will provide their expertise in the detailed design phase.

The client will retain the design consultants during the construction phase to prepare any additional information that is required. To review any designs that are prepared by the specialist contractors, and to inspect the works to ensure quality and workmanship adheres to the proposed design. Usually one consultant would be appointed to administer the contract, in this case it would be the Architect.

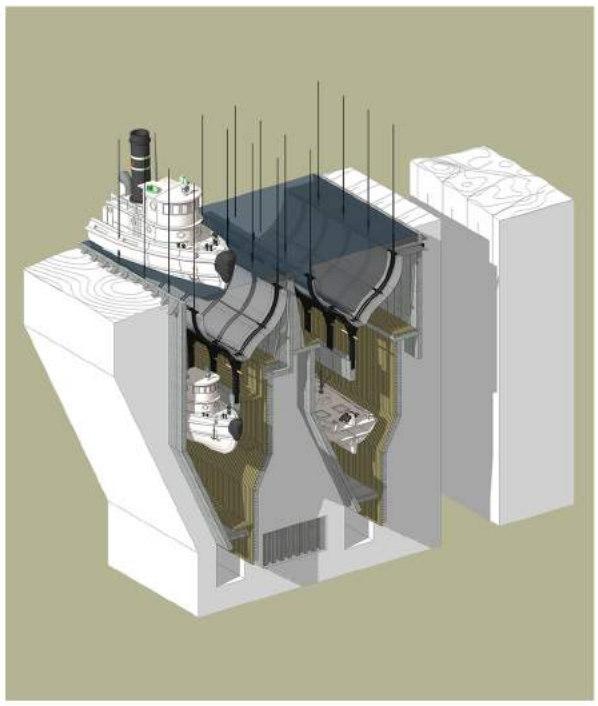
This type of procurement means the design will be fully developed prior to tender which will ensure the client receives certainty about design quality and cost. However, as the contractor is appointed prior to the design development they are not able to help improve the buildability of the proposals they develop. This strategy is a low risk option for the client who wish to keep overspending rates to a minimum. The design phase will need sufficient time to fully develop the scheme and prepare unrushed and complete tender documents.

Management Procurement

Management procurement is a route of procurement where the work is completed by a number of specialist work contractors who are contracted to a management contractor. The management contractor is appointed at an early stage in the design process to take full advantage of their expertise, and incorporate their knowledge into the scheme designs as they develop. This ensures buildability. This enables some works contractors to be tendered earlier than others. This can reduce the overall length of the project. This will mean however there will be cost uncertainty until the design is complete.
This type of procurement means the client can be flexible with design matters which means that sensitive exhibitions can be altered throughout the construction process to ensure their suitability for the exhibits. It also means the contractor can contribute towards cost calculations of the works. The works are let competitively by the management contractor to subcontractors and specialists. As there is an overlap between the design process and the construction process, tender packages are made available at times that suit the construction timetable.
As the construction managers in this procurement method act as consultants to the client, the client accepts the risk for the trade and specialist contractor's/sub-contractors performance, and in some cases the client and construction manager together have not been able to impose discipline on design development, coordination and decision making. In such cases the contract manager has exposed existing weaknesses in project management capability.
Out of the two procurement types the chosen is 'Management procurement' as it lends itself to the sensitive nature of the project ensuring the highest level of buildability. Specialist contractors can undertake specific works at different times as the design continually evolves. The specialist experts of the maritime museum organisation (SNMM) will be able to oversee the construction of the project and have the flexibility to change the design as the project develops to optimise the end result.



4.05 Procurement Form, Effect upon Design and design information



Collateral Warranties

On such a large and specialised project the involvement of many consultants and sub-contractors will mean there will be many warranties. There can be difficulties with onerous terms that all parties are unable to agree to as their insurers will not provide covers. This can cause issues in attaining collateral warranties within the designated time.

Investigations, funding and programme

Investigations

Prior to the commencement of the project, initial tasks must be undertaken in order for the project to go ahead. The following investigations need to take place to ensure funding and procurement for the project.

- A full measured survey of the existing site
- A hydrological survey
- Arboriculture survey
- archaeological survey
- condition survey of existing adjacent public infrastructure
- geotechnical survey of ground and water conditions

Funding and programme.

The proposed outline for the project will pitched to the Swedish Ministry of Culture, who meet in the Spring and the Autumn to agree and discuss funding for new projects. The proposal will be submitted with an outline of works and initial budget for the Spring 2018 deadline.

As part of the Spring 2018 proposal, an outline of the programme aims and objectives will be defined. These will be in line with the Government cultural and environmental objectives they aim to meet by 2020. Within the proposal, it will be clarified that the museum will form part of the SNMM group.

The proposal will also include a brief structure for the project delivery. This will define the following:

- Key dates for the submission of specific reports and applications
- A fee breakdown for each project stage
- An overall timescale for the project

Ensuring cost certainty

From the outset of the project there must be a realistic alignment between the client's aspirations and the budget requirements. If the Architect fails to fully interrogate the feasibility of the project within the clients set parameters, the cost of the project can increase significantly. The integration of specialist contractors from the outset and continuing discussions throughout the duration of the project will minimise costly mistakes.
Working to a 'system of work stages'

To ensure the project runs smoothly within a 'system of work stages' it is important to understand the requirements needed to successfully complete the project. The key issues are:

- To understand and define a timetable when key tasks must be completed within each individual stage
- Understand the level of design required for each stage, this means avoiding producing unnecessary levels of detail where it is not required
- Understanding the expectations of other design team members at each stage

Programme delivery and quality control
The project delivery will follow the seven work stages outlined within the RIBA plan of work 2013, "developed to ensure that the many subjects that will facilitate successful project outcomes are considered in a holistic manner providing a Plan of Work suitable for a 21st century collaborative project team".

RIBA

RIBA Plan of Work 2013

Stages

9 months | 3 months | 2.5 yrs | 2 years

	0 Strategic Definition	01 Preparation and brief	02 Concept Design	03 Developed Design	04 Technical Design	05 Construction	06 Handover and close out	07 In Use
Core Objective		Devlopment of brief/project objectives/ anticipated outcomes/Project Parameters Feasability study undertaken	Preparation of conceptual level design	Preparation of developed proposal. Including strategies for structure, services,systems. Initisal specification documents are provided with an outline cost.	Preparation of detailed drawings and specialist subcontractors design specifications.	Both offsite and Onsite construction occurs	Handover of building	Building in use services taken in strict accordance with the schedule of services
Procurement	Design competition advertised and design team assembled	Most suitable Procurement method established		Project Programme reviewed and discussed with client and Design Team	Project Programme reviewed and discussed with client and QS	Building contract administered	Building contract administered Site inspections undertaken	Building contract administration sucesfully completed
Programme	Establish the programme for the project	The programme is reviewed with the contractors that have been appointed. Changes to programme are discussed with client			Programme reviewed by project manager to ensure deadlines are met			
Planning		Pre-application discussions and submitted once approved	Planning approved and consent is given. It is at this point that any alterations are made and refered back to local					
Key Support Tasks	Review feedback from previous SNMM projects	Preparation of Risk assesments and project execution plan	Prepare Strategy for maintainance and operations, Creation of health and safety documents. Consult with specialist contractors			Architect to visit site regurlarly to ensure build quality		
Architects Involvement	Sucessful Architect appointed following the announcement of the design competition		Architect roles are defined and the design is developed with contractor and specialist subcontractors guidance	Final plans are to be approved by client and upon doing so the technical drawing packages are created	Architect present to sign off glazing prototypes	Sign off for all building components and finishes Design ammendaments are made as bulding sectins are completed and dimensioned		
Specialist Contractors	Specialist contractors are appointed	Consultations with deign team to develope scheme			Glazing prototypes produced			
SNMM GROUP Exhibition Specialists		Exhibition pieces are 3d scanned and dimensions are taken for scheme to develop				Dimensions taken during construction and ammendaments made accordingly		