Triangle Island Competition Concept

Team G

Triangle Island presents an extremely remote site, with relatively harsh environmental conditions and a diverse seabird ecosystem. The design was shaped by the extraordinary wind forces on Triangle Island, with frequent wind speeds of 180 km/h, as well as the highly efficient hollow-bone structure of the birds in the region.

Wind-Resilient Design

The frequent intense wind speeds of 180 km/h, sparked a focus on designing a structure that can efficiently withstand these extraordinary forces. A number of wind-resilient strategies inspired the form of our research station design. Through our own research, our team found that structures with more than four sides were optimal for wind resistance. Also, bringing the roof edge as close to the ground as possible was beneficial. Sloping walls inward rather than vertically-oriented walls were utilized where the roof edge was a little higher. In addition, a central hollow shaft was found to help equalize the air pressure below and above structures.

Hollow-Bone Structure

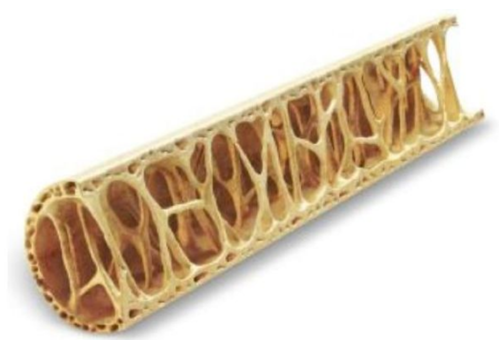


Figure 1. Hollow-bone structure adds strength without adding weight. (Moscato, 2017)

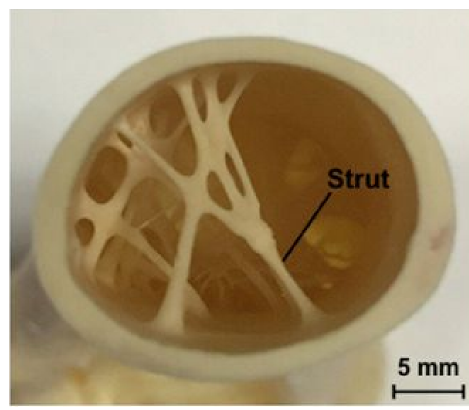


Figure 2. Cross Section of Bird's Hollow-Bone (Sullivan et. al, 2017)

To understand how best to design most efficiently in serious wind conditions, we observed the hollow-bone structure of birds living in the region. In addition to dealing with the intense wind loads in the area, most bird species also have to support their entire weight with just their wings. Thus, many bird species have adapted a hollow (pneumatic) bone structure to lighten their own weight, and keep the strength needed to carry itself through the air (see Figure 1 or Figure 2). This differs from seabirds that spend more time diving in the water hunting for food, which have solid bones to reduce buoyancy and increase control underwater.

For our design, creating a central shaft in the research station helped save material by cutting material from six of the cross-laminated timber (CLT) panels. Additionally, it allowed a great deal of natural light into all of the interior spaces on the floor plan, as well as a more equalized air pressure below and above the station's envelope.

Structural System

Cross-Laminated Timber (CLT) panels were chosen for the structural members because of their simple, and solid form that has great strength, particularly in shear. All walls, floor and roof are prefabricated CLT panels that can be easily air-dropped into place, with the same helicopter that transports the pieces from the barge. This will greatly expedite the construction timeline. Specifically, the panels are 175V V2M1.1 SPF CLT which consist of 5-35 mm layers. This system allowed for our walls to structurally self-support themselves, and resist all external forces on the building, reducing any need for structural elements distinct from the envelope (e.g. columns, beams, or joists). This structural system creates a solid structure on the exterior of the building with a primarily hollow void inside (or space with no structural elements).

The CLT panels are connected along the edges with self tapping screws (STS). The STS provide sufficient structural strength to resist all gravity and lateral loads while providing a clean architectural finish. The selected STS is a 10 x 480 mm SWG ASSY Countersunk Head, spaced every 200 mm, and installed at 45 degrees to maximize withdrawal strength.

The foundation for the design consists of screw piles which can be installed with small machinery air-lifted onto site. The station sits on the screw piles raised above the ground to retain a light impact on this vulnerable environment. The pile locations have been designed to act in accordance with the shear walls to resist bearing and uplift forces.

Structural Forces

The loading was calculated using the National Building Code of Canada 2015. A wind pressure of 1.6 kPa was provided and climatic data was implemented from Port Alice, British Columbia to analyze all load cases. CLT shear walls within the structure have been oriented to resist lateral forces in both directions. The CLT roof, wall, and floor system effectively transfer all gravity and lateral forces to the screw piles.

Cladding

The station is proposed to be clad in aluminum composite panels. These panels can be easily bolted onto the CLT panels on site, once the CLT panels have been fastened together. This light-weight cladding offers a smooth, and weather-resistant cover on the exterior of the building. This type of panel also has the ability to bend into double curves, allowing us to bend it over our edges, and reduce the number of perceivable edges on the building; creating a more homogenous form, and smooth, continuous surface for the easy movement of air along its surfaces. The aluminum is coated in a low-reflective teal-grey paint to reduce glare impacts on the local seabirds.

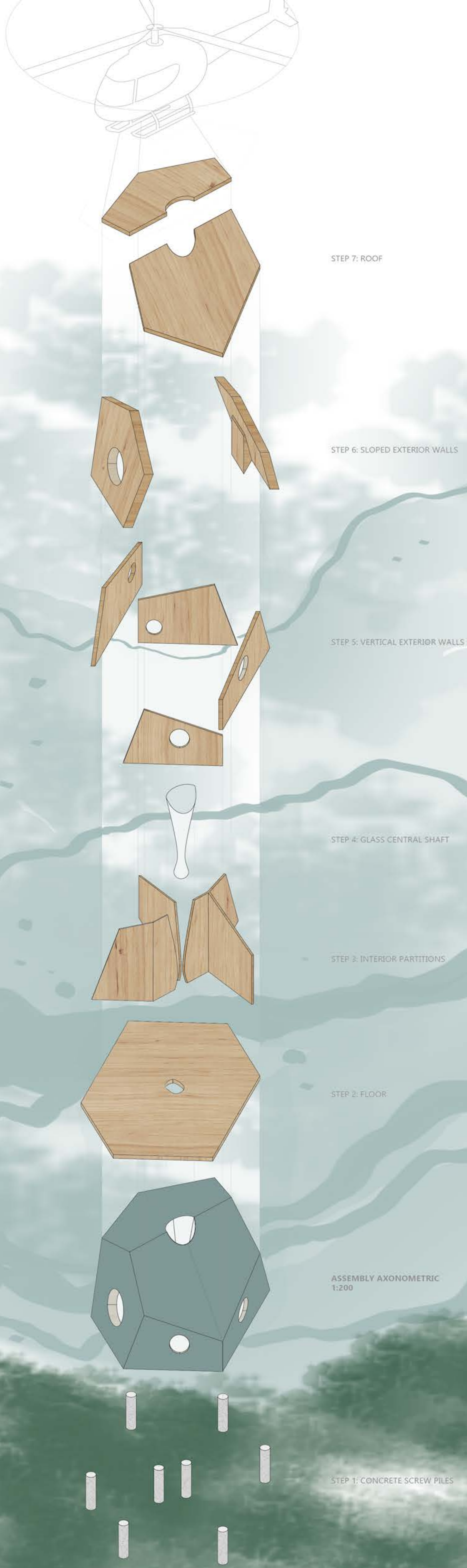
Sources

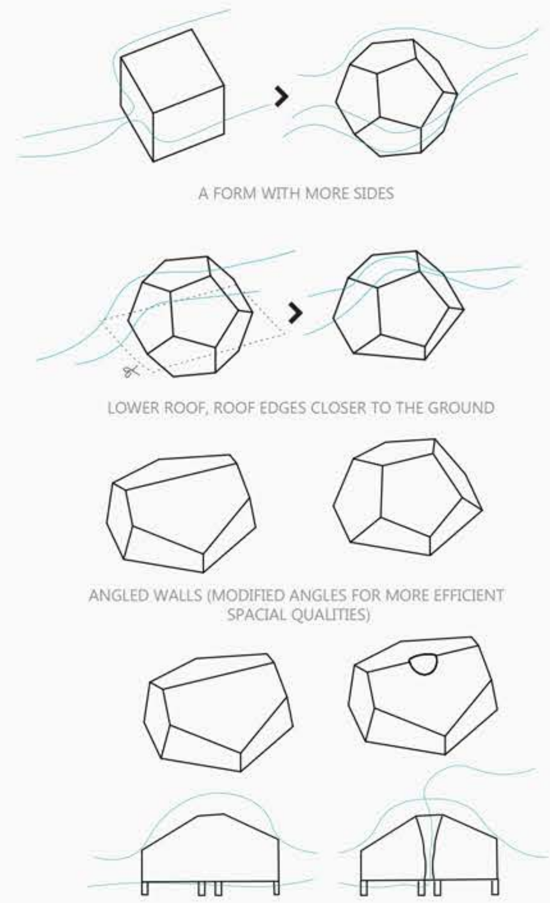
Moscato, David.”Why do dinosaurs have hollow bones?” Last modified Feb. 5, 2018. https://www.quora.com/How-and-why-do-dinosaurs-have-hollow-bones.

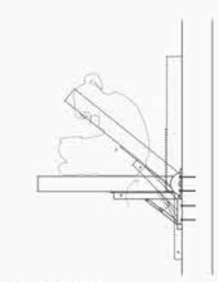
Sullivan, Tarah N., Bin Wang, Horacio D.Espinosa, and Marc A.Meyers. “Extreme lightweight structures: avian feathers and bones.” *Materials Today 20*, No. 7, (September 2017): 377-391.

TRIANGLE ISLAND SEABIRD RESEARCH STATION

TEAM G







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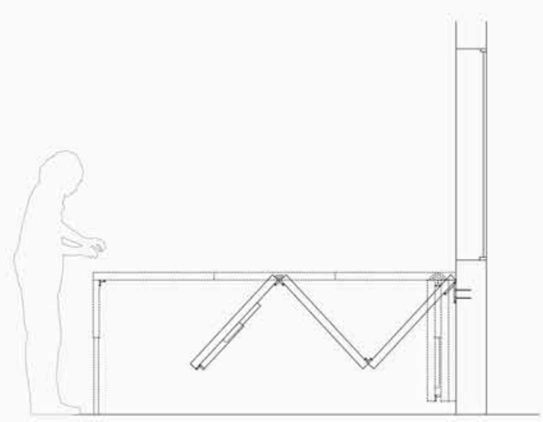

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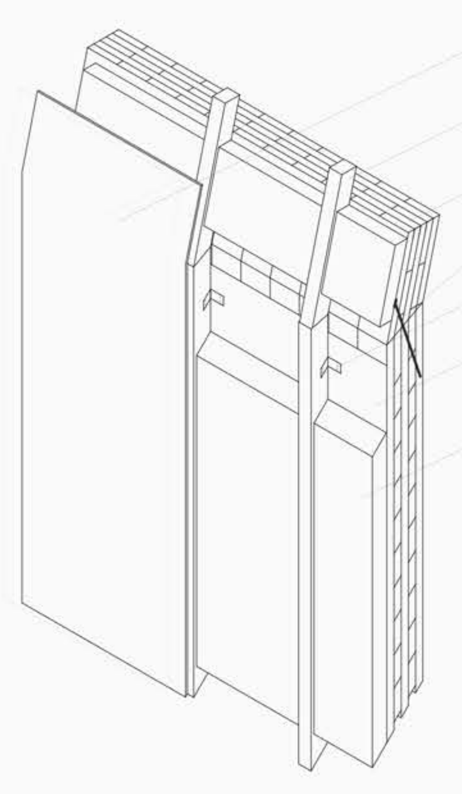

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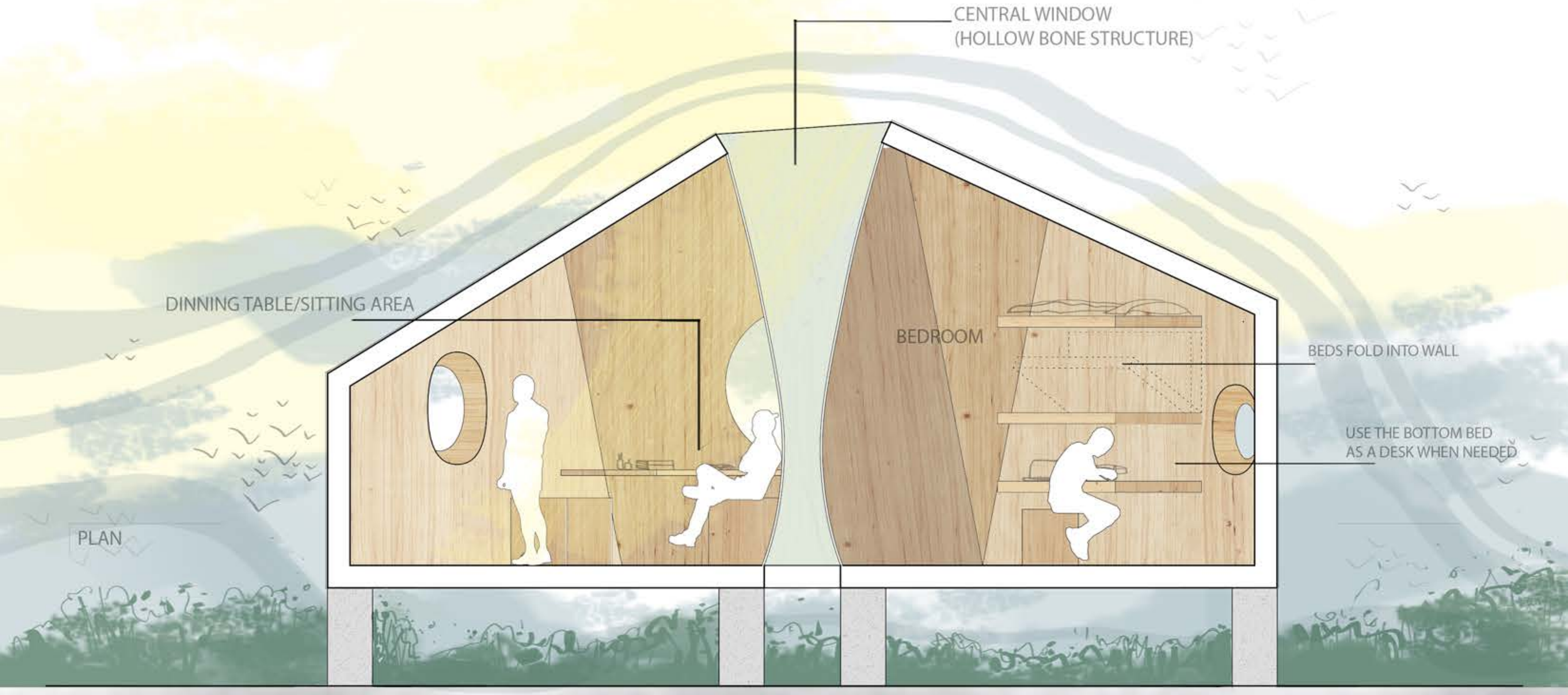

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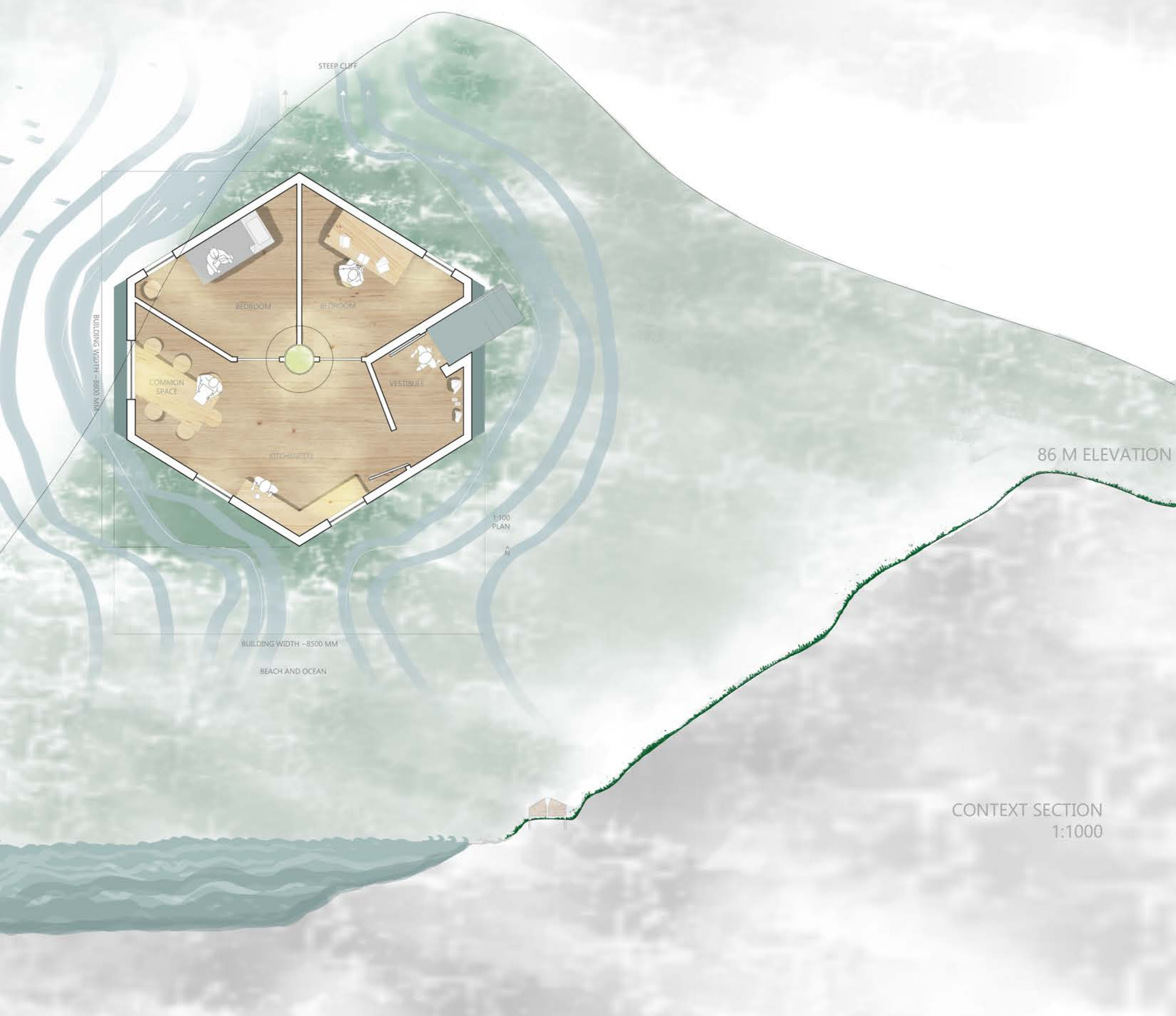

CONTEXT SECTION
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