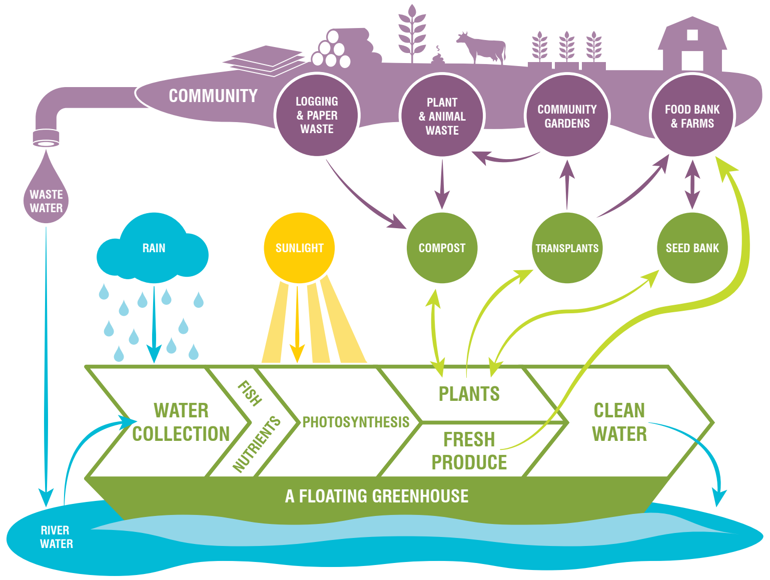
“The health of our Nation’s rivers, lakes, bays and coastal waters depends on the vast network of streams where they begin, and this new science shows that America’s streams and rivers are under significant pressure.”

—Nancy Stoner, Office of Water Acting Assistant Administrator, EPA

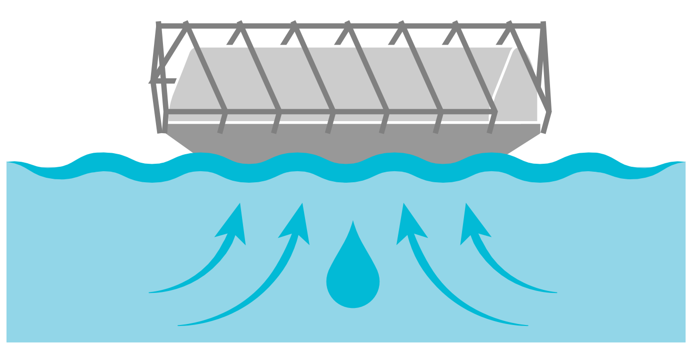
LOOPER



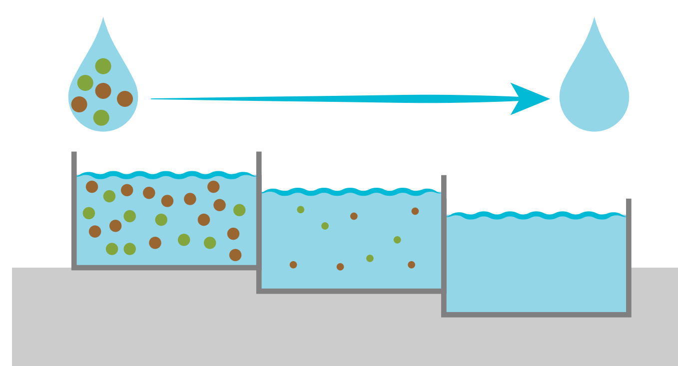
“The world view of abundance is based on sharing and on a deep awareness of humans as members of the earth family. This awareness that in impoverishing other beings, we impoverish ourselves, and in nourishing other beings, we nourish ourselves, is the real basis of sustainability.”

—Vandana Shiva

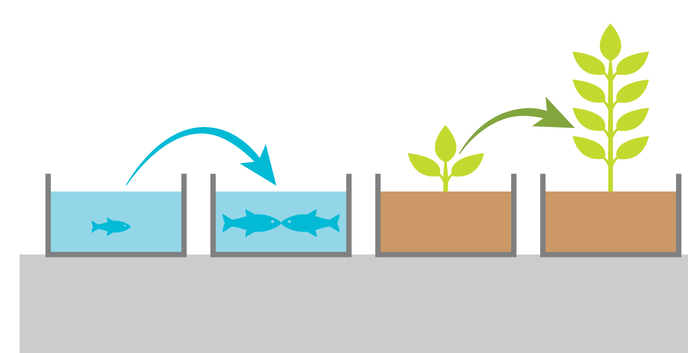
CLOSING A BIGGER LOOP WHILE FEEDING A GROWING COMMUNITY



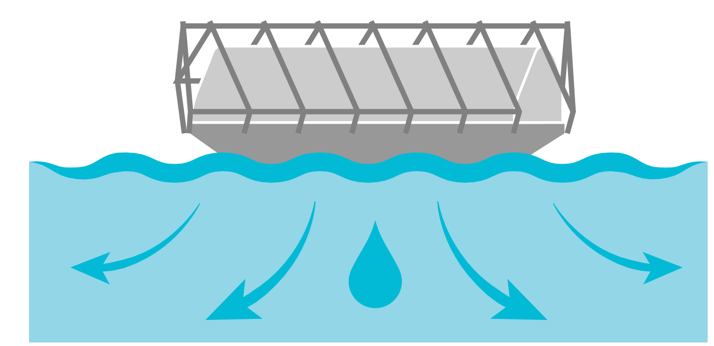
1 COLLECT POLLUTED WATER



2 FILTER WATER



3 GROW FISH & VEGETABLES



4 RETURN CLEAN WATER

THE LOOPER

The United States Environmental Protection Agency (EPA) recently reported that approximately 55% of the nation's rivers and streams are in "poor condition for aquatic life[1]". The study found that many of these rivers suffer from excessive nitrogen and phosphorus from fertilizer runoff, decreased vegetative cover from human development, and have increased bacteria and mercury levels. The state of our nation's waterways are indeed threatened. Knowing that they are vital resources to our health, prosperity, and the natural environment, the Looper is an attempt to use a greenhouse reverse this trend.

The Looper challenges the idea of a greenhouse and leverages one very simple concept: the growing of plants inherently cleans an ecosystem. To do this, The Looper repurposes an existing river barge into a greenhouse which collects, uses, filters, and returns water to the river in a remediated state – a loop. At the heart of the vessel is a "living machine" that distributes filtered river water to an aquaponics system growing both plants and fish. As the greenhouse barge moves along the river, it is able to restore water and habitat, serve multiple communities with access to fresh produce, and act as a floating classroom for an ecologically abundant future.

The project is designed to align with the seven petals of the Living Building Challenge Standards.

SITE

Restoring a Healthy Coexistence with Nature

The site for the project is an atypical one – the Snohomish River. A tributary to the Puget Sound, it, like many rivers and streams across the country, is well used by its human neighbors but suffers from increased levels of pollution. In particular, it suffers from excessive levels of fecal coliform, pesticides, dissolved oxygen, PH variation, and temperature issues[2]. While still relatively healthy, the river is in need of our respect and attention and would serve as a case study on community-centered remediation. In this sense, the project considers the Snohomish River as a "brownfield" site.

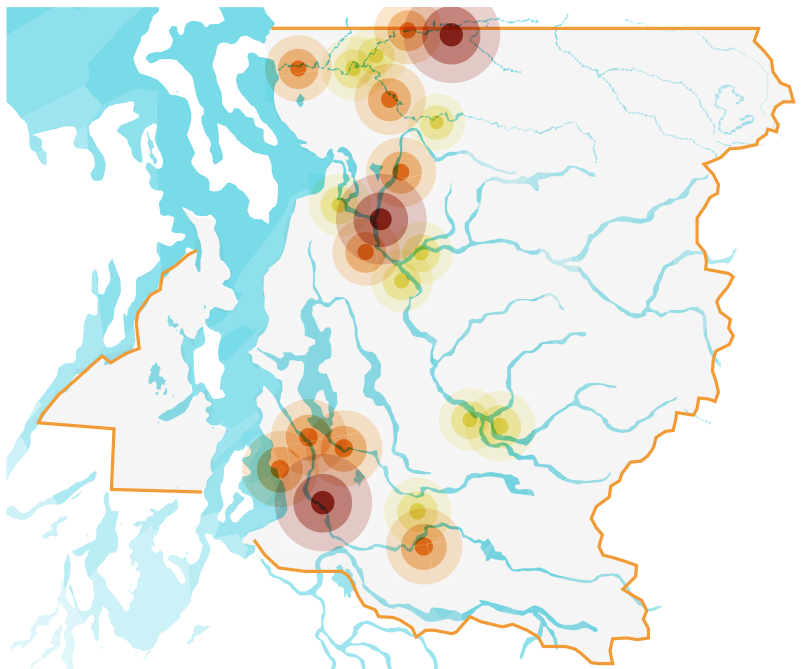
Through the living machine and corresponding greenhouse processes, the "building" filters approximately 220,000 gallons of river water per year while providing fresh produce to several communities along the way. At the conclusion of each living machine cycle a bioremediation island (a "Poop Pod") is released, along with the cleansed water, which acts as a floating wetland that cleans the water and provides habitat for local flora, fauna, and restorative microbes. The "Poop Pod" floats away downstream as a reminder to the restorative power of plant growth.

Because the greenhouse structure is built on a repurposed river barge and is capable of moving up and down the length of the waterway, the Looper is not limited to one site as if rooted on the land. Instead, it can travel to multiple communities and thus serve multiple purposes. As a greenhouse, the Looper can deliver fresh produce and plants to markets, food banks, food bank farms, and community gardens along the route. As an educational tool, the living machine can dock near schools and community centers for a participatory experience showcasing ecological processes and urban agriculture.

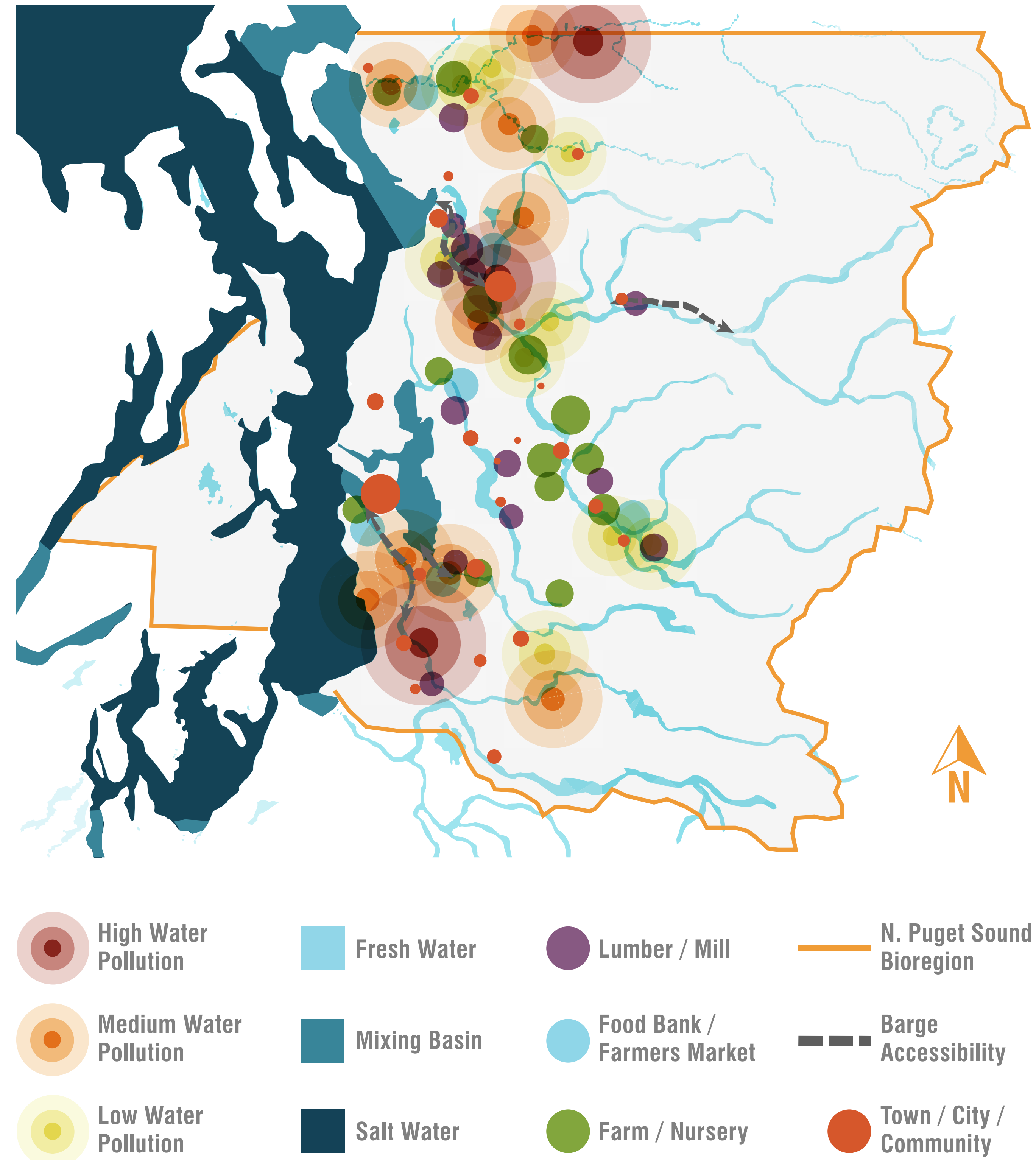
As an idea, the Looper is scalable to other sites and locations outside of the Puget Sound region. Waterways across the country are in similar conditions and the idea of a floating remediation education center could be applied throughout. Each Looper would have the opportunity to be customized to its locale in terms of culture, technology, and specific program. Every living machine needs to be precisely designed for the amount of water, type, and extent of pollution to achieve its maximum working potential.

SITE: SELECTION CRITERIA

POLLUTION

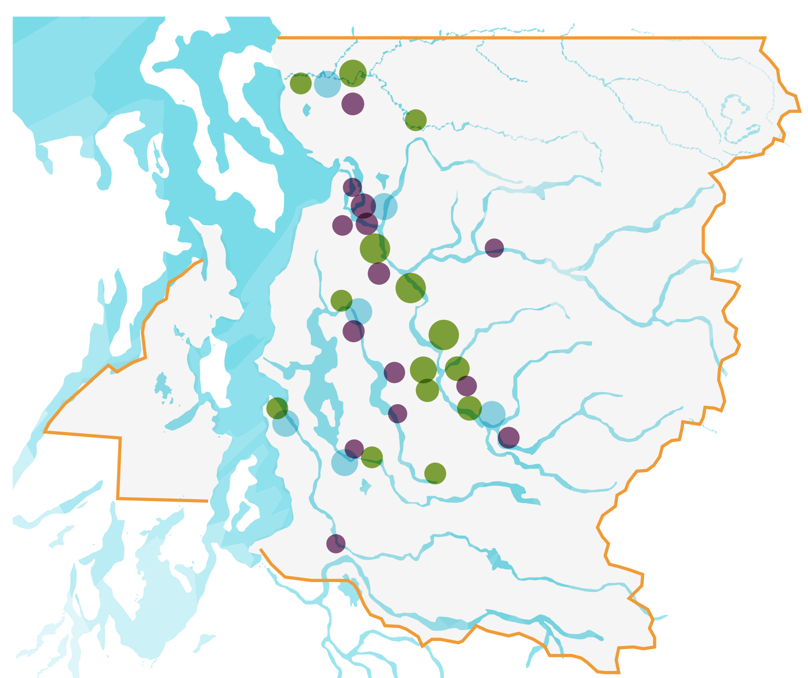


BARGE ACCESSIBILITY & WATER TYPES



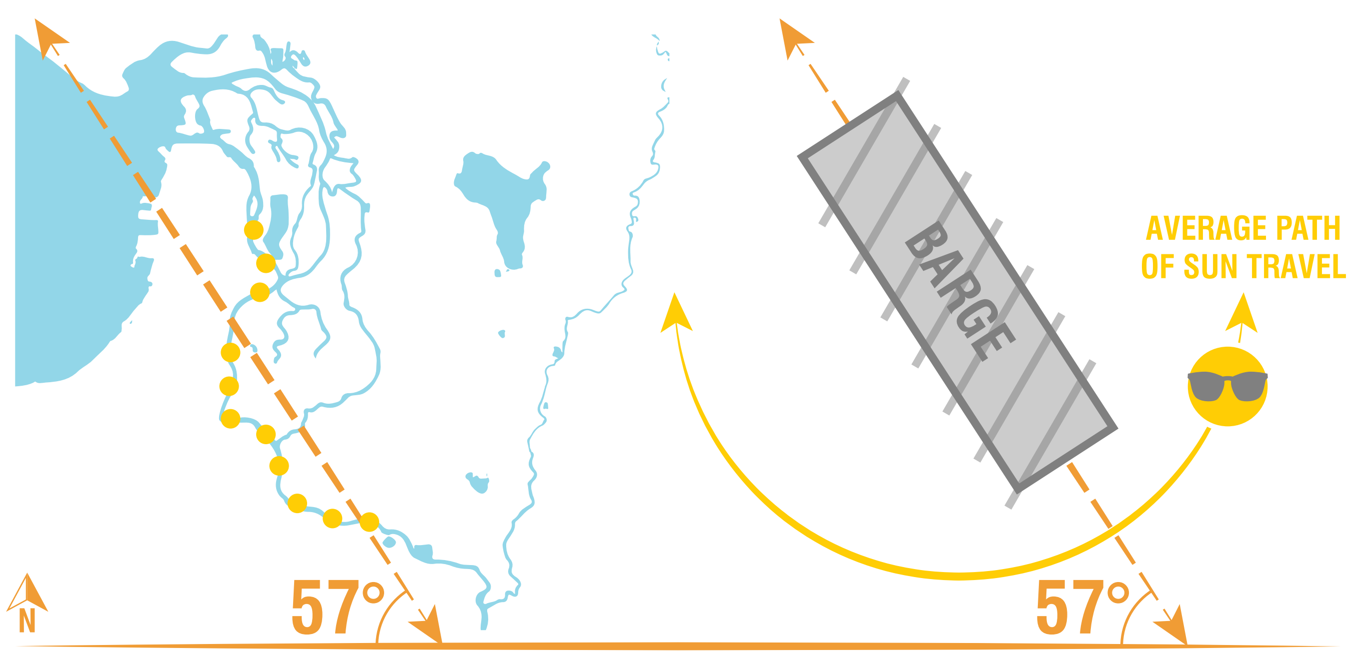
COMMUNITIES

RESOURCES

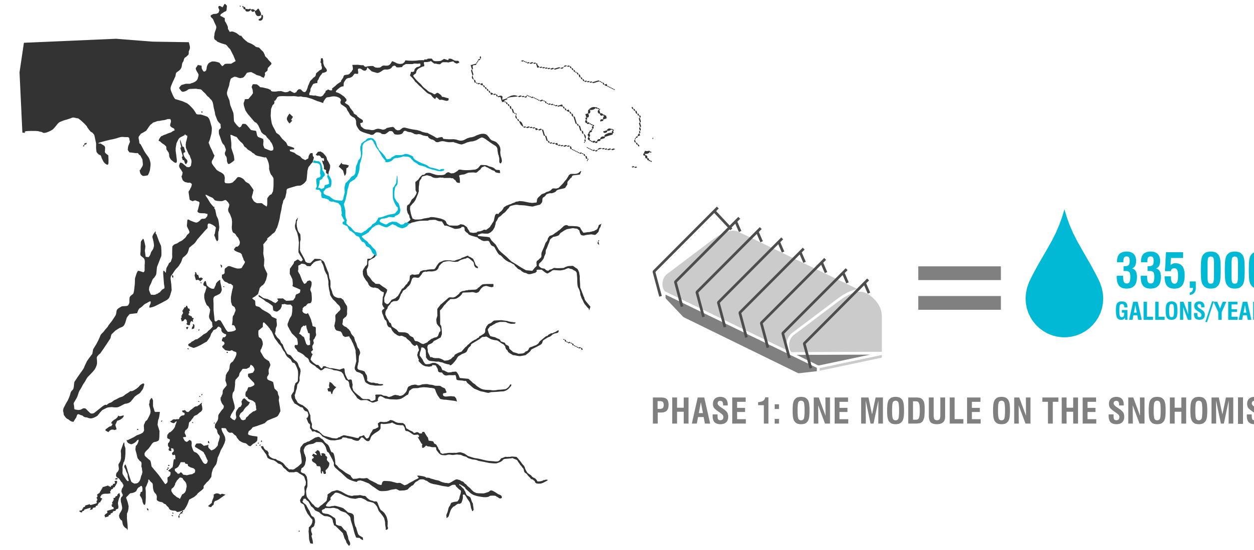


SITE: SNOHOMISH RIVER

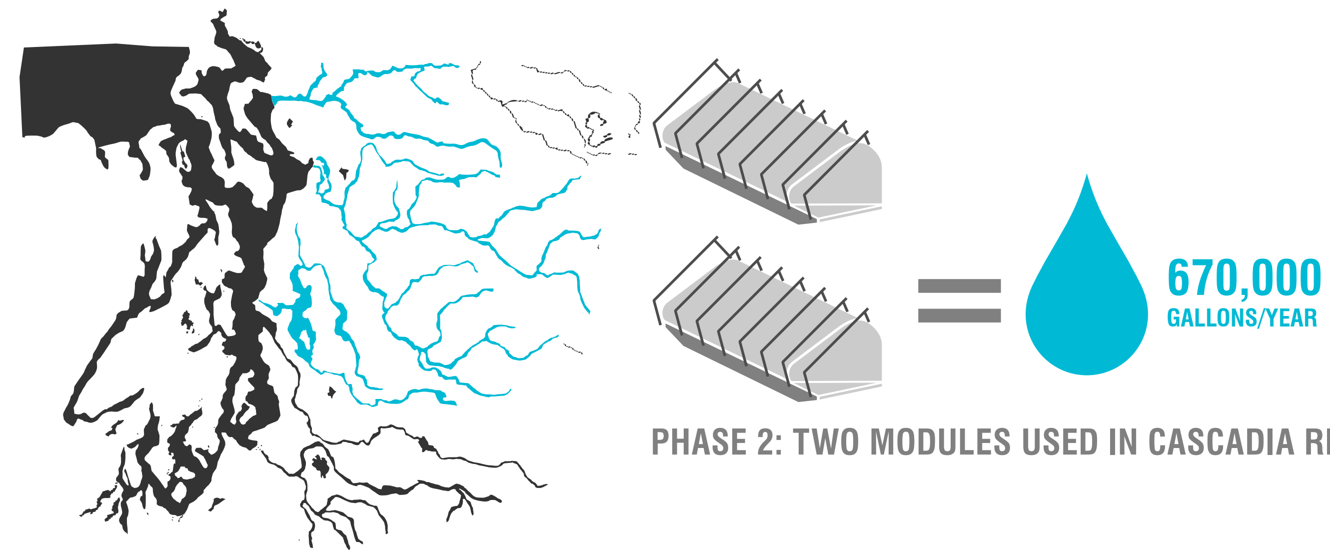
	Does the water need to be cleaned?	Is it large enough for a barge to travel?	Is there community access?	Are there resources along the river?	Is it fresh water?
Cedar River		✓		✓	✓
Duwamish / Green River	✓	✓	✓		✓
Sammamish River			✓		✓
Skykomish River		✓			✓
Snohomish River	✓	✓	✓	✓	✓
Snoqualmie River	✓		✓	✓	✓
Stillaguamish River	✓			✓	✓



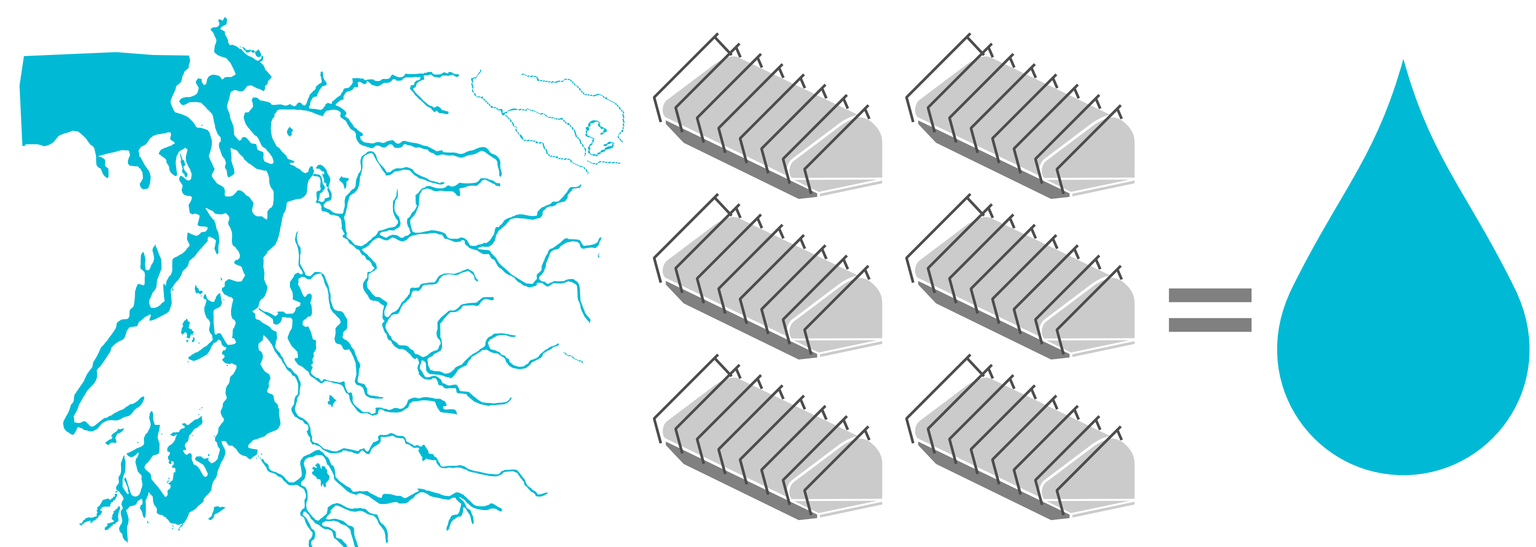
AVERAGE ANGLE OF RIVER BARGE TRAVEL



PHASE 1: ONE MODULE ON THE SNOHOMISH RIVER

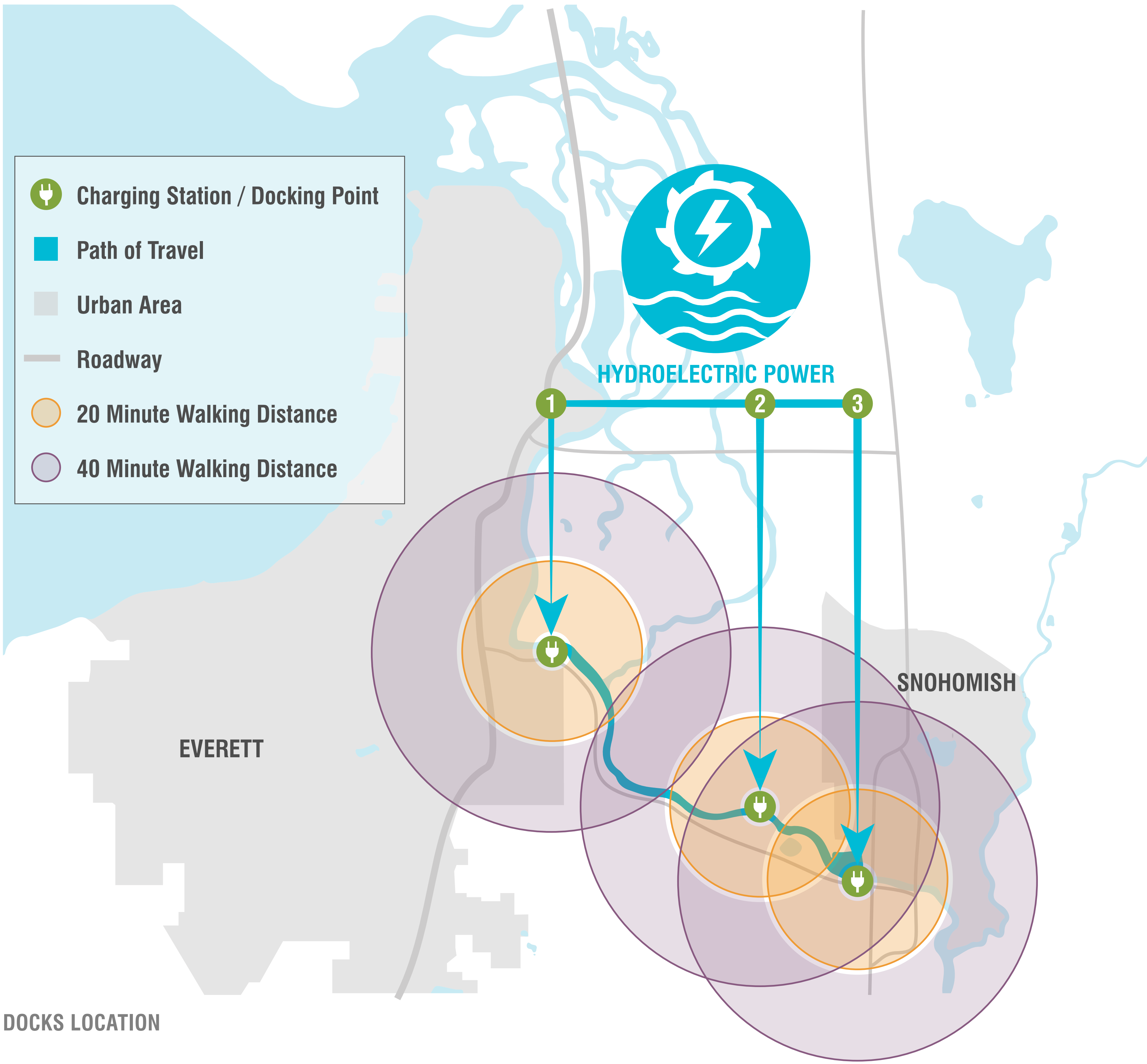


PHASE 2: TWO MODULES USED IN CASCADIA REGION

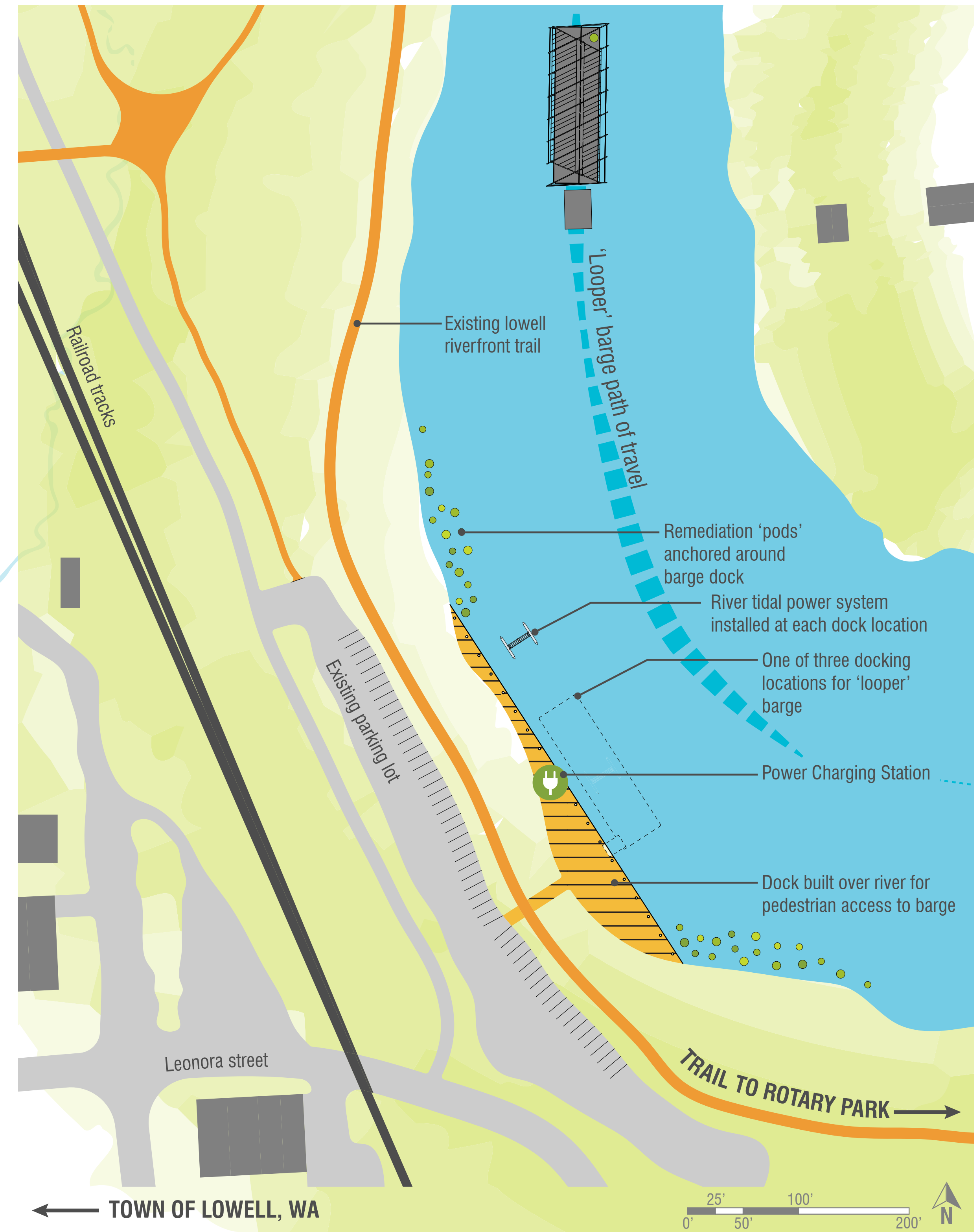


PHASE 3: MULTIPLE MODULES SPREAD TO ANY WATERWAY

SITE: THE LOOPER DOCKS AT AND TRAVELS BETWEEN THREE L4 TRANSECT SITES

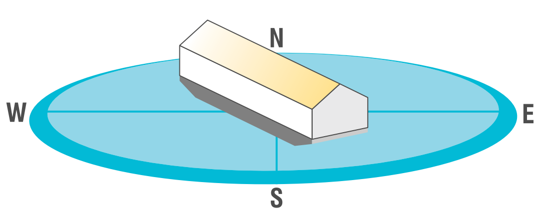


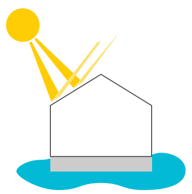
DOCKS LOCATION



SITE PLAN DOCK 1

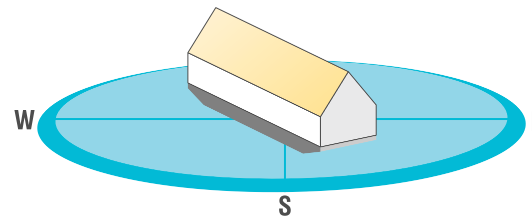
FORM OPTIMIZATION STUDY

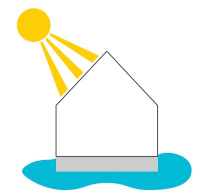




TYPICAL GREENHOUSE

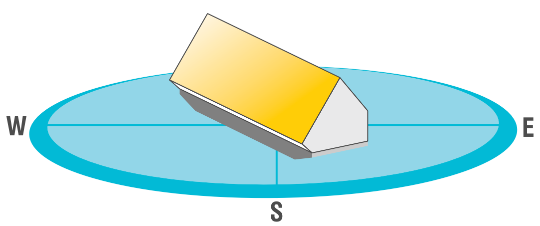
Light reflects off of the roof during the Spring and Winter.





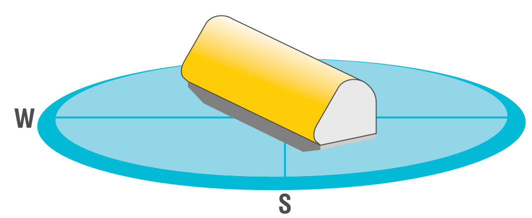
STEP 1

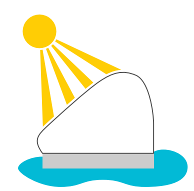
Adjust roof pitch to 47° to optimize solar gain for Snohomish location.



STEP 2

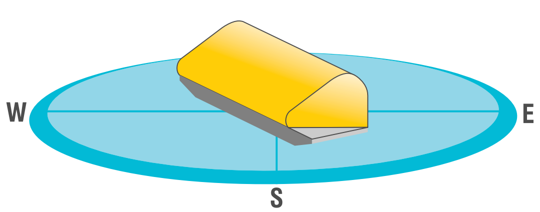
Extend the roof to account for the 57° angle of the Snohomish river and maximize solar gain.

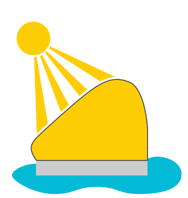




STEP 3

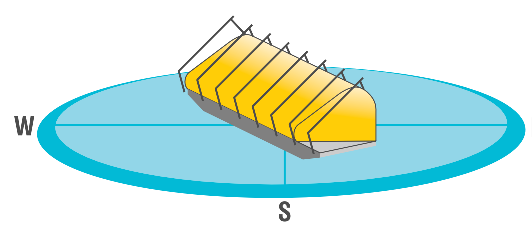
Curve the form to reduce surface area.

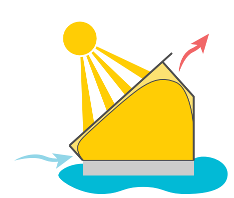




STEP 4

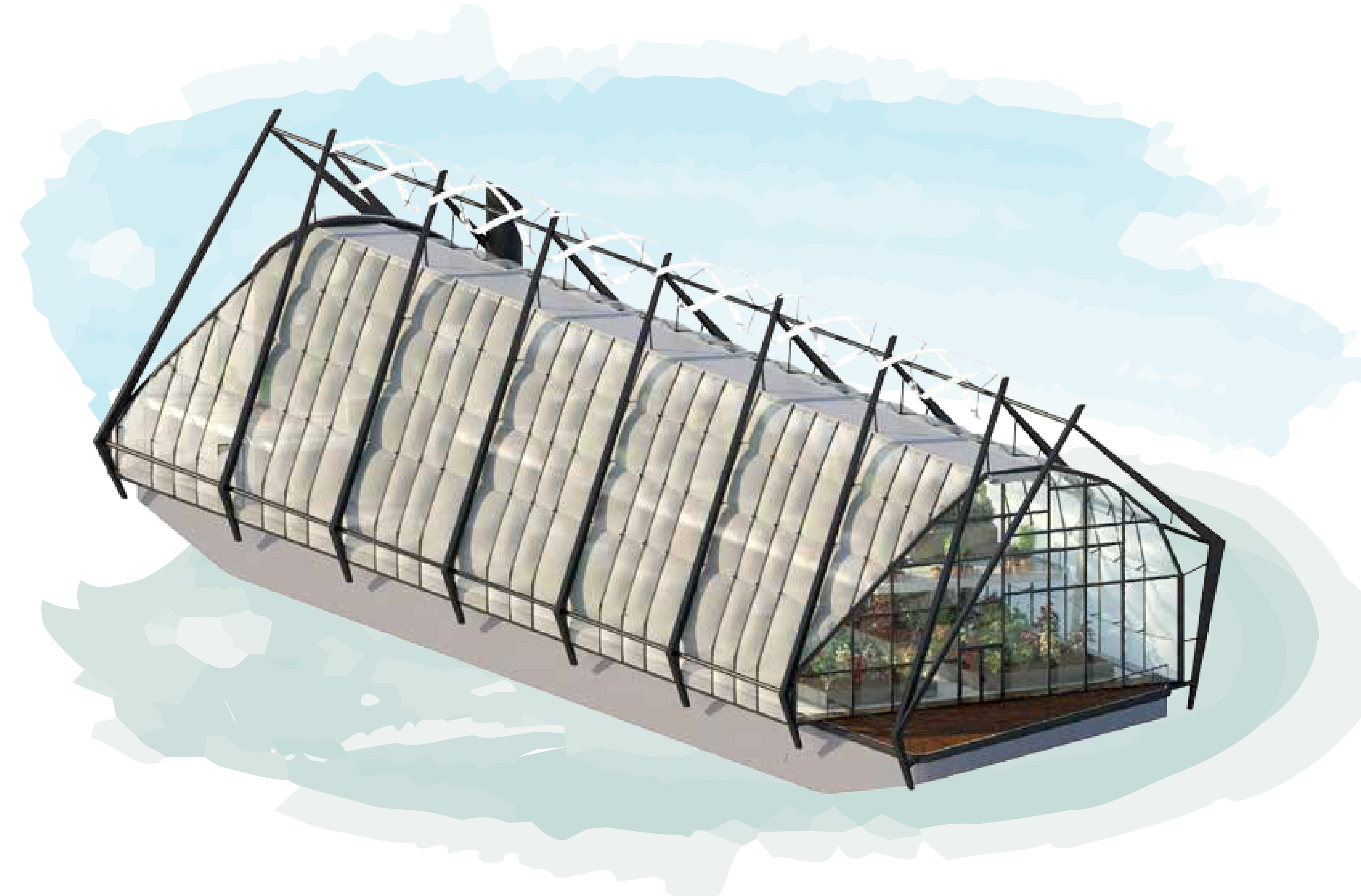
Remove corner to maximize southern exposure.

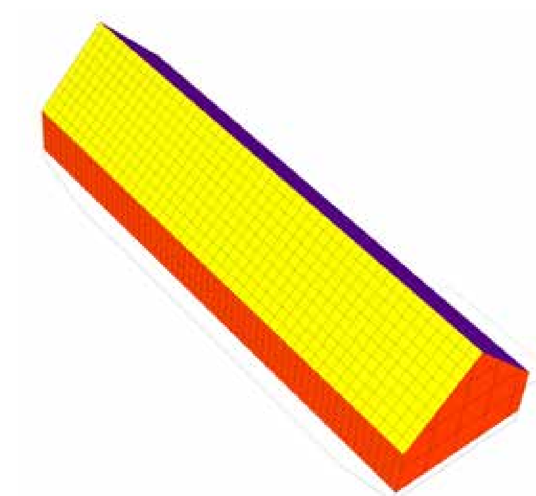




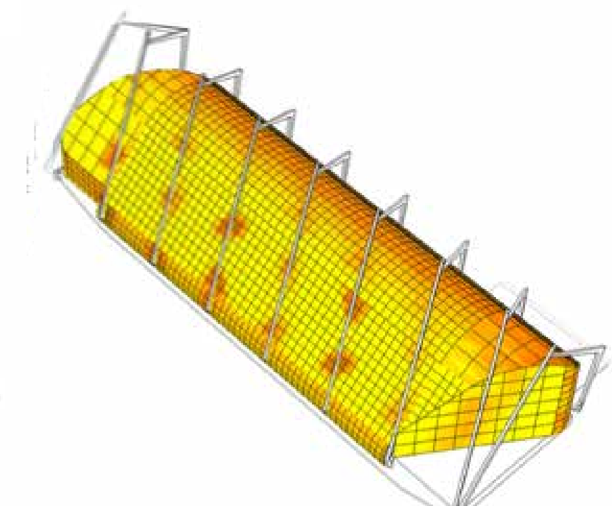
STEP 5

Add structure to support sustainable, passive systems.

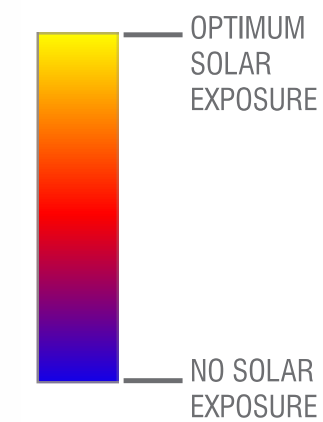


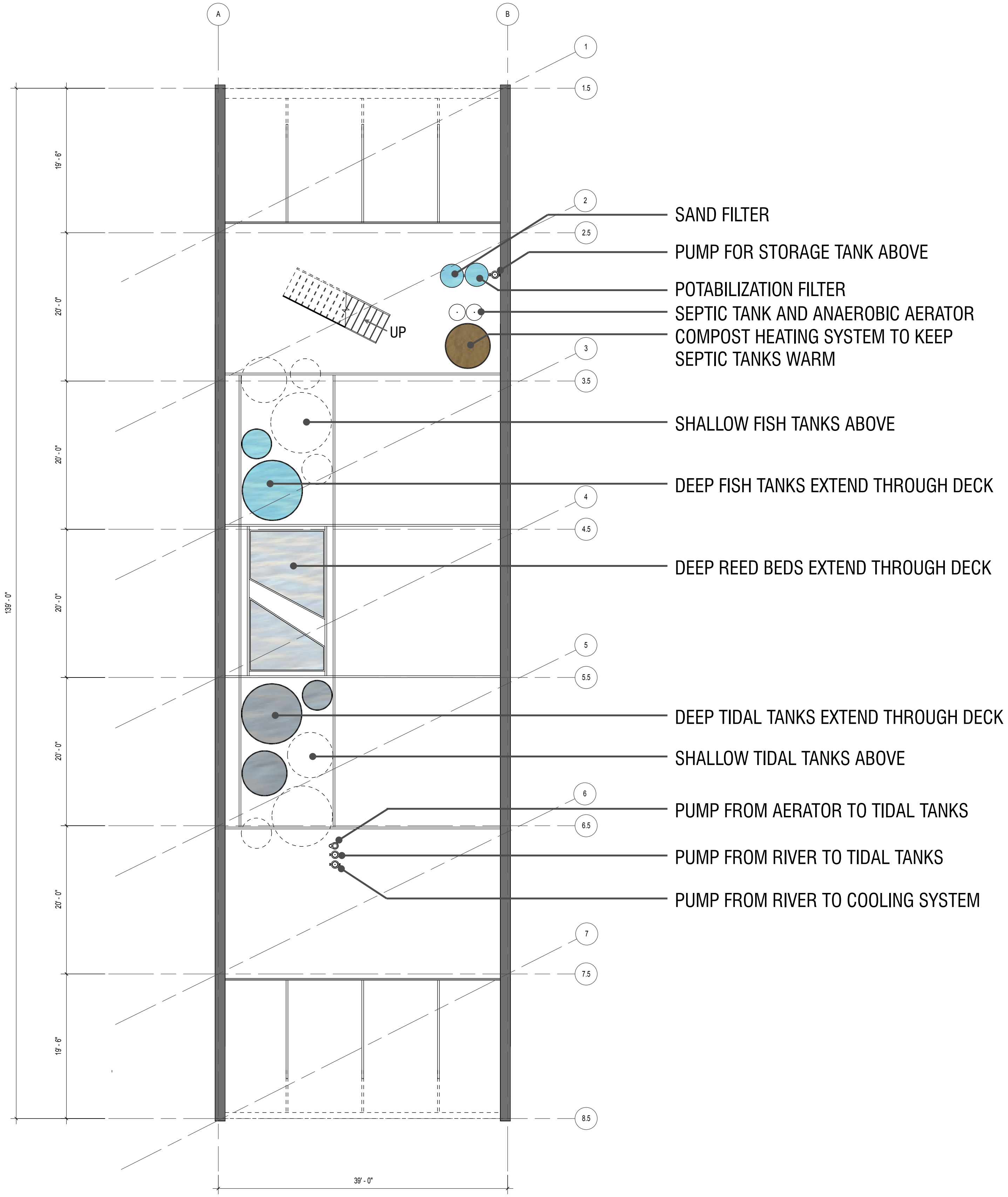


RADIATION STUDY OF A TYPICAL GREENHOUSE



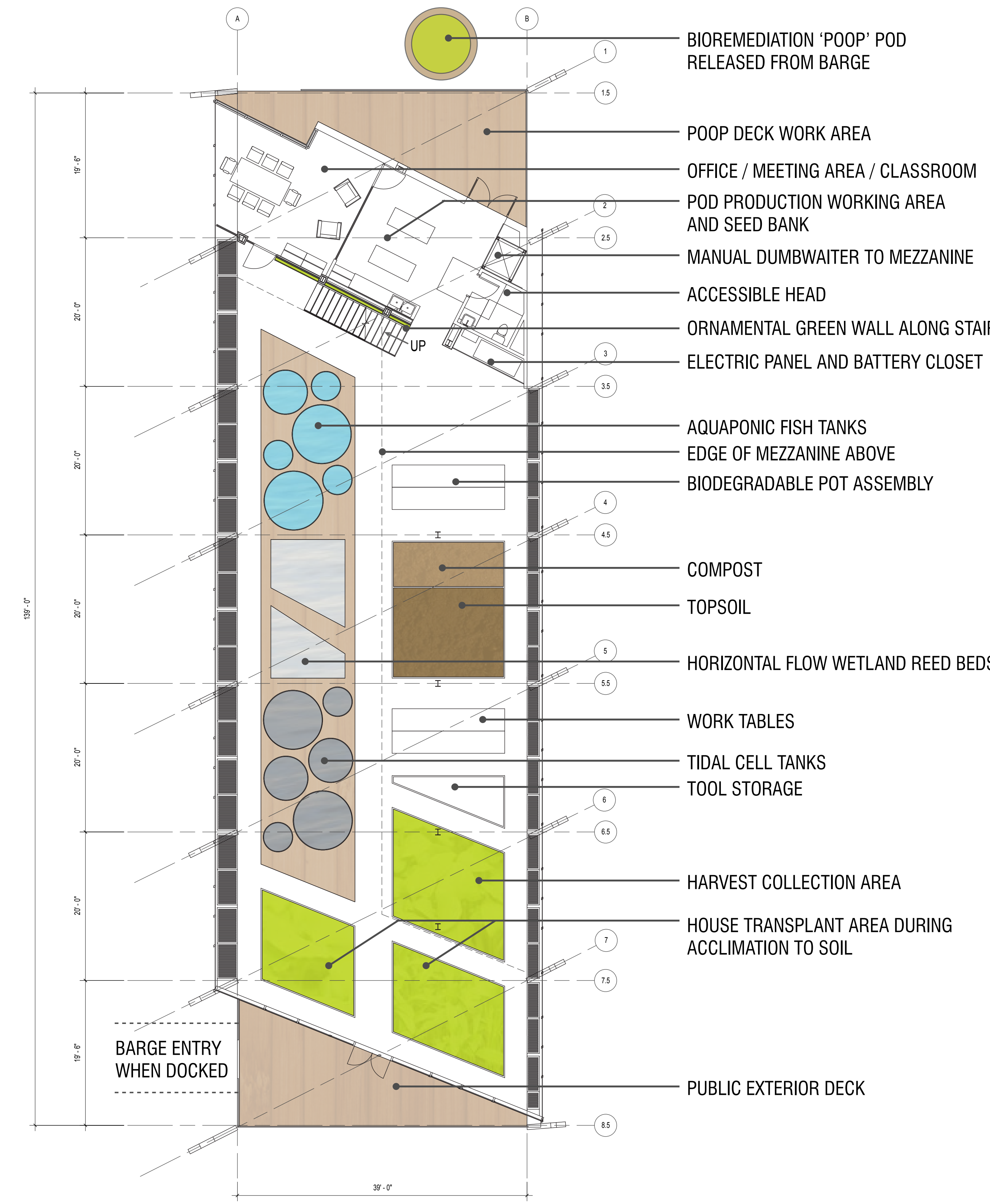
RADIATION STUDY OF OPTIMIZED GREENHOUSE





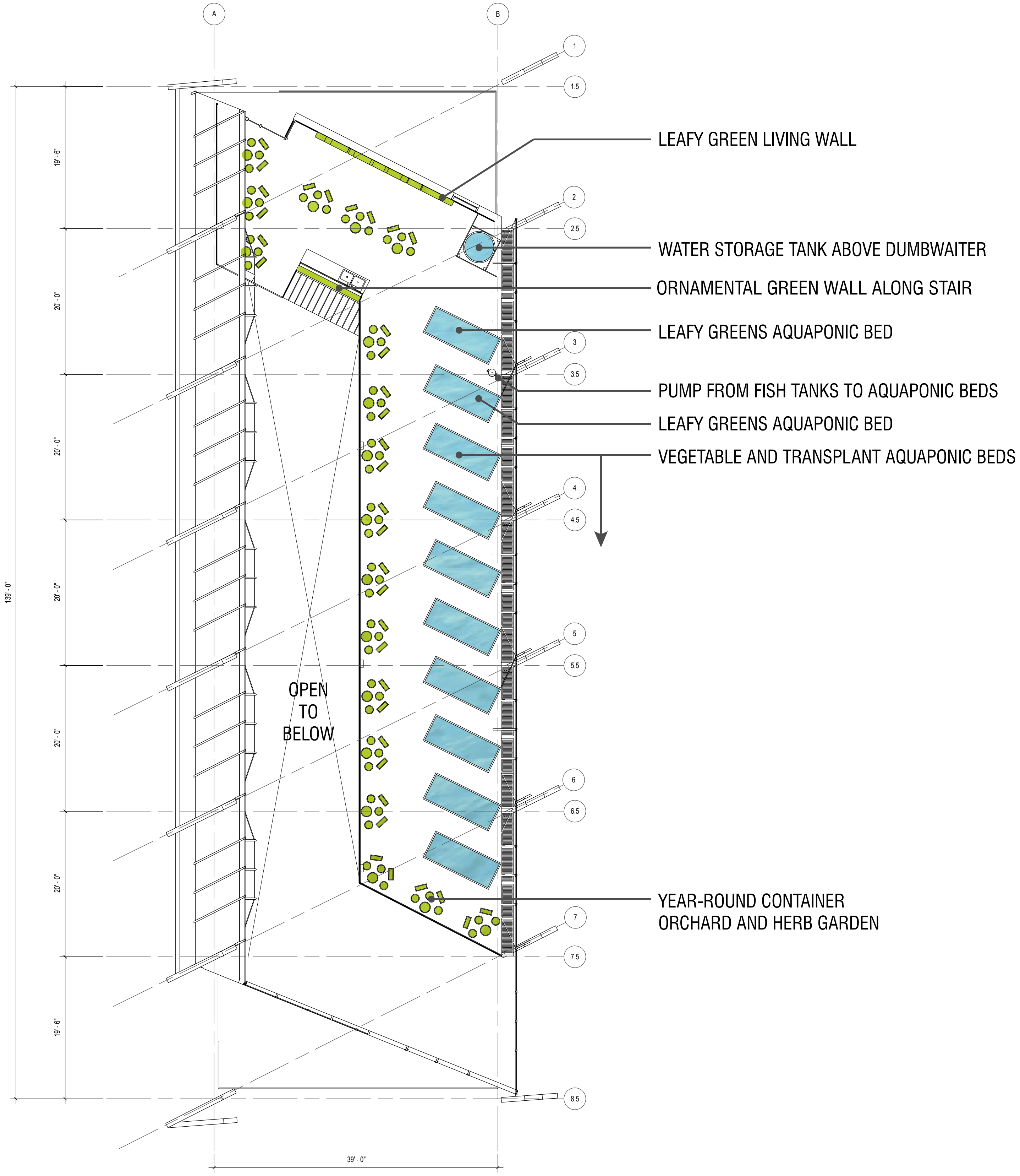
BELOW DECK PLAN

1/16”=1’-0”



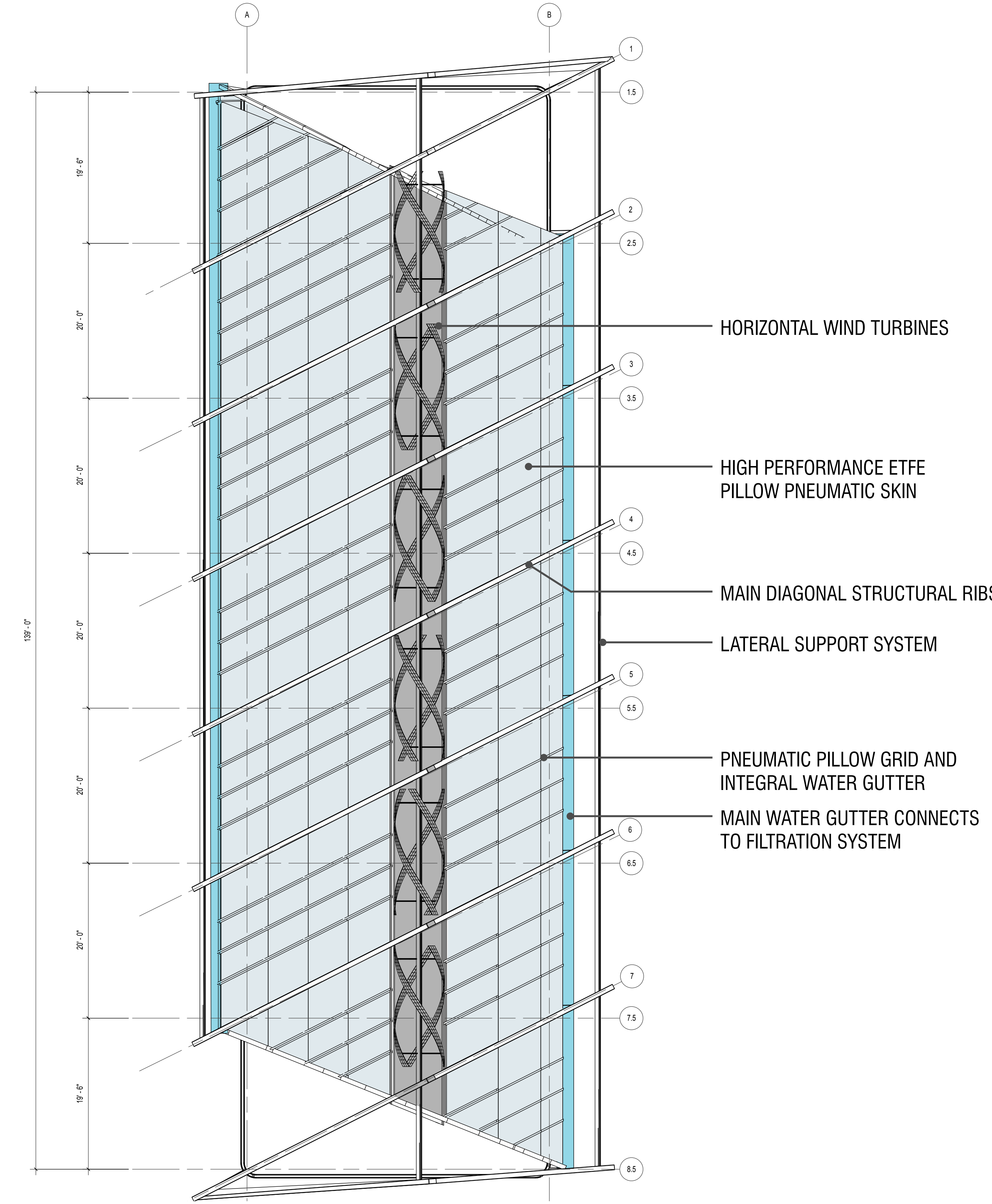
DECK PLAN

1/16”=1’-0”



MEZZANINE PLAN

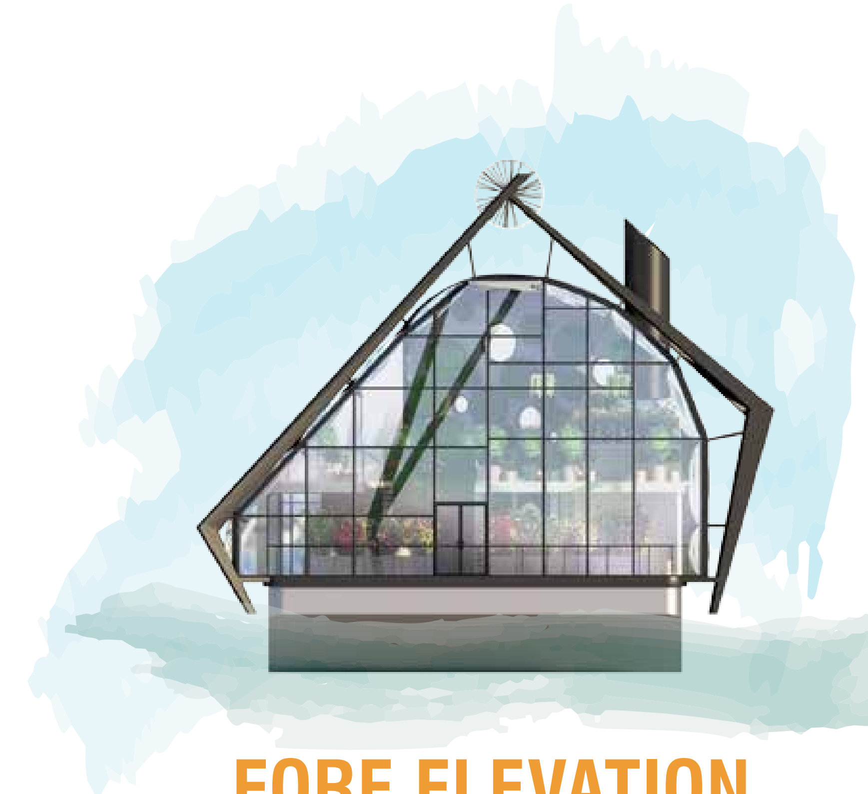
1/16"=1'-0"



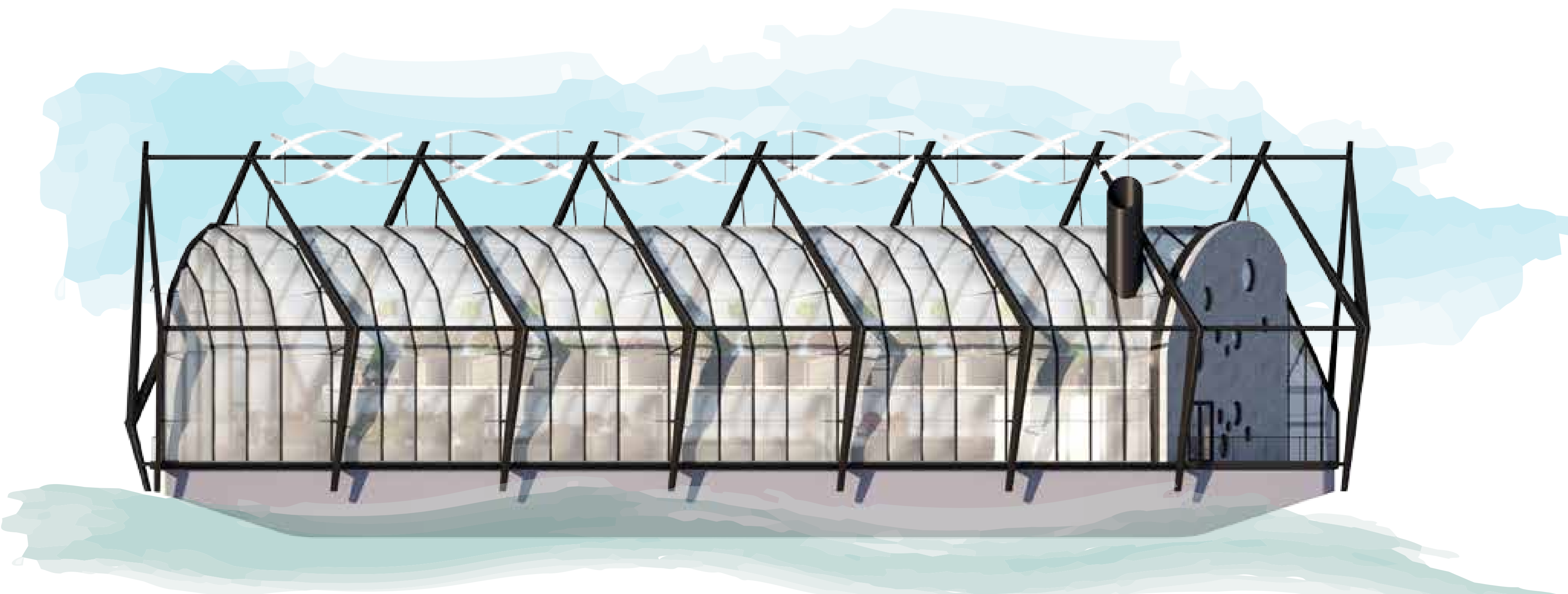
CROW'S EYE PLAN

1/16"=1'-0"

STARBOARD ELEVATION



FORE ELEVATION



PORT ELEVATION

AFT ELEVATION

ENERGY

Relying Only on Current Solar Income

The Looper uses a three-stage design approach to achieve energy independence. The first stage considers passive planning strategies that will maximize inherent efficiencies. These efficiencies are then optimized in the second stage by implementing active systems. In the final stage, remaining energy needs are offset with renewable sources.

Every greenhouse, regardless of location, puts a premium on solar exposure. Almost all plants need ample access to direct and regular solar radiation in order to grow properly. A greenhouse that travels on a river is no different. In fact, its mobility can be considered an asset. The Looper takes the typical shape of a greenhouse as a baseline, and then optimizes its shape, size, section, and structure to better adapt to local lighting conditions, natural ventilation, and heat gain/loss. This form optimization passively adapts the Looper to the Snohomish region and climate.

After passively optimizing the structure for its locale, the Looper almost eliminates the cooling load by using natural ventilation and a river water heat exchange cooling system. The heating load is reduced by using a high-performance pneumatic skin, a thermal mass, radiant heating, and an insulating blanket to eliminate nighttime heat loss. Warm air is then recirculated from the peak of the greenhouse down to the planting zone by way of skin integrated fan units.

The lighting load is passively minimized through solar optimization and by giving preference to native plants requiring lower lighting levels. Supplemental lighting is provided by high-efficiency LED lamps. Horizontal wind turbines collect available wind energy and supplement electrical needs.

To offset additional energy consumption, the Looper will install underwater tidal flow turbines at each docking location. In this way, each dock is a charging station for both the barge and the community. Batteries are charged and used onboard to satisfy electrical needs, and excess energy is fed back into the community electrical grid.

ENERGY OPTIMIZATION

PASSIVE SYSTEMS

- Form oriented for 57° river angle and the prevailing winds
- Form adjusted for maximum solar radiation to achieve optimal plant growth and artificial lighting reduction
- Integrated natural ventilation system for summer cooling
- Nighttime thermal blanket to reduce heat loss in winter

ACTIVE SYSTEMS

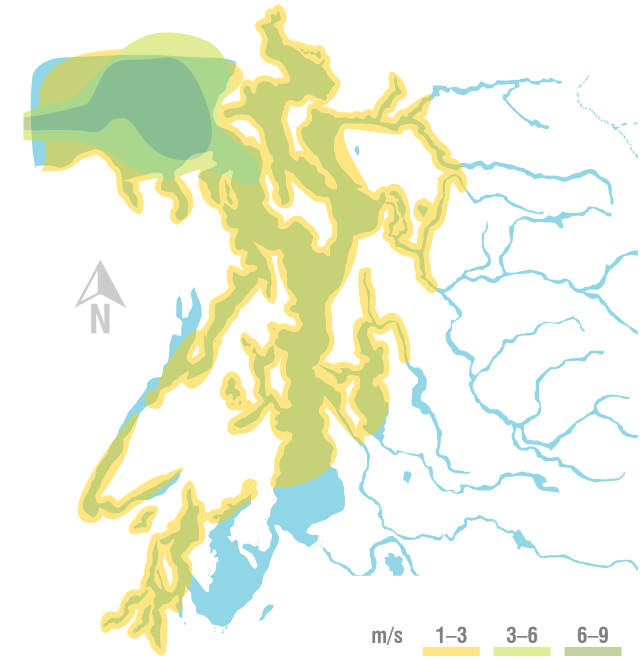
- River Water Heat Exchange Cooling System
- Fan for Hot Air Recirculation in Winter
- High Efficiency Lighting
- High Performance Pneumatic Skin for better insulation and more air tightness

RENEWABLES

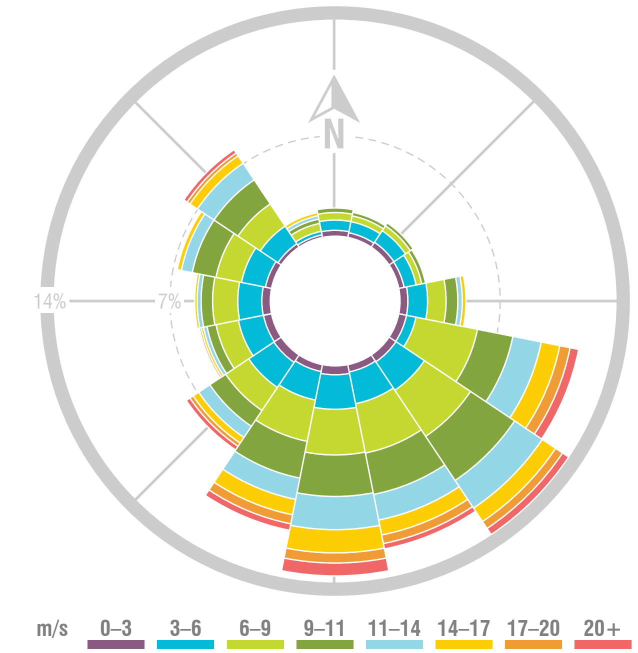
- Tidal Turbines
- Horizontal Wind Turbines
- Use of Direct Current electricity to avoid conversion losses

RENEWABLE ENERGY SOURCES

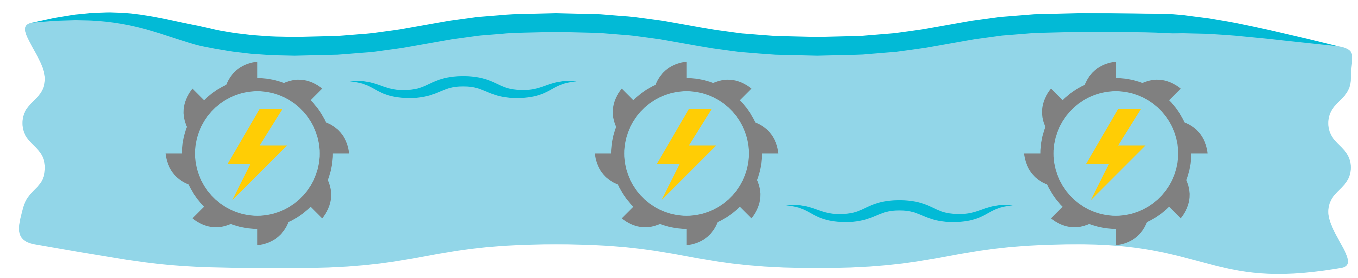
OFFSHORE WIND SPEED



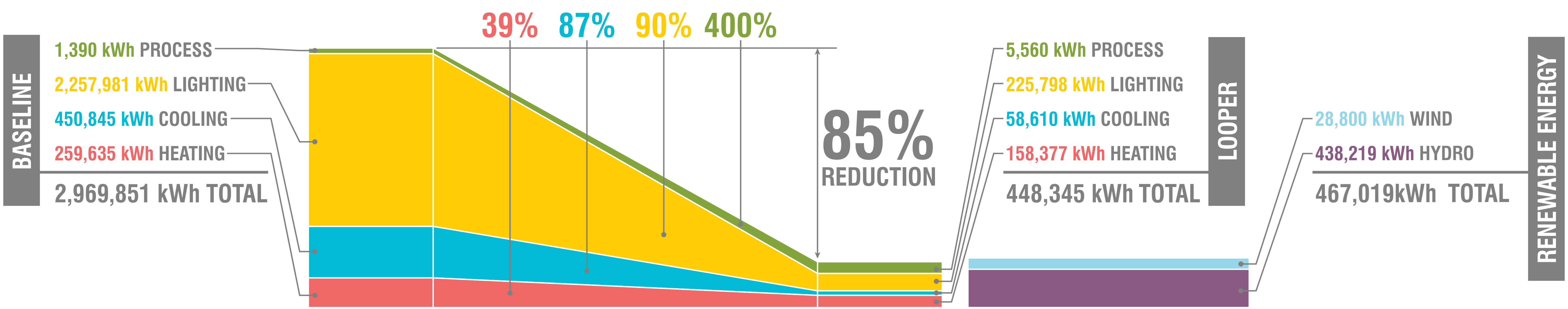
ANNUAL WIND ROSE



HYDROELECTRICTY



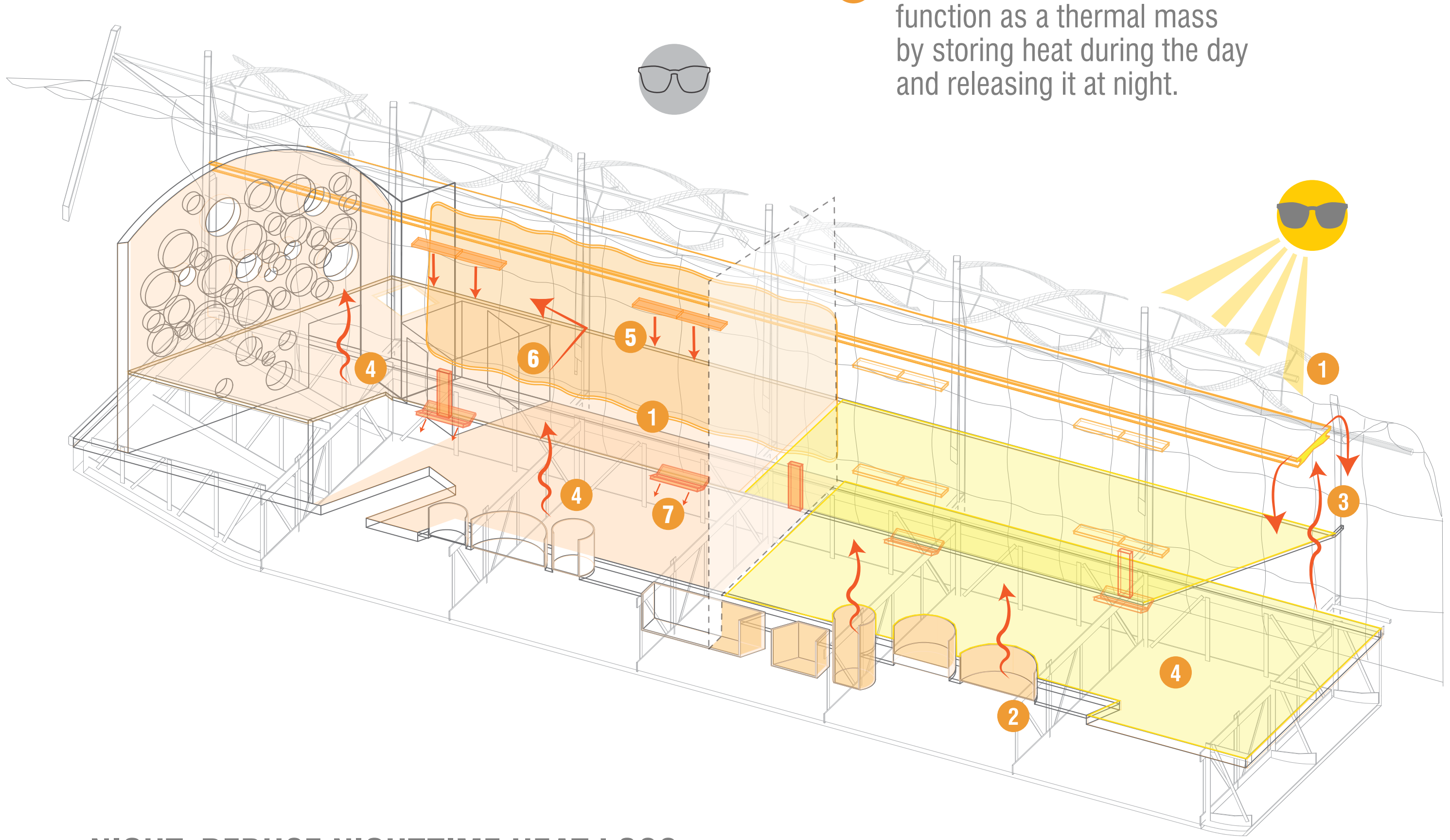
ENERGY MODEL



VENTILATION/COOLING AND HEATING SYSTEMS

DAY: MAXIMIZE SOLAR HEAT GAIN AND COLLECTION

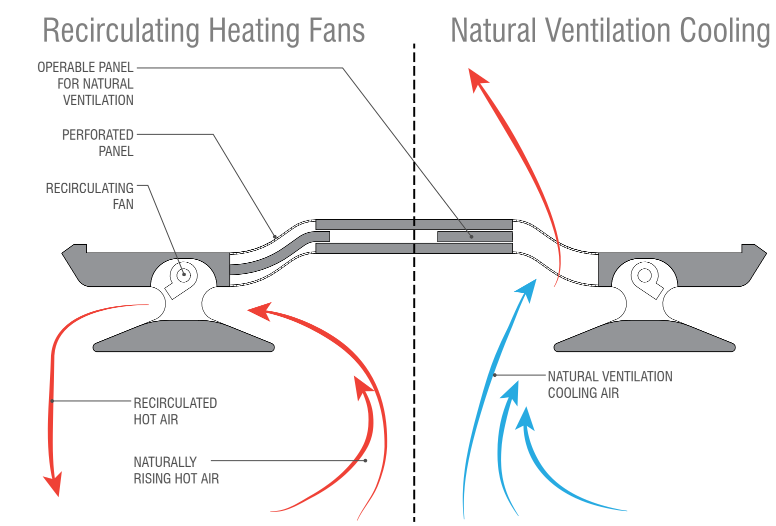
1. Solar heat gain
2. Solar heat collection: Living Machine functions as daytime thermal mass.
3. Hot air circulation: the ventilation system takes the hot air from the peak of the greenhouse and circulates it through the building
4. Concrete floors and North wall function as a thermal mass by storing heat during the day and releasing it at night.

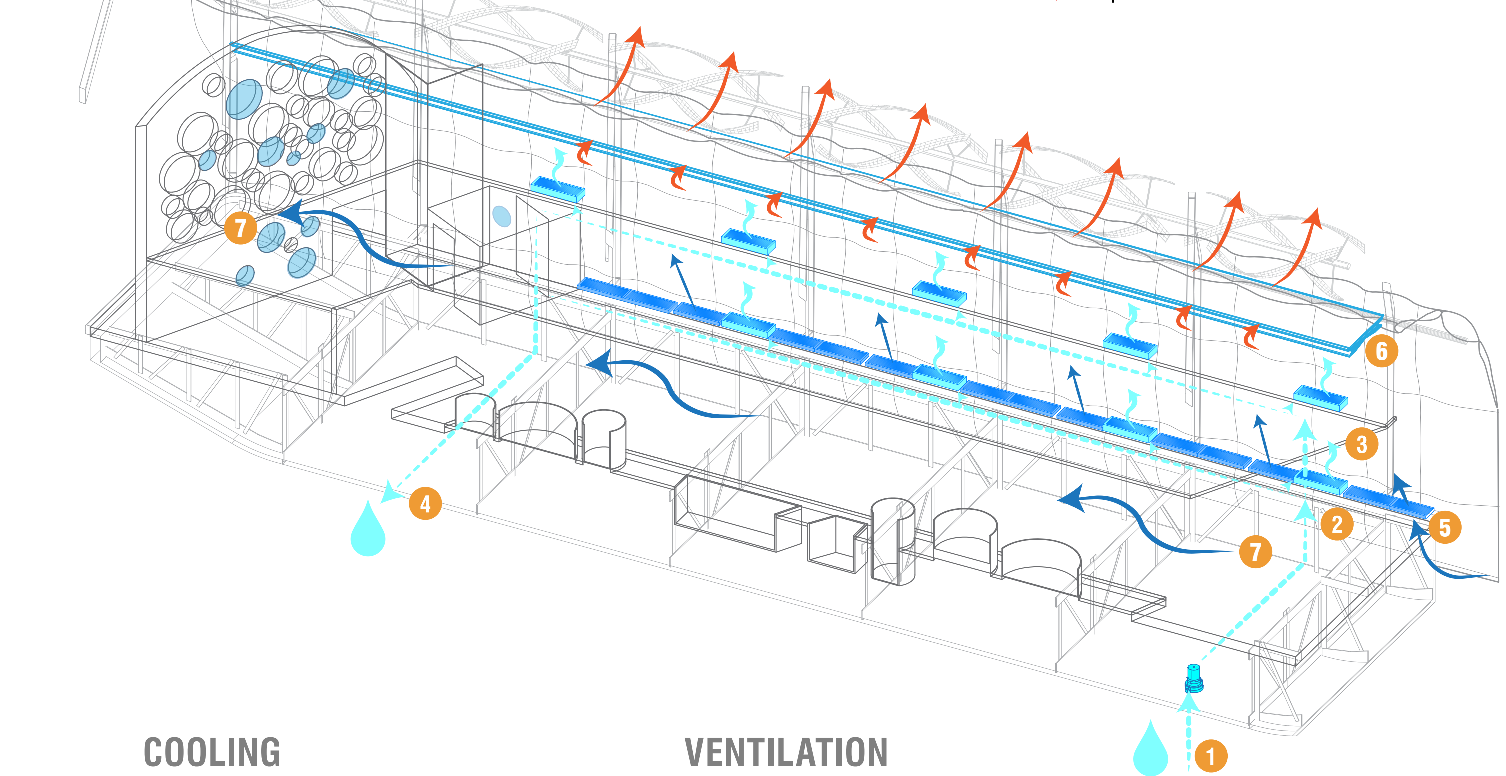


NIGHT: REDUCE NIGHTTIME HEAT LOSS

4. Concrete floors and North wall function as a thermal mass by storing heat during the day and releasing it at night.
5. Heat production: growing lamps provide additional heating.
6. Heat retention: a thermal blanket will be drawn at night to provide further insulation.
7. Supplementary heat from direct current electic heaters: only when necessary.

INTEGRATED CEILING PANEL





COOLING

1. Cold water is pumped from the bottom of the river.
2. The cold river water is distributed to coils throughout the barge.
3. Fans draw outdoor air over cooling coils.
4. Water goes back into the river.

VENTILATION

5. Floor operable vents on the sides of the barge allow the air to enter into the barge and circulate through the plants and push hot air out.
6. Operable roof panels allow hot air to naturally exit the barge.
7. Operable windows facing prevailing winds allow for natural cross ventilation.

WATER

Creating Water Independent Sites, Buildings, and Communities

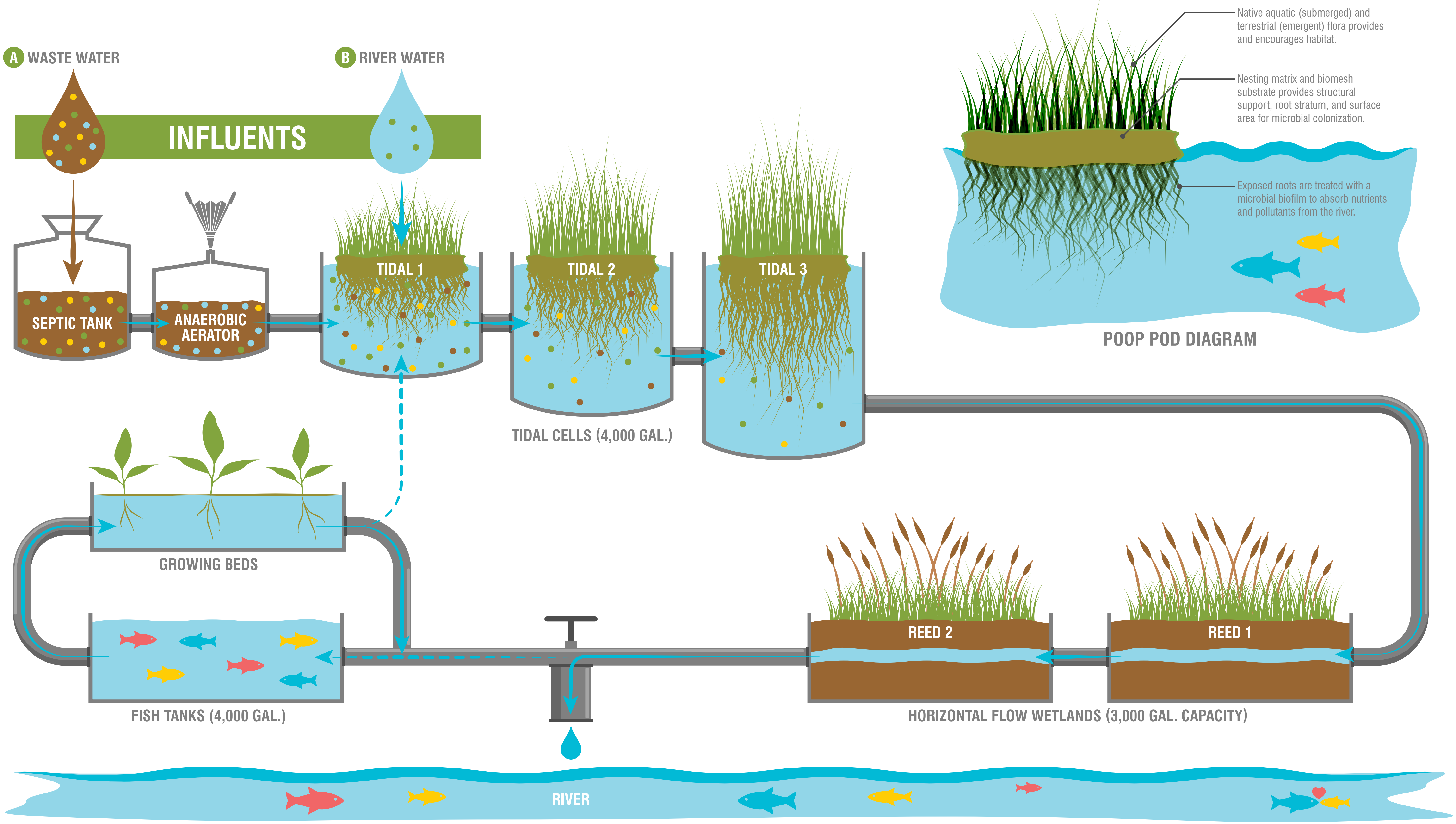
The Looper acts on the principle that the use of water should occur in closed loop cycles at both a micro scale and a macro scale. Locally, all water needs for the greenhouse are supplied by two streams of influent – river water and collected precipitation. Both are filtered, used on site, and returned to the river cleaner for ecosystem recharge.

River water is brought into the barge, cycled through the living machine, and then either returned to the river in a remediated state or used as supply water for the aquaponics loop. Approximately 220,000 gallons of water will be filtered and returned to the river per year. The shape of the greenhouse exterior is optimized to collect rainwater runoff, fog, and condensation. This collected water is filtered through an onboard sand filtration unit and used to water ornamentals and other soil-based vegetables. Approximately 117,000 gallons of water per year will be collected and used. Any excess water will be routed through the living machine for polishing and return to the river.

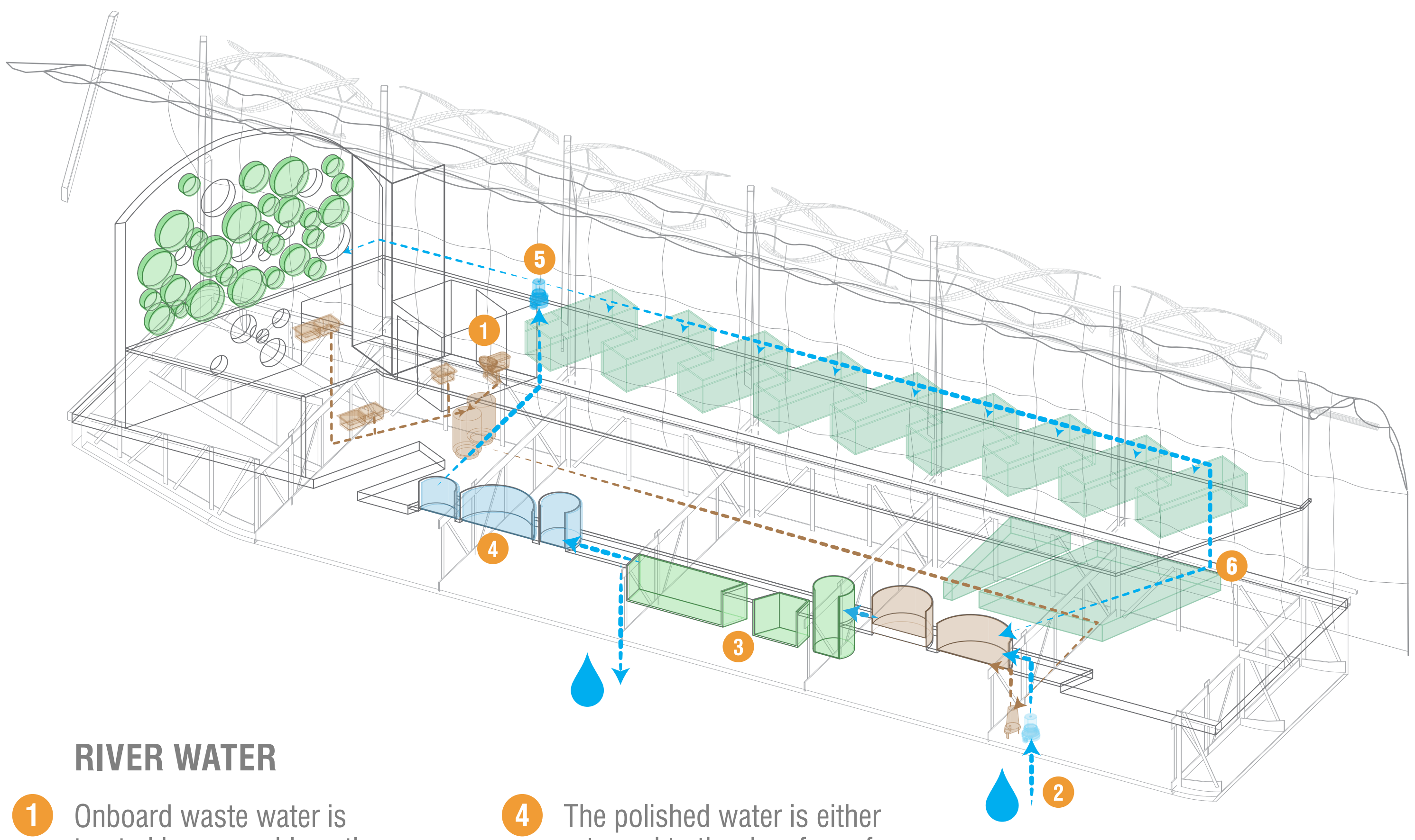
The living machine itself is the centerpiece of the Looper and is essential to its function as a greenhouse, an educational experience, and a remediation tool. The living machine has three stages, each of which is accessible, visible, and conceptually described by their shape, layout, and onboard educational campaign. The first stage encompasses two units – a closed anaerobic septic tank and an anoxic reactor which handle the effluent from the onboard toilets. Solids are settled out and toxins are broken down in order to move the grey water to the open cells of the living machine. River water is introduced to the cycle after the wastewater has been brought to tertiary standards from the first phase. Here, the living machine consists of several “tidal cells” and mimics a natural tidal ecosystem with varying degrees of depth, microbes, plant material (submerged, floating, and emergent species), and fauna (water bugs, snails, mollusks, and small fish). “Horizontal flow wetlands”, are used for final polishing of the water. At the outcome of this stage the water is not potable, but is considered safe for irrigation and grey water use. The water is then either returned to the river or cycled into the aquaponics loop.

The aquaponics component is a closed-loop system that produces organic fish and vegetables and is supplied by water filtered through the living machine. Tanks raise two types of fish – one as a source of protein (tilapia) and the other for the reintroduction of threatened local species (longfin smelt and shiner perch). The plants in this loop are grown in soilless beds and include leafy vegetables (arugula, lettuce, parsley, etc.), micro-greens (beets, turnips, peas), and fruiting plants (tomatoes, cucumbers, strawberries, peppers, etc.). As a closed loop, the fish and plant beds work in symbiosis with each other. The fish waste produces ammonia which bacteria convert to nitrates which is then absorbed by the plants as fertilizer. The clean water is then returned to the fish tank and is recirculated. Following each growing season, the water in the aquaponics loop is circulated through the living machine and returned to the river.

LIVING MACHINE, AQUAPONICS AND BIOREMEDIATION 'POOP PODS'

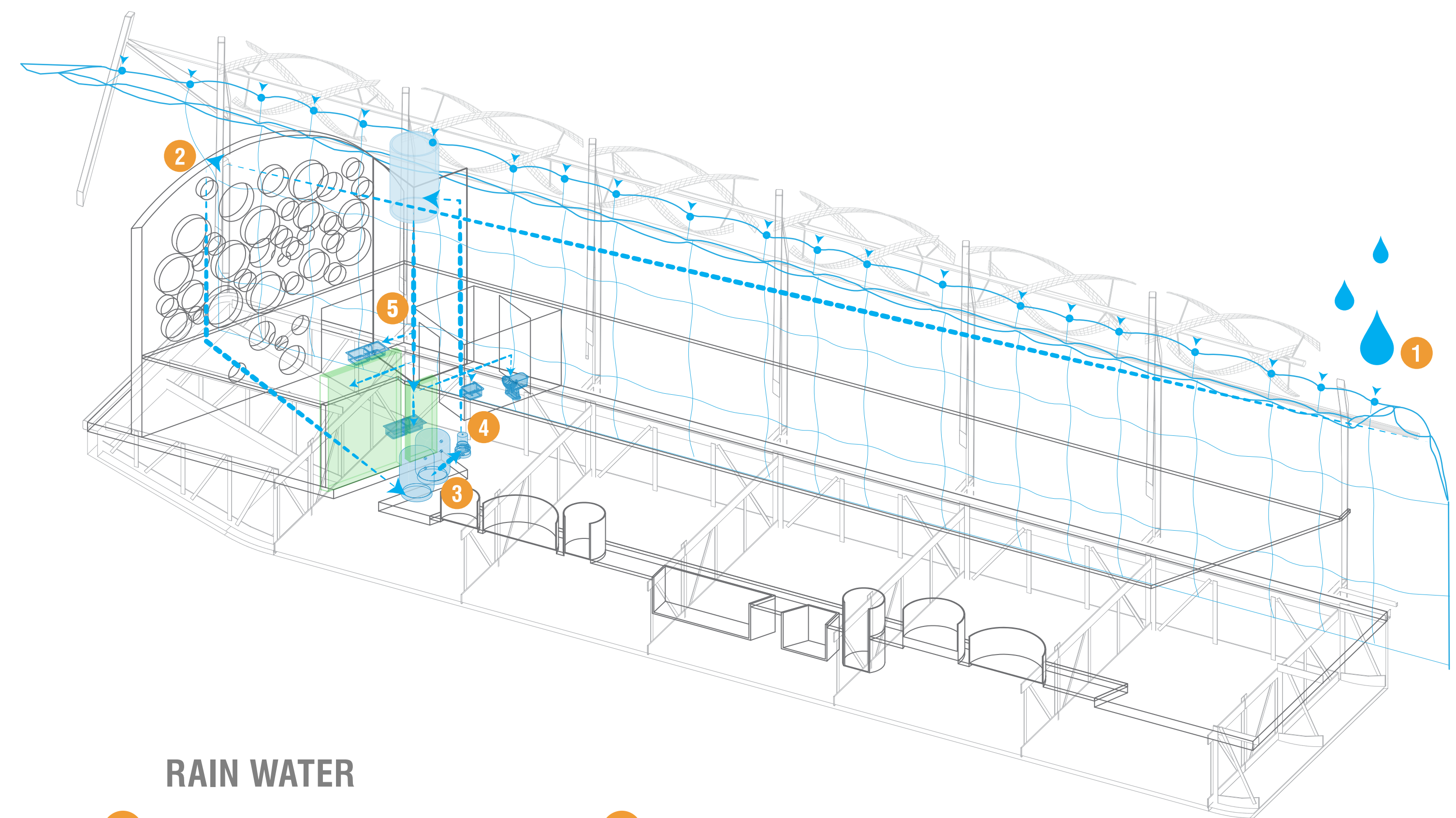


RAIN WATER AND RIVER WATER PURIFICATION AND CIRCULATION SYSTEMS



RIVER WATER

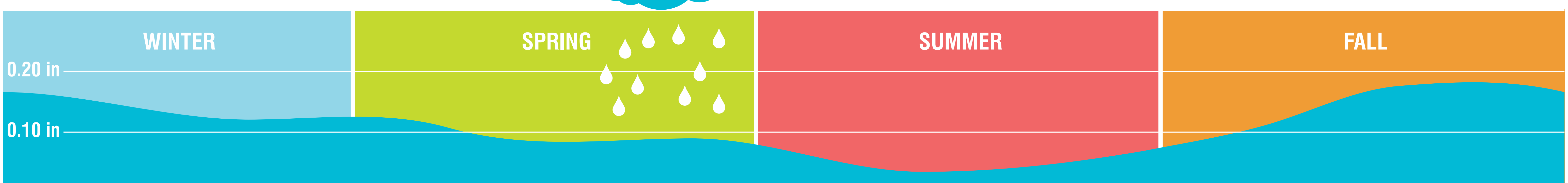
1. Onboard waste water is treated by anaerobic action in a septic tank and anoxic reactor below deck and is then pumped to the initial cells of the living machine.
2. River water is brought directly into the initial cells of the living machine.
3. River water and grey water is filtered through the living machine via tidal cells and horizontal flow wetlands.
4. The polished water is either returned to the river free of pollutants or used to supply the fish tanks.
5. The water from the fish tanks is circulated through the soilless aquaponic beds where the plants convert the fish waste into nitrates for fertilizer.
6. At the conclusion of the aquaponic growing cycle, the water is recirculated through the living machine for polishing and release into the river.



RAIN WATER

1. Rain water and condensation is collected and transmitted on the skin via channels and gravity.
2. Collected rain water is conducted to storage tanks located in the hull of the barge.
3. The rain water is percolated through a sand-filtration unit.
4. Cleansed rain water is pumped to a storage tank above the top deck.
5. Water is gravity-fed to the restrooms and to irrigate the ornamental green wall and ornamental plants.

ANNUAL PRECIPITATION (in)



EQUITY

Supporting a Just, Equitable World

The Looper promotes community interaction, negates the need for parking and other forms of surface disruption, and improves access to nature through the very fact that it is a floating greenhouse and educational space. The user must engage the river in order to take part in the program of the building. By serving several communities along the river as an educational and volunteer center, the greenhouse and living machine are able to reach more communities than a traditionally rooted greenhouse and empower more people to work together towards the common goal of food security.

The Looper is a transparent window into the natural processes of nature. By engaging communities and highlighting the way in which nature functions and human beings interact with it, the greenhouse seeks to reinforce the biophilic connection through hands-on experience and, in turn, reinforce how the community interfaces with its natural components. As users engage the living machine and see how the movement of waste and water through ecosystems is a natural way to promote environmental health, it will encourage better habits and commitment to stewardship beyond the greenhouse and into the community.

HEALTH

Maximizing Physical and Psychological Health and Well Being

According to the Center for Progressive form, “The Swinomish and other Native communities measure overall community health and resilience to climate change impacts using unique factors that link physical, mental, and spiritual aspects. Five primary indicators define overall community health: community cohesion, food security, ceremonial use, knowledge transmission, and self-determination. For example, a severe weather event that causes the community to disperse—affecting community cohesion and knowledge transmission—would have a negative impact on community health. Because place is so central to identity, communities are likely to resist relocation as a response to climate change impacts.” [3]

Due to its mobility, the Looper is able to create and strengthen the link between separate communities by forming a common element and enabling the cross-pollination of citizen stewards, volunteers, and school interaction. Following the indigenous communal philosophies of the region, the living machine and greenhouse highlights and reinforces the connection to ecological stewardship by familiarizing the user with the process of natural wastewater treatment, water collection, habitat creation, aquaponics, and urban agriculture. As a greenhouse, the Looper provides communities with not only access to fresh organic produce and plants, but allows them to understand the importance of food security for everyone by providing a space to participate, share, and foster relationships.

EDUCATION AND COMMUNITY INVOLVEMENT

The Looper is a volunteer destination that will provide practical, first-hand experience growing vegetables, tending to plants, caring for fish and interacting with the living machine, and will act as a mobile hub for the three communities it serves. The volunteers bring the life, labor and love to the entire system by not only tending to the needs of the greenhouse, but by creating the connections that reach out beyond the river, into the towns and villages that will support and benefit from it. Transporting plants to farms and community gardens, delivering fresh produce to food banks, collecting seeds for the bank and securing waste for compost creation are just a few major outreaches that sustain the purpose of the Looper.

We envision the Looper having a co-op style work ethic with volunteers being able to fulfill their needs for giving, finding purpose and participating by sharing in the bounty by bringing it back to their own kitchens and gardens and nourishing their families and friends. Co-op systems are incubators of ideals where people can gather, work together toward a common goal, and share knowledge not only with each other, but with the public at large by hosting workshops and lectures, inviting schools to visit on field trips and allowing connections to be made organically as needs arise in the community.

GREENHOUSE PLANT MAXIMIZATION PLAN AND CROP LIST

SUMMER / FALL PRODUCTION

OUTDOOR TRANSPLANTS FOR FOOD BANK FARMS & COMMUNITY GARDENS

(hearty shade tolerant plants and other common vegetables & herbs)


- Arugula
- Bok Choy
- Totsoi
- Broccoli Raab
- Brussel Sprouts
- Celery
- Chard
- Collard Greens
- Endive


- Kale
- Leeks
- Okra
- Peppers
- Peas
- Beans
- Squash
- Cucumbers
- Cherry Tomatoes


- Tomatillos
- Leaf Lettuce
- Basil
- Cilantro
- Dill
- Marjoram
- Rosemary
- Parsley
- Garlic

FALL / WINTER PRODUCTION

2 CROPS OF FRESH ORGANIC PRODUCE FOR FOOD BANKS

(supplemental fruiting plants)

- Tomatoes
- Cucumbers

- Beans
- Peppers

- Strawberries
- Peas

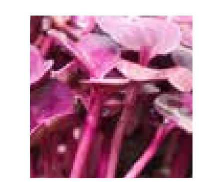
YEAR ROUND PRODUCTION

LIVING WALL LEAFY GREEN PRODUCTION

(aquaponic leafy greens)

- Arugula
- Bibb Red
- Parsley
- Green Lettuce

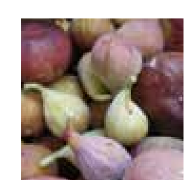
- Romain Lettuce
- Water Cress
- Water Celery
- Water Chestnut



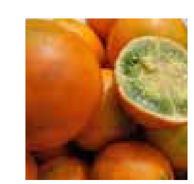
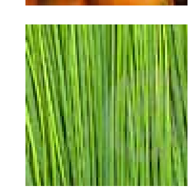
- Micro-Greens:
- Beet
- Turnip
- Pea

CONTAINER ORCHARD / HERB GARDEN

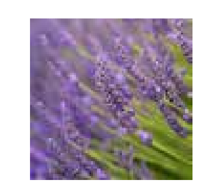
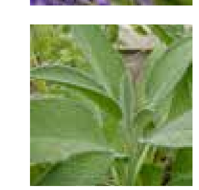
(containers with small bushes/trees that bear fruit, sturdy perennial herbs and vine plants)




- Figs
- Mayer Lemons
- Dwarf Tangerines
- Pomegranate
- Pepin Dulce
- Cape Gooseberry
- Strawberries

- Bacon (Papaya)
- Jillana
- Tomato De Arbor
- Oregano
- Chives
- Mint
- Thyme

- Lavender
- Aloe Vera
- Capers
- Lemon-Grass
- Sage
- Curry Leaf Tree

FOOD NARRATIVE

Our food production plan is to use a combination of aquaponic and soil growing techniques to grow organic, pesticide-free, fresh produce and plants to fill the gap between what the environment and climate can naturally grow and what is needed to create more food security in the bioregion.

According to Feeding America's 2011 food insecurity studies, in Washington State 24.7% of children and 14.8% of the total population are food insecure. These numbers increase in non-metro rural counties, like Snohomish County, where poverty rates are higher and fresh produce is not readily available.

Our plant list also includes a variety of shade tolerant plants that thrive in the climate for outdoor planting that are indigenous to other similar climates around the world. Not only does this help meet the dietary preferences of Asian, Hispanic and other demographics in the area, but it expands the palette of vegetables. Bok choi, tot soi, tomatillos and collard greens are a few.

The vegetable production plan is four–fold:

1. Produce healthy transplants for local Food Bank Farms and community gardens in for the summer growing season.
2. Year-round aquaponic leafy green production.
3. Two supplemental crops of aquaponic grown common vegetables.
4. A year-round container orchard and perennial herb garden.

Our plant production approach starts with a seed and ends with a seed. A seed bank will store seeds that are gathered after crops are harvested. In the spring time these seeds will be germinated, grown into seedlings and begin to mature in aquaponic beds. As the plants begin to mature and their root systems are well established, they can begin a careful transition into soil. Compost from the greenhouse waste and the community will provided added nutrients to the soil. Biodegradable transferring pots can be made out of a number of sources including paper, mushroom waste from the community. The last couple weeks of their growth in the greenhouse in the transition area near the deck will establish and harden, getting them ready for their life at the Food bank farms and in community gardens. When the plants are harvested, fresh produce will supplement the local food banks and the seeds will be collected and saved in the bank.

> "...in Washington State **24.7%** of children and **14.8%** of the total population are food insecure."

An ebb and flow aquaponic growing system was chosen for a number of reasons. Not only does it allow for year-round fresh produce production, but the growth rates of plants are faster and the yields greater. The fish waste dissolves in the water, creating soluble nitrates and other minerals that are absorbed directly into the root system of the plants as their beds are flooded 3 to 5 times per day. Aquaponic beds are soilless and a variety of growing mediums can be used, from pea gravel and sand to recycled wool and other fibrous natural materials.

Aquaponic tanks will support the growth of fishes with clean water sourced from the living machine. The fish typically raised are vegetarian leaning and can feed on a variety of sourced foods from garden waste, larvae, worms and insects or with spent barley or other grains left over from breweries. There are multiple tanks to raise a variety of fish to meet the demands of the community. Growing small quantities of local species like longfin smelt, shiner perch, echelon or the northern anchovy can be sourced for protein or used to restock the river. Tilapia is a very popular, fast growing fish that most aquaponic systems use to meet high protein demands. If two of the larger 1,100 gallon tanks are used to raise tilapia for a 90-day cycle, an estimated 720 lbs of tilapia could be harvested.

Eight aquaponic beds have been have been designated to grow transplants and two supplemental crops of common vegetables in the fall and winter. The bioregion's climate conditions of high moisture, moderate temperatures and cloudiness make it an ideal place for root vegetables to thrive. These conditions make it difficult to grow sun and heat loving vegetables like cucumbers, tomatoes, peppers and lettuce outdoors, but the greenhouse will maximize the growth of these vegetables to fill the gap and create direct access to these important nutritious foods. We estimate one aquaponic bed of Sweet 101 Cherry tomatoes could produce up to 800 pounds of tomatoes in 90 days. (see plant chart)

An aquaponics fed living wall on the 2nd floor and two growing beds will be designated to grow leafy greens year round. Leafy greens take about 30 days to grow and if plantings are staggered, an estimated about 200 heads of lettuce could be harvested every week.

A container orchard will provide one to two yearly crops of smaller citrus, low shrubs fruit bearing plants and containers of perennial herbs that can be regularly harvested. The production yield of the soil containers will not be exceedingly high, but will provide an enriching and educational experience, creating a natural environment and atmosphere for the staff and volunteers. Plants for the container garden include hearty trees, shrubs and herbs that thrive indoors, provide variety and inspire food preparation like meyer lemons, naranijilla and sage. These plants will be able receive regular nutrient fertilization from the compost tea that the greenhouse compost creates.

MATERIALS

Endorsing Products/Processes That Are Safe For All Species Through Time

Rather than building a new structure, the Looper has repurposed a small standard deck river barge. By doing so, the project symbolically connects its use to the maritime culture intrinsic to the Puget Sound region while also giving new life to a structure that would have otherwise been discarded or left to rust. The reuse of an existing barge allows for future fleet expansion or modification as other retired river transport vessels become available. On account of their standardized nature, decommissioned barges could be joined together to create larger coordinated uses or venues.

In contrast to the industrial reuse of the existing structure of the barge, the skin of the greenhouse is designed to be a light, technologically high-performance system. The Looper's exterior envelope is composed of a pneumatic ETFE pillow outer layer on a structural steel cable tensile structure beneath. The skin is dynamic, resource efficient, and modular. ETFE pillows weigh approximately 1% that of comparable-sized glass panels which allow for a lighter structural system and decreases the overall weight of the barge. Again, as compared to glass, ETFE has improved Solar Heat Gain Coefficient (SHGC), higher insulation values, and is fully recyclable. An added benefit to the system is its modularity. If the skin needs to be expanded or contracted, more units can be added or subtracted to the superstructure as needed. In addition, if a pillow is punctured, only that singular pillow need be replaced rather than the whole system.

MATERIAL LIST

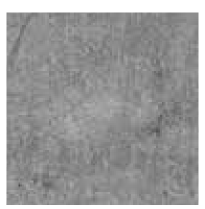
HIGH PERFORMANCE PNEUMATIC SKIN - ETFE FOIL

ETFE is a polymer, scientifically known as polyethylene-co-tetrafluoroethylene. As a non-chlorinated polyethylene material, ETFE is not on the LBC's Red List it is 1% the weight of glass, recyclable, and allows UV light (plant growth light) to transmit while absorbing infra red light.

RECYCLED STEEL

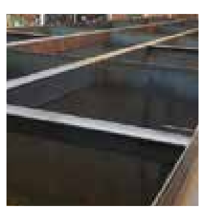
GLASS

SUSTAINABLY SOURCED WOOD DECKING FROM THE CASCADIA REGION



POST-INDUSTRIAL CONCRETE USING 60% RECYCLED SLAG

Concrete with recycled slag reduces the use of Portland cement and can reduce greenhouse gas emissions by up to 45%.



REPURPOSED STEEL BARGE

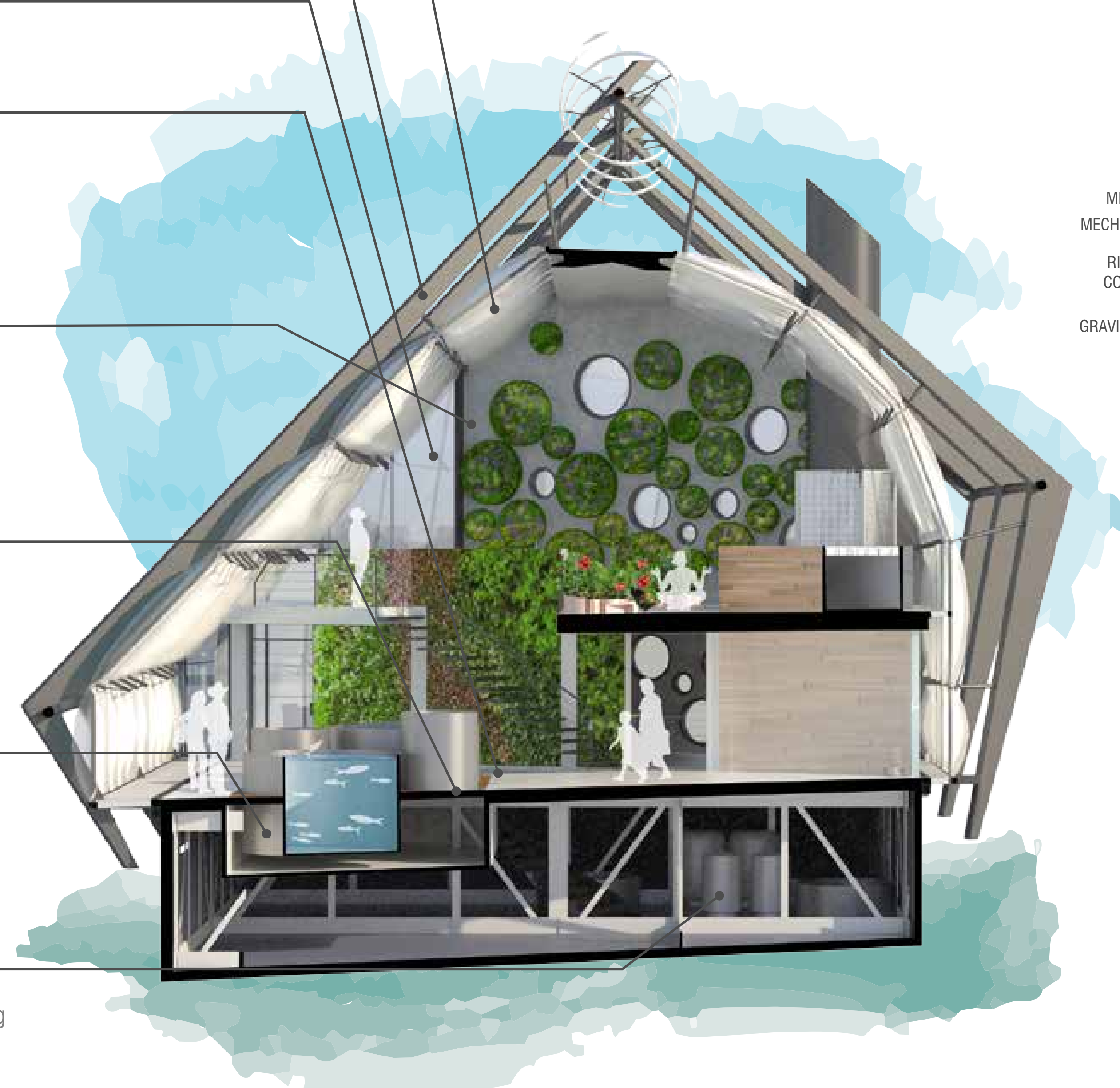
Salvaging an existing barge saves waste and extends the material's useful life.

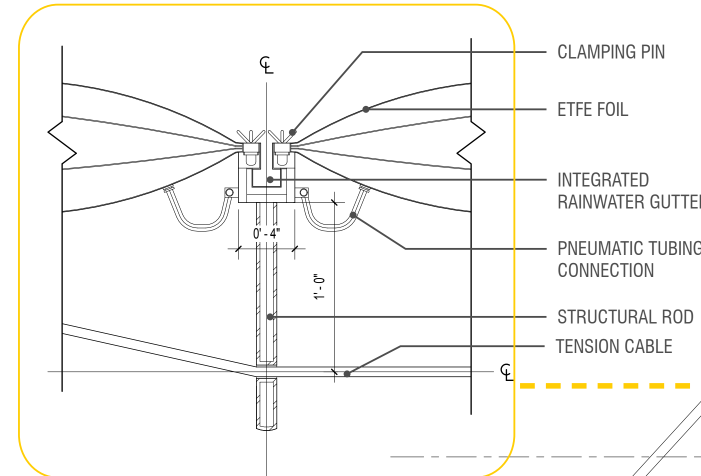
HIGH DENSITY POLYETHYLENE (HDPE) AQUAPONIC TUBS

HDPE aquaponic tubs prevents harmful toxins from leaching into the water from solar and heat exposure.

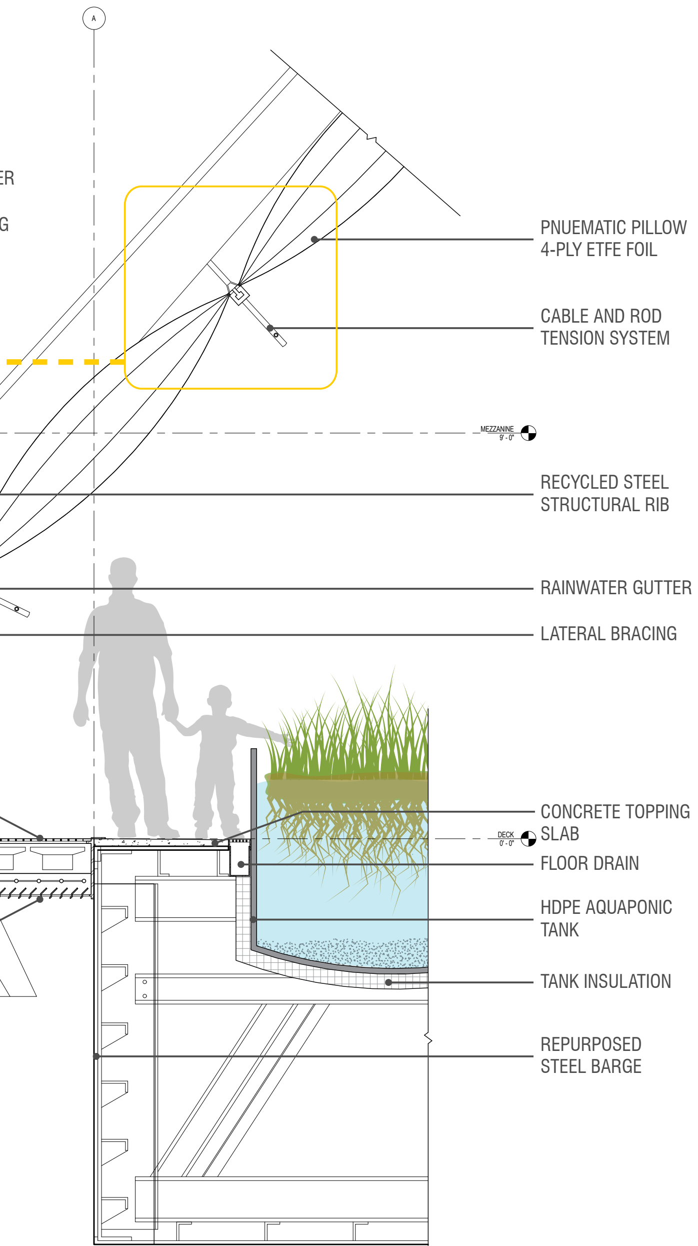
COPPER PIPING

Copper piping prevents harmful toxins from leaching into the water from solar and heat exposure.





TRANSVERSE PNEUMATIC PILLOW DETAIL



TECHNICAL WALL SECTION

BEAUTY

Celebrating Design That Creates Transformative Change

The Snohomish River and the Puget Sound region encompass a long history of maritime culture and local influence. The barge, as a symbol of industrial accomplishment, stands as an icon of development in the region. The greenhouse, a self-righteous necessity of the times stands as hope and determination for the future.

The primary structure of the greenhouse is a repetitive rib system which allows for easy adaptability to new barge sizes, disassembly, and reuse. Large structurally exposed ribs also aesthetically relate to the industrial nature of the local sawmills, ports, and factories of the region.

SOURCES

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