# $H_2$OTEL: A NEW MODEL FOR INTEGRATING WATER SYSTEMS AND COASTAL ARCHITECTURE

by

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Danielle C. Brown

Submitted to the Department of Architecture on January 14th, 2011
in Partial Fufillment of the Requirements for the Degree of Master of Architecture

## Abstract

During the Industrial Era, "dams, water towers, sewage systems, and the like were celebrated as glorious icons, carefully designed, ornamented, and prominently located in the city, testifying to the modern promise of progress."[1] When technology failed to meet society's expectations, "these icons lost their mobilizing powers and began to disappear from the cityscape."[2] These systems became material embodiments of disillusionment and emphasis shifted from the process of production to the product of production. As technological systems were visually severed from society and natural processes, water became re-conceptualized as a commodity that miraculously enters the "domestic sphere, coming from nowhere in particular."[3]

This separation between process and product has transformed consumers' perception of water into a limitless and inexhaustible resource. This misconception has placed the world's freshwater supply is in a state of crisis. Dieter Grau explains that "water is wasted all over the world, in countries with rapidly growing cities that are in the early stages of industrialization, in industrialized countries growing at a moderate rate, in regions that have little water and regions that have a lot of water."[4]

The thesis addresses these issues by re-evaluating the organizational strategy of a typical hotel design to emphasize the connection between the consumer and both active and passive water processes. The $H_2$Otel is a new model for coastal architecture that not only mitigates the effects of industrialization on water but also takes water out of its current status as a limitless commodity and, once again, transforms it into a valuable resource.

Thesis Supervisor: Shun Kanda
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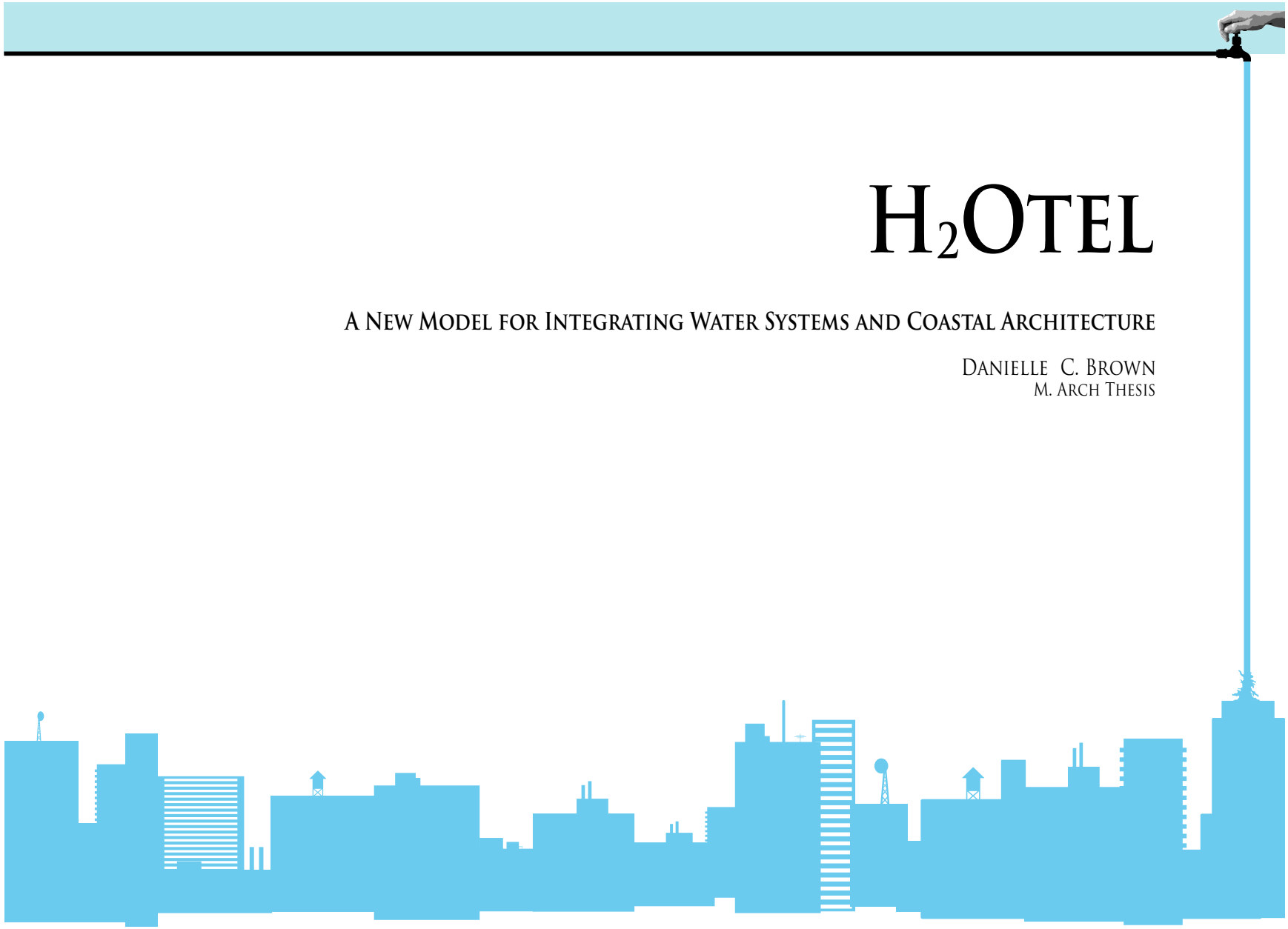
# $H_2O$TEL

## A New Model for Integrating Water Systems and Coastal Architecture

Danielle C. Brown
M. Arch Thesis



# Table of Contents

Thesis Statement 13

## Background

Macro Research 16
Precedent Analysis 29
Location of Tinos Island 36
Tinos Town 38
Site Selection 40
Site Annotations 41
Site Analysis 44

## Defining the Components

Program Development 48
Water System Comparison 51
System Calculations 56
Desalination System Analysis 58
Basic Hotel Program and Size Options 64
Tourists Visiting Tinos 66
Program Development Details for Guest Engagement and Education 68

## Design Process

Models 80

## Final Project

Models 86
Drawings 90
Presentation Boards 112

# Thesis Statement

During the Industrial Era, "dams, water towers, sewage systems, and the like were celebrated as glorious icons, carefully designed, ornamented, and prominently located in the city, testifying to the modern promise of progress."[1] When technology failed to meet society's expectations, "these icons lost their mobilizing powers and began to disappear from the cityscape."[2] These systems became material embodiments of disillusionment and emphasis shifted from the process of production to the product of production. As technological systems were visually severed from society and natural processes, water became re-conceptualized as a commodity that miraculously enters the "domestic sphere, coming from nowhere in particular."[3]

This separation between process and product has transformed consumers' perception of water into a limitless and inexhaustible resource. This misconception has placed the world's freshwater supply is in a state of crisis. Dieter Grau explains that "water is wasted all over the world, in countries with rapidly growing cities that are in the early stages of industrialization, in industrialized countries growing at a moderate rate, in regions that have little water and regions that have a lot of water."[4]

The thesis investigates how freshwater quantity and quality can be conserved, rather than exploited, through designing a hotel on the coast of Tinos, one of the Aegean Archipelago Islands in Greece. Greece serves as an important location for analysis as the nation's history illustrates a strong understanding of natural water processes. Additionally, the Islands are experiencing a significant water deficit exacerbated by national debt, yearly population influx from tourism, rapid urbanization, and the semi-arid climate.

During ancient times, the Island of Tinos was called Ydrousa, meaning water, because of its plentiful supply.[5] The plentiful supply of water was supported by water systems that were "modest, highly integrated, and economical."[6] Conversely, today, industrialization in Tinos has allowed for an inundation of tourist activities which has destroyed the island's natural balance and severely threatened water resources. Through the application of existing technologies alone, hotels could significantly reduce water usage by 50%. This application could allow for tourism to increase in the future and decrease water stress on the Aegean Archipelago Islands.

However, introducing water systems that attempt to mitigate the damage of water resources on the island will not produce knowledge or incentives for the consumer. The hotel promotes an attitude of consumption through providing economic growth to the producer and fulfilling excessive desires of consumers while placing the environment it is situated in to the side. The thesis addresses these issues by re-evaluating the organizational strategy of a typical hotel design to emphasize the connection between the consumer and both active and passive water processes. The $H_2O$tel is a new model for coastal architecture that not only mitigates the effects of industrialization on water but also takes water out of its current status as a limitless commodity and, once again, transforms it into a valuable resource.

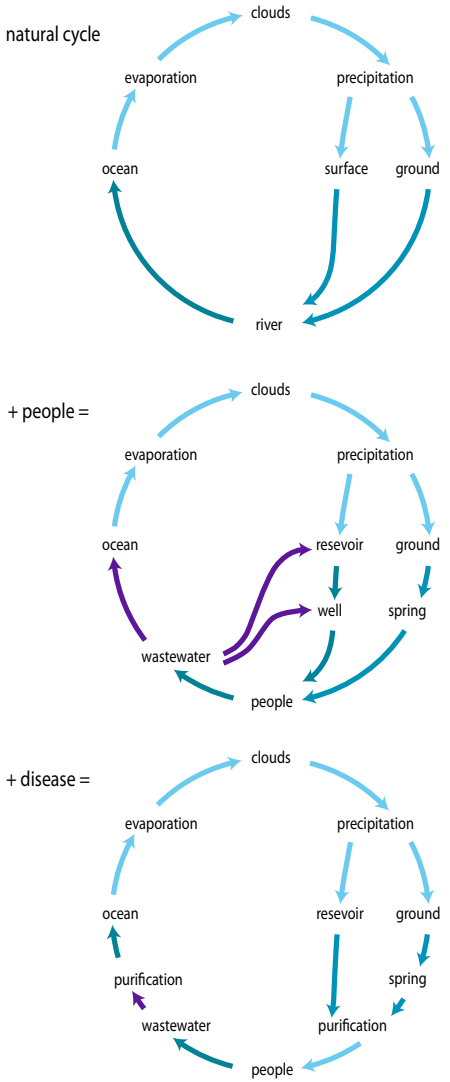
# Background

## In The Beginning

It is important to commence the discussion of water consumption thousands of years ago before the natural balance of water was interrupted as shown in Figure 1. Before humanity the hydrologic cycle created a natural and continuous filtration process, rain from the sky landed on the earth's surface and drained into the rivers which flowed into the oceans. Heat from the sun caused bodies of water to evaporate bringing the water vapor back into the clouds. Once humans came into being obtaining freshwater for survival took time and work. Only in the last 10,000 years have people discovered how to manipulate water to raise crops and support domesticated animals. The first ancient civilizations to successfully control the flow of water were in Mesopotamia and Egypt about 5,000 years ago. Around the same time period, urban hydraulic systems appeared in Greece supported by an understanding of natural processes and the utilization of science. These hydraulic systems were implemented in aqueducts, water wheels, cisterns, wells, fountains, and bathrooms. The Romans continued to develop these hydraulic systems through sophisticated engineering practices until the fall of the Empire. Following the fall of the Roman Empire, science and technology probably retrogressed. This time was known as the Dark Ages, a period when sanitation and public health declined. Wastewater was dumped into the streets and intermingled with drinking water facilitating the spread of epidemics through Europe.[7]

In the nineteenth century, problems with disease from wastewater infiltration and urban fires led to the implementation of a central water system. The invention of the steam engine enabled pumping of freshwater from springs, wells, rivers, lakes, and reservoirs throughout the city through a central water system.[8] This time of technological advances was known as

Figure 1: Evolution of the Water Cycle



the Industrial Revolution. The combination of water and technology replaced the natural water cycle with a mechanized process of pumping freshwater to and from the city see Figure 2.[9]

Figure 2: New York City Central Water System

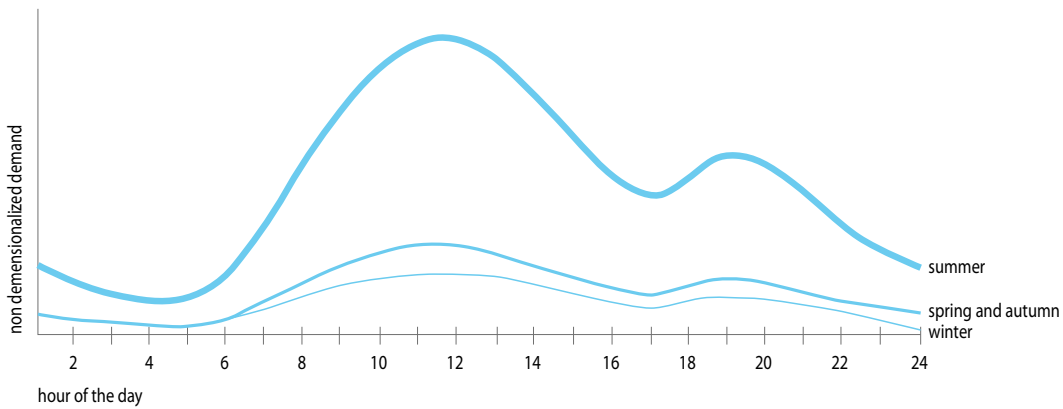
Industrialization of water systems has enabled rapid urbanization and caused increased demand. During this time period, the only limit to obtaining freshwater through a central supply system was the availability of information and engineers to implement the system. Increased demand for potable water came in many forms. Domestic users consumed water for cleaning, drinking, and cooking. Producers were also water consumers including industries like farmers, "bakers, brewers, tanners, sugar refiners, bar owners, and hotelkeepers. In these industries, water quality was as important as water quantity."[10]

Industrialization has allowed countries to consume water beyond their means. "Modern treatment plants have replaced the natural water cycle with a mechanized hydrologic cycle of collection, filtration, and sedimentation."[11] Instead of allowing the natural hydrologic cycle to take place and cleanse our water, we have completely replaced the cycle with one that is quicker and faster in order to meet increasing demands of both the consumer and the producer. Rem Koolhaas has found that technological innovations have not been the agents of "objective and quantifiable improvements…It is a superior substitute for the 'natural' reality that is being depleted by the sheer density of human consumers."[12]

## Environment of Consumption

Greece is currently in the midst of bankruptcy with an increasing percentage of its gross domestic product dependant on tourism. Tourism activities peak in the summer months when natural water availability is at its lowest and consumption of water is at its highest as shown in Figure 3.[13] In the summer, the Greek islands can experience water demand five to ten times higher than in the winter.[14] Industrialized activities have allowed Greece to meet high water demands through drawing groundwater, damming rivers to create reservoirs, and importing water to the islands. "Some 80-85% of freshwater resources are in the form of surface water and the rest are from groundwater."[15] The combination of dry summers, an inundation of water consuming tourists, and

Figure 3: Typical Daily Water Demand for the Aegean Archipelago Islands




industrialization of natural water systems have become major contributors to the degradation of Greece's natural environment.

"Normally governments of any nation always look for immediate solutions [to meet demand] and in the whole process ignore future consequences."[16] Overexploitation of groundwater in coastal aquifers has led to seawater infiltration.[17] As groundwater is extracted, the water level decreases creating a suction that pulls nearby saltwater into the fresh groundwater. A lack of freshwater on the Aegean Archipelago Islands has put many of them in serious danger of desertification. The unequal distribution of tourism activities on the Islands has caused Greece to overexploit groundwater resulting in seawater infiltration and the threat of desertification as shown in Figure 4.[18 19]

A Lack of freshwater on the islands has forced Greece to take other measures in supplying demands. In 2004, Greece operated seventeen large dams which served to provide electricity, and create reservoirs of freshwater used for both drinking water and agriculture.[20] A recent study by the World Resources Institute has shown that damming alters the dynamics of rivers. Dams decrease the flow of water passing through the river creating massive flooding upstream and a small flow of water downstream. By decreasing the flow of water, dams increase stagnation which decreases the ability of water to breakdown organic pollutants.[21] Damming also prevents the flow of important sediments and migratory fish from passing through severely changing the river's natural ecology.

Fresh groundwater has been exploited to the point that it cannot be renewed. Ultimately, the natural water cycle has been damaged.[22] To solve this problem, Greece transports water from

Figure 4: Groundwater
Overexploitation and Desertification

areas of groundwater overexploitation
high desertification vulnerability
medium desertification vulnerability

the reservoirs that the dams create to the Aegean Archipelago Islands and other coastal areas in Greece lacking freshwater. Water imports to the Islands are increasing and "almost 80% of the freshwater required on the Islands is imported."[23] See Figure 5.[24]

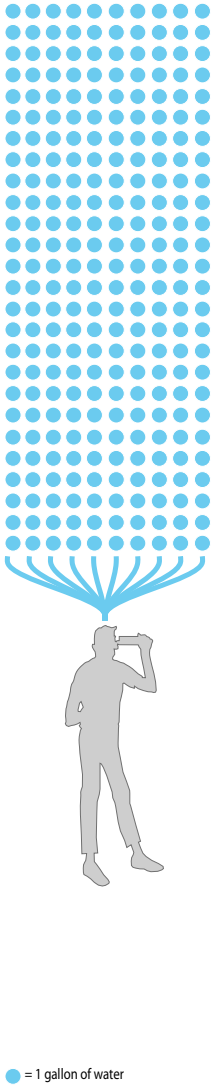
This solution appears to solve the lack of freshwater on the islands, but in actuality, it replaces one environmental problem with another. In the past ten years, Greece has put effort into implementing new methods of obtaining freshwater on the islands attempting to reduce imports. These solutions will be discussed in the section Current Practices Promoting Water Conservation.

Figure 5: Water Quanitity Transferred Annually to the Aegean Islands

## Perception of Consumption

Industrialization of water systems has made the resource easily accessible and has changed the perception of it. Greece takes a demand-oriented approach by constantly meeting high water demands. This produces a "false belief that water consumption can be endless"[25] For example, A typical Mediterranean tourist uses 260 gallons of water a day.[26] See Figure 6. Low water charges also encourage this perception of unlimited water. In Greece, water prices do not accurately reflect its market value. "Thus, users remain unaware of the price they are really paying for water, and this leads to careless handling of the resource."[27]

Figure 6: Daily Freshwater Consumed



False perceptions of freshwater availability have caused its value to depreciate. Before the technological inventions of the Industrial Revolution, water was a precious source for survival. The Romans brought freshwater into the cities through the aqueducts, where its arrival was celebrated in ceremonial fountains. Roman fountains served as a main focal point of public life. Water was not celebrated simply because it was mystical and beautiful but because of its virtue for sustaining life. Today, industrialized citizens do not go to fountains for drinking water, but "it is still a focal point in communities."[28]

As water has become easily accessible, it is no longer valued as a precious commodity and many people "perceive water as a non-limited resource."[29] The value of water in industrialized nations has changed from signifying survival to becoming another item for exploitation at the consumers' disposal.

For example, the Dubai Fountain designed by WET Design is one of the largest fountains in the world. See Figure 7.[30] The body of water is about 900 feet wide and the fountain can shoot a maximum of 500 feet high. The extravagant entertainment this fountain offers can be viewed from up to 20 miles away.[31] Dubai is located in a desert, so the fountain loses much of its water through evaporation. However, it provides a spectacle for those who gather around it.

Figure 7: Dubai Fountain

## Architecture of Consumption

The attitude of consumption has pervaded the lifestyle of every industrialized citizen and architecture has served to promote this exploitation of water and splendor. Through the burgeoning industrial order architecture has created "palaces of consumption designed to bedazzle, delight, and seduce the customer."[32] The Ice Hotel in Sweden is made completely of water and provides an example of this condition. Using "10,000 tons of clear ice…and 30,000 tons of pure snow,"[33] the ice hotel is rebuilt every year creating a unique spectacle of consumption that attracts many tourists. See Figure 8.[34]

Architecture not only promotes water exploitation through entertainment but also through excess consumption and waste. Once water leaves the treatment plant it is piped underground to showers, sinks, ice-makers, toilets, dishwashers, washing machines, and sprinklers, pools, and fountains. After the water has met the

demands it is then flushed away and out-of-sight.

Figure 8: Ice Hotel in Sweden

To understand architecture's role as a facilitator in water consumption, it is important to compare different industries. For example, a survey conducted on industrial, commercial, and institutional buildings in Vancouver, British Columbia identifies that dairy farms use approximately 3,000 gallons of water per day, offices use 2,500gpd, hotels use 21,000gpd, car washes use 2,300gpd, golf courses use 8,000gpd, hospitals use 8,200gpd, recreational facilities use 6,000gpd, universities use 83,000gpd, and shopping malls use 7,000gpd as shown in Figure 9. [35] This survey offers only an estimate of water use, and a comparison of water use between these industries is difficult as the type of water usage and occupancy changes as well as the size of the buildings.

## Consumption Leads to Pollution

In Greece, tourists' excessive water consumption has produced excessive waste. For every tourist that uses 260 gallons of freshwater per day, 50 gallons of wastewater is produced as shown in Figure 10.[36] Waste from tourism contributes 7% of pollution in the Mediterranean Sea through increased industrialized activities including motor vehicles, insufficient

Figure 9: Average Daily Water Demand

sewage systems, detergents, and other harmful chemicals that are directed into the sea.[37]

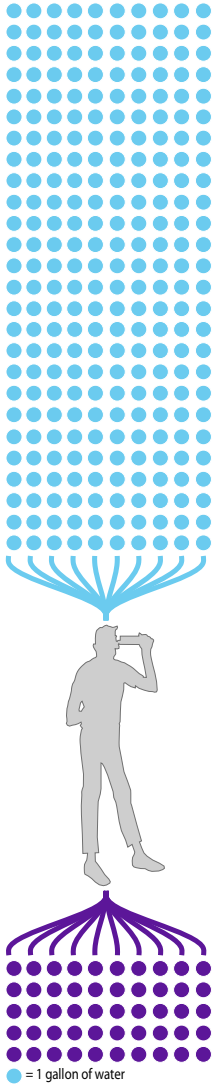
Many hotels in Greece, located in isolated areas near the coast, are not connected to a water treatment network. Greece requires that these hotels build their own treatment system, but many times these local systems are not properly maintained or do not have the ability to meet the summer influx of waste produced by tourists.[38] Insufficient wastewater practices not only have an adverse affect on the island environment, they also adversely affect tourism. Tourists swimming in polluted sea water could become severely ill. This would serve as both a health and economic hazard for Greece.

## Current Practices Promoting Water Conservation

### Governmental Policies

Shortly after Greece joined the

Figure 10: Consumed and Wasted Water




European Union in 1981, pressure for better freshwater management heightened. In 2003, a new legislative and institutional framework for water protection and sustainable management of water resources has been put into force in the country.[39] The new legislation takes a holistic approach which explicitly recognizes the importance of ecological function, protection and remediation of water resources, appropriate pricing of freshwater, reduction of pollution, and the mitigation of droughts. Though Greece's legislative plan has proven quite successful in retaining water quality, it is difficult to implement these laws.[40] Currently, Greece permits the discharge of effluence by industries within a specified threshold. This threshold is difficult to control as monitoring must be implemented in each case. Water quality monitoring is conducted by the Ministry of Health and its Regional Laboratories for Public Health. Studies have found that drinking water in the Aegean Archipelago Islands is "good for 82% of

the population, satisfactory for 8%, and not satisfactory for 2% due to marine water intrusion in coastal aquifers."[41]

## Basic Filtration Methods

While industrialization has allowed for excessive consumption and pollution of freshwater, there are many solutions that can be implemented to cleanse and recycle water including reverse osmosis, silver colloidal filters, ultra violet lights, distillation, and biofiltration. These methods are safer practices for cleansing water without introducing potentially harmful chemicals such as chlorine. Reverse osmosis is used primarily in desalinating sea water and it "is found to be the best alternative, especially for applications in remote, often off-grid areas…such as islands."[42] However, because reverse osmosis does not always remove the bacteria from the water, it is usually coupled with ultra violet lighting which serves to remove the water's bacteria. Colloidal silver is another method of removing bacteria which has been approved as a filtration method by the Environmental Protection Agency.[43] Distillation is also used in desalinating sea water. This process boils unfiltered water and collects the evaporation for drinking. Alternatively, biofiltration systems are not used for the purpose of creating drinking water but rather primarily used to cleanse water before it enters the ground. Biofiltration is a "land-based practice that uses chemical, biological and physical properties of plants, microbes and soils to control the both the quality and quantity of water within a landscape."[44]

## Implementing Different Water Systems

Water efficiency can be implemented in many common domestic water systems. These systems come in the form of faucets, showerheads, different types of lavatories, washing machines, and irrigation systems. The use of low-flow fixtures such as faucets and showerheads can reduce water usage by 50%.[45] Types of lavatory systems which use less water include low flow or dual flush toilets. There are also lavatory systems which remove the need for water including incinerating and composting toilets. Sanyo has recently developed a waterless washing machine called Aqua AWD-AQ1 Ozone that cleans clothes by transforming air into ozone.[46] Also, using drip irrigation systems instead of traditional sprinklers significantly reduces water usage by 60-90%.[47]

## Dealing with Excess Wastewater, Water Scarcity, and Recycling

In Singapore, the country's small land area does not have enough space to collect and store the water it needs. So they have traditionally dealt with high volumes of water by directing it through large concrete underground channels. Recently, Singapore has begun implementing an open biofiltration system as opposed to a

closed pipe system for removing water. These systems use reinforced soil to accommodate for the erosive energy from high water flows.[48] By using biofiltration, Singapore is not only creating beautiful landscaping but also naturally cleansing the unwanted water. In addition to removing water, Singapore has also been forced to recycle wastewater. Their system for filtration uses advanced membrane technology, resulting in the end product called NEWater.[49]

In arid or semi-arid climates creative solutions must be implemented to conserve water for yearly use. For example, the monks in the Hoggar Mountains in Algeria have survived on rainwater catchment for the last fifty years. Though it rains about once a year, rainwater catchment allows them to collect enough water for the entire year.[50] Rainwater catchment systems have been used for centuries as they are essentially reservoirs, but what makes the monks in Hoggar Mountains unique is how they conserve water. Through carefully rationing daily water use, they have been able to survive using little water.

In the Aegean Archipelago Islands, rainwater has been collected in small domestic or public cisterns and one of the most widely considered solutions for the water shortages has been constructing new surface water reservoirs. Unfortunately, these solutions may only be temporary as precipitation in the area has decreased approximately .8 inches per year during the last 40 years.[51] Some of the Aegean Archipelago Islands have begun implementing desalination plants as "significant progress has been achieved in reducing costs of desalinating water."[52]

Another example of recycling systems can be learned from using a hierarchy of water to balance and conserve water usage. Traditionally, before the Industrial Revolution, all water was treated as valuable even after its first use. Potable water was only used for drinking and cooking, cleaning and maintenance could use lower quality water, lastly, agriculture and business could use the lowest water quality.

L'Aubier Hotel and Restaurant in Switzerland provides an example of how water can influence organization see Figure 11.[53] Through a series of pools and fountains water is celebrated and separated into high and medium quality. The water is kept continuously circulating in and out of the pools which avoids the need to chlorinate the water. Within the hotel, medium quality rainwater is harvested and used for hotel's washing, cleaning and toilet flushing. Rainwater is also used to feed the hotel's organic crops.

Figure 11: L'aubier Hotel

Food produced by the crops is used in the hotel's restaurant.[54]

Vitruvius also suggests a hierarchal organization of water when explaining the water systems in Rome. The system he describes does not address recycling of water but rather a social hierarchy that places the public sector in priority over the private household. Vitruvius specifies that there will be three separate cisterns for storing water before it reaches the city, from the "central tank, pipes will be laid to all the basins and fountains; from the second tank, to baths, so that they may yield an annual income to the state; and from the third, to private houses, so that water for public use will not run short."[55]

## Certification Processes

According to the United Nations Environmental Programme in 2001, there were seventy eco-labeling and certification programs offering seals of approval for sustainable tourism. Certification is divided into three types of programs. The first type is general tourism certification; it is most often used by mass tourism industries such as hotel chains who are more concerned with certification for the purpose of marketing rather than wider conservation issues. The second type is a sustainable tourism certification which focuses on socio-cultural and economic impacts of environmental conservation. The third type is an ecotourism certification. This type of program is for companies that identify as being involved in ecotourism. These industries are primarily located in protected ecosystems in isolated areas. They promote the reduction of negative environmental impacts through sustainability and eco-efficiency.[56] Ecotourism does not directly correspond to water conservancy though promoting sustainability implies this notion. Many of the hotels with ecotourism certification are not connected to main wastewater treatment facilities. Sometimes wastewater disposal is not handled properly and leads to ground water pollution that threatens the delicate ecosystem the hotel is situated in.[57]

Due to the wide variety of certification programs in the tourism industry, it is difficult to evaluate the environmental effectiveness. The European Environmental Agency has reported that there was a "five-fold increase between 1990 and 2001 in the use of eco-labels for accommodation."[58] Unfortunately, there is no data being collected or evaluation being done to ensure positive environmental results through certification processes making their existence a question of sustainability or marketing ploys.

## Conclusions

The $H_2O$tel transforms the role of the hotel as an "instrument of consumption"[59] into a building that connects the consumer to both passive and active water processes. The $H_2O$tel is located on the island of Tinos, where unbalanced tourist activities as well as physical scarcity have created a serious

threat to water resources. Due to Greece's geography, water resources are ample in the mountainous North West with yearly precipitation at more than 76 inches. Conversely, freshwater resources in the Aegean Archipelago Islands are scarce with yearly precipitation at about 12 inches with half being lost through evapotranspiration. See Figure 12.[60]

Currently, there is a detachment between governmental policies in Greece for conserving water, using different water systems to conserve usage, and the water consumption of the tourist. Governmental policies and conserving water systems exist behind the scenes. The buildings' system are out-of-sight and hidden behind the walls never reaching the sight of the consumer. To encourage consumers to use less water many hotels have begun placing signs out to hang towels up if the guest does not want them to be cleaned daily. However, these tactics alone cannot affect the consumer without creating incentives at the source.

Hotels are a place which people go for pleasure and relaxation. They provide luxury, where people feel free to act as they would not at home. Hotels embody splendor and excess providing ample amenities such as hot tubs, daily fresh linens and towels, pools, gardens, fountains, and other means of recreation. Hotels only exist as another "mechanism of distribution and consumption"[61] that industrialization has made possible.

A typical Hotel uses the highest water quality for all of its water consuming functions. See Figure 13. The $H_2O$tel addresses these issues by re-evaluating the organizational strategy of a typical hotel design to emphasize the connection between the consumer and both active and passive water processes. The $H_2O$tel is a new model for coastal architecture that not only mitigates the effects of industrialization on water but also takes water out of its current status as a limitless commodity and, once again, transforms it into a valuable resource.

Figure 13: Typical Hotel Water System

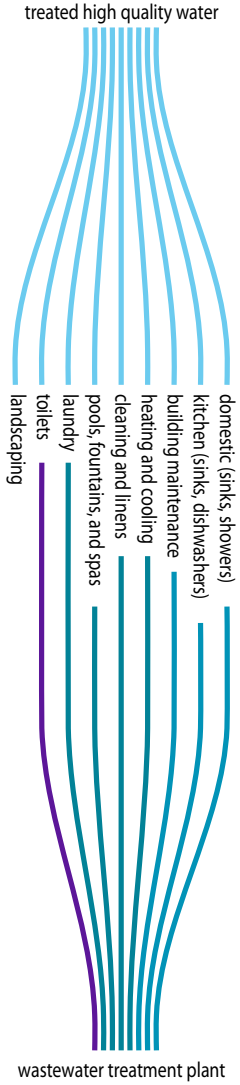


Figure 12: Annual Rainfall in Greece

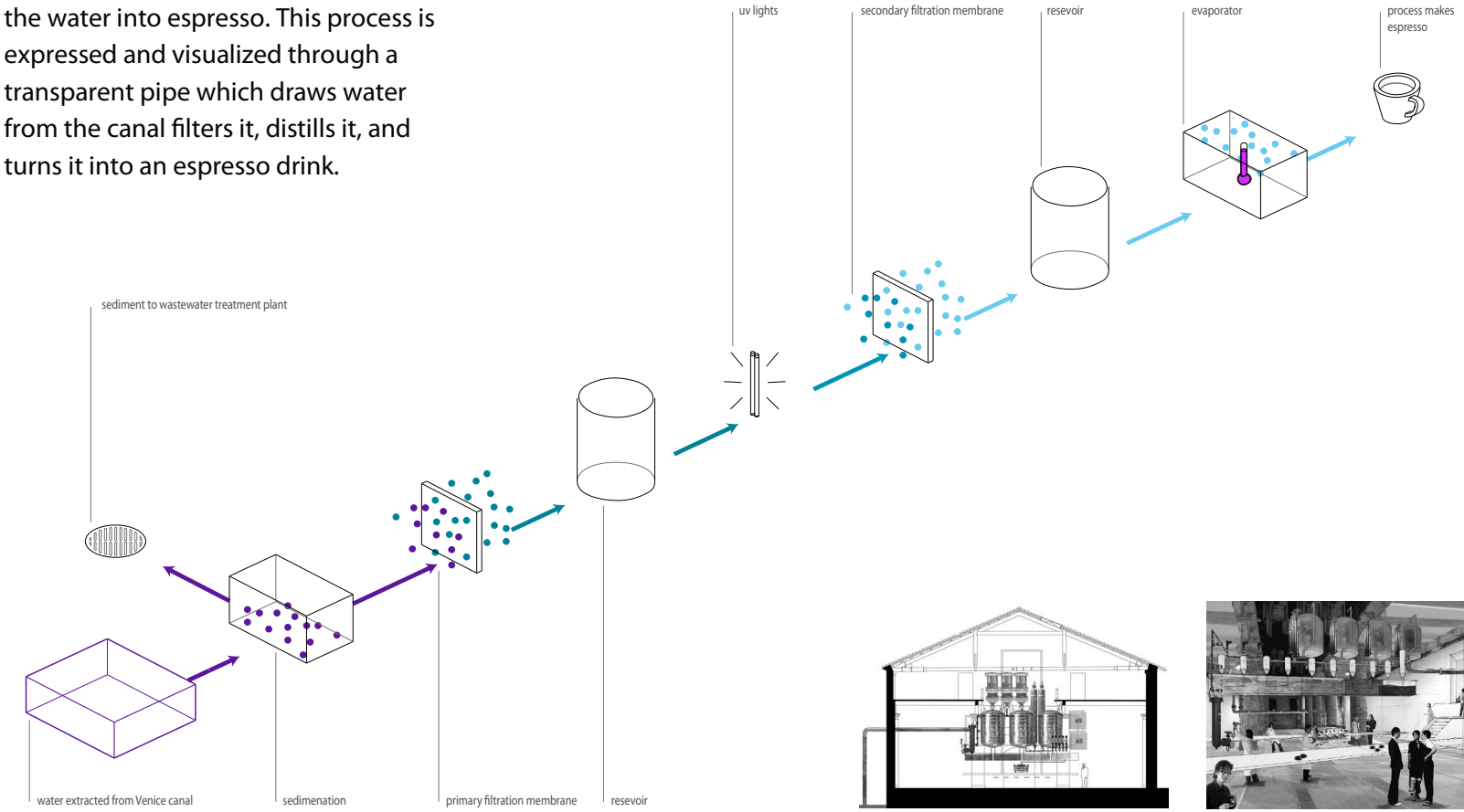
12 - 24
24 - 36
36 - 48
48 - 52
52 - 76

measurements given in inches per year

## PH PROJECT

designer: Diller, Scofidio, + Renfro

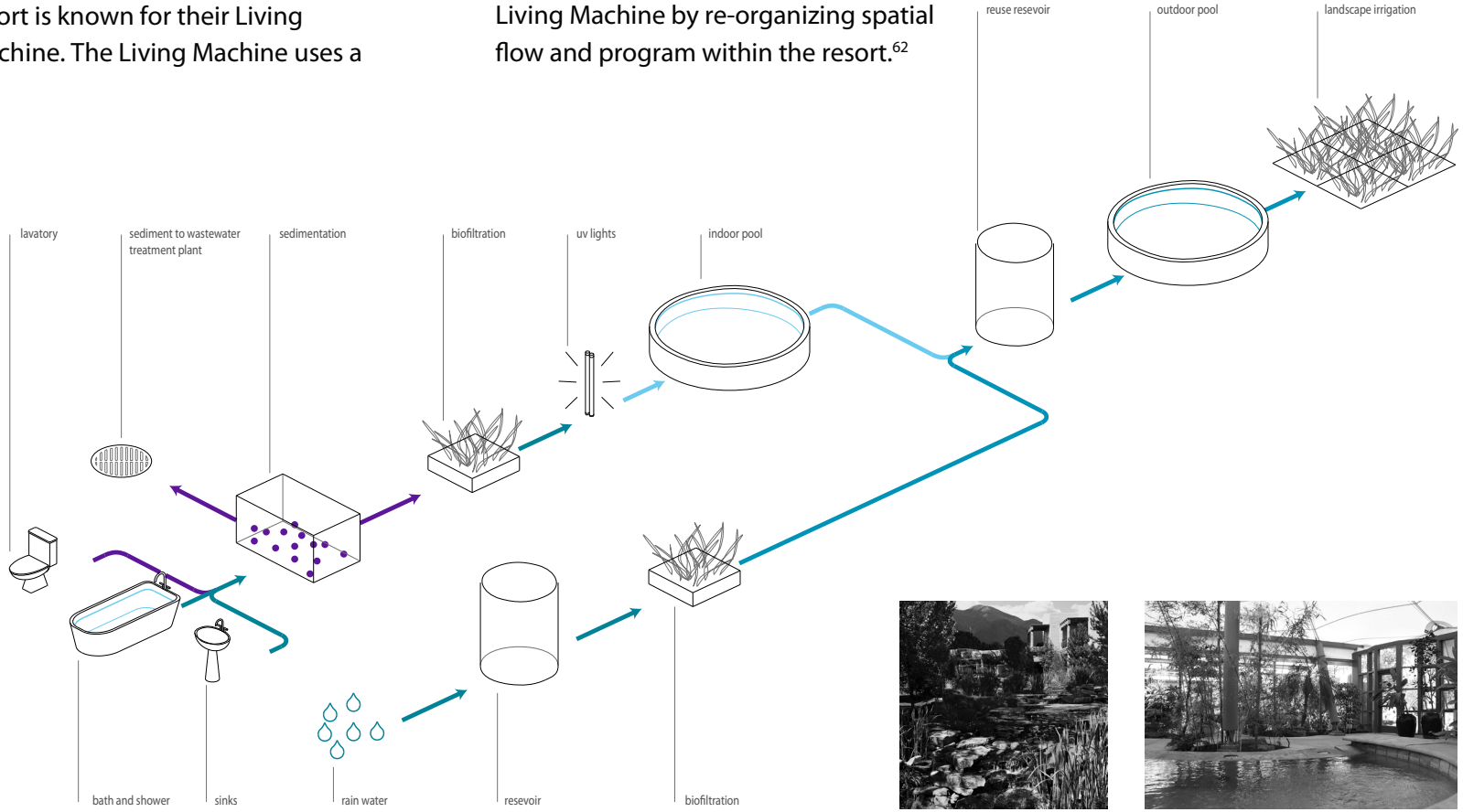
Diller, Scofidio, and Renfro designed the PH project for Venice. It is a purification system that cleans the polluted tidal wetlands and converts the water into espresso. This process is expressed and visualized through a transparent pipe which draws water from the canal filters it, distills it, and turns it into an espresso drink.



## El Monte Sagrado Resort

designer: Living Designs Group Architects

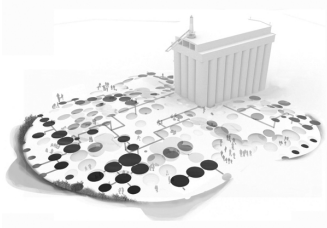
The El Monte Sagrado Resort in New Mexico is an example of how water systems can influence awareness through spatial organization. The resort is known for their Living Machine. The Living Machine uses a biofiltration system to visualize, naturally cleanse, and recycle water. The system creates an ecosystem of its own that flows throughout the resort and encircles the swimming pool. The El Monte Sagrado Resort expresses their Living Machine by re-organizing spatial flow and program within the resort.[62]

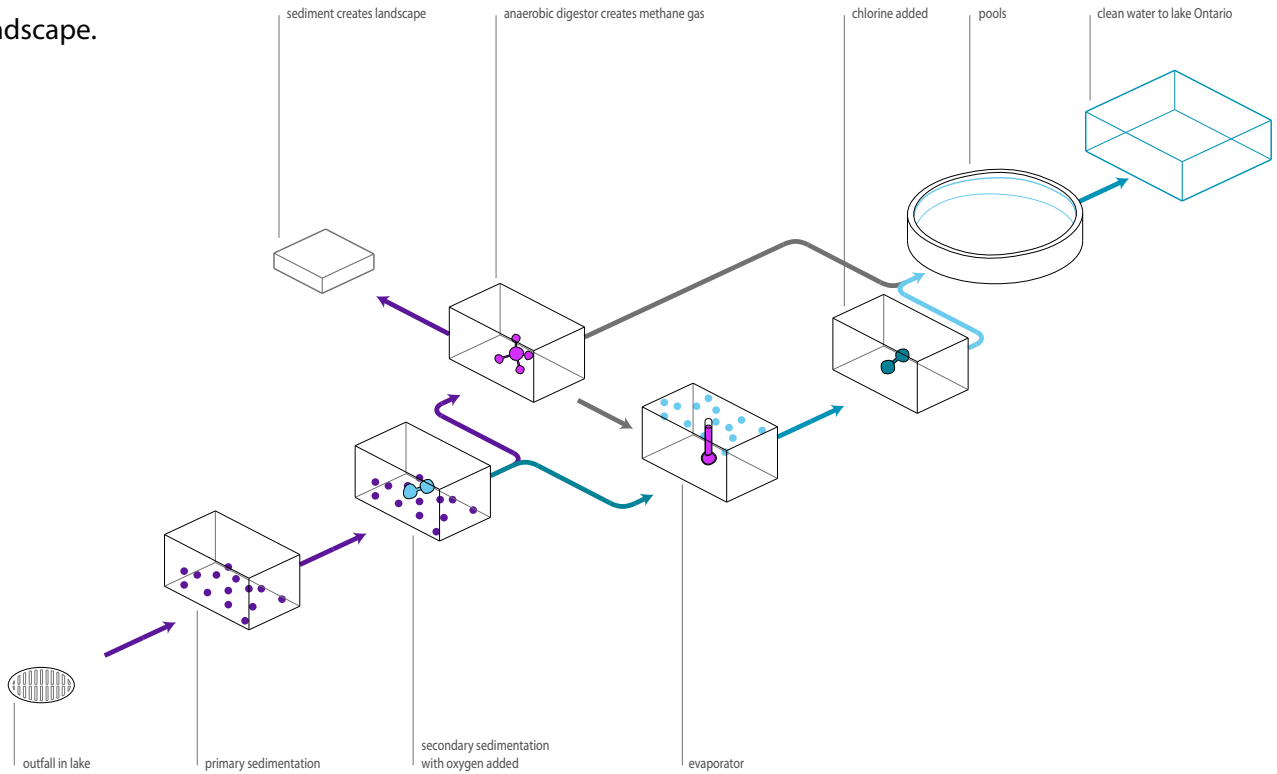


## Thermarium

designer: Daniel Rabin and Annie Ritz

The Thermarium project incorporates procession through spaces as well as a multiple sensory experience into the design. The project processes polluted water in Lake Ontario and "reuses its by-products: sediment, heat, and clean water"[63] to create a new beach typology that restores the landscape.

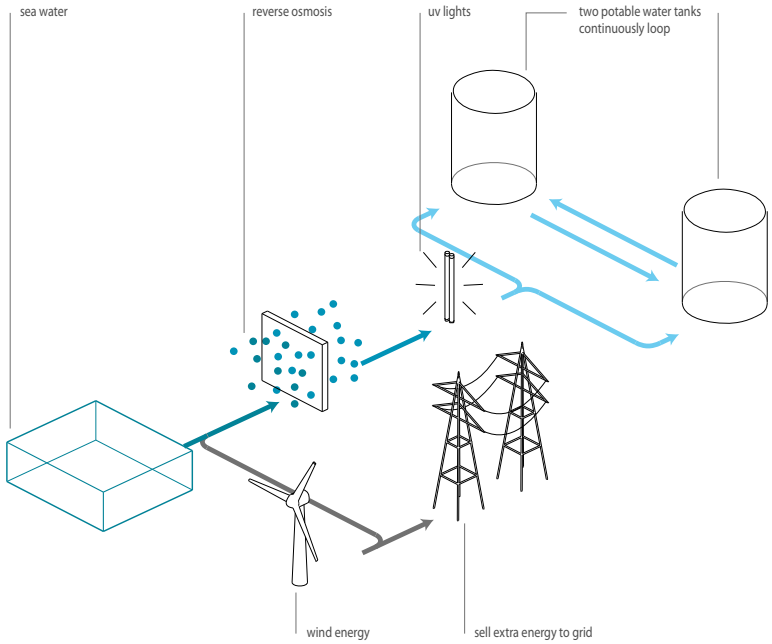




## Energy and Clean Water Coproduction in Remote Islands

designer: John Kaldellis and Kosmos Kavadias

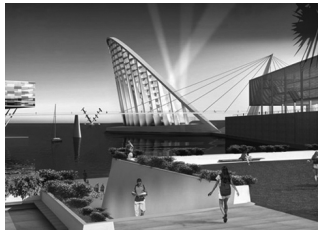
This project proposes a "combined wind-hydro configuration in collaboration with an appropriate desalination plant."[64] The proposal analyzes production costs and considers environmental and macro-economic benefits.

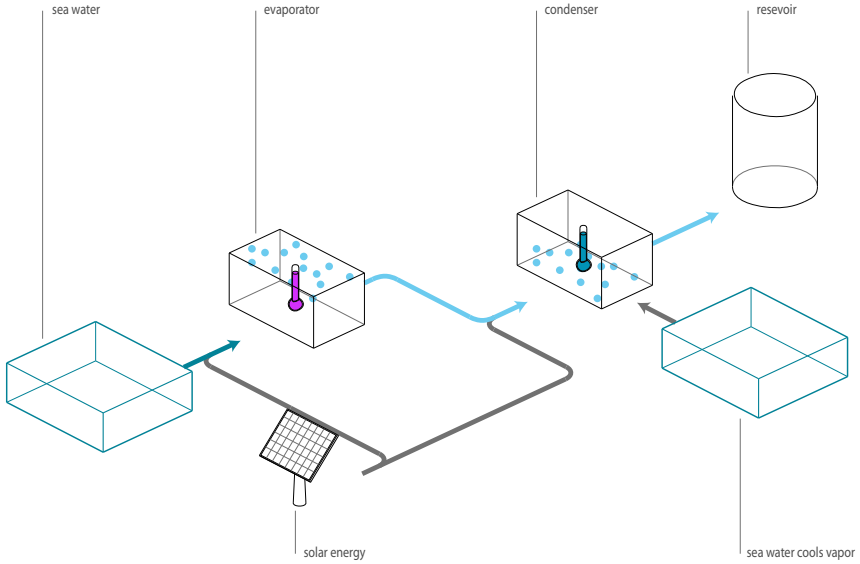



## Water Theater

designer: Grimshaw Architects

The desalination plant couples condensers and evaporators for creating distilled water. The evaporators are powered by solar panels and from the evaporators moisture is then collected in the condensers which are cooled using deep sea water.[65] This desalination plant becomes a backdrop for an auditorium as well as a visual demonstration that infrastructure can create awareness.





# Perception of Procession:

## Jewish Museum in Berlin

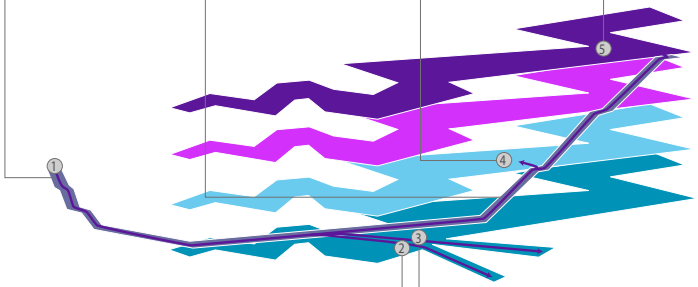
designer: Daniel Libeskind

dark underground entrance requires visitors to choose a path

stair of continuity

path to Memory Void. This space is a dead end which embodies absence, a straight line whose impenetrability becomes the central focus around which the exhibitions are organized.

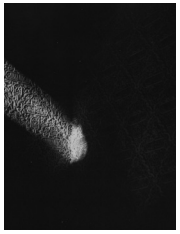
path to Permanent Exhibition which emphasizes the continuum of history




path to Holocaust Tower

path to Garden of Exile which is in remembrance to those who were forced to leave Berlin.

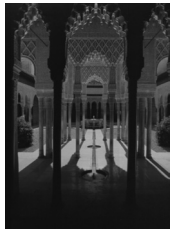
## Alahambra



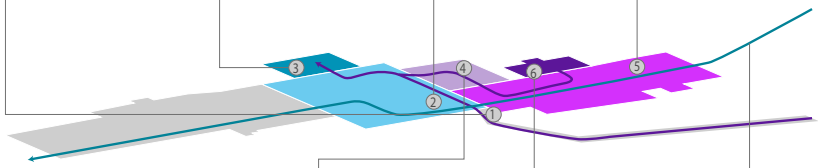
entrance through dark stairwell leads to a luminous courtyard

Salle des Ambassadeurs contains vases which store fresh water for travelers

Patio des Myrtes is a long courtyard with a reflection pool



Patio de los Leones has an iconic central fountain




the visitor continues through a series of rooms for bathing which culminate in a boiler room. As one moves through the spaces grow in temperature from cool to hot creating nodes of social interaction.

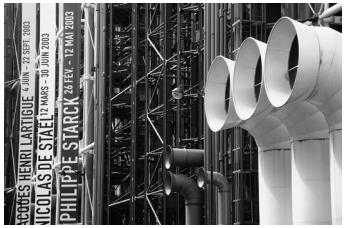
Salle des Deux-Sceurs is the space where water enters the palace. the room culminates in a small space that frames a view

the water flows opposite to the movement of visitors. The water comes from snow melt at the top of the mountain and flows down a series of canals and pools to the palace.

## Pompidou Centre

designer: Renzo Piano and Richard Rogers

This project changes perception through revealing the building's "functional elements such as escalators, water pipes, and air conditioning to the outside of the building, freeing interior space for the display of art works."[66] These exterior systems are color-coded, giving the visitor a sense of the overall buildings systems.




## Dufttunnel

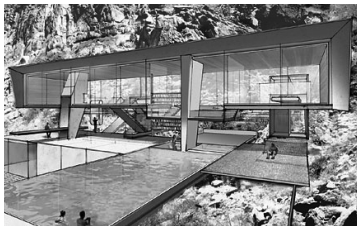
designer: Olafur Eliasson

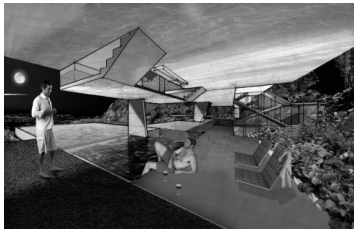
In this instillation Eliasson emphasizes the sensory experience. A revolving cylinder with plants embedded in the frame arouses the senses through both color and scent. The plant types change throughout the course of the year creating "permanent mutation and transformation. It is a transformation founded not only in the kinetic aspect of the work, but in its temporal dimension as well—in the changes of weather and season."[67]

## Phantom House

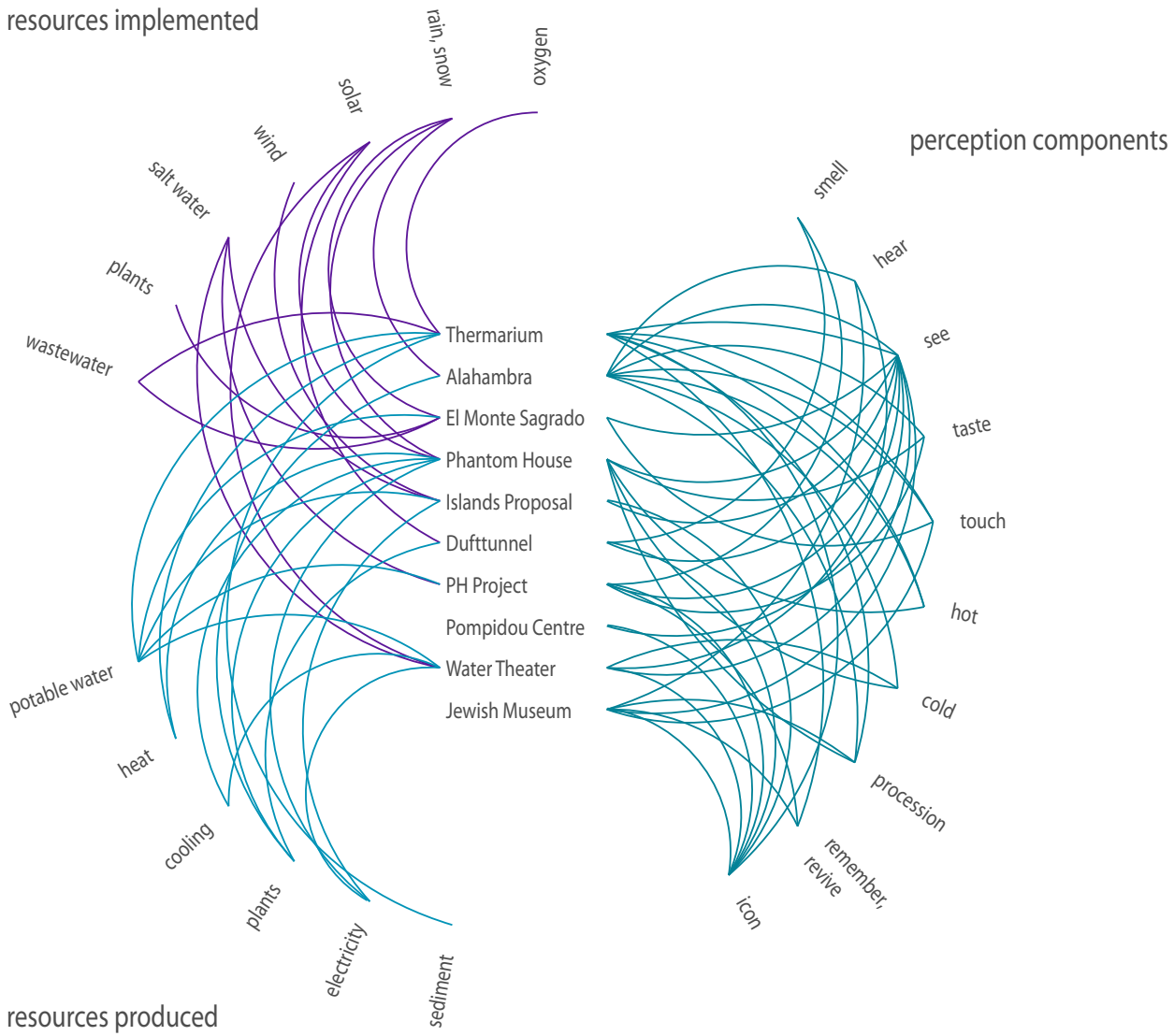
designer: Diller, Scofidio, + Renfro

This project exhibits a "guilt-free, sustainable luxury house that thrives on excess, and the couple, M. and J., who live in it."[68] The house is located in an arid climate and utilizes existing technologies to produce more energy than it consumes.

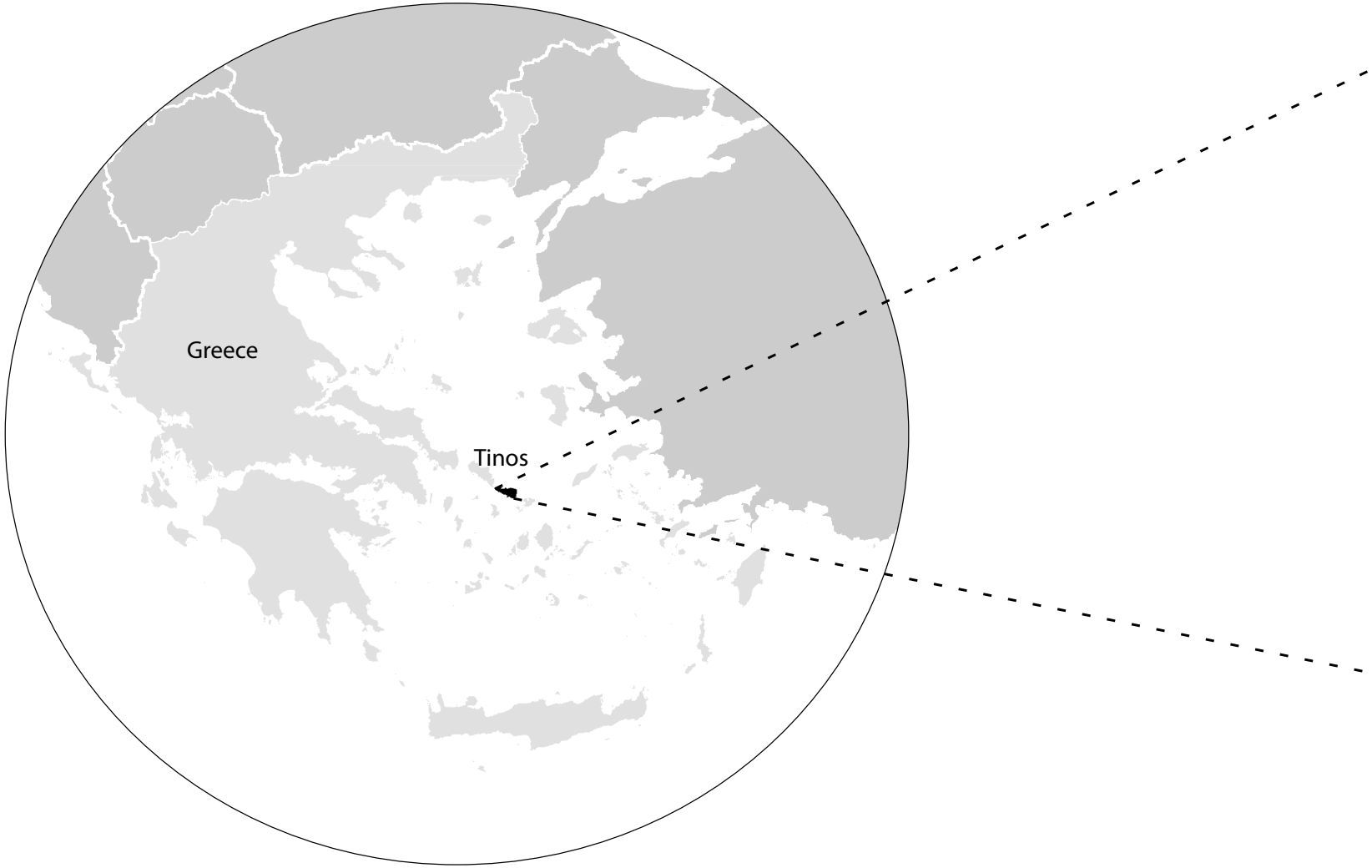


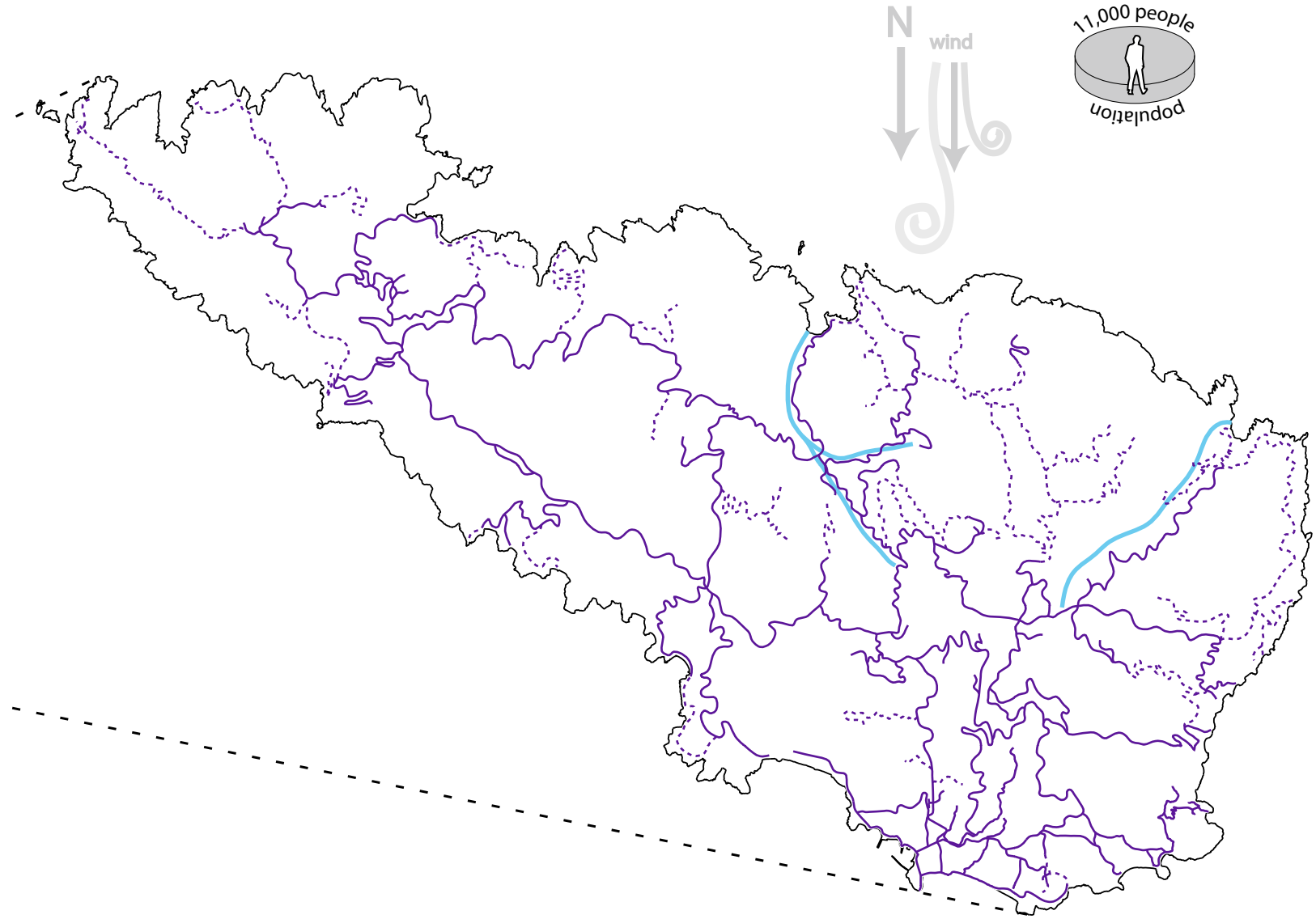


# Analysis of Precedent Components



# Location of Tinos Island

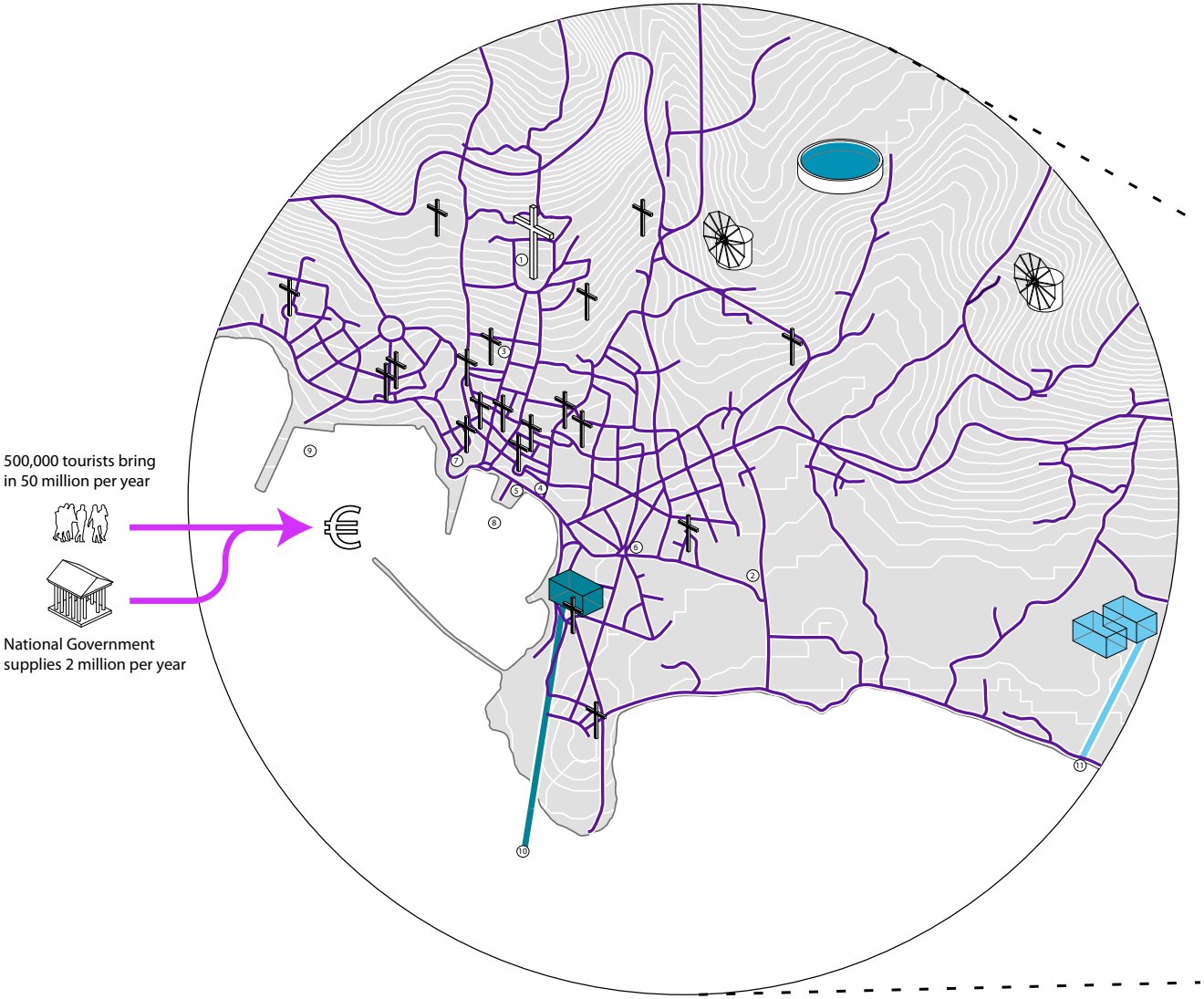


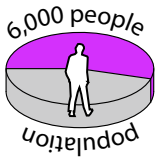

N
wind
11,000 people
population

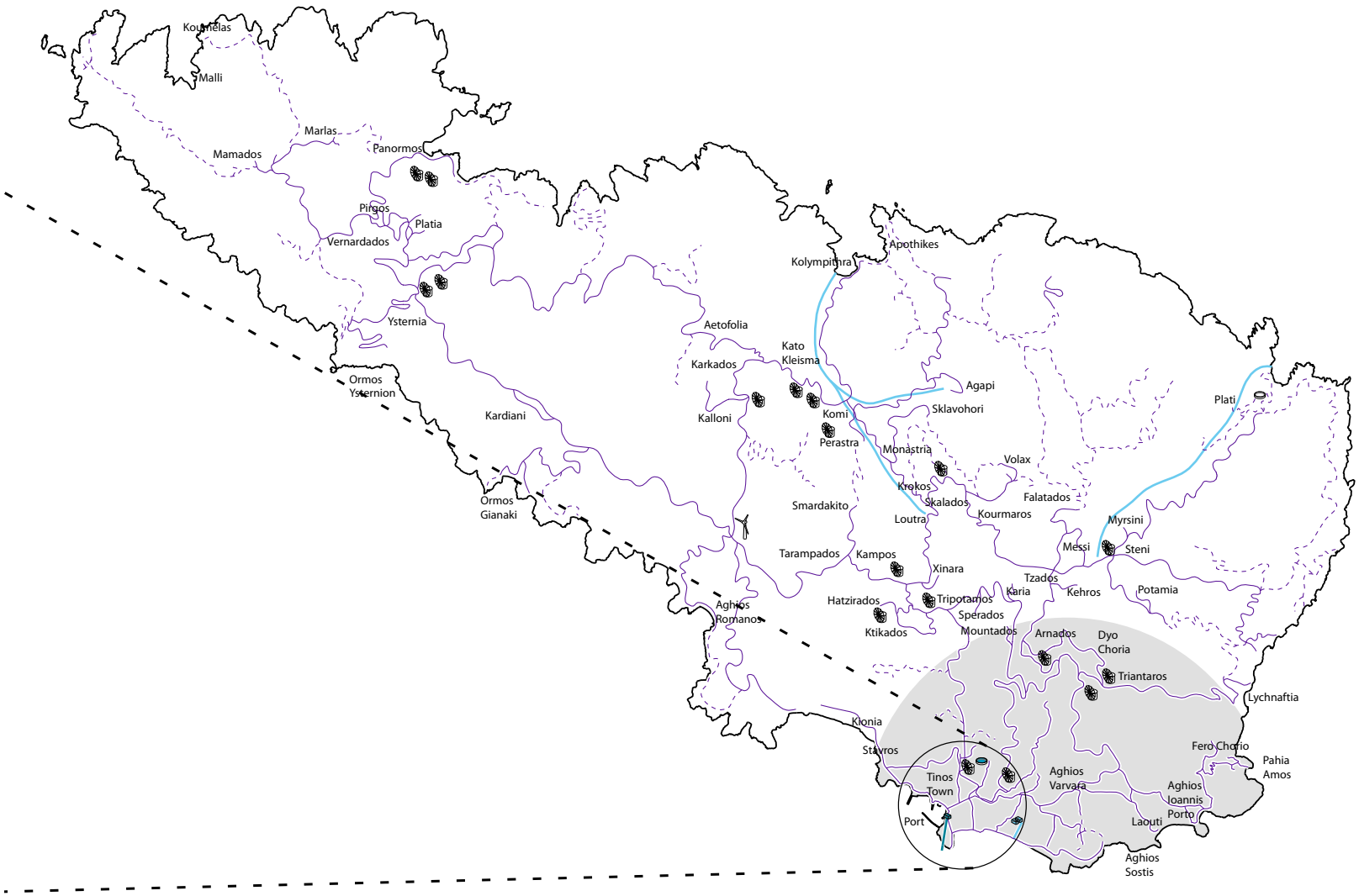
# Tinos Town

1. virgin mary's chruch
2. hospital
3. archeological museum
4. taxi station
5. bus station
6. movie theater
7. local market
8. old port
9. new port
10. wastewater drainage
11. saltwater intake

- church
- old windmill
- wind turbine
- reservoir
- unused reservoir
- wastewater treatment
- desalination system
- water distribution area
- roads
- unpaved roads




Koumelas
Malli
Marlas
Mamados
Panormos
Pirgos
Platia
Vernardados
Ysternia
Ormos
Ysternion
Kardiani
Ormos
Gianaki
Aetofolia
Karkados
Kato
Kleisma
Kalloni
Komi
Perastra
Kolympithra
Apothikes
Agapi
Sklavohori
Monastria
Volax
Krokos
Skalados
Falatados
Kourmaros
Loutra
Smardakito
Tarampados
Kampos
Xinara
Tzados
Karia
Kehros
Potamia
Messi
Steni
Myrsini
Plati
Aghios
Romanos
Hatzirados
Ktikados
Tripotamos
Sperados
Mountados
Arnados
Dyo
Choria
Triantaros
Lychnaftia
Klonia
Stavros
Tinos
Town
Port
Aghios
Varvara
Fero Chorio
Pahia
Amos
Aghios
Ioannis
Porto
Laouti
Aghios
Sostis

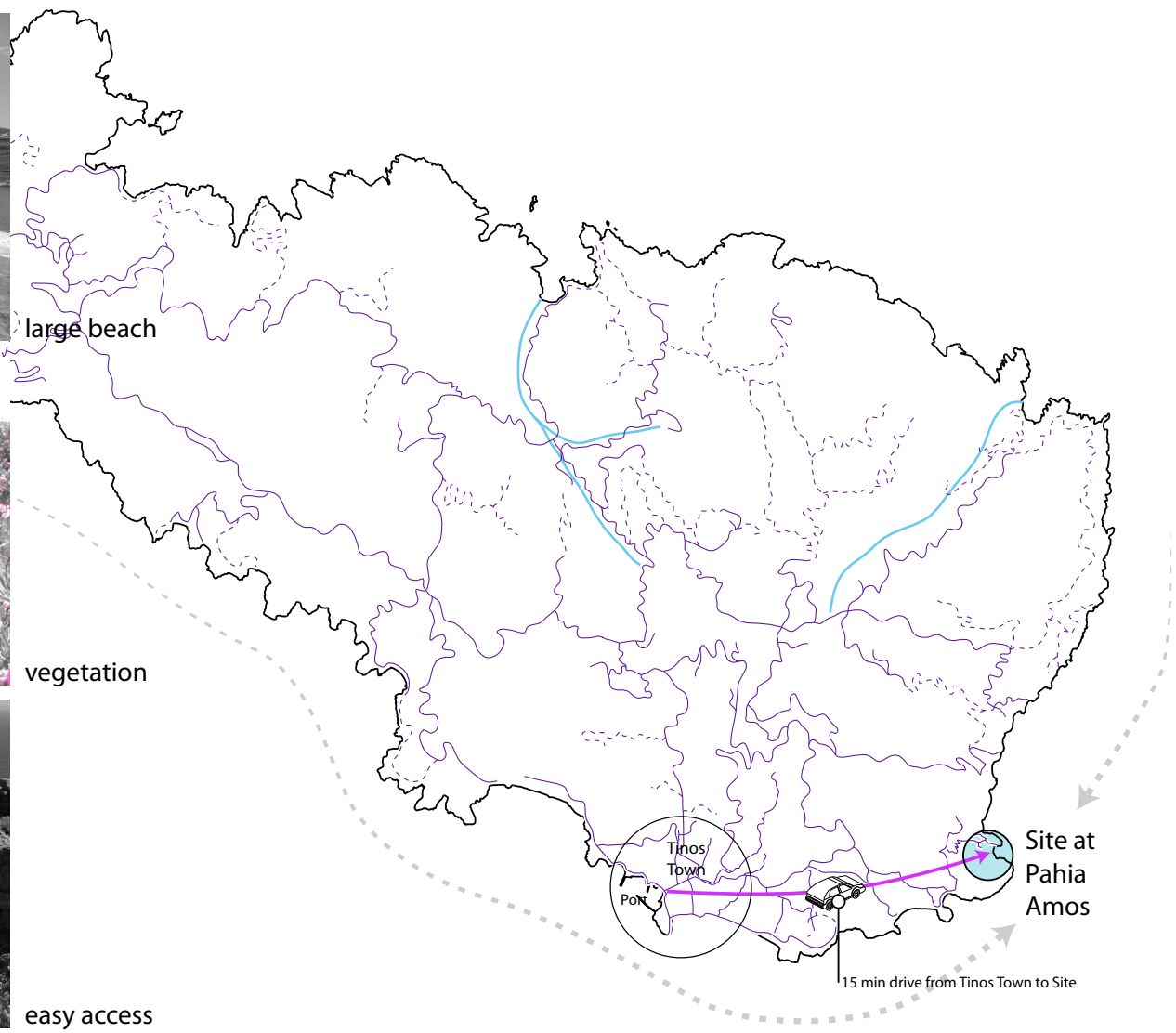
# Site Selection

## Requirements

large beach

vegetation

easy access



# Site Annotations

## Beach:

The beach is a favorite place for playing, socializing, and relaxing for both families and friends. It far from the parking area, but it is worth the walk.

## Hike:

The site provides a steep slope for hiking and the chance to discover beautiful, distant views of Tinos, Mykonos, and the Sea at the top of the ridges.

## Preserved Area:

Two parts of the site I have labeled for preservation. The rocks on the northern side of the site as well as part of the beach are frequently used and provide many natural amenities.

## Preserved Area:

The second preserved area is naturally lush even during the harsh, dry summer months. It is a beautiful area lined with pink oleanders and small shrubs with purple blossoms.

## Climb:

The rocks on the north side of enclave are easily accessible and a great place to climb. Many kids use this part of the site for exploring and trying to find sea urchins in the water below.

## View to Mykonos:

The view from the beach is quite spectacular. On the right, the onlooker can see Mykonos and on the left, an endless view to the sea. This view creates both a relationship to surrounding islands in the close distance and to the vast sea in the far distance.

## Sunbathe:

The sun warms the rocks on the north side of the enclave throughout the day. Lying on this smooth, warm surface creates a nice juxtaposition to the northern winds as they brush over your skin.

## Jump:

This rock seems to be a favorite jumping spot for adults or adults who would bring their children along. The water is deep here and the surrounding area is quite slippery, so it could be dangerous.

## Swim:

The water stays shallow for about 15 meters before becoming deep. Though the sea water is cool, it is quite refreshing to swim in after being in the sun for a while.

## New:

Two homes are being built on the western portion of the site. This area of the island has an abundance of new development as it is located in close proximity to the main town.

## Club House:

The Club house is the only commercial development on the site, and currently provides the main pathway to the beach. It has a pool as well as a bar and restaurant; however, is it quite underutilized by both tourists and locals.

## Relax:

These warm rocks provide a quiet spot to relax separate from the commotion of the beach. They are easy to climb up and there is a wide, flat surface ideal for lounging.

## Rock:

Rocks at Pahia Amos encircle the site as well as a part the Aegean Sea. On the southern portion of the site, rocks prevent pedestrians from passing this point. Conversely, the northern rocks are easily accessible.

## Slide:

This area is located on the northern side of the beach. It is the only spot where the sand reaches upwards to create a soft slope. Kids as well as some adults attempt to run to the top of the slope so that they can be carried down by the soft sand.

## Private Residences:

There are two small private residences on the site that are surrounded by landscaping.

## Cave:

The cave is small, but it provides a nice place for a couple to relax in. It is protected from the hot sun and open to the view of the water.

# Site Analysis

## Native Site Features

dry, thorny shrubs

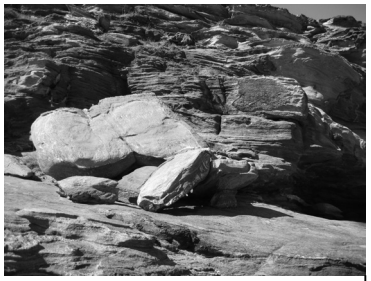
sandy soil

lush, flowering shrubs

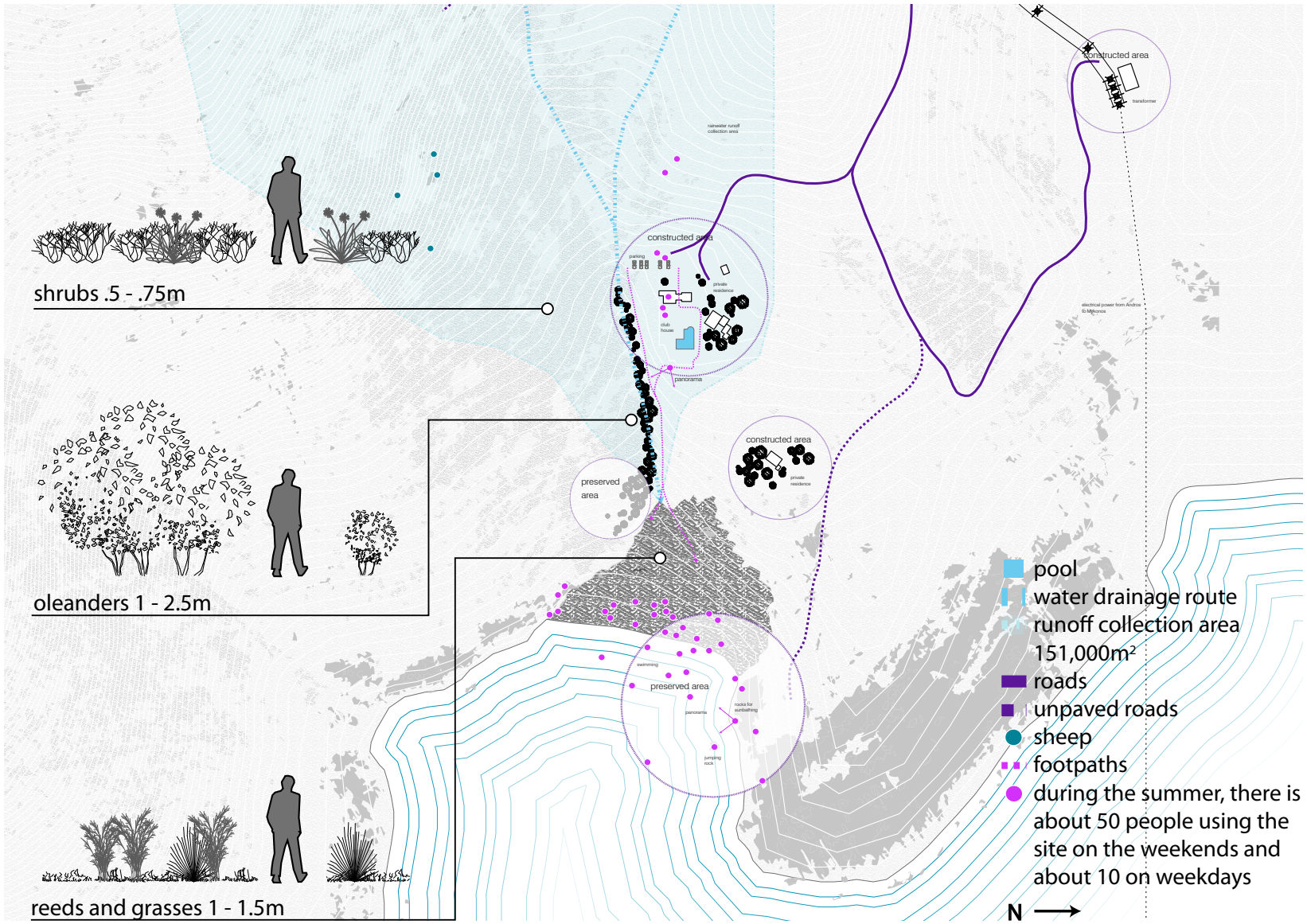
oleanders

reeds and grasses

sand



rocks


shrubs .5 - .75m
oleanders 1 - 2.5m
reeds and grasses 1 - 1.5m
constructed area
parking
private residence
club house
panorama
preserved area
constructed area
private residence
constructed area
transformer
rainwater runoff collection area
electrical power from Andros to Mykonos
swimming
preserved area
panorama
rocks for sunbathing
jumping rock
pool
water drainage route
runoff collection area
151,000m²
roads
unpaved roads
sheep
footpaths
during the summer, there is about 50 people using the site on the weekends and about 10 on weekdays
N

# Defining the Components

# Program Development

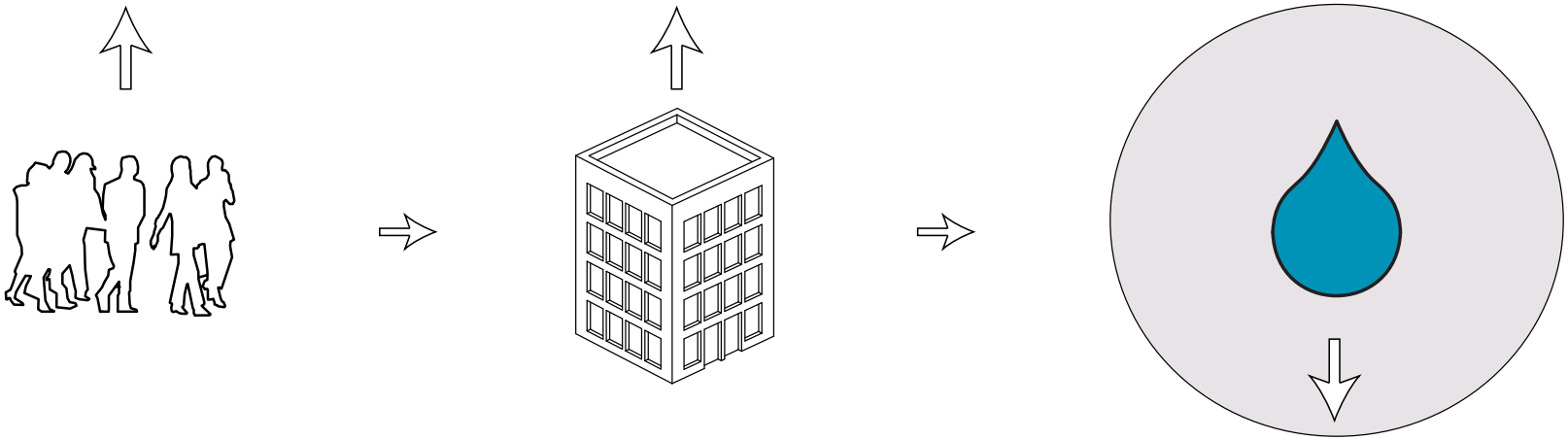
## The Rise of Tourism in Greece

tourism activity in 1995

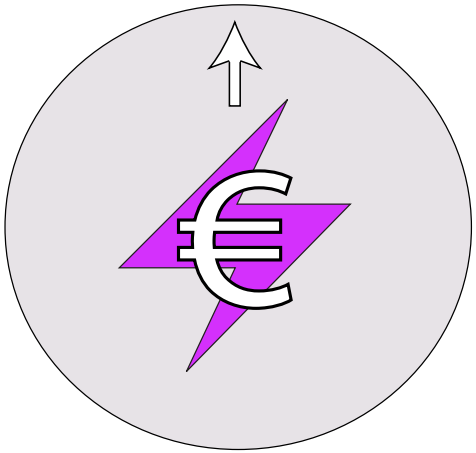
very high
high
medium

tourism activity in 2005

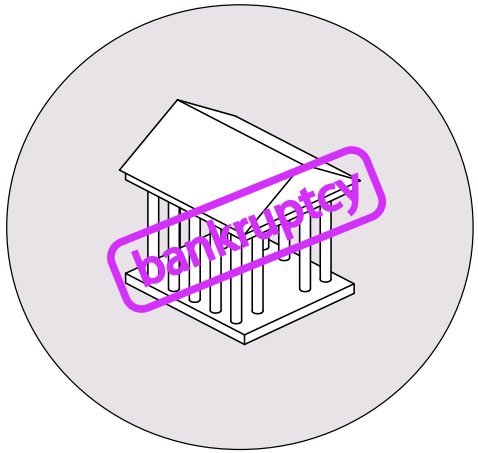
## The Program Based on Existing Conditions



increased tourism has led to an increase in the number of hotels which has depleted natural water resources

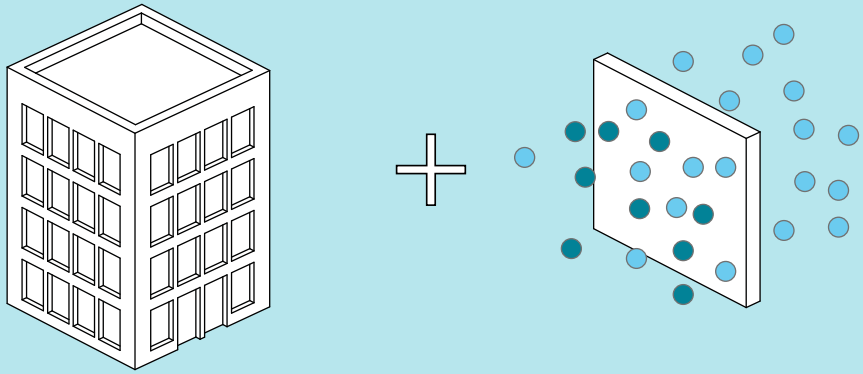


rising energy costs




corruption of National Government and bankruptcy

# Program



the hotel will accomodate tourists and the desalination system will provide and help replenish water resources

# Water System Comparison

## Current Water Systems in Tinos

Figure 13: Industrialization of Drinking Water[69]

system notes:

water is not valued

overdrawing of groundwater has caused seawater infiltration

process for obtaining potable water is inefficient and expensive

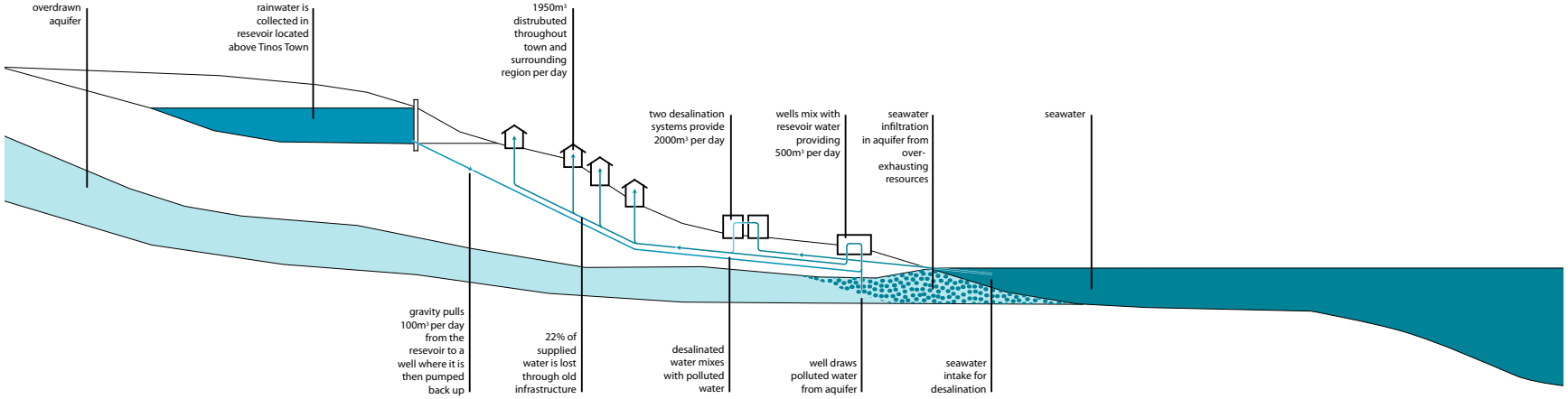
process for obtaining electricity is inefficient and uneccessary

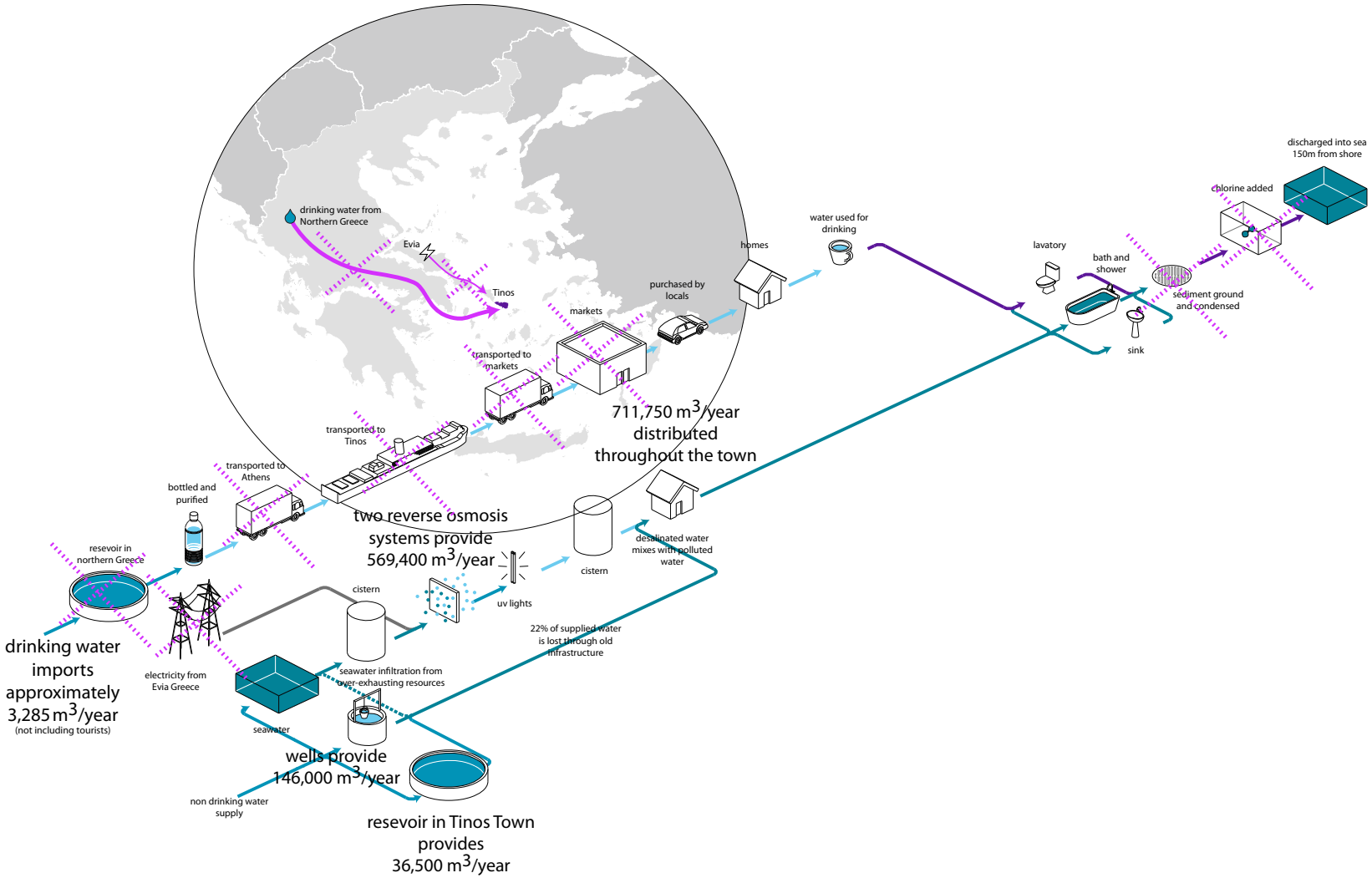
desalination system produces potable water, but mixes with polluted well water so it is not utilized to its full potential

potable water is wasted on lavatories and agriculture

rain water is treated as a polluted hindrance that is quickly removed from the town

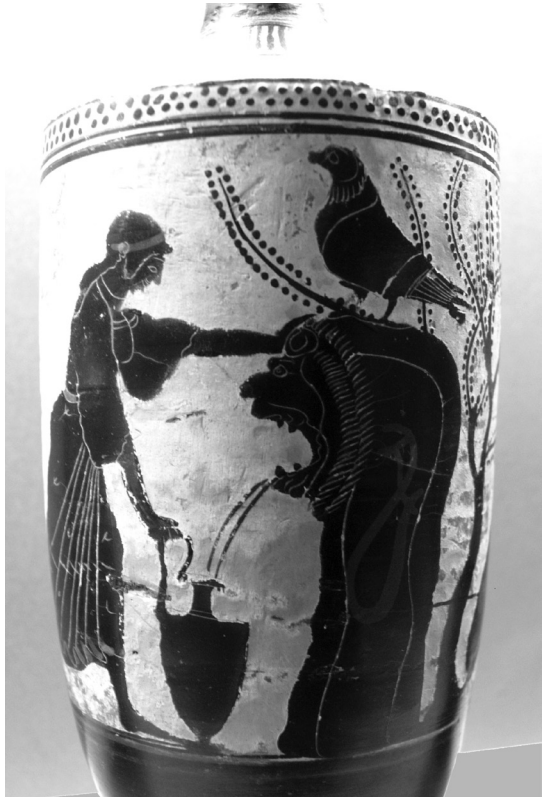
## Domestic Water Supply in Tinos Town and Surrounding Area

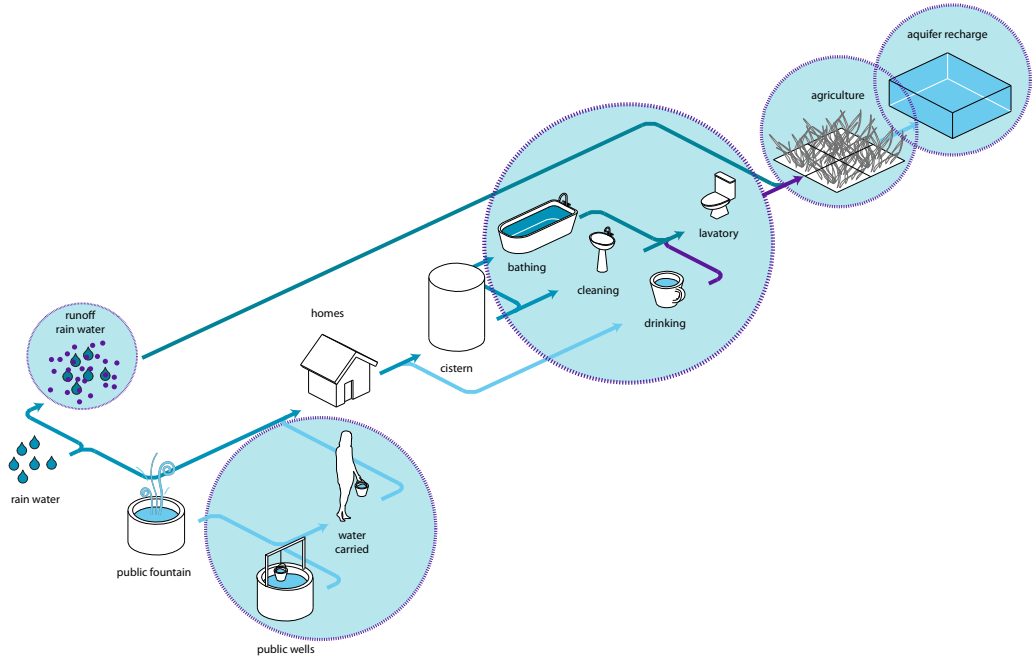



drinking water from Northern Greece
Evia
Tinos
markets
purchased by locals
homes
water used for drinking
lavatory
bath and shower
sink
sediment ground and condensed
chlorine added
discharged into sea 150m from shore
transported to markets
transported to Tinos
711,750 m3/year distributed throughout the town
transported to Athens
bottled and purified
two reverse osmosis systems provide 569,400 m3/year
desalinated water mixes with polluted water
cistern
uv lights
22% of supplied water is lost through old infrastructure
resevoir in northern Greece
cistern
drinking water imports approximately 3,285 m3/year
(not including tourists)
electricity from Evia Greece
seawater infiltration from over-exhausting resources
seawater
wells provide 146,000 m3/year
non drinking water supply
resevoir in Tinos Town provides 36,500 m3/year

# Ancient Greek Water Systems

Figure 14: Ancient Greek Fountain[70]






system notes:

all water is valued

system is efficient and highly integrated

maximum water recycling

modest hydraulic solutions that take advantage of gravity

individual and communal water sources ensure water quantity in dry season

water is heated or kept cool using natural conductivity

sewage and stormwater are used for agriculture. sunlight kills the anaerobic bacteria in sewage removing the possibility of the spread of disease

## Integrated Water Systems in $H_2$Otel

system notes:

expedites and localizes current process for obtaining electricity and potable water

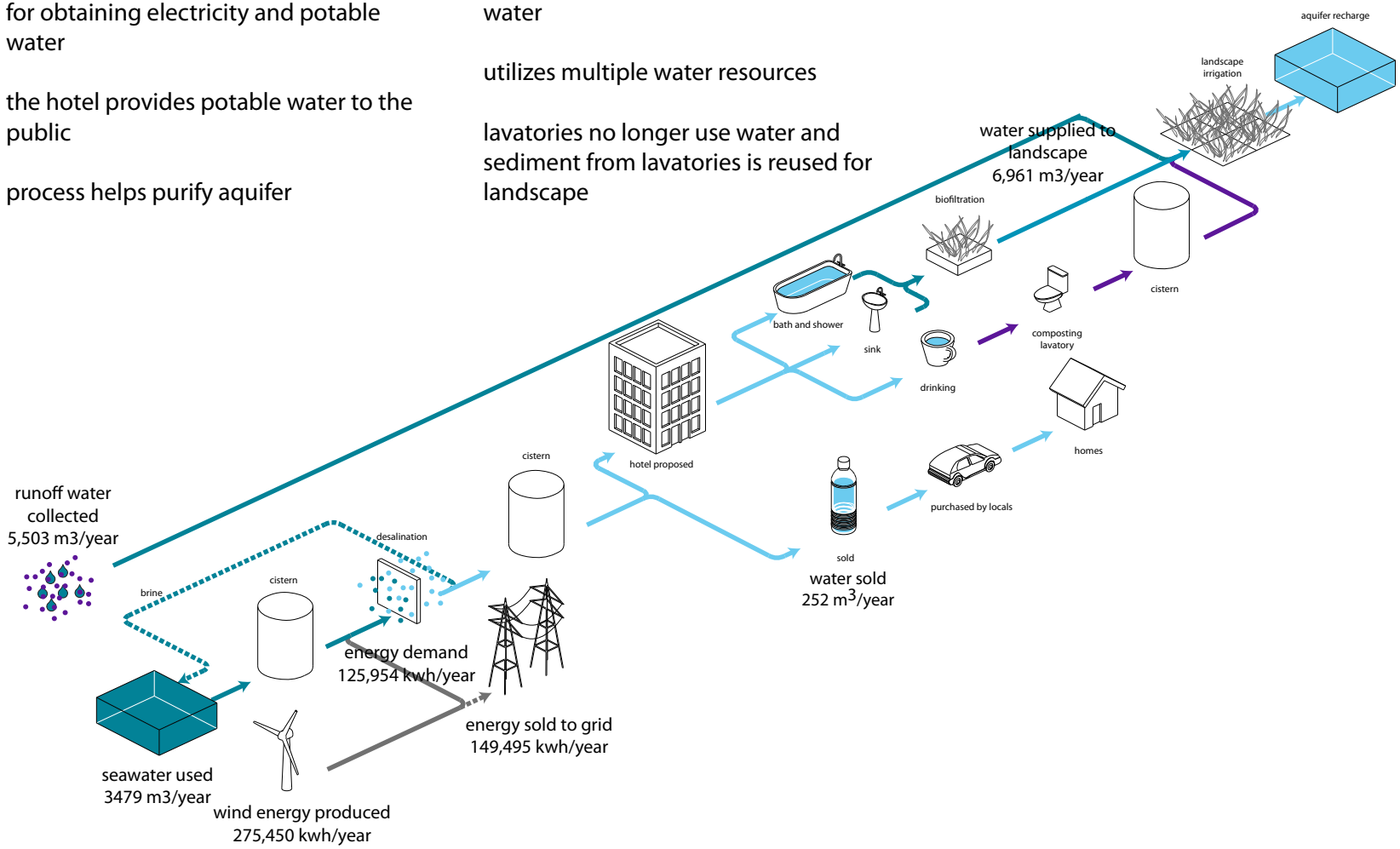
the hotel provides potable water to the public

process helps purify aquifer

maximizes potential for recycling of water

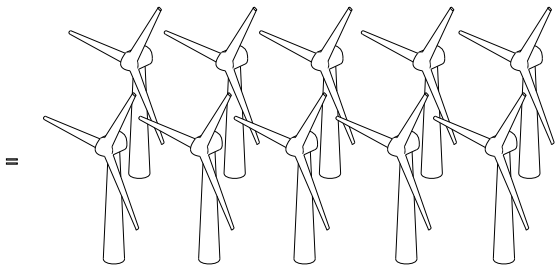
utilizes multiple water resources

lavatories no longer use water and sediment from lavatories is reused for landscape



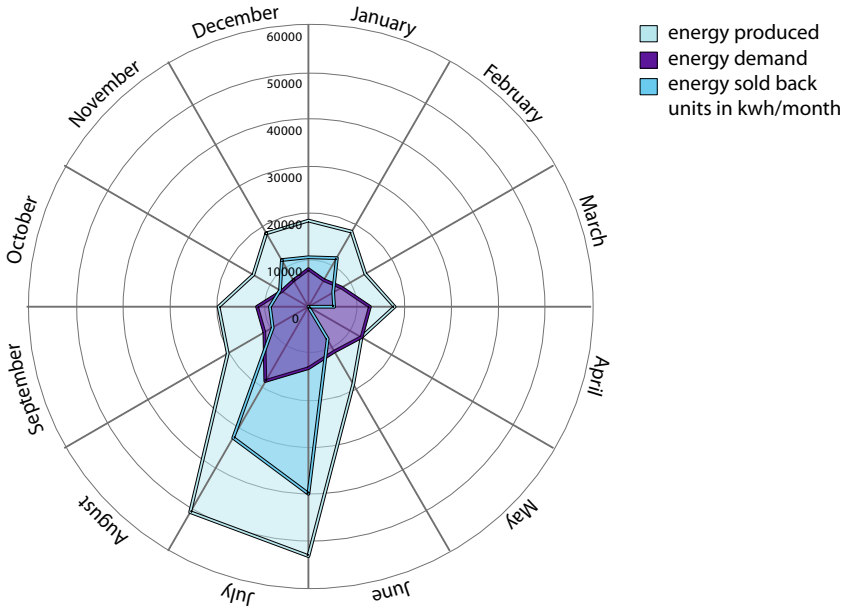
# Wind Energy Calculations

| wind for each month | speed m/s | probability of wind in % | total diameter of 10 turbines at 2.97m diameter | energy produced in kw | energy produced kwh/month | energy demand based on tourist season | in kwh/month | additional energy used on holidays | in kwh/month | total demand for month in kwh/month | total energy sold back in kwh/month |
|---|---|---|---|---|---|---|---|---|---|---|---|
| january | 7.2016 | 0.61 | 29.7 | 27.33182484 | 18366.98629 | low | 6495.183484 | jan 30th .25 (4days) | 1443.998452 | 7939.181935 | 10427.80436 |
| february | 7.2016 | 0.61 | 29.7 | 27.33182484 | 18366.98629 | low | 6537.506065 | | | 6537.506065 | 11829.48023 |
| march | 6.6872 | 0.58 | 29.7 | 20.80715667 | 13982.40928 | low | 6495.183484 | march 25th .25 (4days) | 1443.998452 | 7939.181935 | 6043.227346 |
| april | 7.2016 | 0.61 | 29.7 | 27.33182484 | 18366.98629 | med .5 | 10832.79794 | easter .75 (4days) | 2166.934194 | 12999.73213 | 5367.254163 |
| may | 6.6872 | 0.54 | 29.7 | 19.37218035 | 13018.10519 | med .5 | 10832.79794 | first Sunday .75 (4days) | 2166.934194 | 12999.73213 | 18.37306418 |
| june | 7.2016 | 0.63 | 29.7 | 28.22795024 | 18969.18256 | med .5 | 10978.08826 | | | 10978.08826 | 7991.094305 |
| july | 9.2592 | 0.83 | 29.7 | 79.04061203 | 53115.29128 | med-high .75 | 13198.37935 | | | 13198.37935 | 39916.91193 |
| august | 9.2592 | 0.79 | 29.7 | 75.23142591 | 50555.51821 | high 1 | 13274.11084 | august 15th 1.25 (7days) | 5057.272387 | 18331.38323 | 32224.13498 |
| september | 7.2016 | 0.66 | 29.7 | 29.57213835 | 19872.47697 | med .5 | 10978.08826 | | | 10978.08826 | 8894.388713 |
| october | 7.2016 | 0.64 | 29.7 | 28.67601295 | 19270.2807 | med .5 | 10978.08826 | | | 10978.08826 | 8292.192441 |
| november | 6.6872 | 0.56 | 29.7 | 20.08966851 | 13500.25724 | low | 6537.506065 | | | 6537.506065 | 6962.751173 |
| december | 7.2016 | 0.6 | 29.7 | 26.88376214 | 18065.88816 | low | 6537.506065 | | | 6537.506065 | 11528.38209 |
| total for year | | | | | 275450.3685 | | | | | 125954.3737 | 149495.9948 |



10 wind turbines at a 3m diameter required

| | kilowatts | number of devices | hours used | total kwh/day | total kwh/month | % of kwused at peak time: 8pm | kw peak |
|---|---|---|---|---|---|---|---|
| Hotel | | | | | | | |
| offices | | | | | | | |
| printer | 0.1 | 2 | 8 | 1.6 | 44.8 | | |
| desktop computer | 0.225 | 4 | 8 | 7.2 | 201.6 | | |
| fitness room | | | | | | | |
| treadmill | 2 | 4 | 2 | 16 | 448 | 100% | 8 |
| cleaning | | | | | | | |
| vacuum | 0.55 | 3 | 3 | 4.95 | 138.6 | | |
| washing machine | 2 | 2 | 2 | 8 | 224 | | |
| dryer | 2 | 2 | 2 | 8 | 224 | | |
| rooms | | | | | | | |
| 50 units reg room and suite | | | | | | | |
| hairdryer | 1.25 | 50 | 0.5 | 31.25 | 875 | 50% | 31.25 |
| tv | 0.15 | 50 | 2 | 15 | 420 | 50% | 3.75 |
| 10 family room plus | | | | | | | |
| hairdryer | 1.25 | 10 | 0.5 | 6.25 | 175 | 50% | 6.25 |
| tv | 0.15 | 10 | 2 | 3 | 84 | 50% | 0.75 |
| small fridge | 0.126 | 10 | 24 | 30.24 | 846.72 | 100% | 1.26 |
| microwave | 1.5 | 10 | 1 | 15 | 420 | | |
| small range | 1.2 | 10 | 0.25 | 3 | 84 | | |
| hotel lights for 3094 m2 | 0.016 | 1030 | 6 | 98.88 | 2768.64 | | |
| hotel fans for 3094 m2 | 0.025 | 156 | 6 | 23.4 | 655.2 | | |
| hotel total | | | | 271.77 | 7609.56 | | |
| restaurant | | | | | | | |
| fryer | 1.8 | 2 | 8 | 28.8 | 806.4 | 100% | 3.6 |
| oven | 5 | 2 | 8 | 80 | 2240 | 100% | 10 |
| range | 2.4 | 2 | 8 | 38.4 | 1075.2 | 100% | 4.8 |
| fridge | 1 | 1 | 24 | 24 | 672 | 100% | 1 |
| freezer | 1 | 1 | 24 | 24 | 672 | 100% | 1 |
| ice machine | 0.5 | 1 | 24 | 12 | 336 | 100% | 0.5 |
| ventilation | 3 | 1 | 12 | 36 | 1008 | 100% | 3 |
| dishwasher | 3 | 1 | 2 | 6 | 168 | 100% | 3 |
| coffee maker | 0.8 | 2 | 4 | 6.4 | 179.2 | | |
| restaurant lights for 112 m2 | 0.016 | 37 | 6 | 3.552 | 99.456 | | |
| restaurant fans for 112 m2 | 0.025 | 6 | 6 | 0.9 | 25.2 | | |
| restaurant total | | | | 260.052 | 7281.456 | | |
| bar | | | | | | | |
| fridge | 0.5 | 1 | 24 | 12 | 336 | 100% | 0.5 |
| freezer | 0.5 | 1 | 24 | 12 | 336 | 100% | 0.5 |
| ice machine | 0.5 | 1 | 24 | 12 | 336 | 100% | 0.5 |
| blender | 0.3 | 2 | 2 | 1.2 | 33.6 | 100% | 0.6 |
| bar lights for 28 m2 | 0.016 | 9 | 6 | 0.864 | 24.192 | | |
| bar fans for 28 m2 | 0.025 | 1 | 6 | 0.15 | 4.2 | | |
| bar total | | | | 38.214 | 1069.992 | | |
| desalination system | | | | | | | |
| system | 8 | 1 | 12 | 96 | 2688 | | |
| pump for pool/holding tank | 0.9 | 1 | 0.5 | 0.45 | 12.6 | | |
| desalination total | | | | 96.45 | 2700.6 | | |
| light and fans for 3604m2 | | | | | | | |
| 1 fluorescent light 3 m2 | 0.016 | 1076 | 6 | 103.296 | 2892.288 | 75% | 12.912 |
| fans 1 fans per 20 m2 | 0.025 | 163 | 6 | 24.45 | 684.6 | 50% | 2.0375 |
| light and fans total | | | | 127.746 | 3576.888 | | |
| | | | | | | | |
| total | | | | 666.486 | 18661.608 | | 95.2095 |



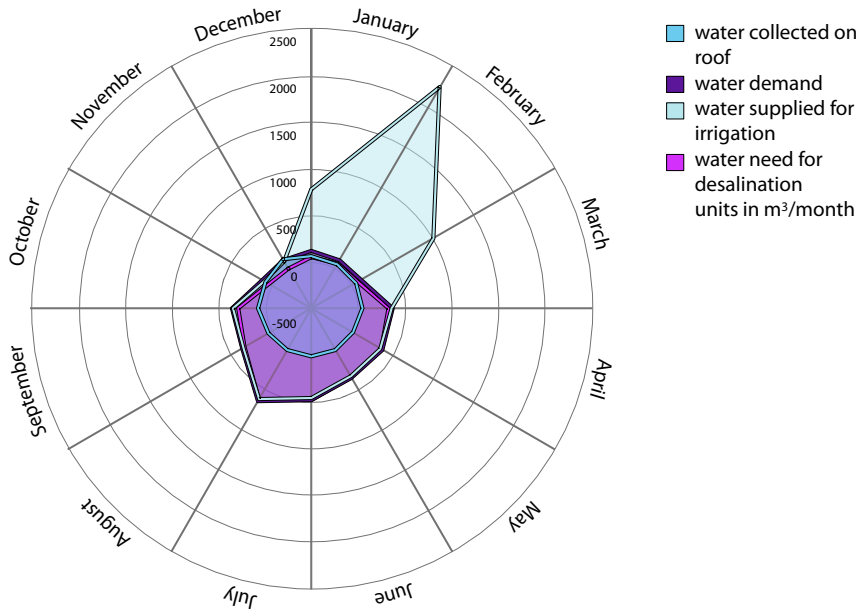
# Water Calculations

| rain for each month | depth in meters | surplus in meters | deficit in meters | collected on two story hotelroof at 90% efficiency in m3 | collected from runoff at 75% efficiency in m3 | total rainwater collected in m3 | water demand based on tourist season | in cubic meters | additional water used on holidays | in cubic meters | total demand for month in m3 | water still needed from desalination in m3 | water supplied for irrigation in m3 | water deficit in landscape remaining in m3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| january | 0.046 | 0.006 | 0 | 64.0458 | 678.784284 | 742.830084 | low | 88.56 | jan 30th +.25 (4days) | 32.715 | 121.275 | 57.2292 | 779.059284 | |
| february | 0.033 | 0.019 | 0 | 45.9459 | 2149.483566 | 2195.429466 | low | 103.32 | | | 103.32 | 57.3741 | 2231.803566 | |
| march | 0.034 | 0.008 | 0 | 47.3382 | 905.045712 | 952.383912 | low | 88.56 | march 25th +.25 (4days) | 32.715 | 121.275 | 73.9368 | 1005.320712 | |
| april | 0.032 | 0 | 0 | 44.5536 | 0 | 44.5536 | med .5 | 304.02 | easter +.75 (4days) | 68.625 | 372.645 | 328.0914 | 351.645 | |
| may | 0.009 | 0 | 0.018 | 12.5307 | 0 | 12.5307 | med .5 | 304.02 | first Sunday +.75 (4days) | 68.625 | 372.645 | 360.1143 | 351.645 | |
| june | 0.01 | 0 | 0.093 | 13.923 | 0 | 13.923 | med .5 | 354.69 | | | 354.69 | 340.767 | 333.69 | |
| july | 0.003 | 0 | 0.148 | 4.1769 | 0 | 4.1769 | med-high .75 | 480.375 | | | 480.375 | 476.1981 | 459.375 | |
| august | 0.006 | 0 | 0.148 | 8.3538 | 0 | 8.3538 | high 1 | 454.545 | august 15th +1.25 (7days) | 182.93625 | 637.48125 | 629.12745 | 616.48125 | |
| september | 0.024 | 0 | 0.08 | 33.4152 | 0 | 33.4152 | med .5 | 354.69 | | | 354.69 | 321.2748 | 333.69 | |
| october | 0.051 | 0 | 0.016 | 71.0073 | 0 | 71.0073 | med .5 | 354.69 | | | 354.69 | 283.6827 | 333.69 | |
| november | 0.049 | 0 | 0 | 68.2227 | 0 | 68.2227 | low | 103.32 | | | 103.32 | 35.0973 | 82.32 | |
| december | 0.081 | 0 | 0 | 112.7763 | 0 | 112.7763 | low | 103.32 | | | 103.32 | -9.4563 | 82.32 | |
| total for year | 0.378 | 0.033 | 0.503 | 526.2894 | 4977.751416 | 5504.040816 | | | | | 3479.72625 | 2953.43685 | 6961.039812 | 68911.95904 |

| availability for rain collected on roof | sqare meters |
|---|---|
| 1 story hotel 60 rooms | 3094 |
| 2 story hotel 60 rooms | 1547 |

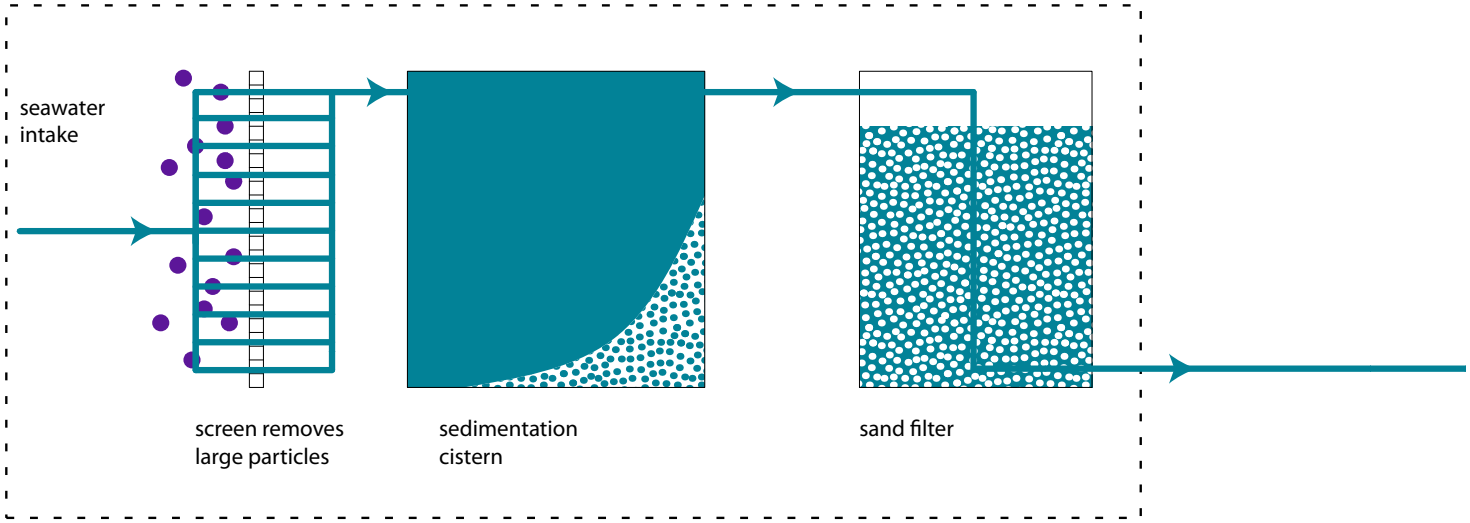
| availability for runoff water collection | |
|---|---|
| minamum for site | 150,840.95 |

| water demand for different programs | occupancy | day | month |
|---|---|---|---|
| hotel total | 210 | 17.22 | 482.16 |
| lavatory (not included) | 1 | 0.072 | 2.016 |
| sink | 1 | 0.028 | 0.784 |
| bath | 1 | 0.019 | 0.532 |
| laundry | 1 | 0.015 | 0.42 |
| landscpaing (not included) | 1 | 0.015 | 0.42 |
| building maintenance | 1 | 0.02 | 0.56 |
| cooling/heating (not included) | 1 | 0.017 | 0.476 |
| total from included demand | 1 | 0.082 | 2.296 |
| | | | |
| cafe total | 35 | 0.735 | 20.58 |
| sinks 3/4 total | 1 | 0.021 | 0.588 |
| lavatory (not included) | 1 | 0.007 | 0.196 |
| total from included demand | 1 | 0.021 | 0.588 |
| | | | |
| pool (not included) | 158 | 6.004 | 0 |
| water used | 1 | 0.038 | 0 |
| | | | |
| restaurant total | 140 | 2.94 | 82.32 |
| sinks 3/4 total | 1 | 0.021 | 0.588 |
| lavatory (not included) | 1 | 0.007 | 0.196 |
| total from included demand | 1 | 0.021 | 0.588 |
| | | | |
| water supplied to locals | 500 | 0.75 | 21 |



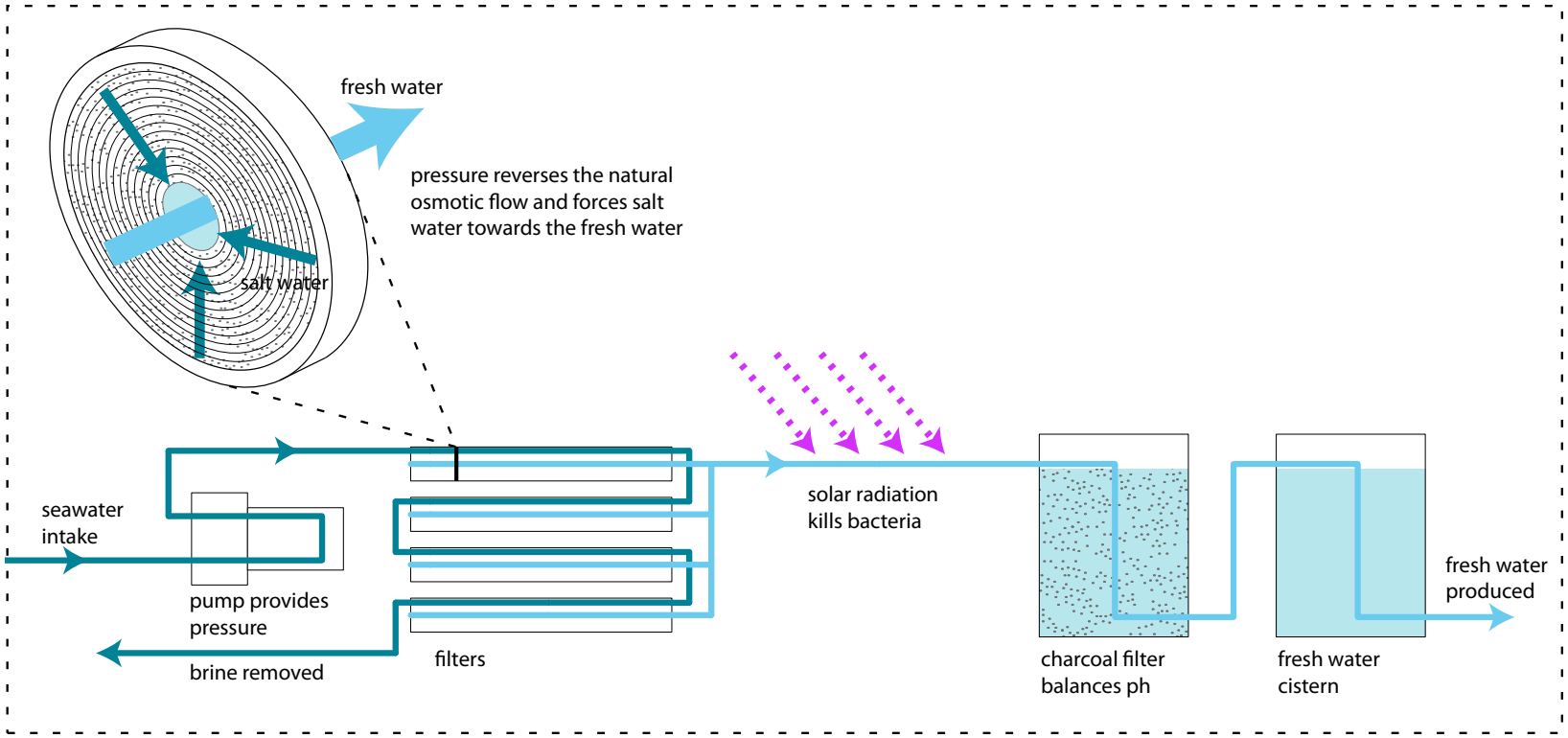
# Desalination System Analysis

## Pre-filtration Process




- - - system integrated in $H_2O$tel

# Reverse Osmosis




system pros and cons:

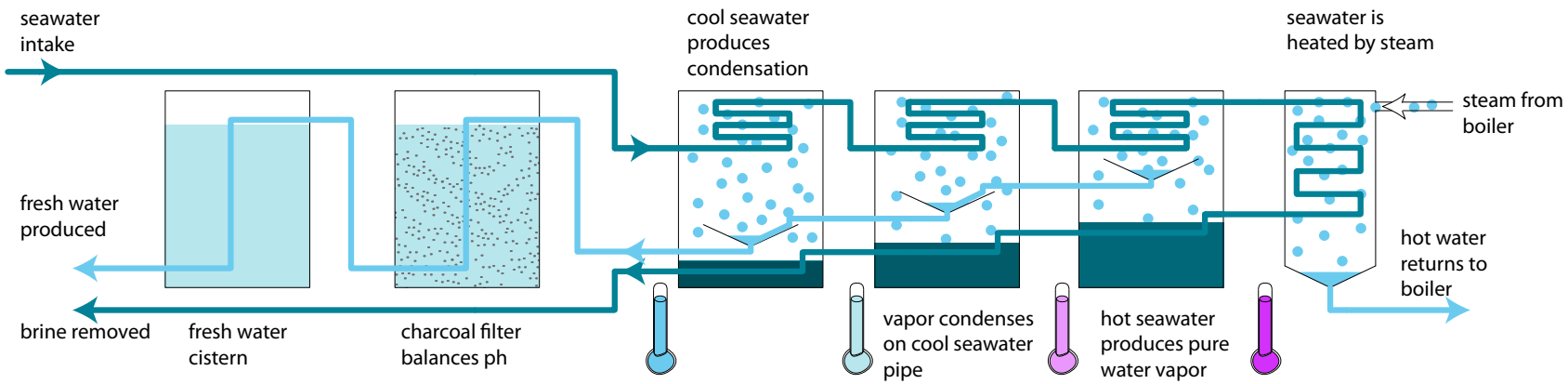
water is produced quickly

electricity required is low in comparison to other systems at about 3.5 kwh/$m^3$

the system is compact

membrane filters are expensive though they do not need to be replaced often

# Multi-Stage Flash Distillation



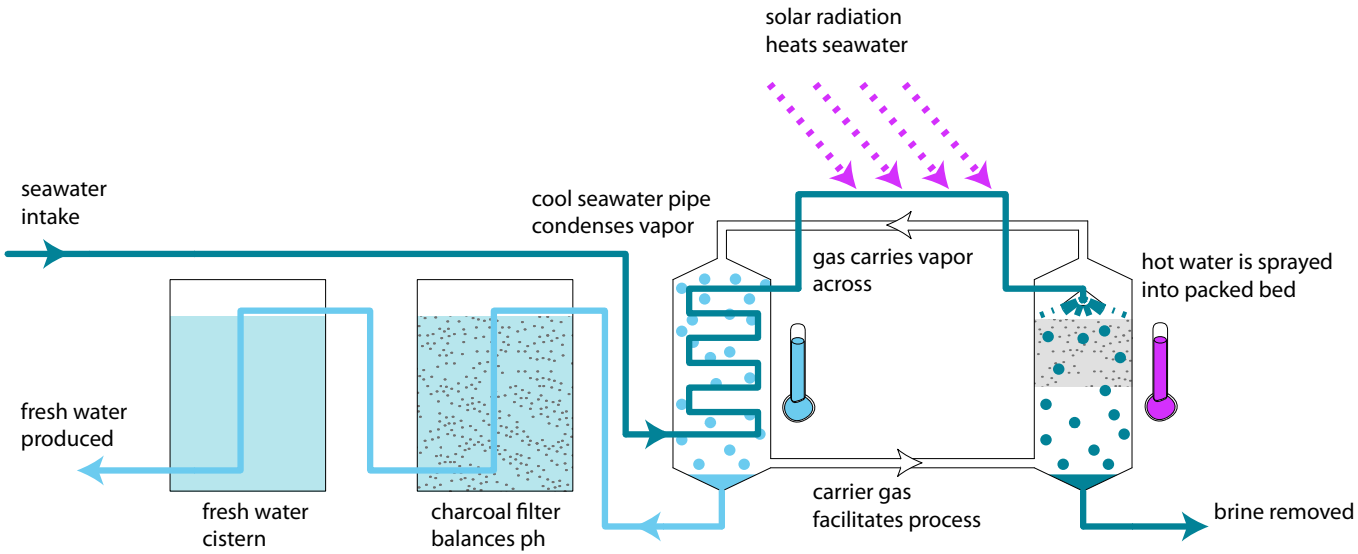

system pros and cons:

the heated seawater causes calcium carbonate and calcium sulfate to build up and clog the piping. This reduces thermal resistance so engineers try to avoid this by not allowing the seawater to reach over 100°C

this system is usually coupled with a power plant so that excess heat produced can be reused. Coproduction uses about 14 kwh/$m^3$

when not coupled with a power plant, this system has the highest energy consumption when compared to its thermal equivalent at approximately 25 kwh/$m^3$

# Humidification/Dehumidification Desalination: Type 1




system pros and cons:

works best in small scale situations. the desired result is that this product is deployed for disaster relief

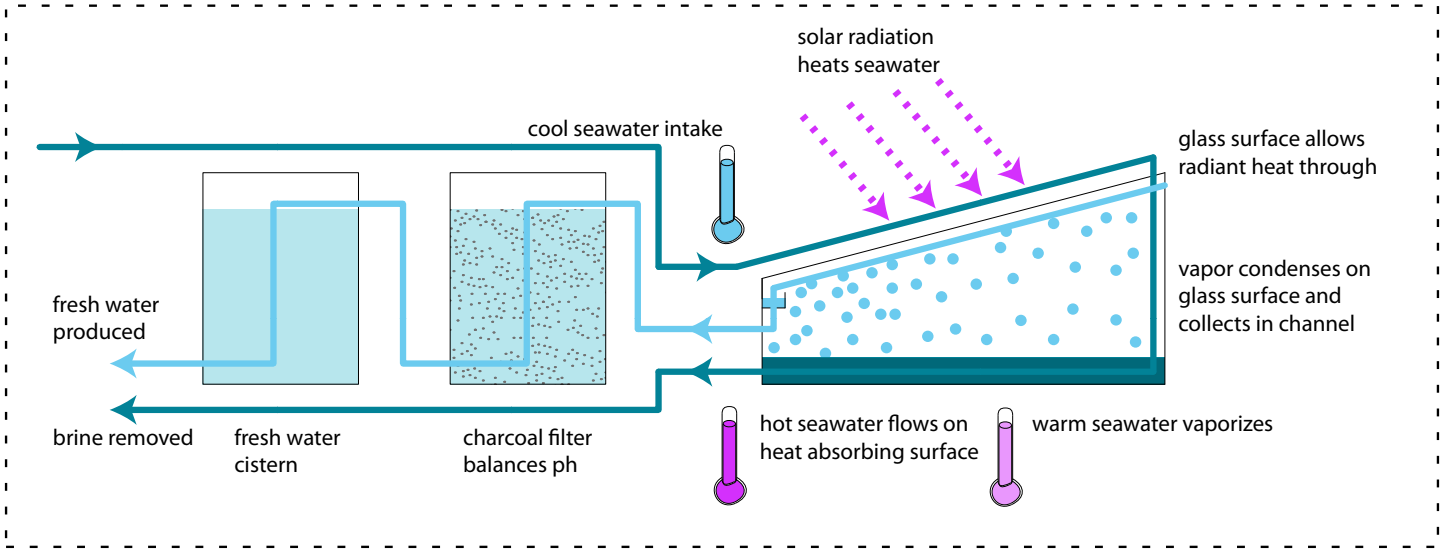
currently uses carrier gas which could be expensive

this system has been tested to work as effectively and efficiently as reverse osmosis

in comparison to less passive systems, the process for producing fresh water is slower

utilizes the sun's radiation

# Humidification/Dehumidification Desalination: Type 2




system pros and cons:

system requires a lot of surface area to produce decent quantities of fresh water

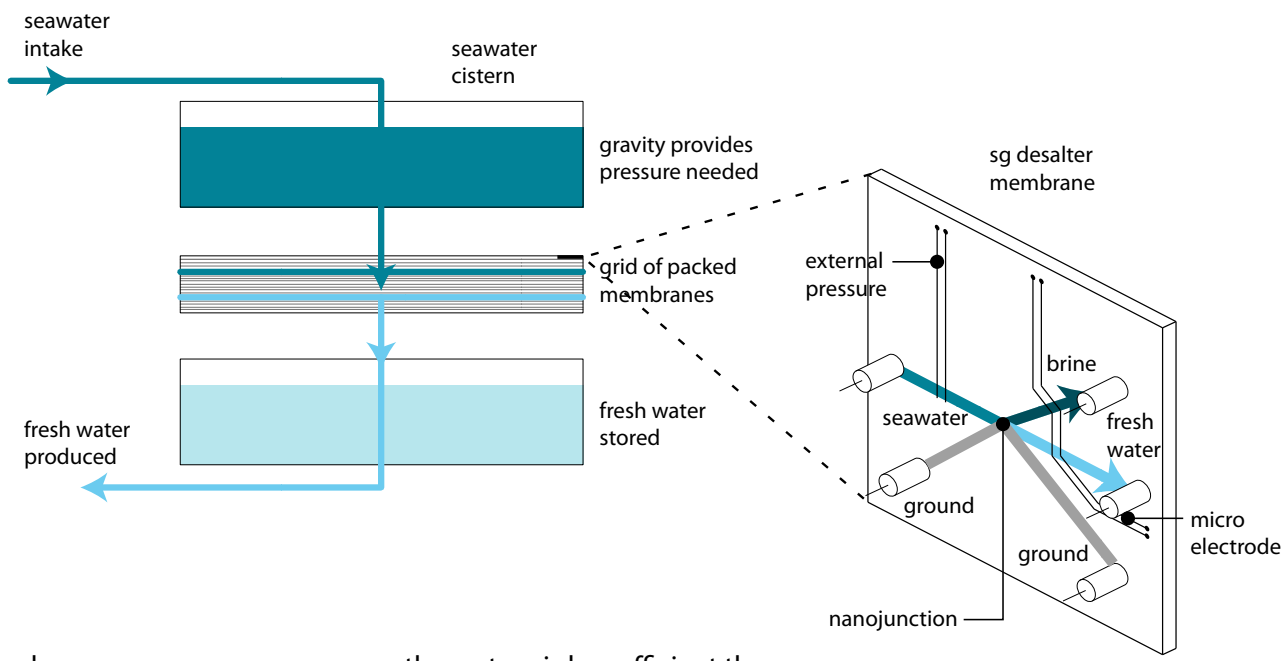
in comparison to less passive systems, the process for producing fresh water is slower

attempts to mimic the natural rain cycle

requires little maintenance and it is low in cost

this system has poor thermal efficiency because the glass surface is required to act as both the hottest surface and the coldest surface

# Desalination Using Ion Concentration Polarization




system pros and cons:

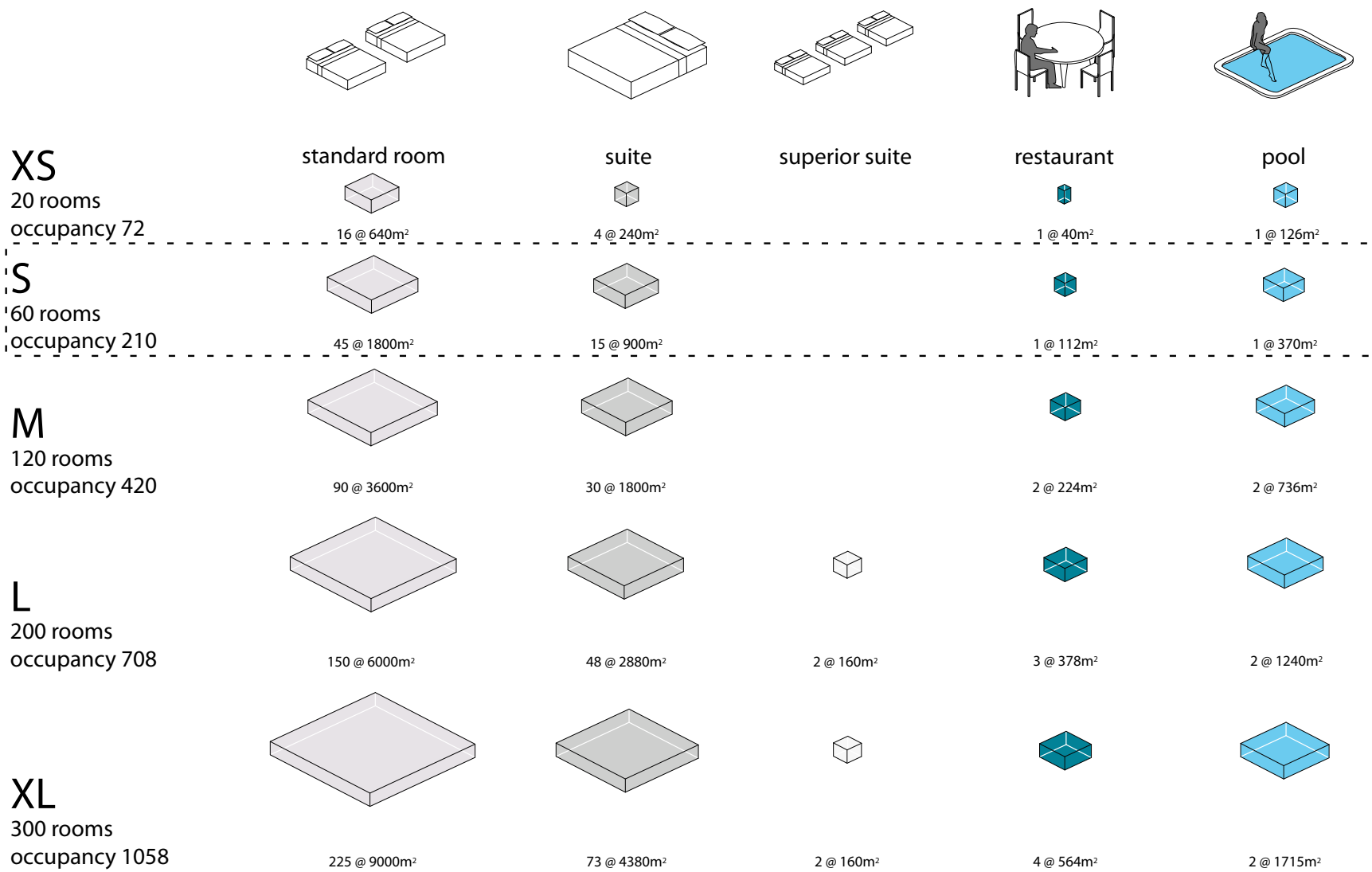
works best in small scale situations. the desired result is that this product is deployed for disaster relief

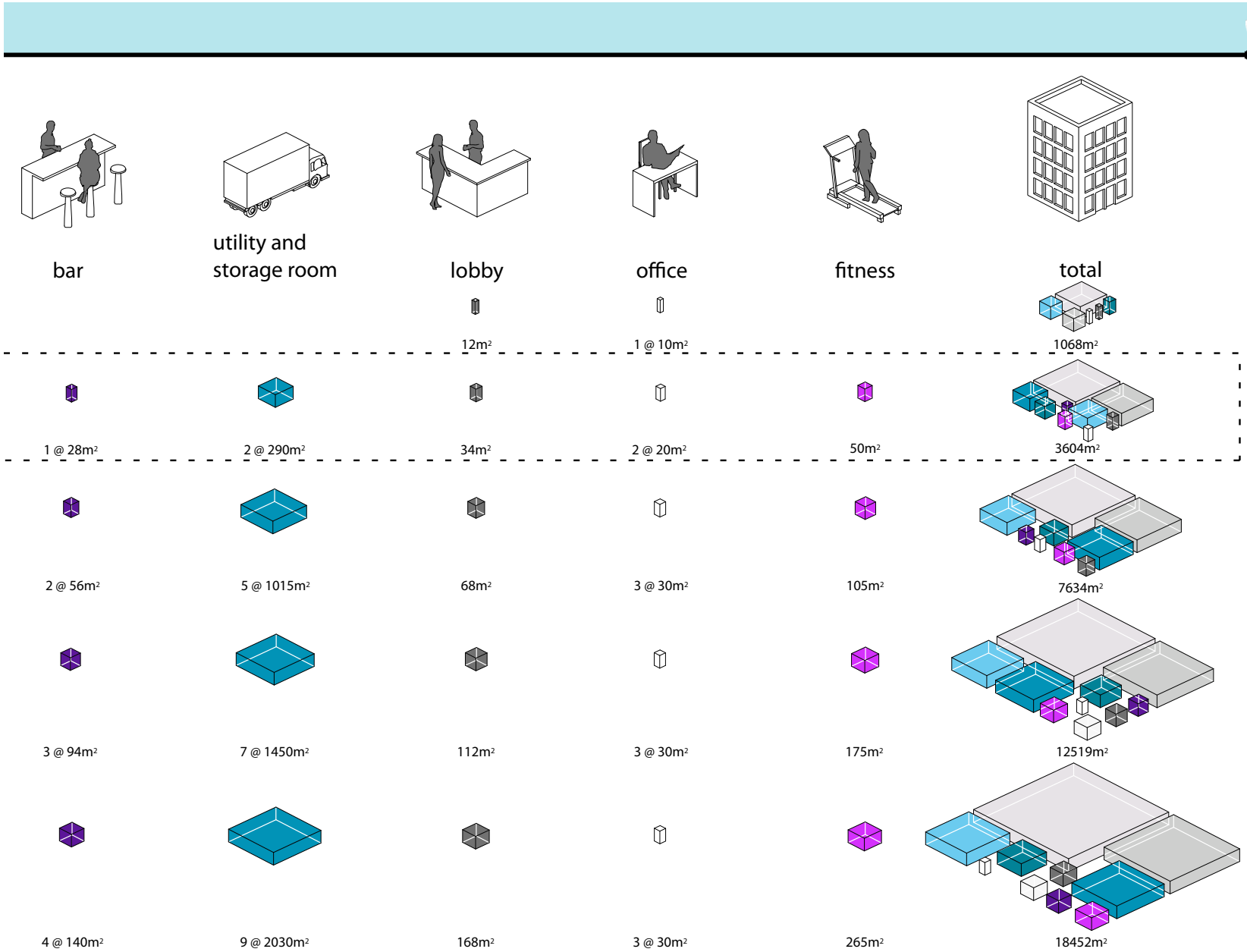
because the filtering membrane is made of hundreds of small sg desalters, there would be an issue in scaling the system to become larger

the system is less efficient than reverse osmosis; energy consumption is 5 kwh/$m^3$

manufacturing costs for membranes would be high and not easily replaceable nor deployable

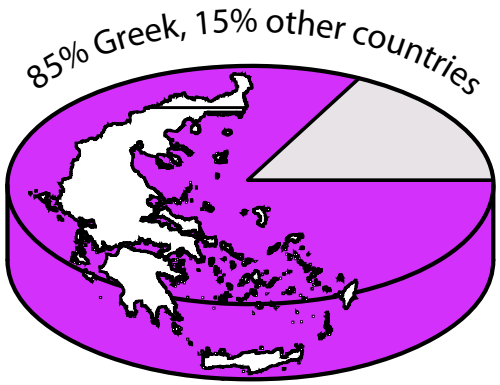
# Basic Hotel Program and Size Options



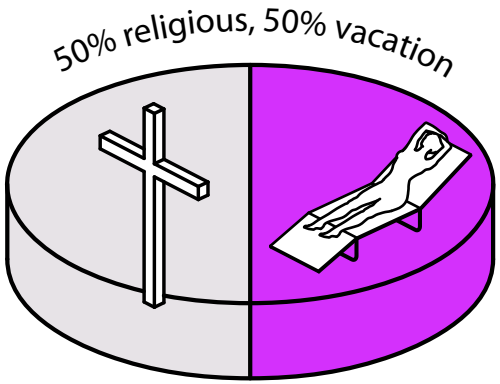

bar
utility and storage room
lobby
office
fitness
total
12m²
1 @ 10m²
1068m²
1 @ 28m²
2 @ 290m²
34m²
2 @ 20m²
50m²
3604m²
2 @ 56m²
5 @ 1015m²
68m²
3 @ 30m²
105m²
7634m²
3 @ 94m²
7 @ 1450m²
112m²
3 @ 30m²
175m²
12519m²
4 @ 140m²
9 @ 2030m²
168m²
3 @ 30m²
265m²
18452m²

# Tourists Visiting Tinos

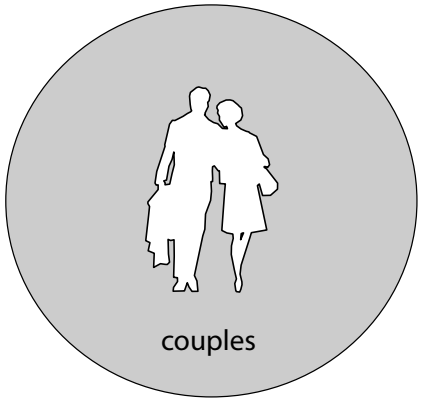
## Where are they from?



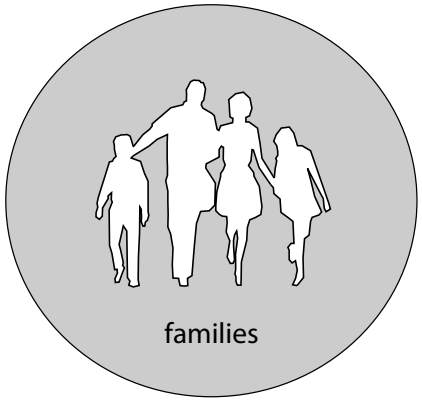

## Why they visit?



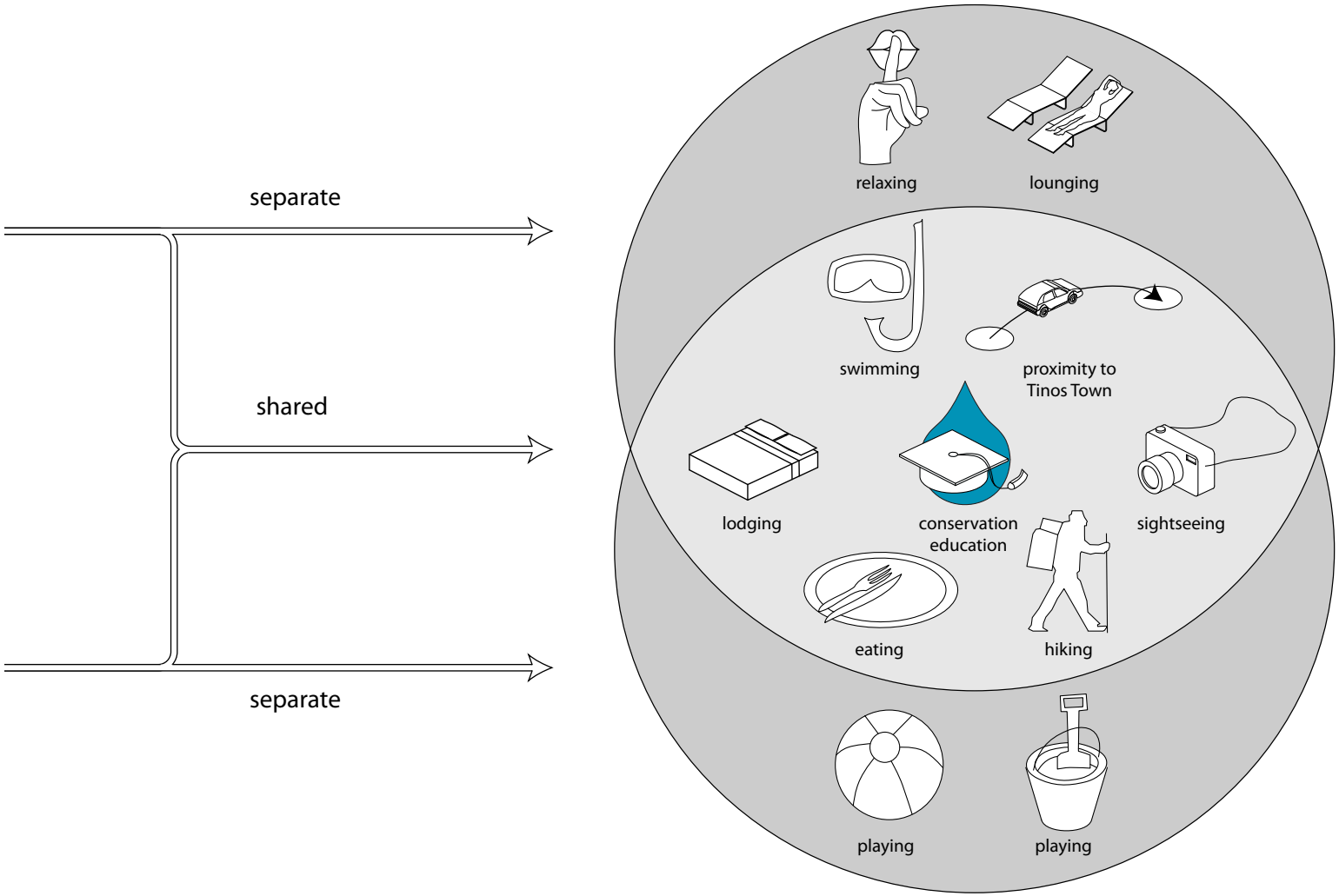

## What types of tourists is the $H_2$Otel for?



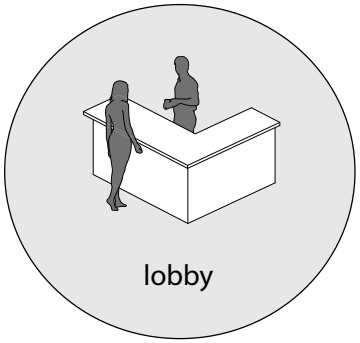

+

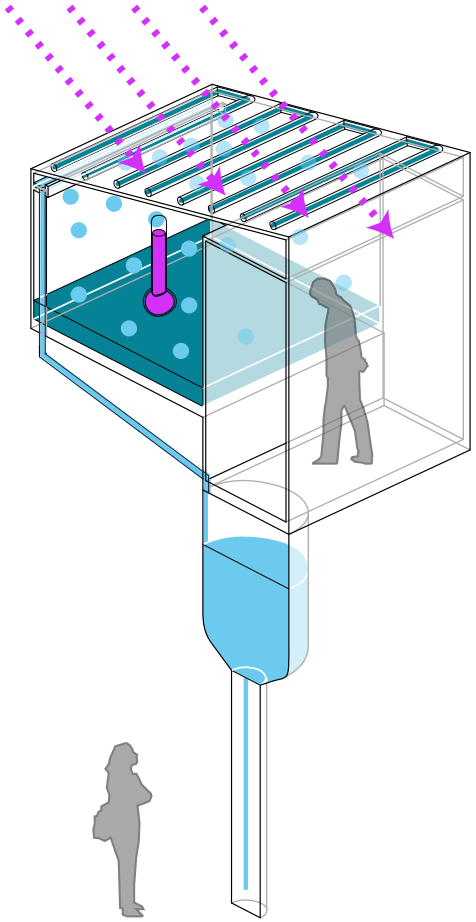


## Why they would come?

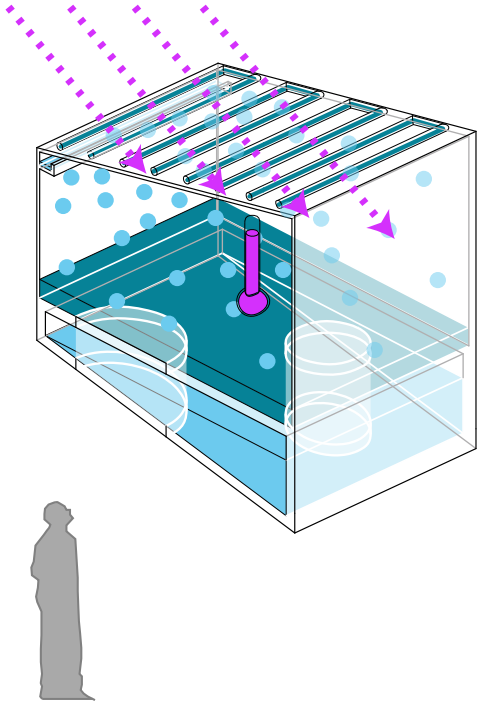


# Program Development Details for Guest Engagement and Education

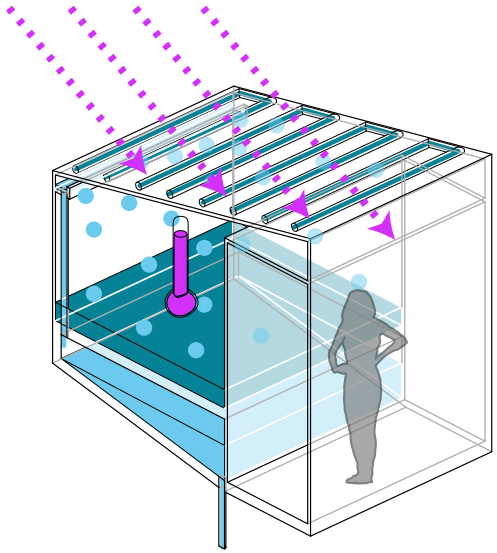


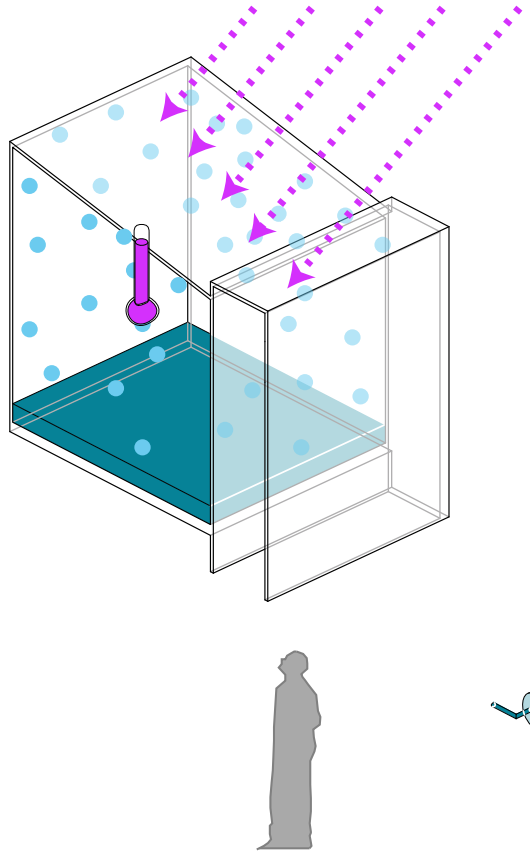
the guest is able to view the passive desalination process from above as well as from below.



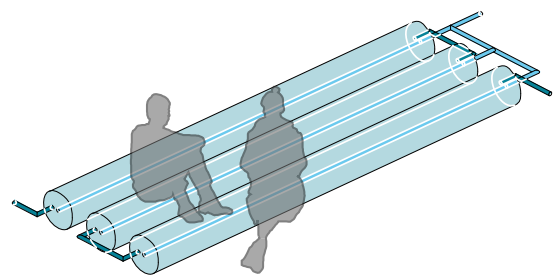
holes cut through the passive desalination process as well as the fresh water tank allowing light to penetrate the surface and enabling guests a look through the process.



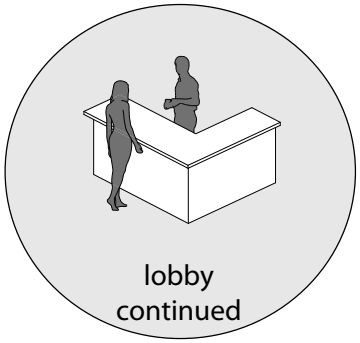
the guest views the passive desalination process and the fresh water tank from above and watches the process through glass.

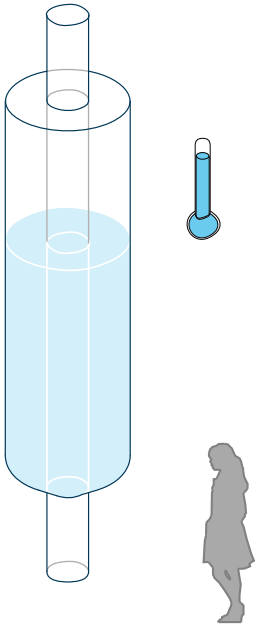


the guest views the passive desalination process from below. the hole pentrates from the roof instead of through the tank allowing a better view of the process.

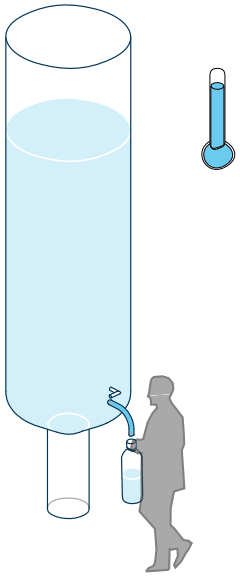


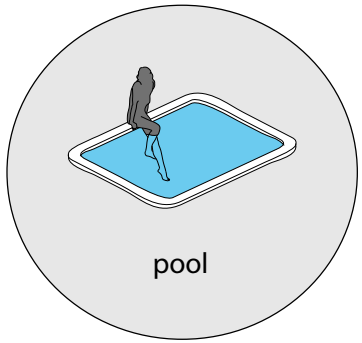
by flipping the typical reverse osmosis system on its side, it provides seating as well as allows guests to feel the water being pumped beneath them.



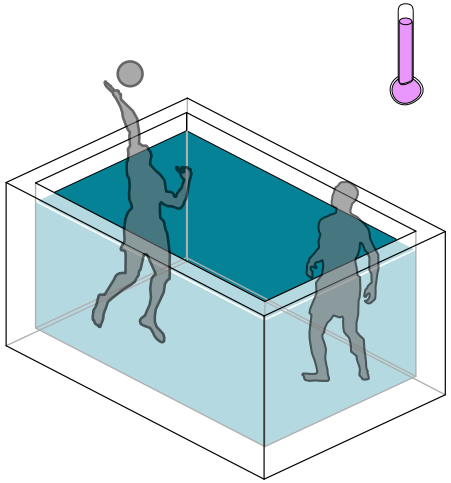



a structural column becomes
combined with a fresh water tank.

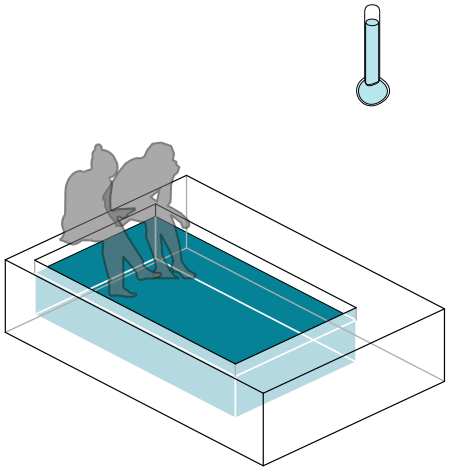




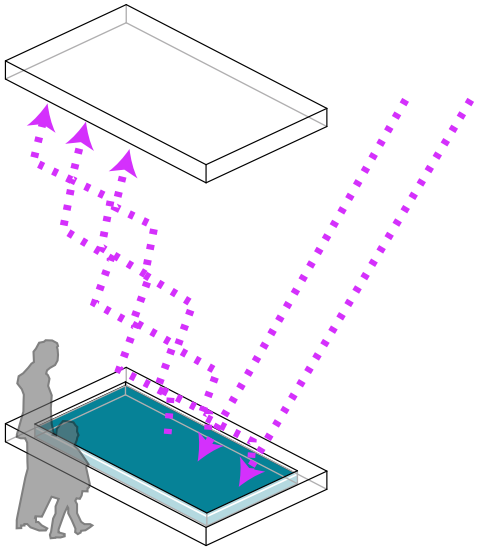

local are able to fill bottles with
drinking water for a lower fee as well
as a different experience.



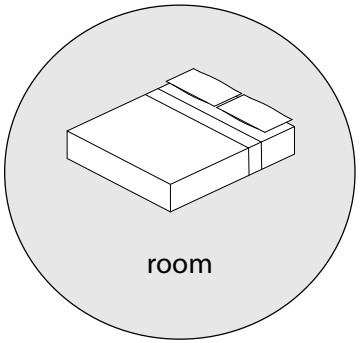
a salt water tank for the filtration system doubles as a pool. the sun heats this body of water making it warmer than the sea.

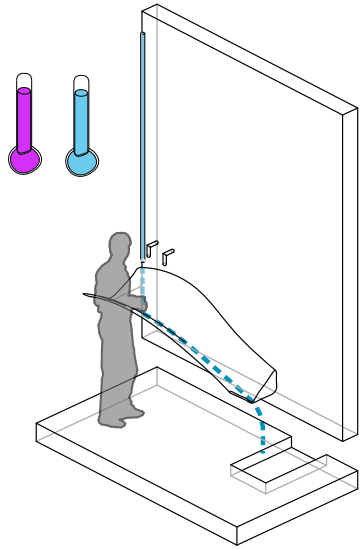


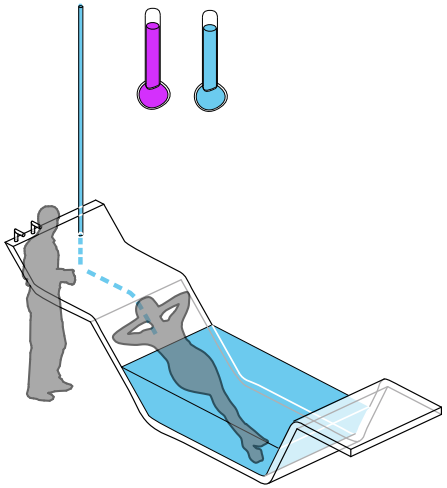
a smaller salt water tank in the shade can double as a place to gather and cool off.



a partially shaded pool of water can create reflections on the roof above it.

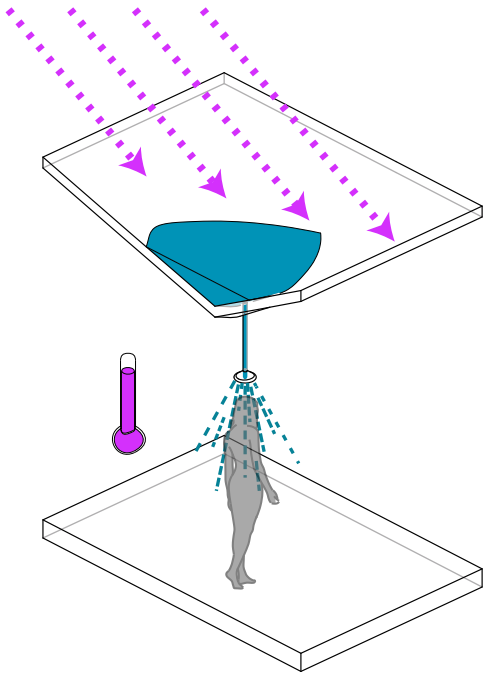


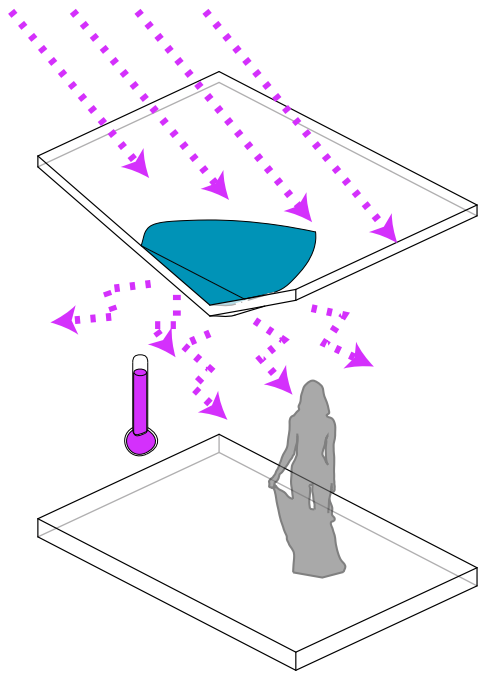


a fresh water pipe hangs from the ceiling and used water drains onto the floor. an opening in the floor allows the water to flow out of the room and into a channel into the pathway

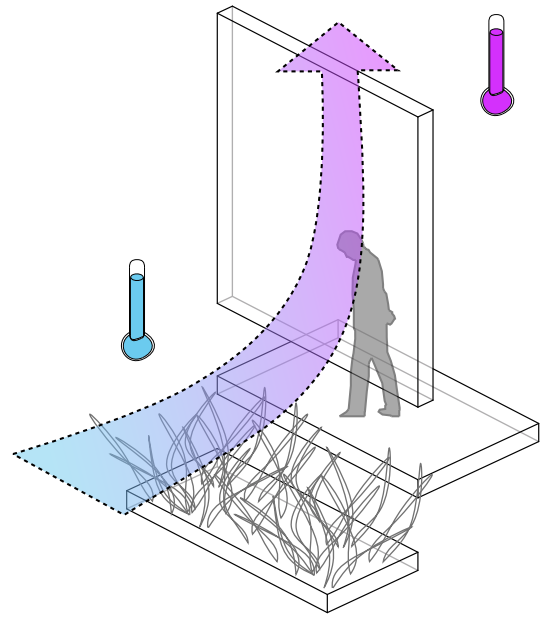
fresh water that feeds the sink drains into the bath. this allows for multiple uses of less water.



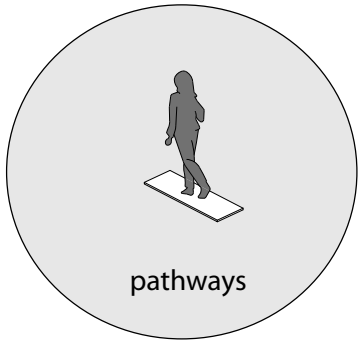
the roof collects rain water and during the day the water is heated by the sun. this water provides a warm shower with gravity-driven pressure.

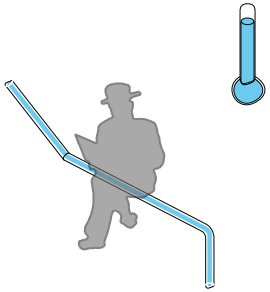


the rain water collected on the roof is heated during the day. at night the hot water provides a thermal mass to keep the room warm

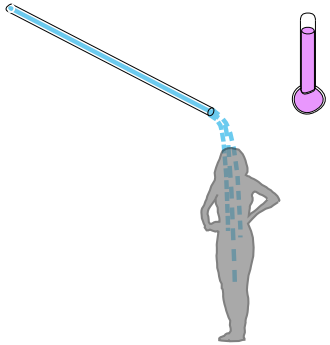


the wet biofiltration system cools hot air and a small opening in the room creates a negative suction that pulls the cool air into the room and expels hot air out of a larger opening.

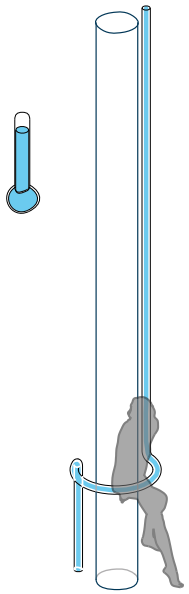


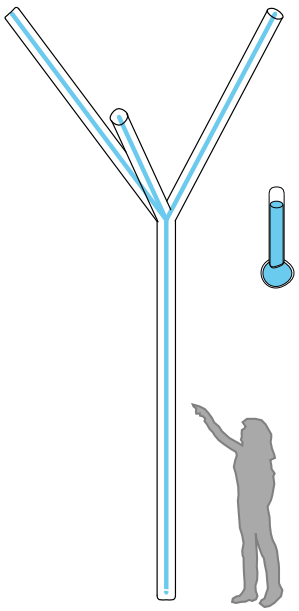
cold water running through the pipes create  a nice place to sit in the summer heat.



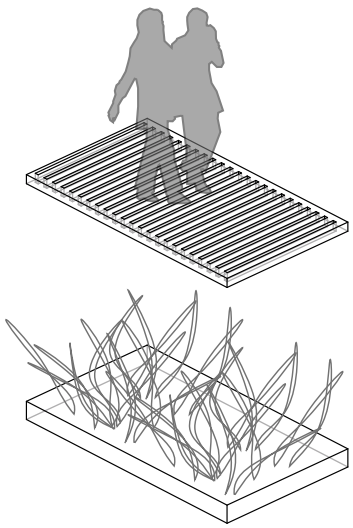
fresh water running through pipes can terminate in an outdoor shower next to the pool or beach to wash off salt water.



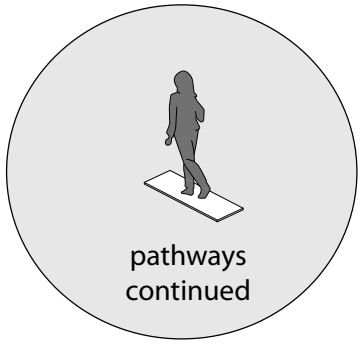
a vertical pipe that flows along the structure can be twisted into a cold seat on a hot  day.

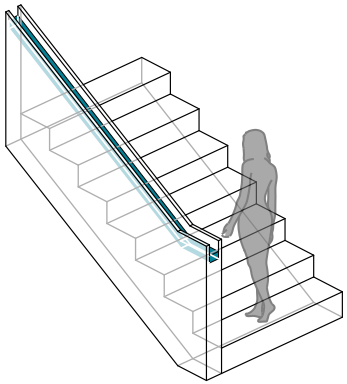


the structural system can double as a carrier for collected rain water or fresh water.

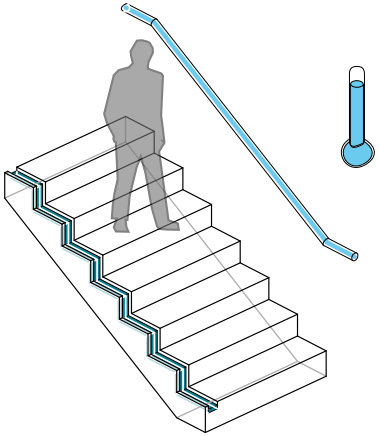


a grated pathway creates a visual connection to the biofiltration system below as well as allowing the fresh smell of flowers to permeate the surface.

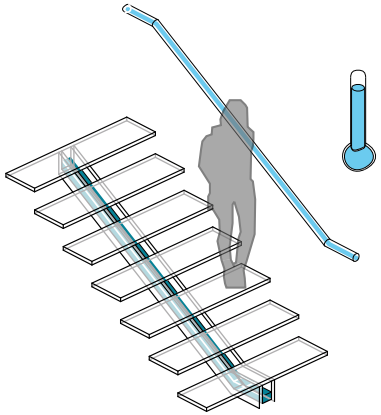


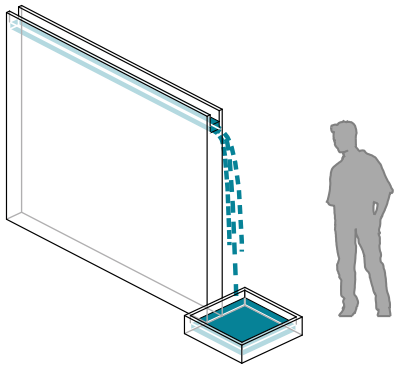
the grey water channel flows along the handrails creating a visual connection to the system.



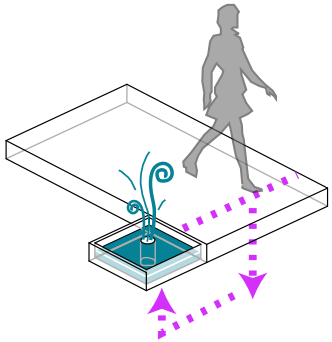
grey water flows along the stairs while fresh water moves in the handrails. this creates a visual and tactile connection to the multiple water systems.



grey water flows beneath the stairs along the structural beam while fresh water flows along the handrail.



the grey water channel terminates into a small water fall that creates a soothing sound.

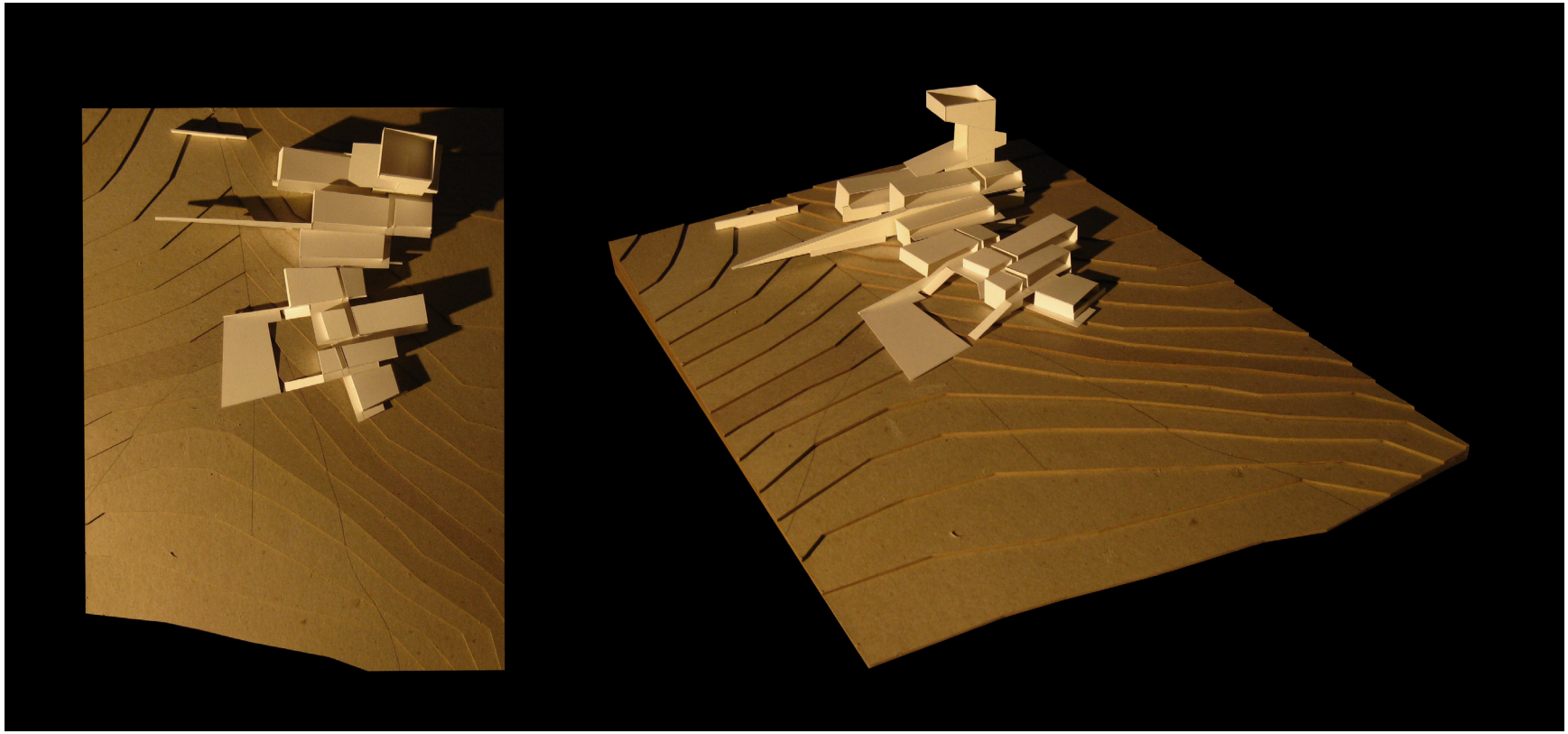


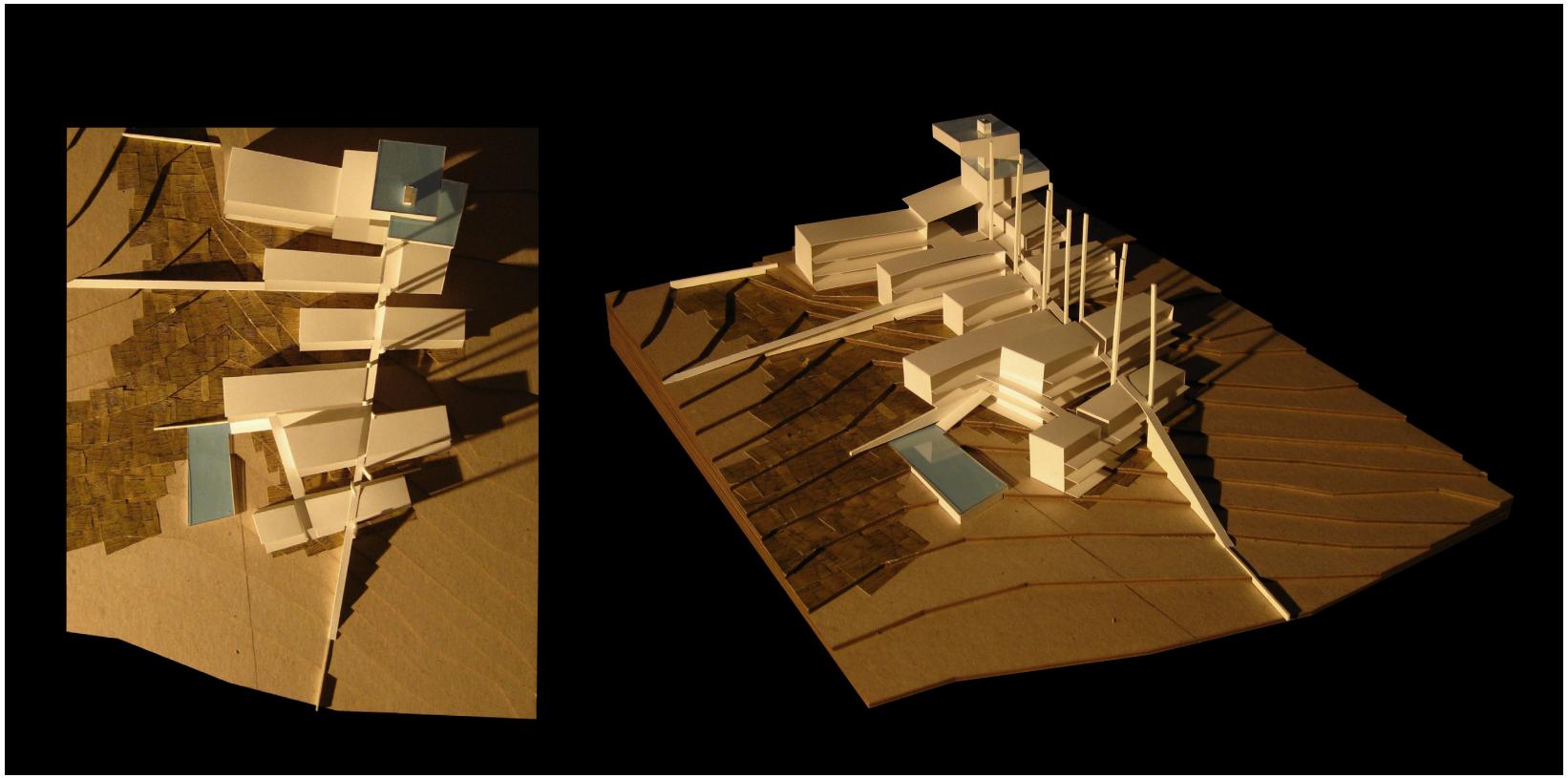
as guests walk along the pathway, the pressure applied creates an intermittant fountain.

# Design Process

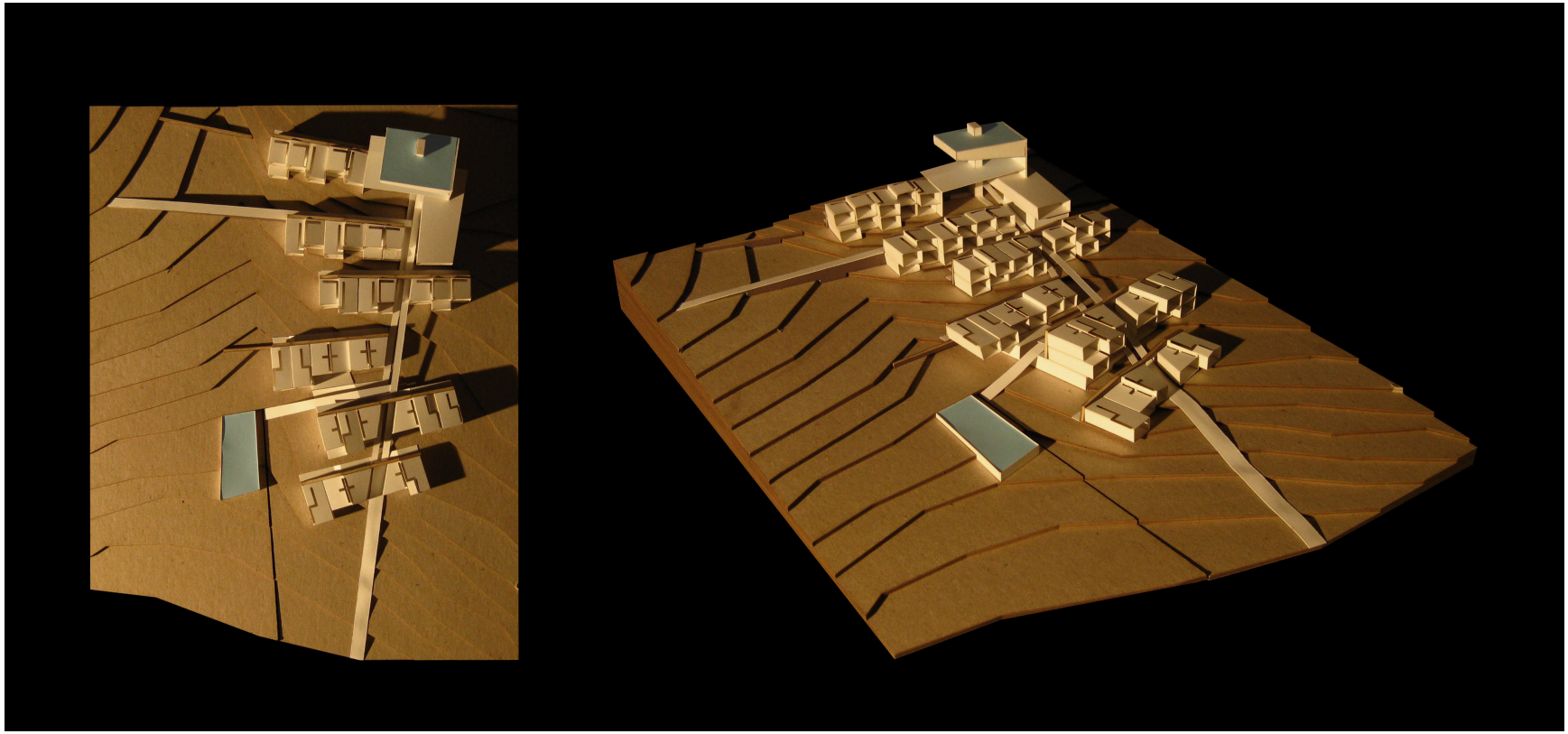
# Models

## Week Four

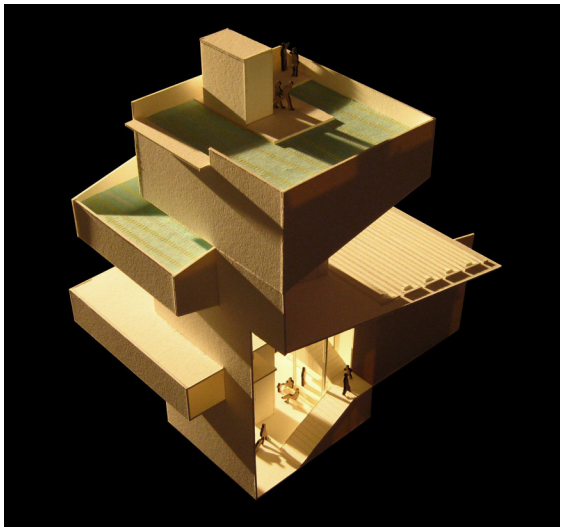


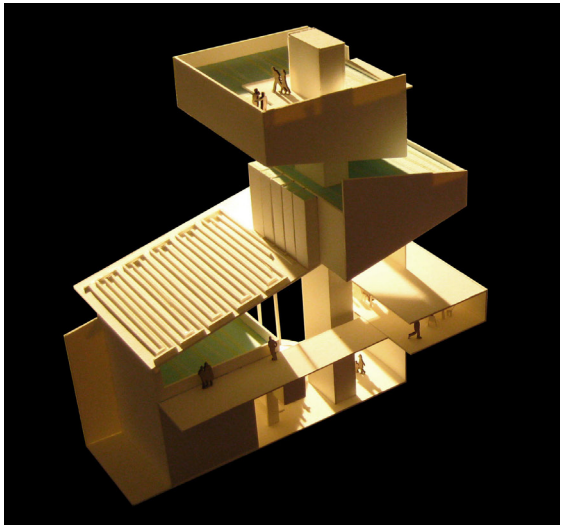


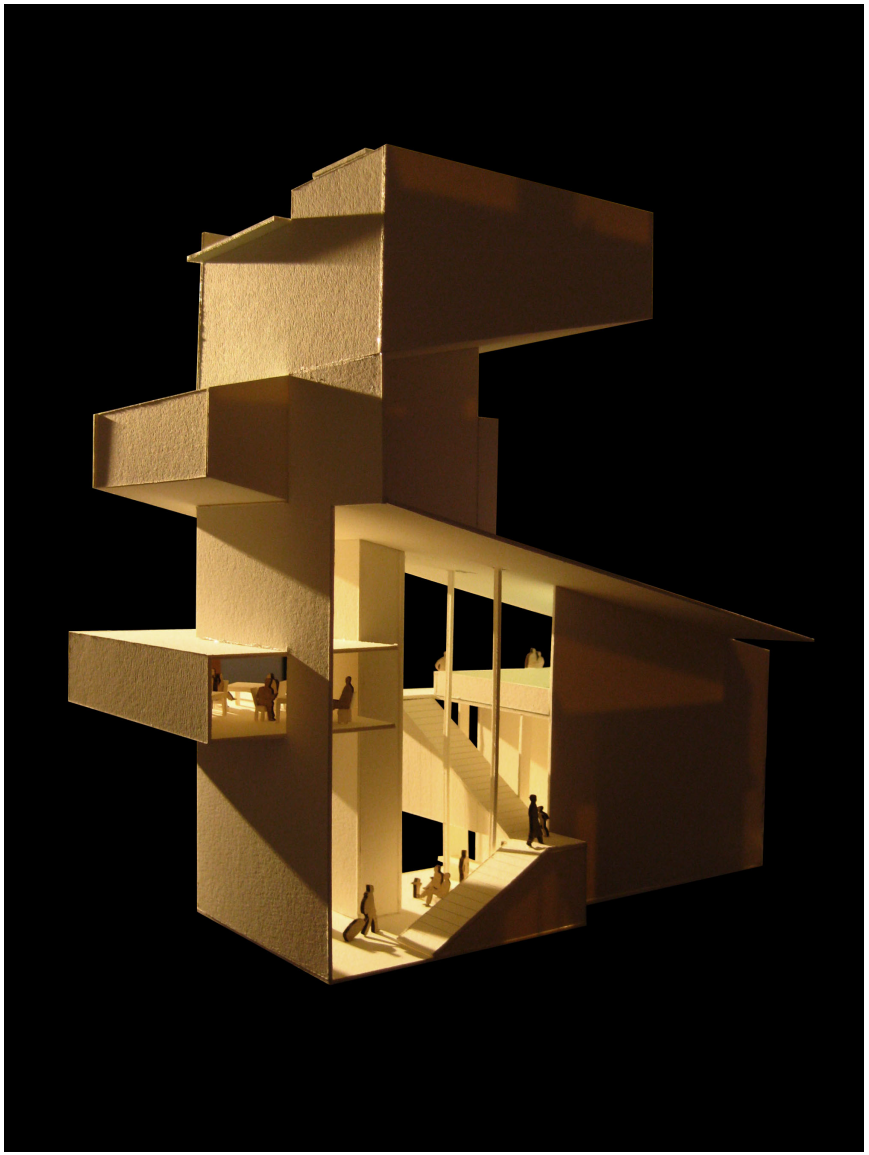
# Week Nine



## Lobby at Midterm



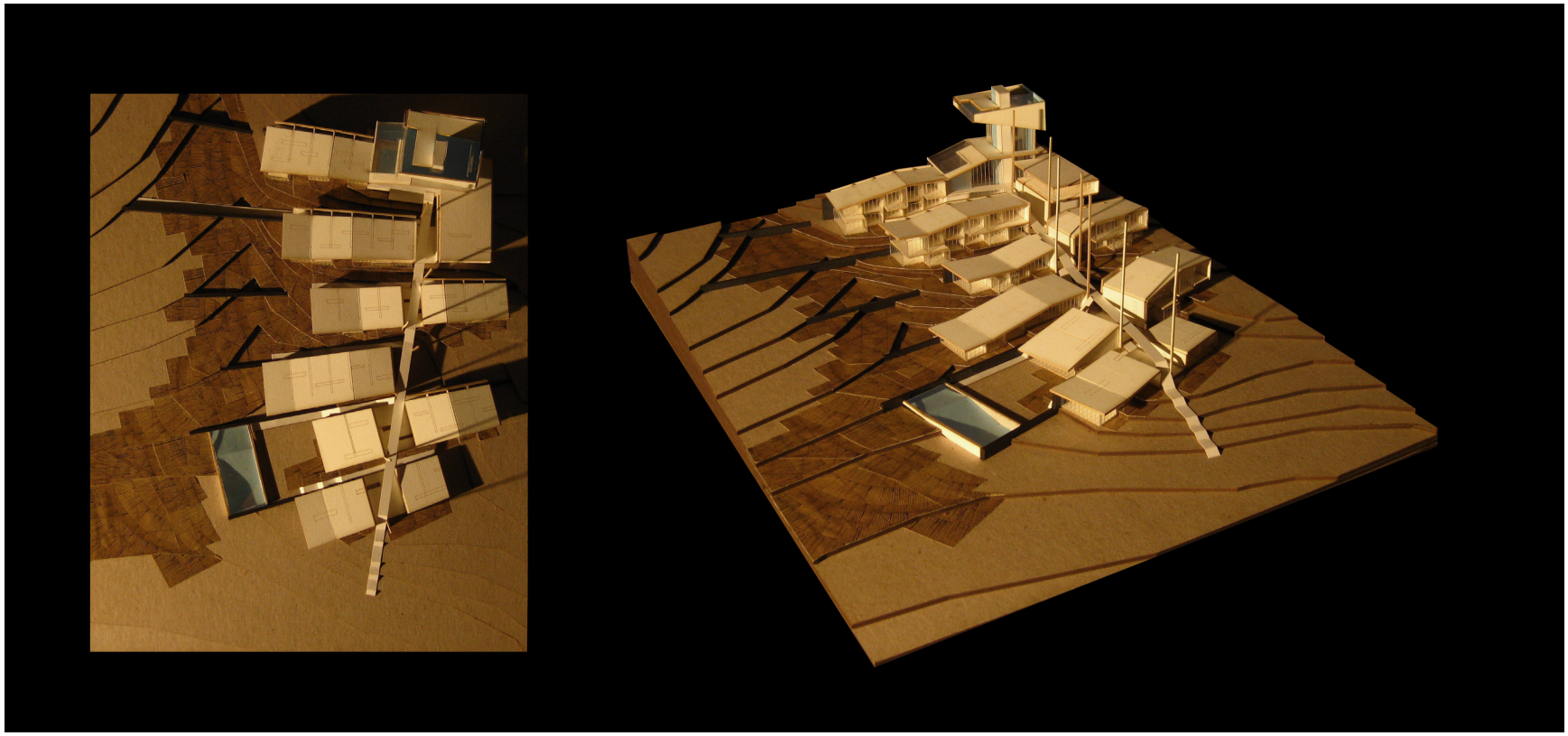


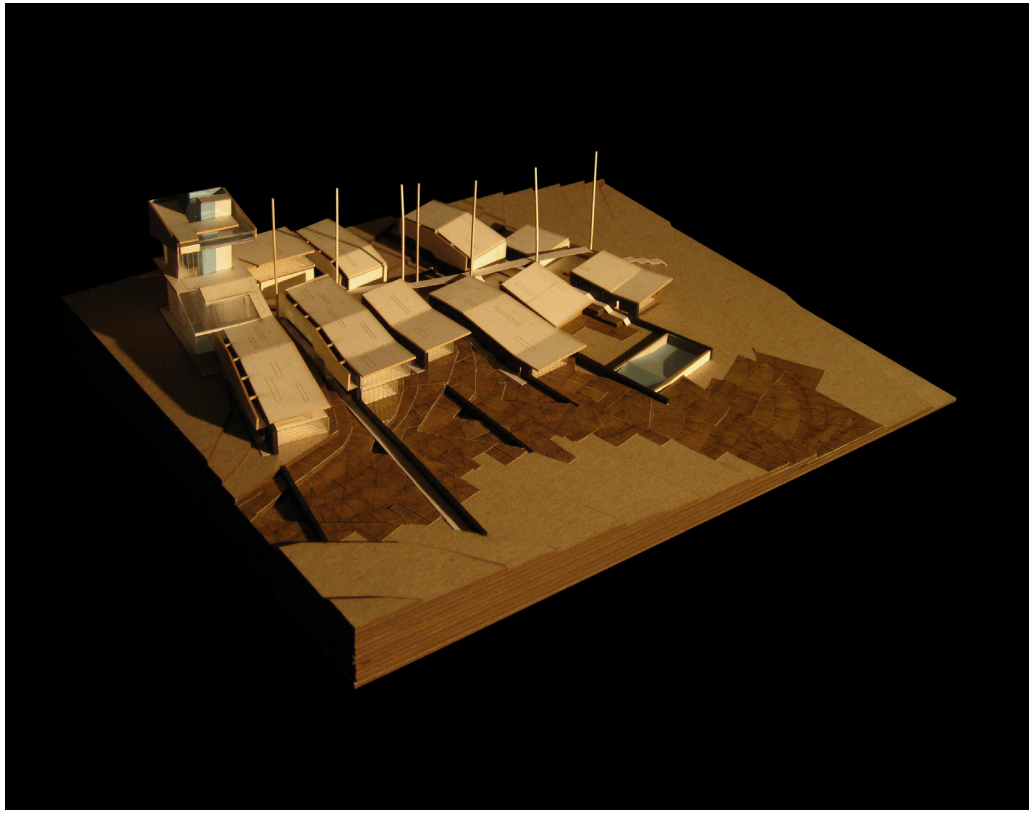


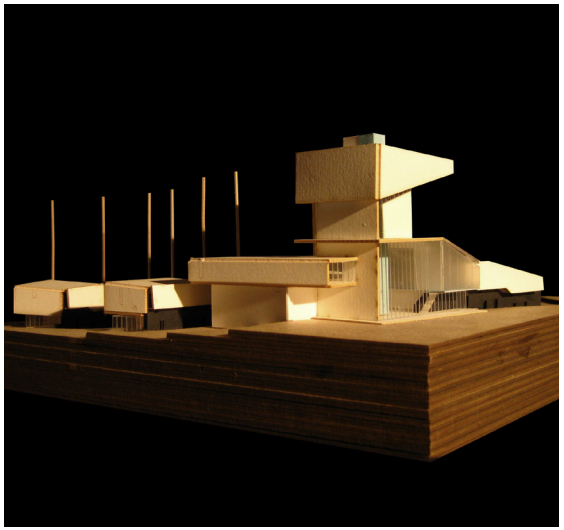
# Final Project

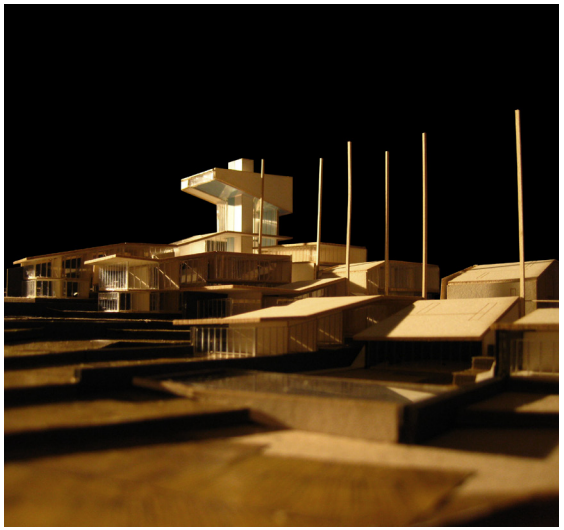
# Models

## Site Model

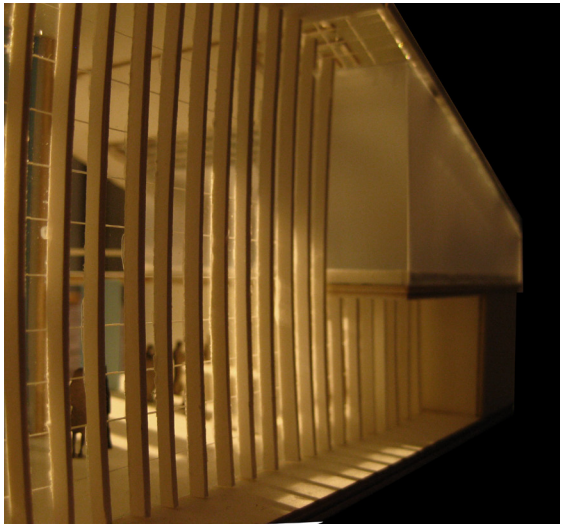


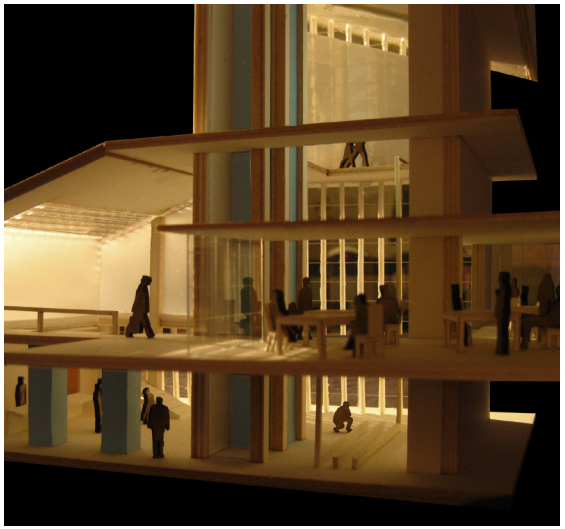


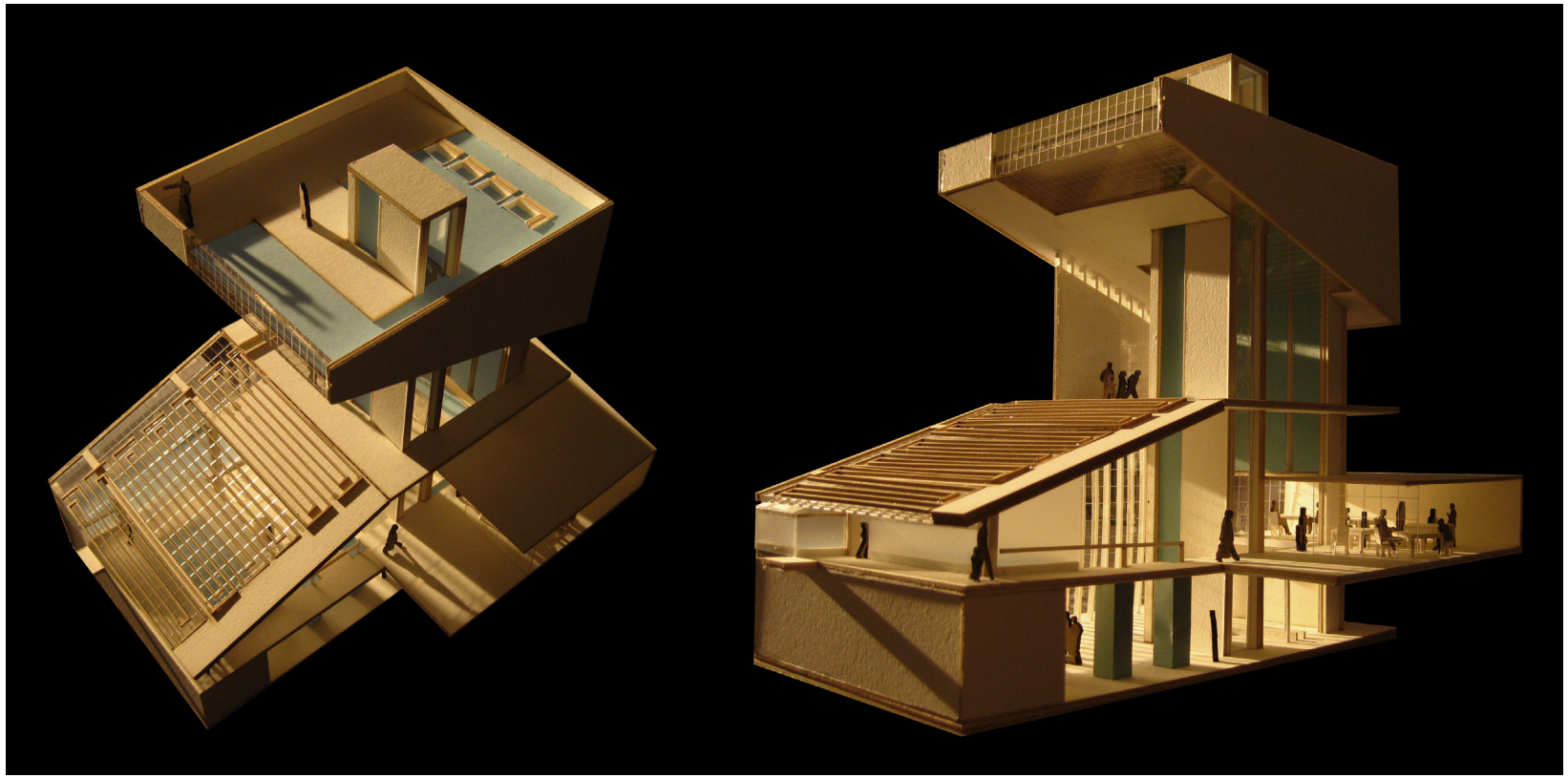




## Lobby

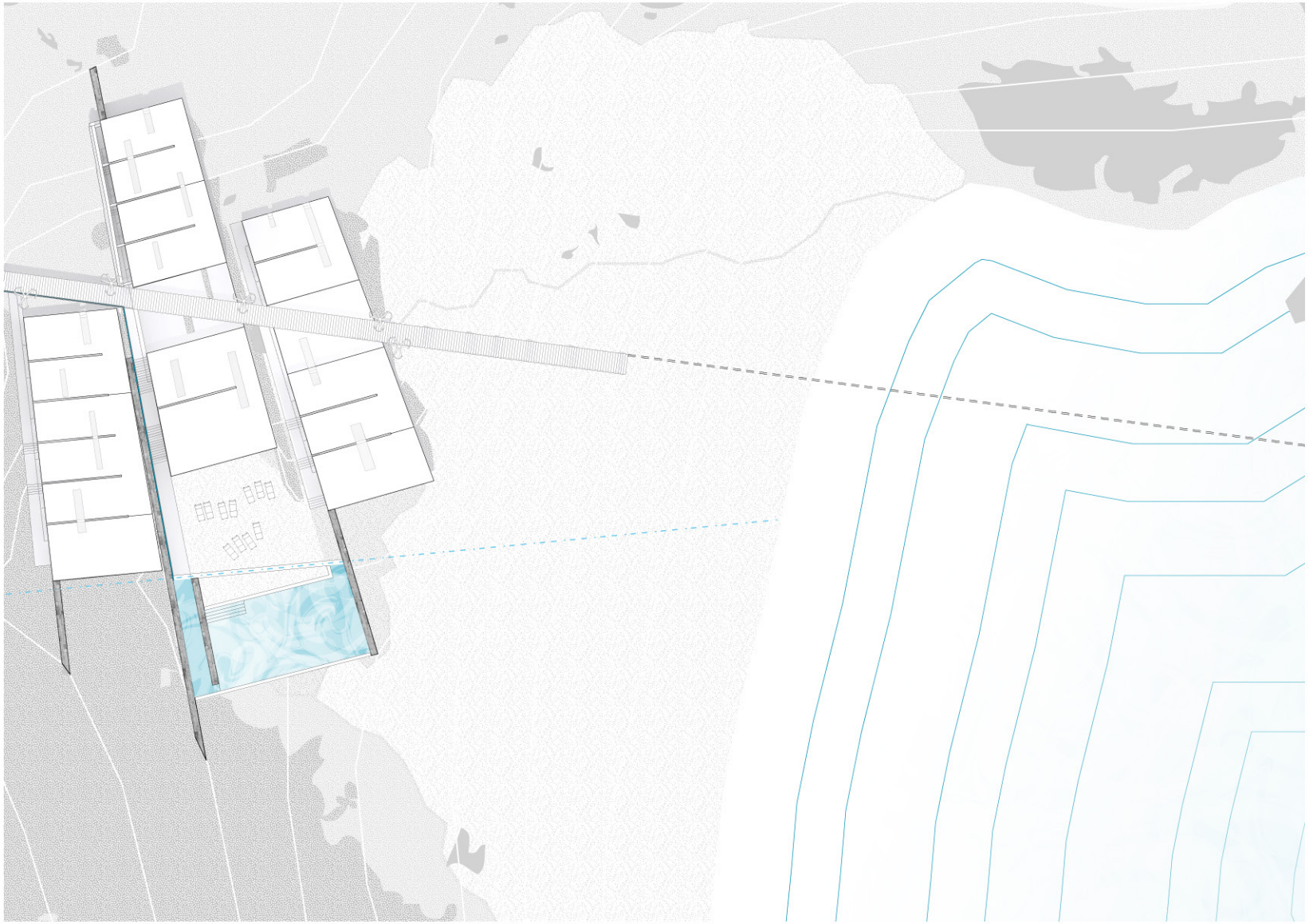




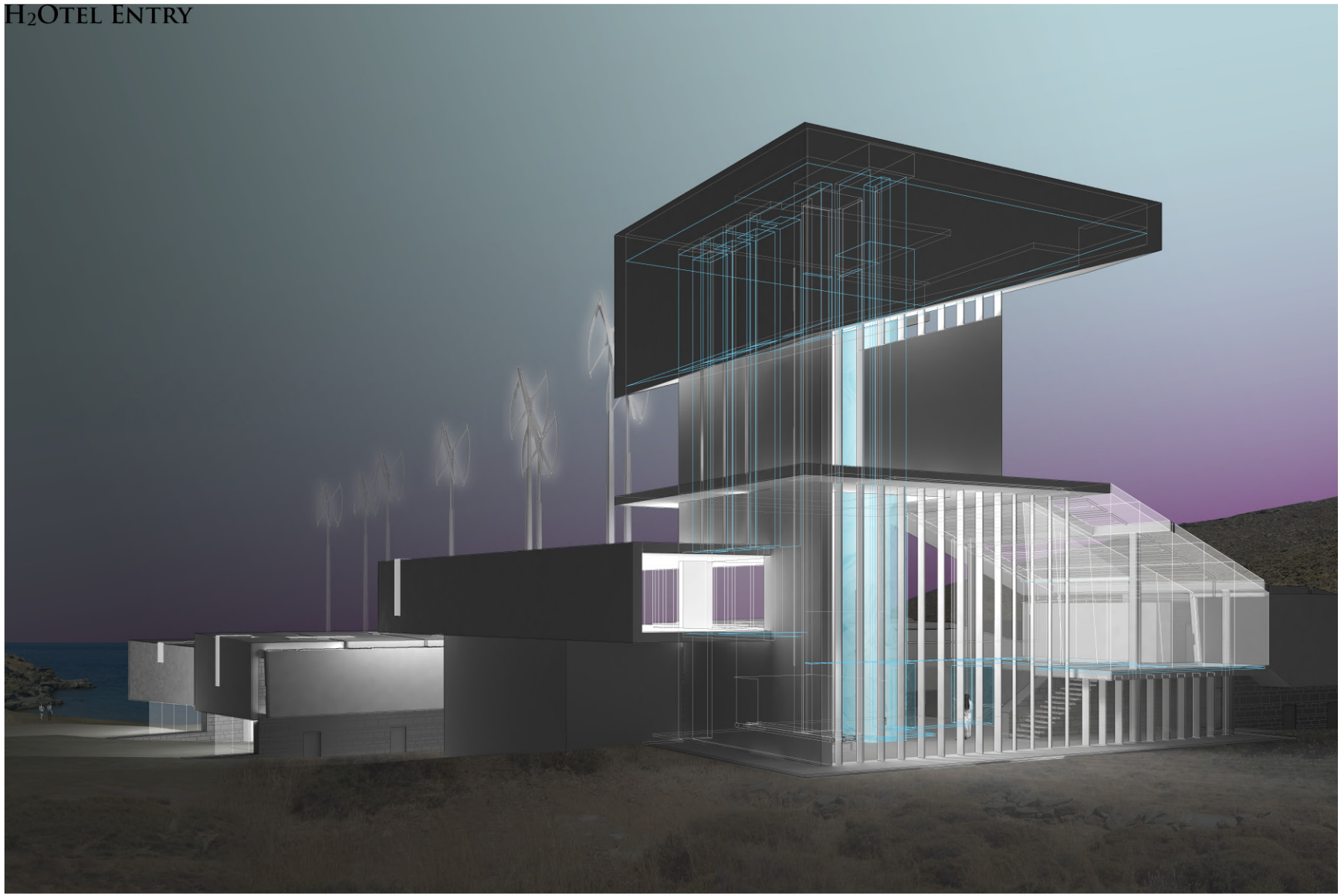


# Drawings

## Site Plan

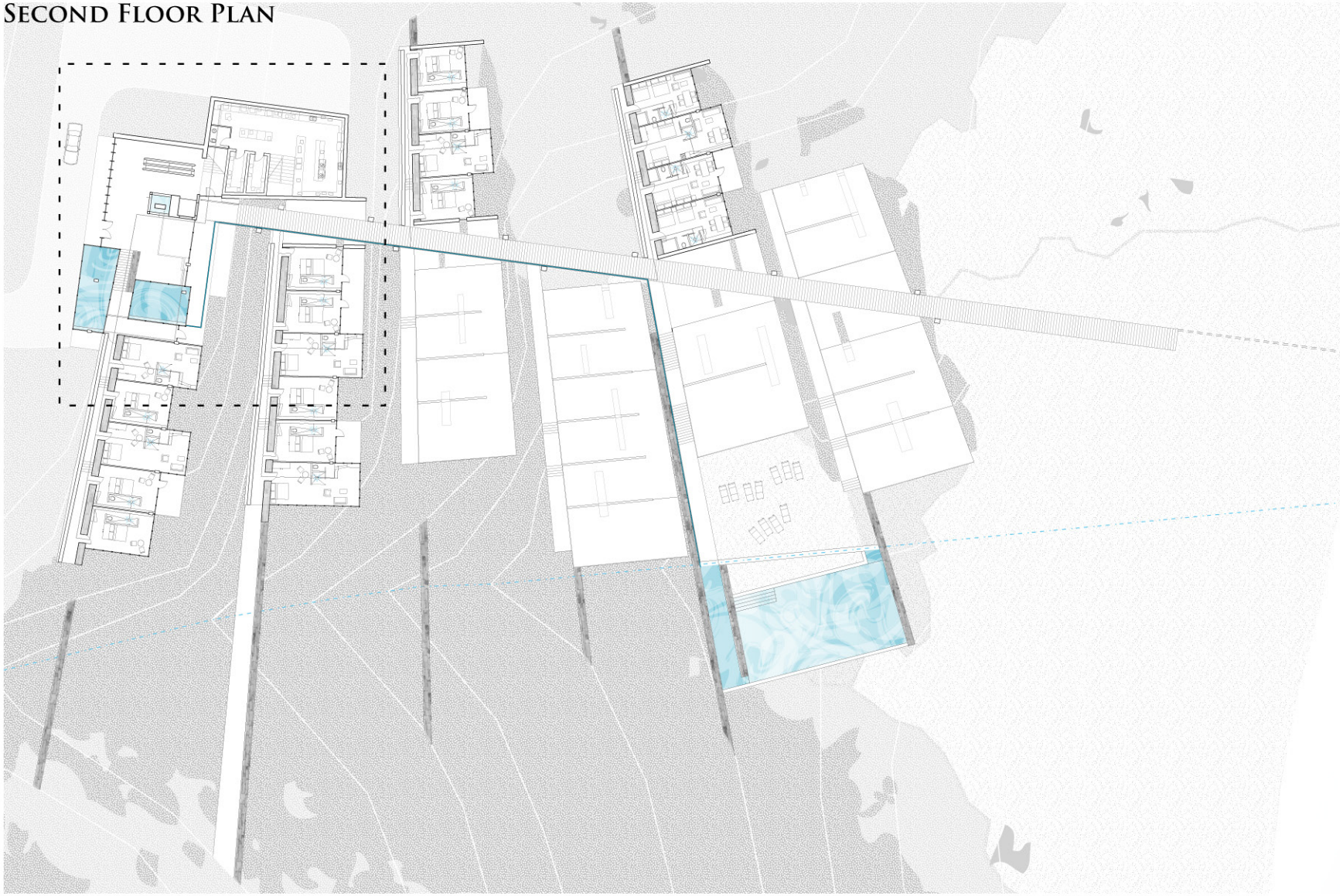


# $H_2$Otel Entry

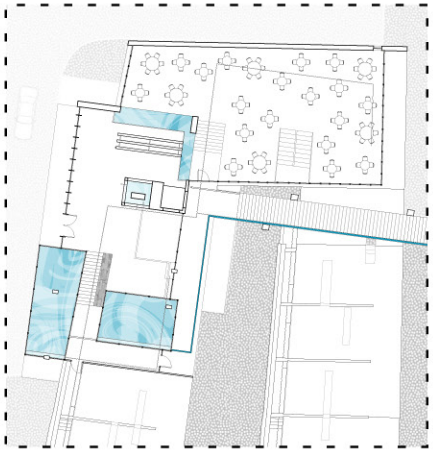


# First Floor Plan

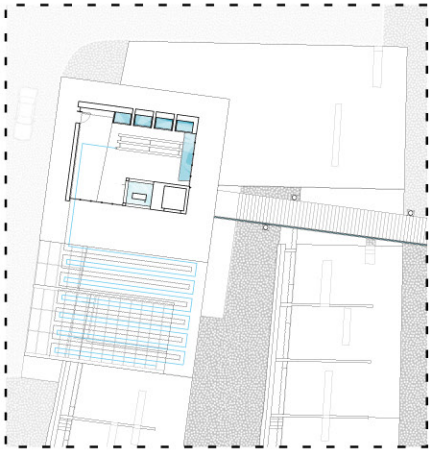
# Second Floor Plan



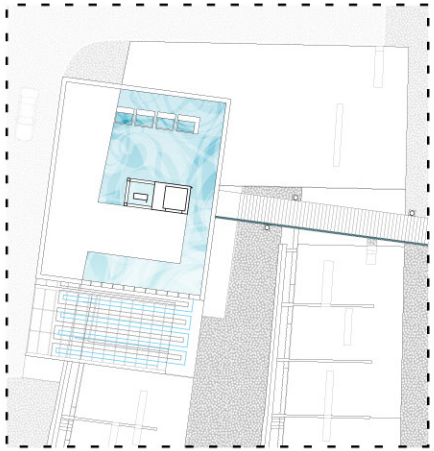
## Third Floor Plan



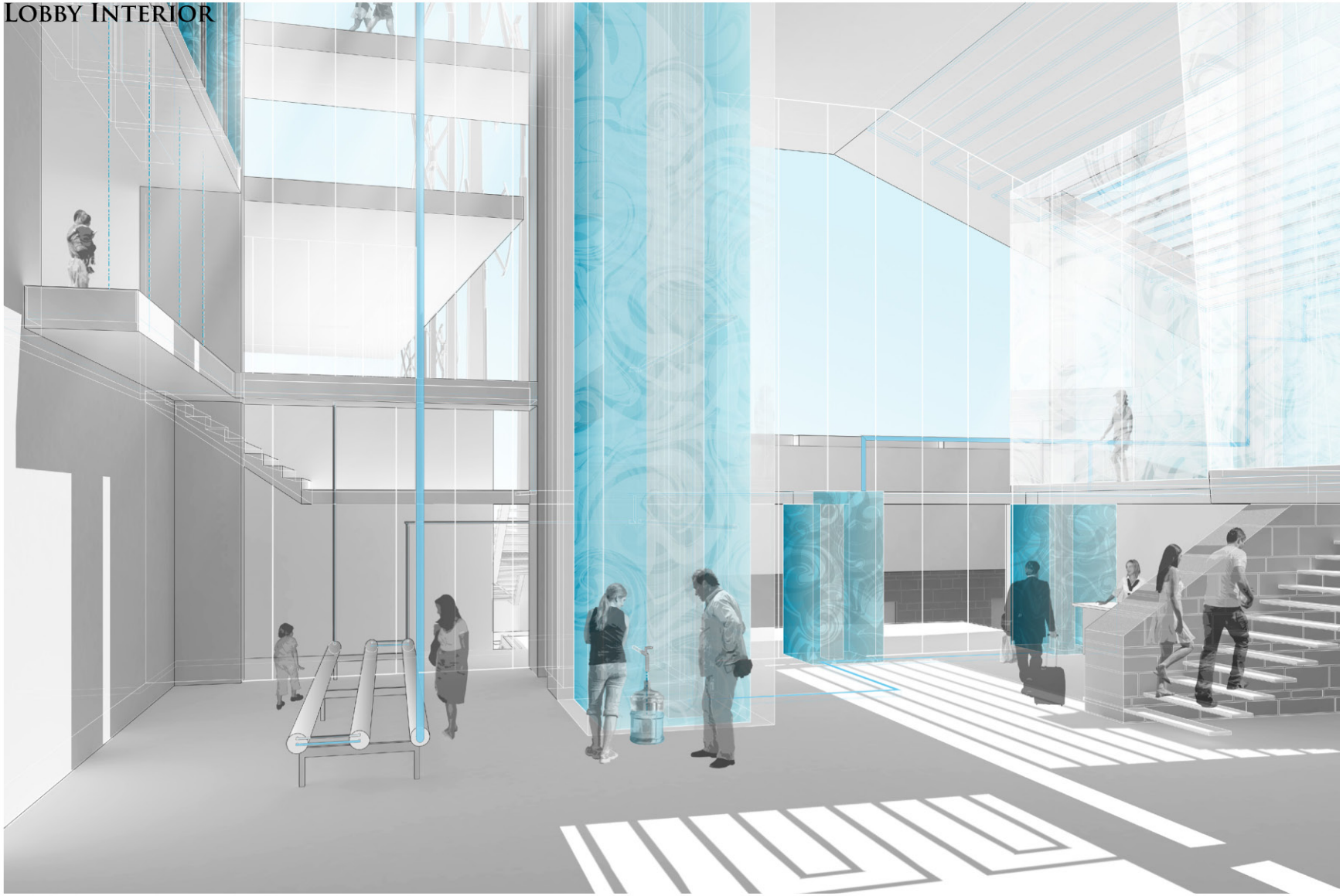
## Fourth Floor Plan



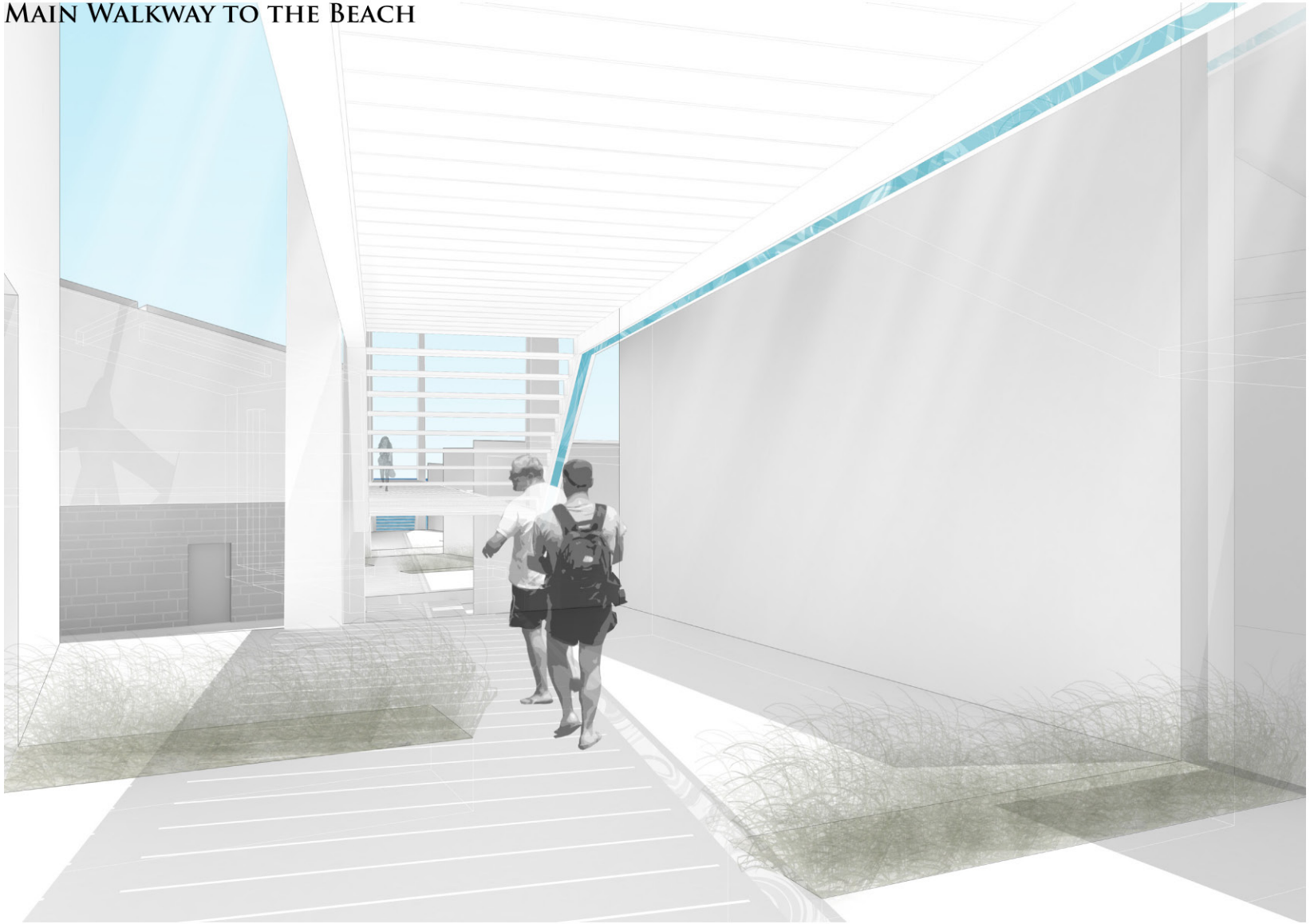
## Fifth Floor Plan



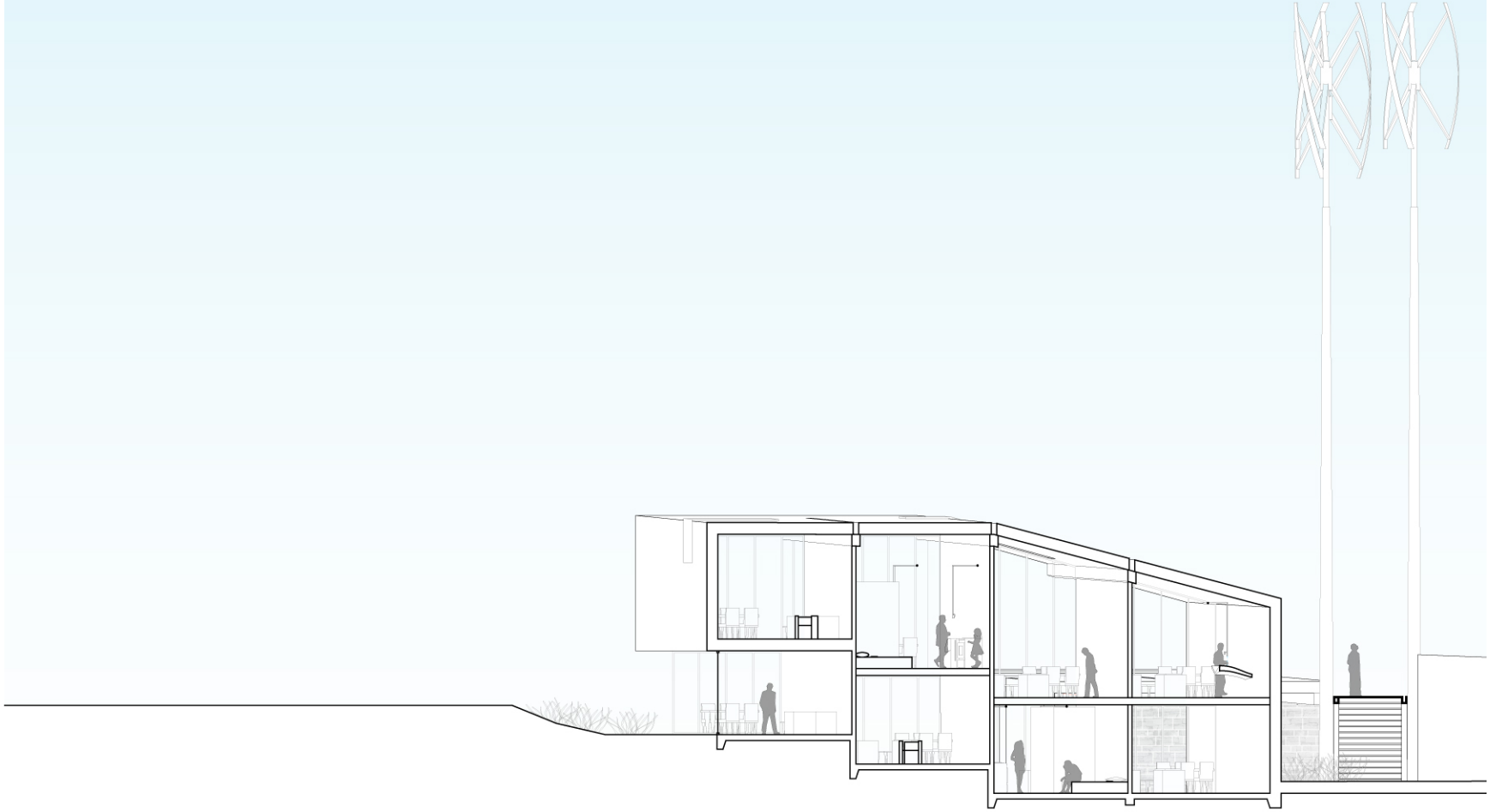
# Lobby Interior

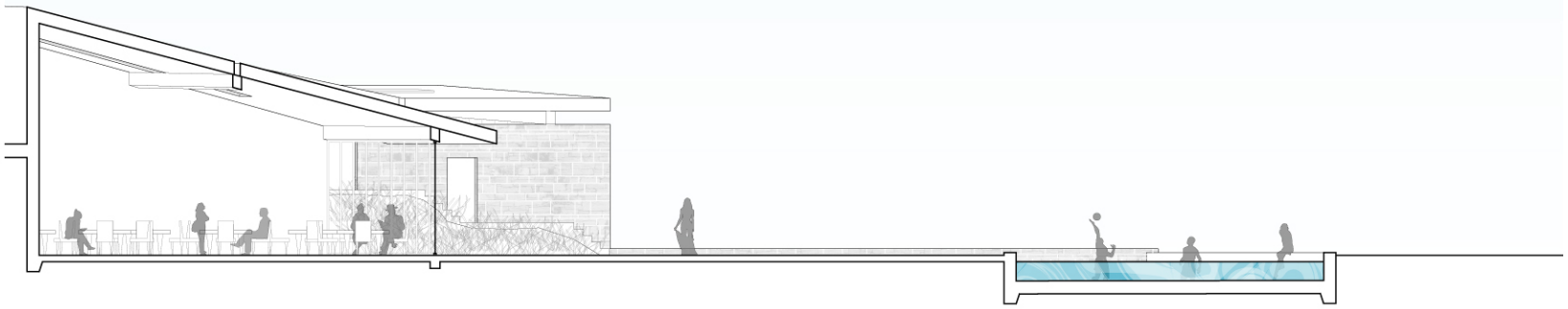


# Main Walkway to the Beach

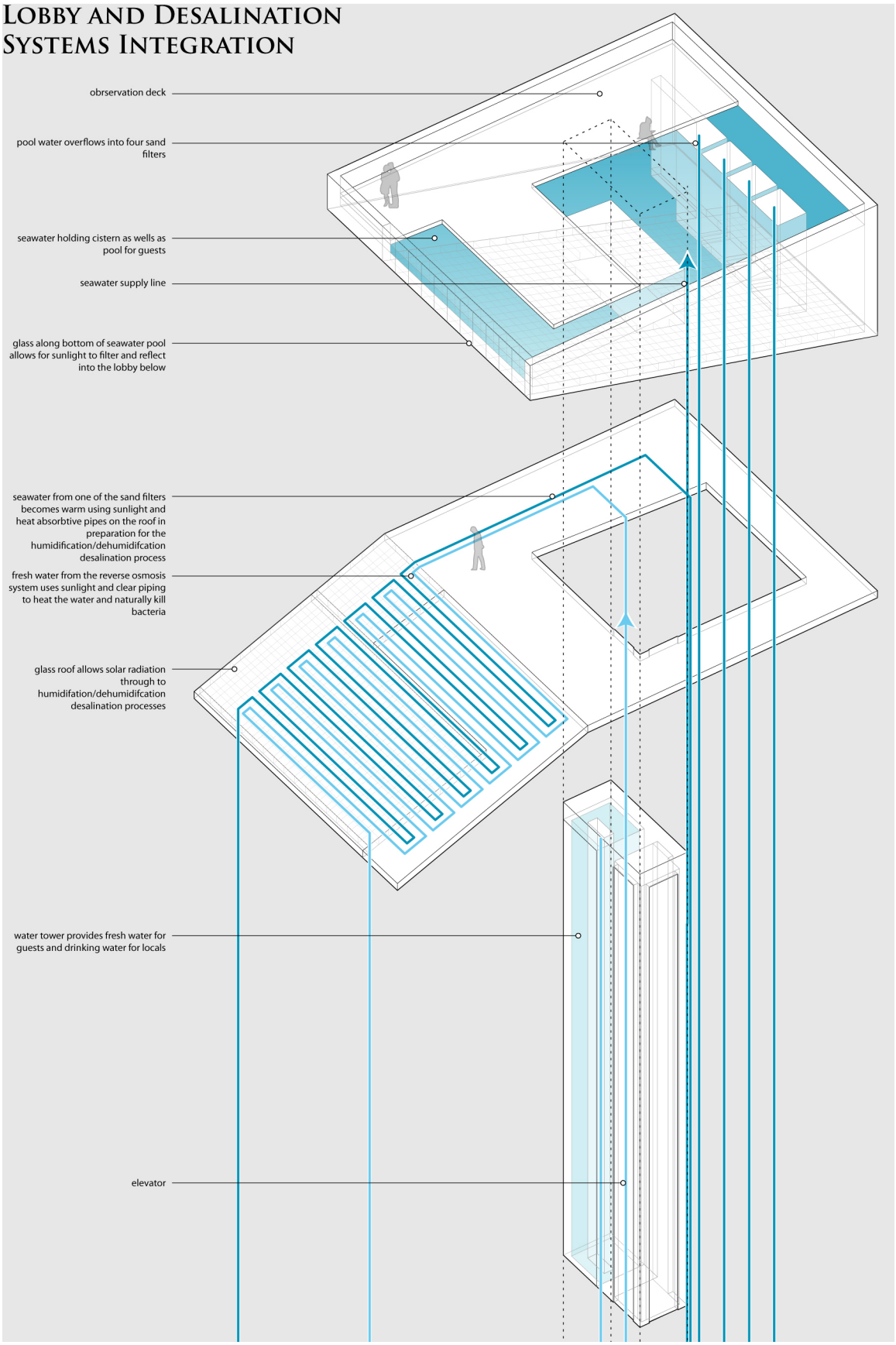


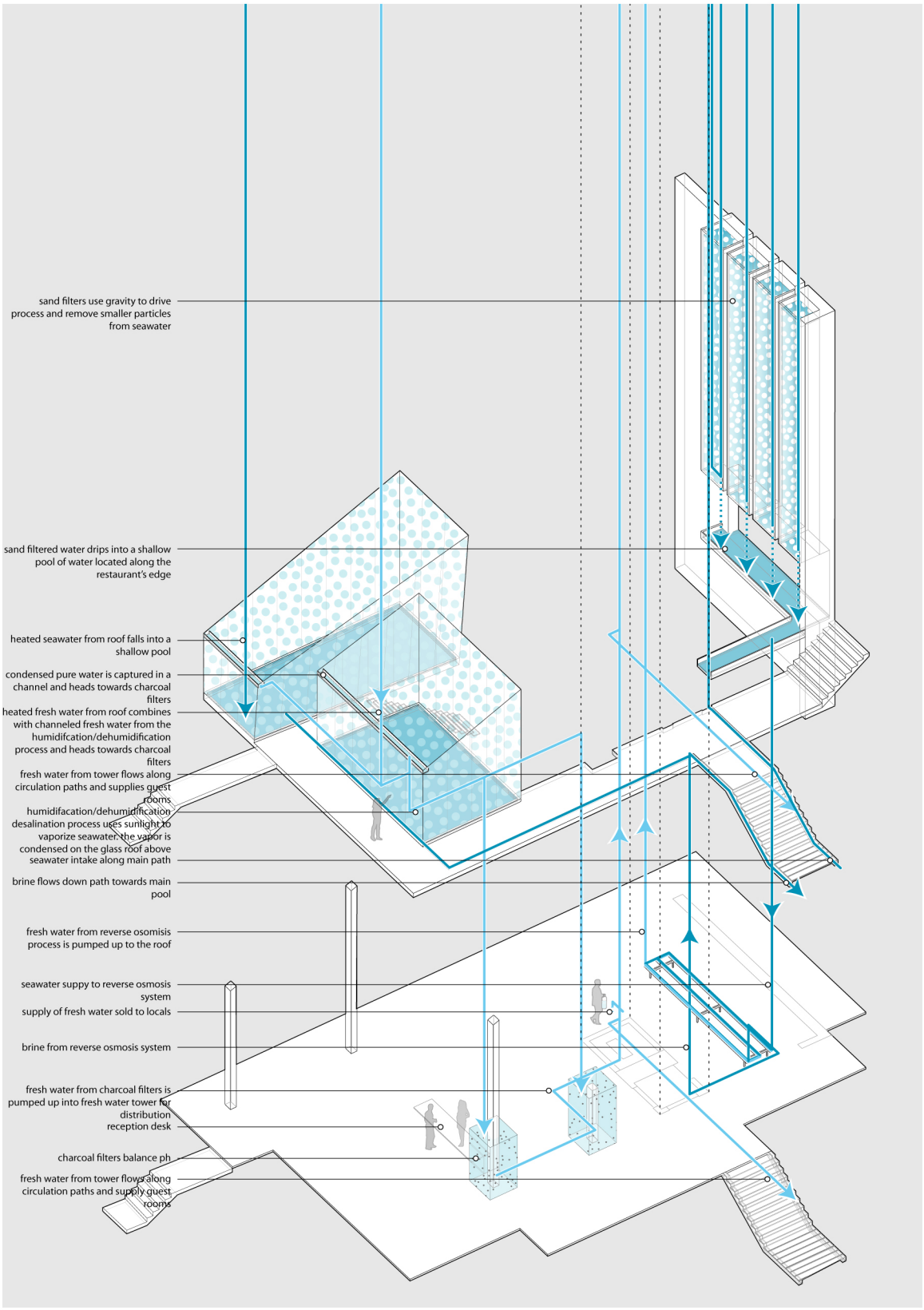
# Cross Section





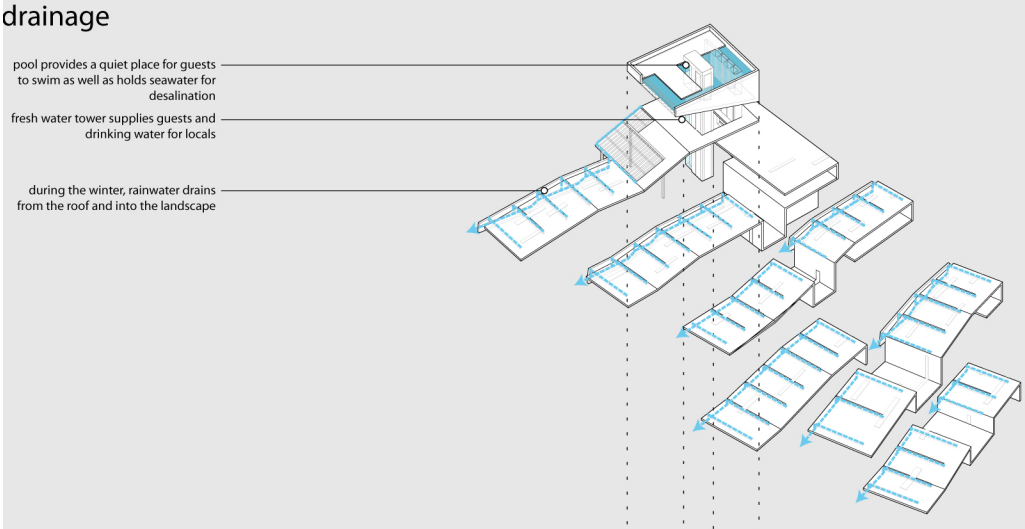
# Lobby and Desalination Systems Integration



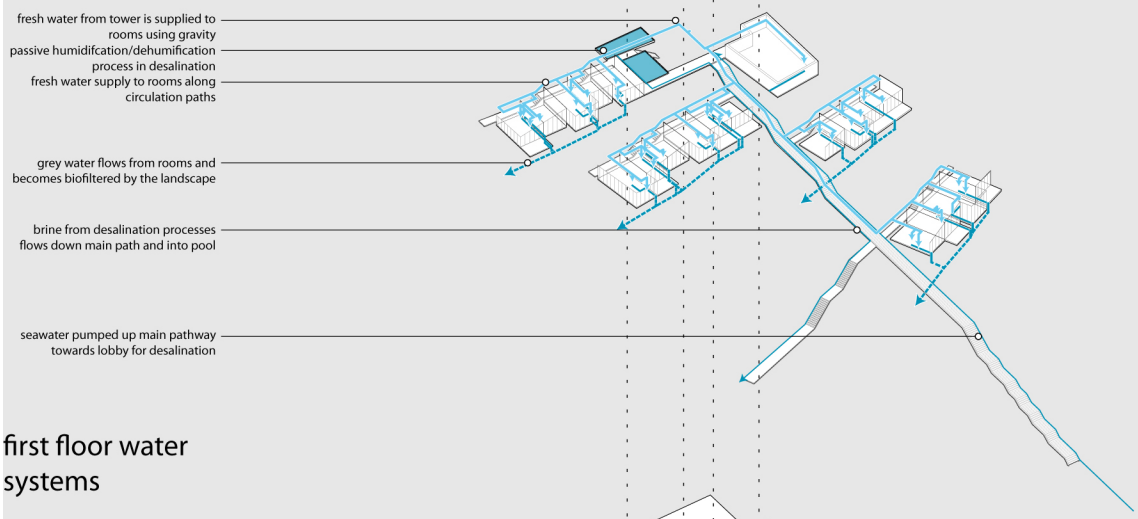

sand filters use gravity to drive process and remove smaller particles from seawater
sand filtered water drips into a shallow pool of water located along the restaurant's edge
heated seawater from roof falls into a shallow pool
condensed pure water is captured in a channel and heads towards charcoal filters
heated fresh water from roof combines with channeled fresh water from the humidifcation/dehumidification process and heads towards charcoal filters
fresh water from tower flows along circulation paths and supplies guest rooms
humidifacation/dehumidification desalination process uses sunlight to vaporize seawater. the vapor is condensed on the glass roof above seawater intake along main path
brine flows down path towards main pool
fresh water from reverse osomisis process is pumped up to the roof
seawater suppy to reverse osmosis system
supply of fresh water sold to locals
brine from reverse osmosis system
fresh water from charcoal filters is pumped up into fresh water tower for distribution
reception desk
charcoal filters balance ph
fresh water from tower flows along circulation paths and supply guest rooms

# Integration of the Hotel and Natural Water Systems

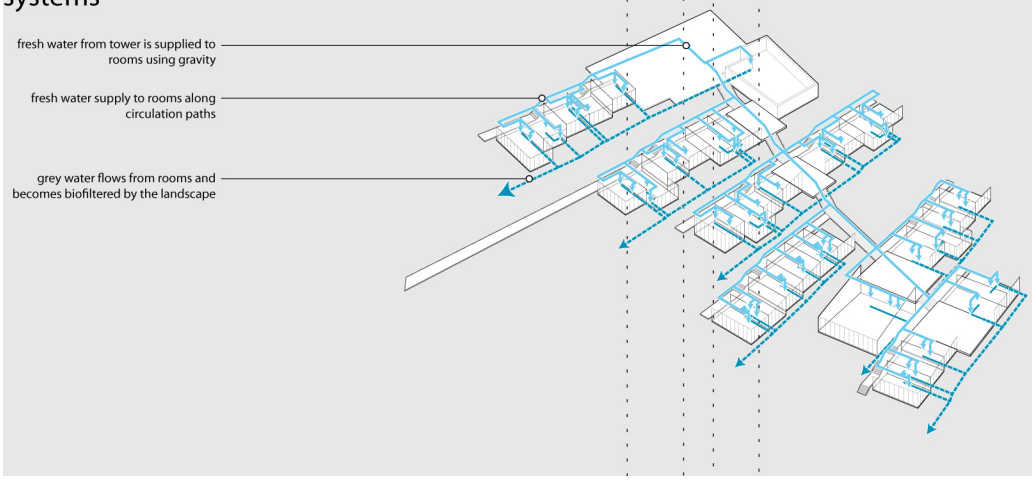
## rain water drainage



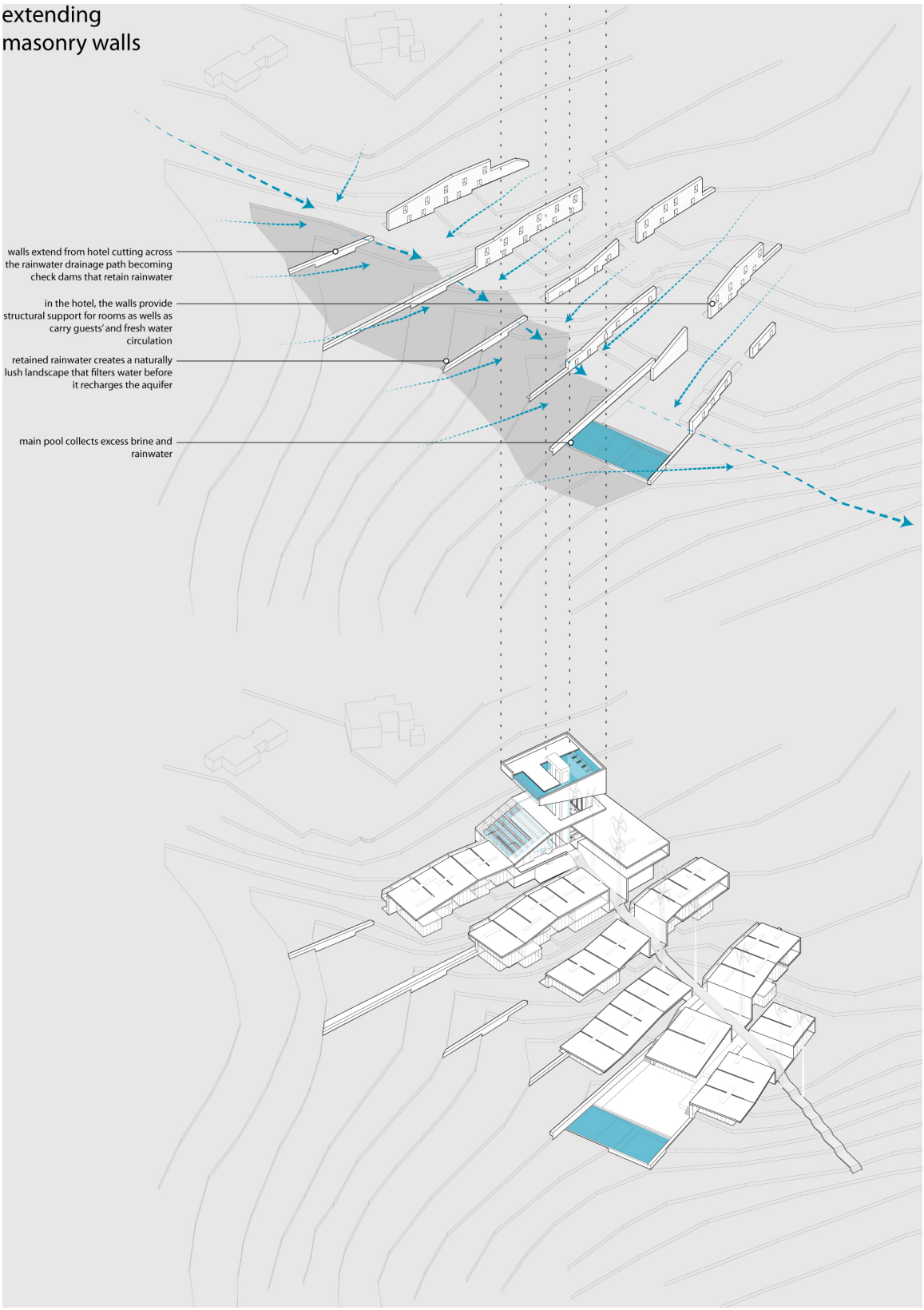

## second floor water systems



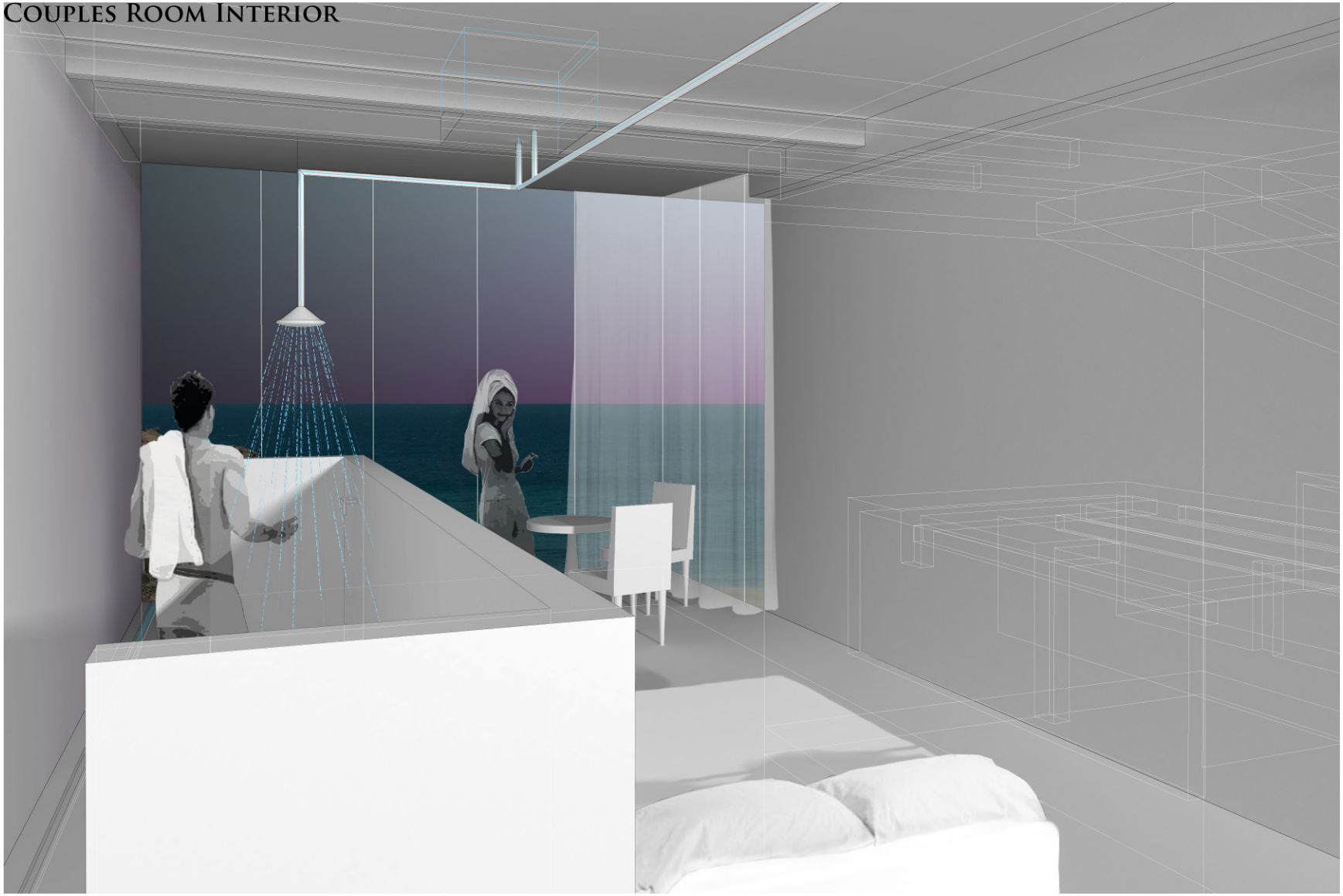

## first floor water systems



# extending masonry walls

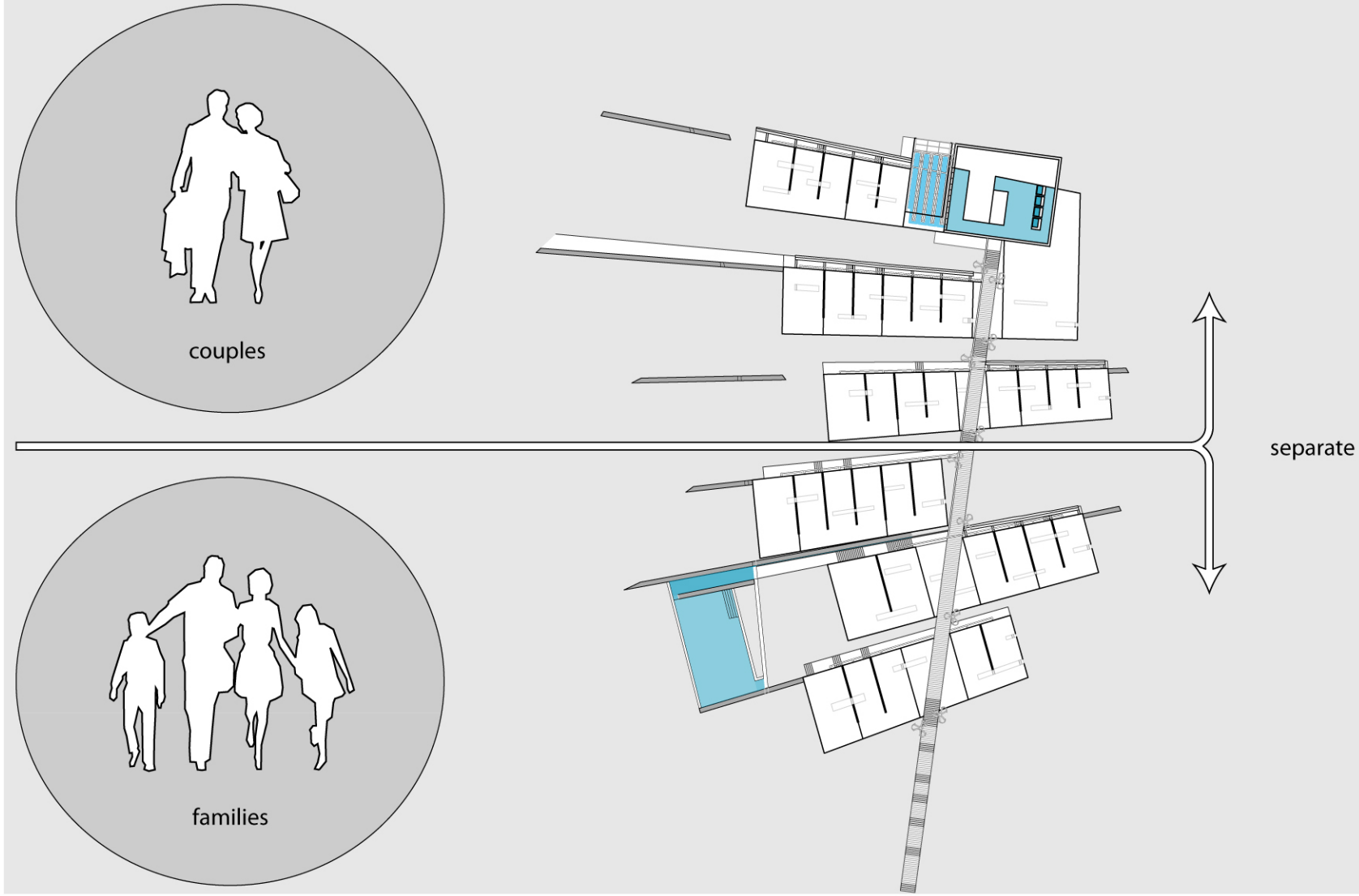


# Couples Room Interior



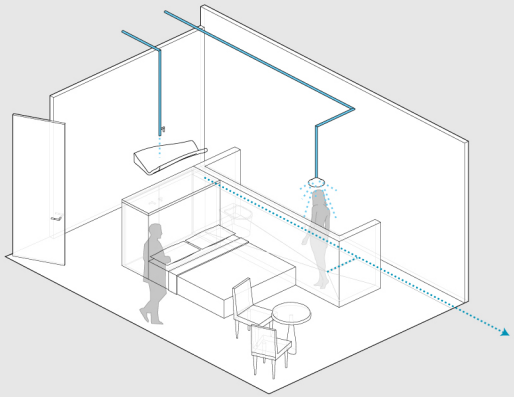
# View of $H_2$Otel from the Rocks

# Division of Guest Rooms

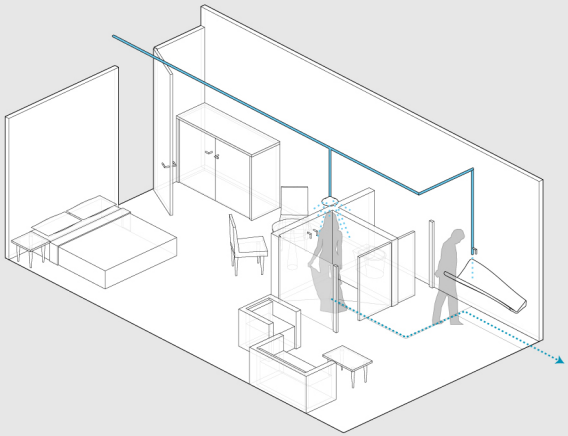


# Types of Guest Rooms

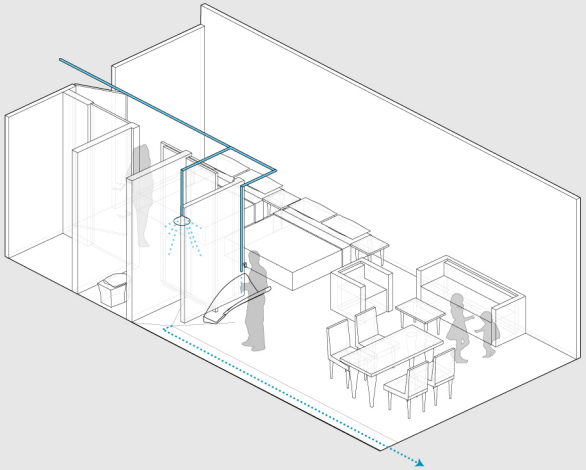
## Couples Standard Room



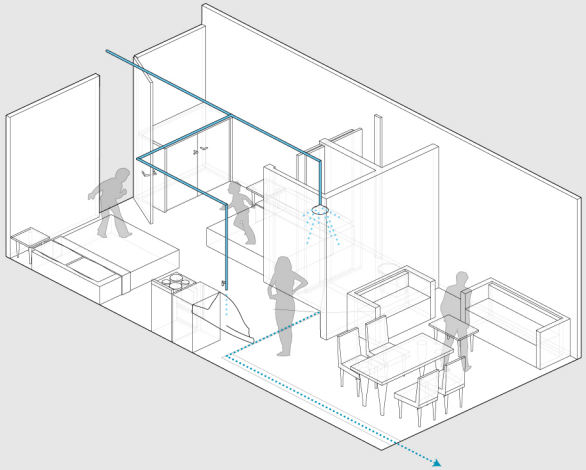
## Couples Deluxe Room



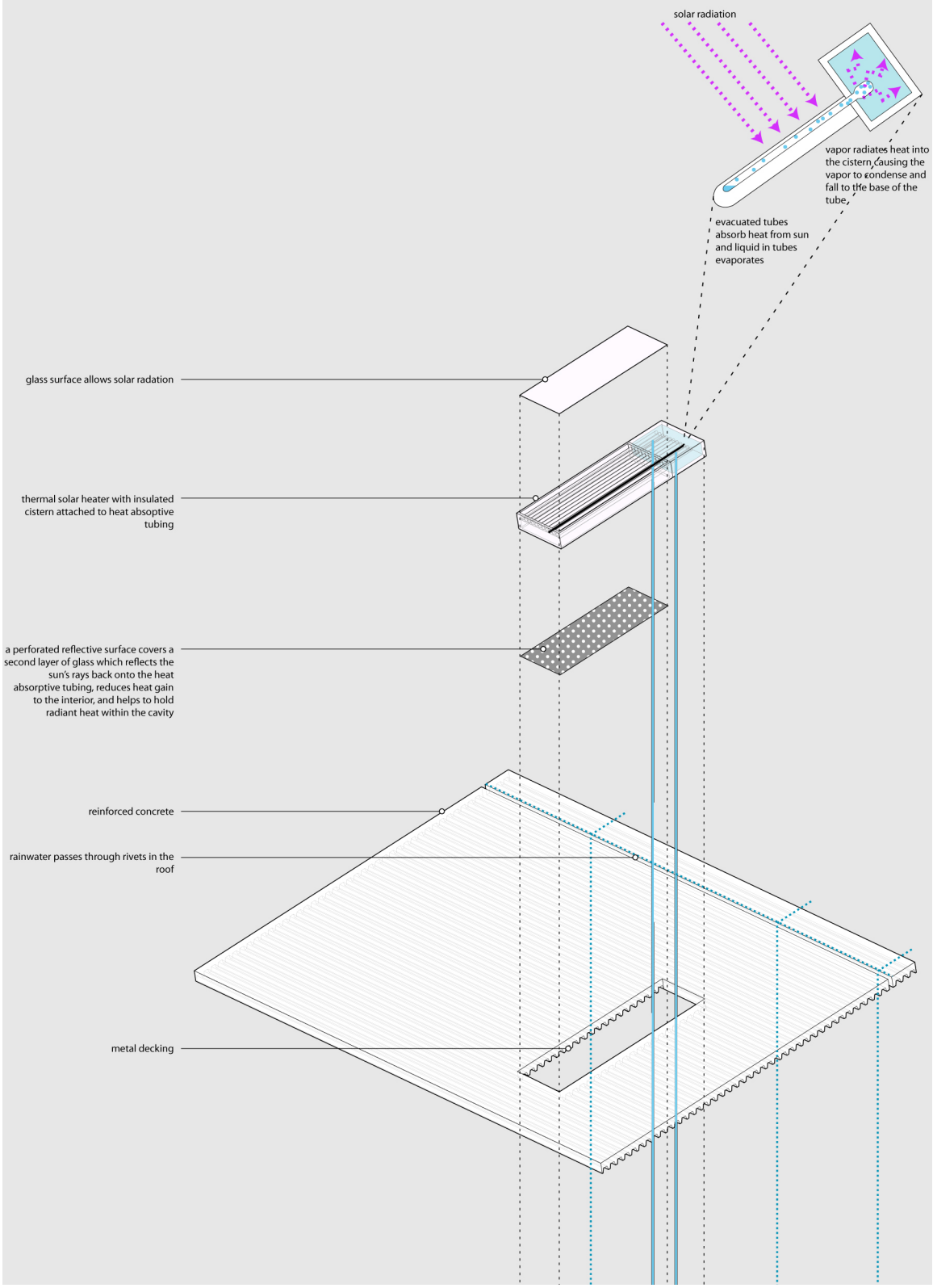
## Family Standard Room

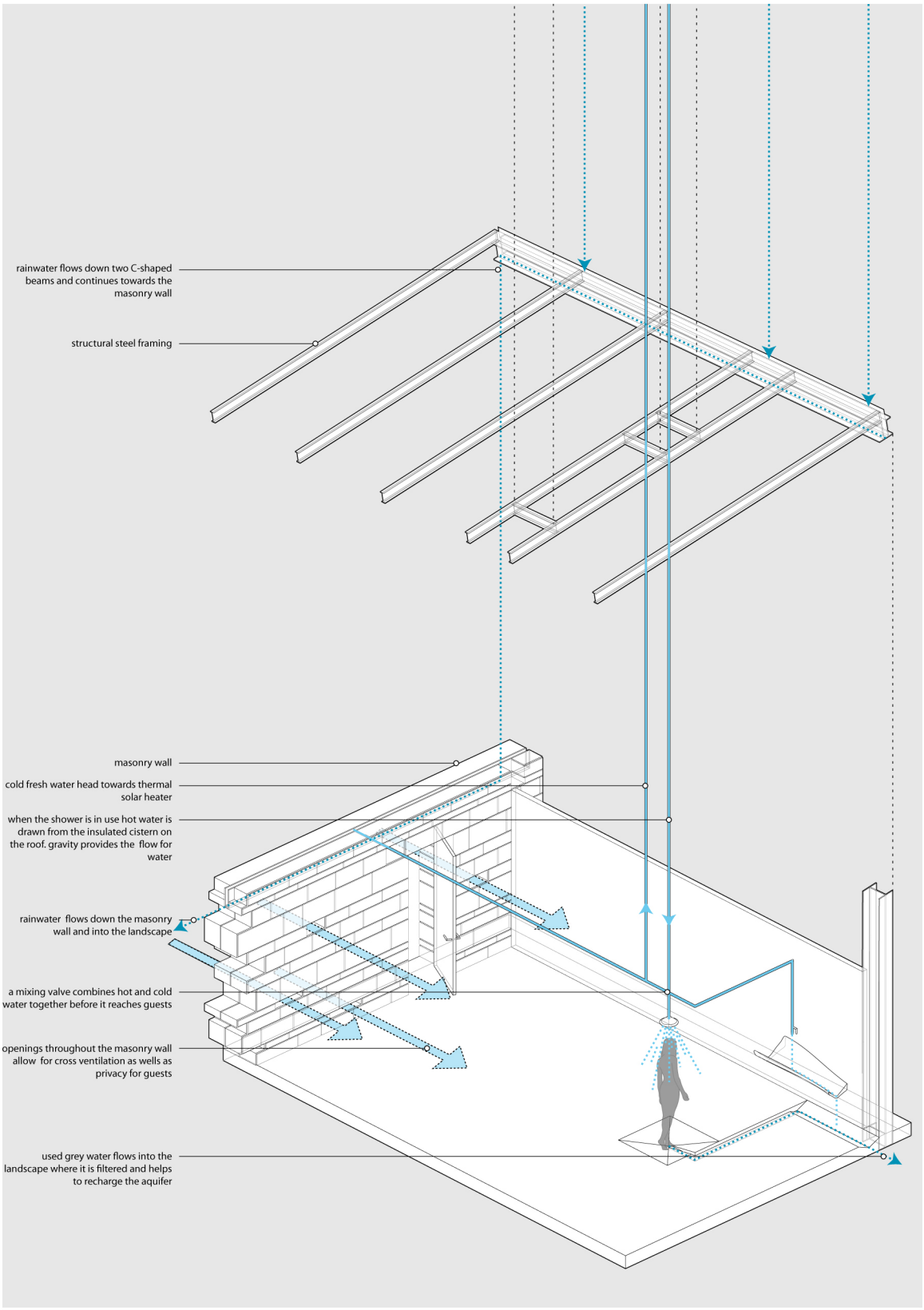


## Family Deluxe Room

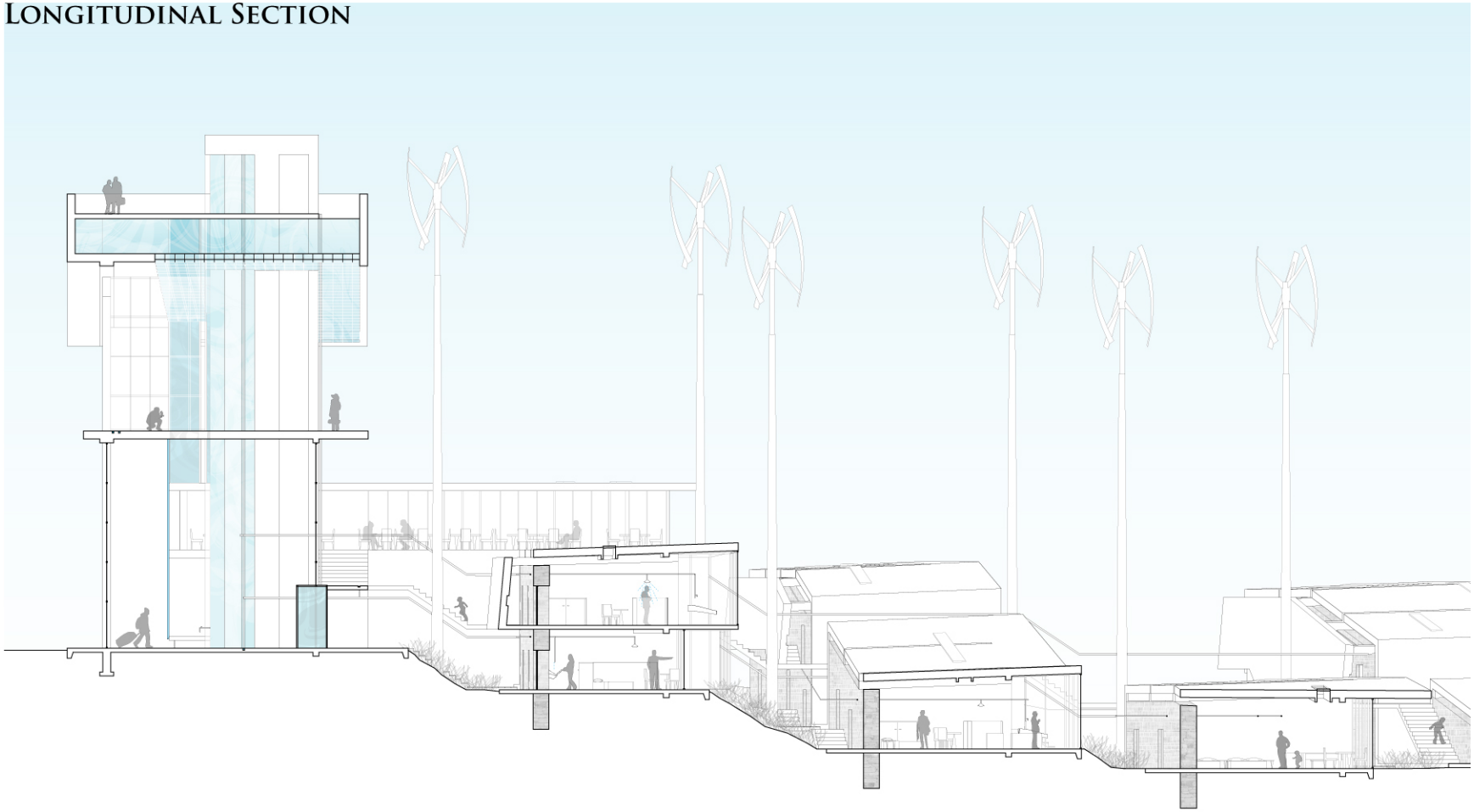


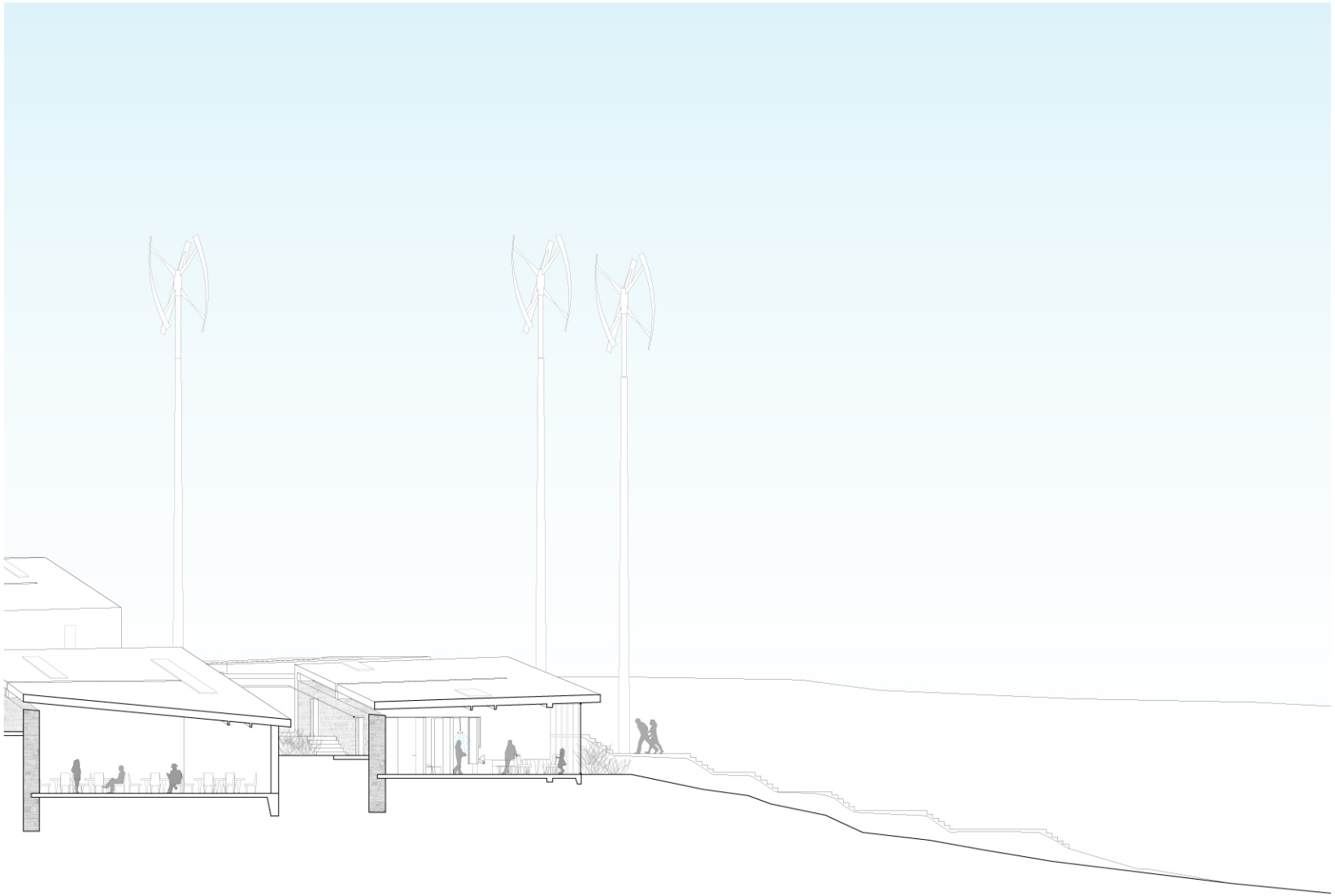
# Lobby and Desalination Systems Integration



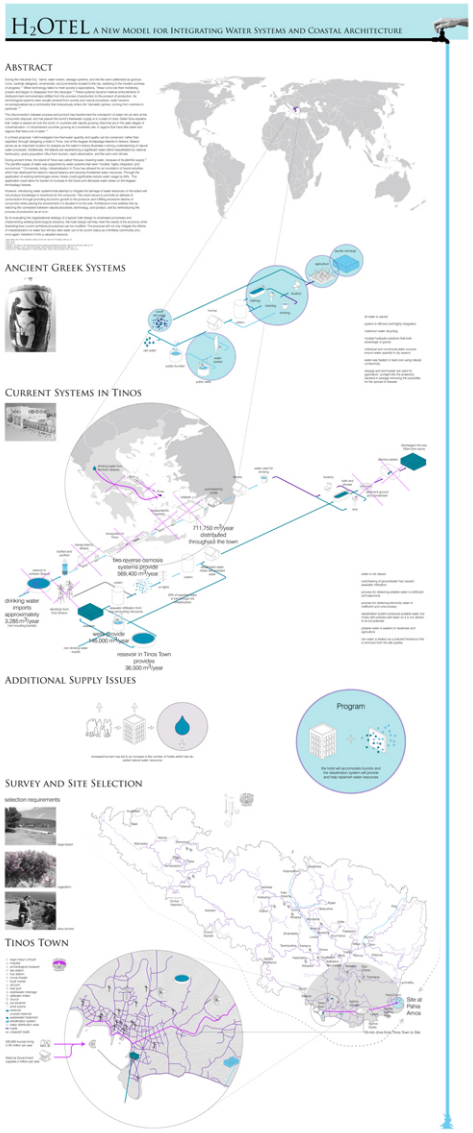

rainwater flows down two C-shaped beams and continues towards the masonry wall
structural steel framing
masonry wall
cold fresh water head towards thermal solar heater
when the shower is in use hot water is drawn from the insulated cistern on the roof. gravity provides the flow for water
rainwater flows down the masonry wall and into the landscape
a mixing valve combines hot and cold water together before it reaches guests
openings throughout the masonry wall allow for cross ventilation as wells as privacy for guests
used grey water flows into the landscape where it is filtered and helps to recharge the aquifer

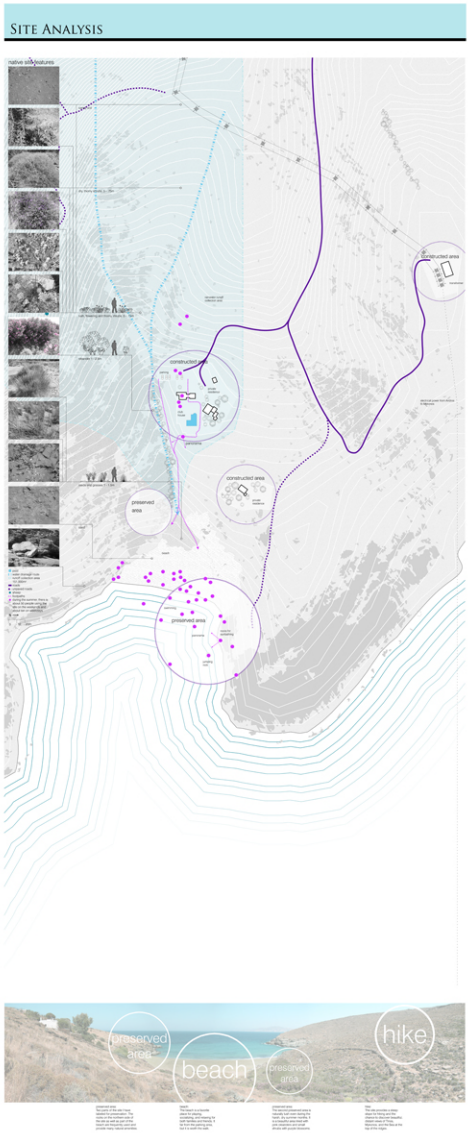
# Longitudinal Section

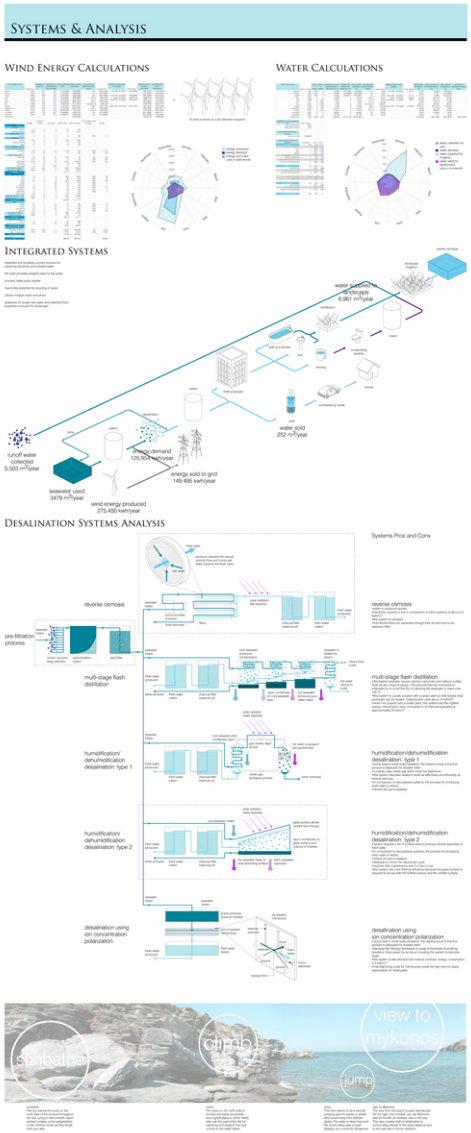




# Presentation Boards



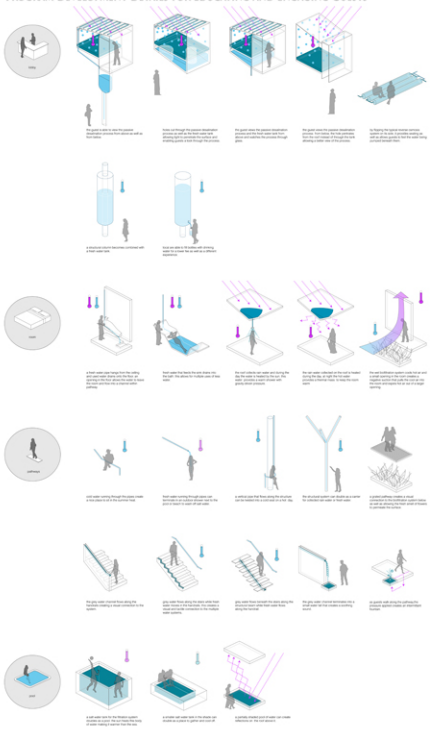



## Engaging Guests

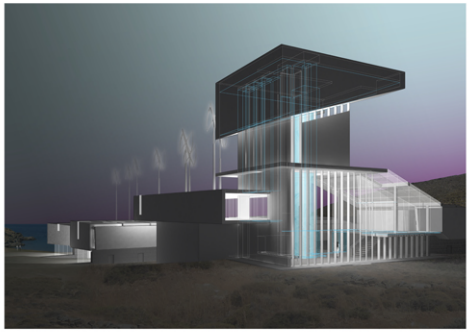
### Tourists Visiting Tinos

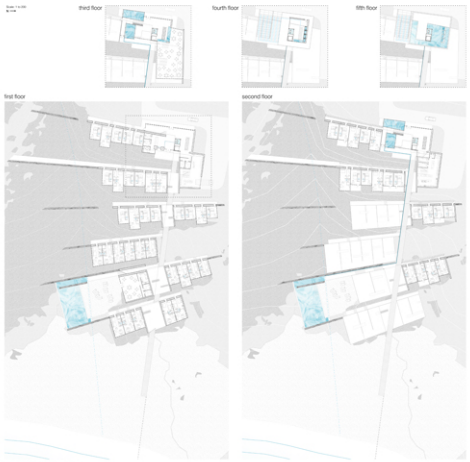
### Program Development Details for Educating and Engaging Guests



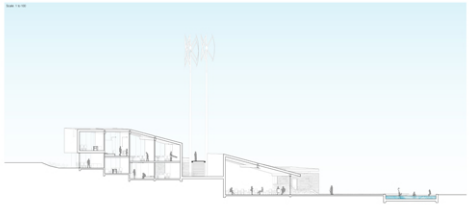
## Site Plan

## Plans

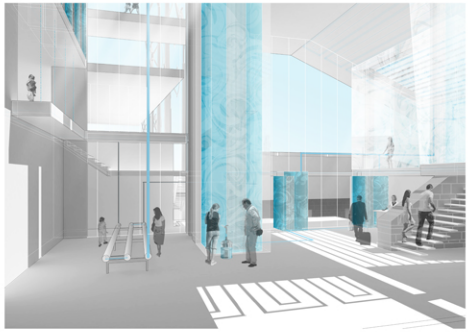


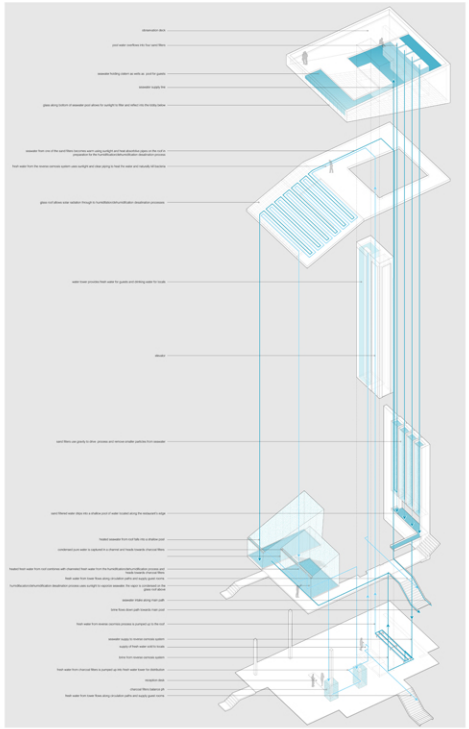



## Cross Section

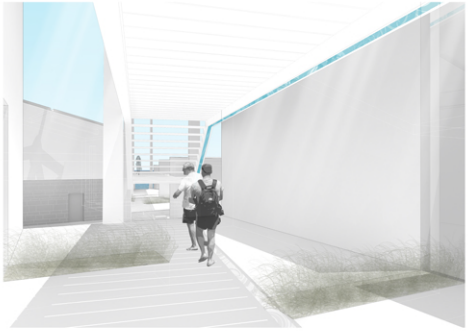


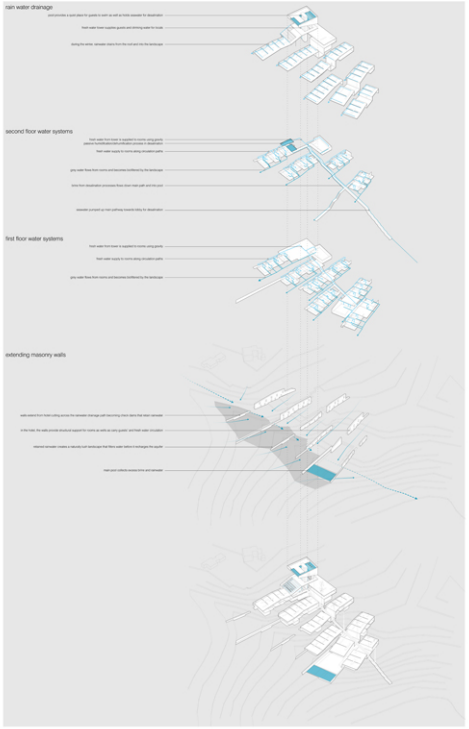
## Lobby and Desalination Systems Integration



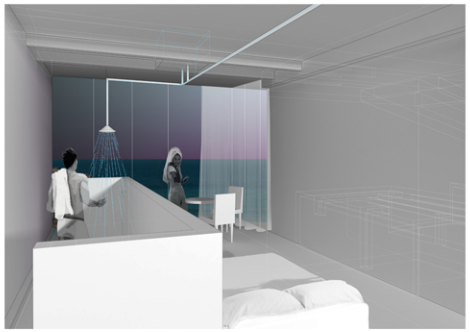


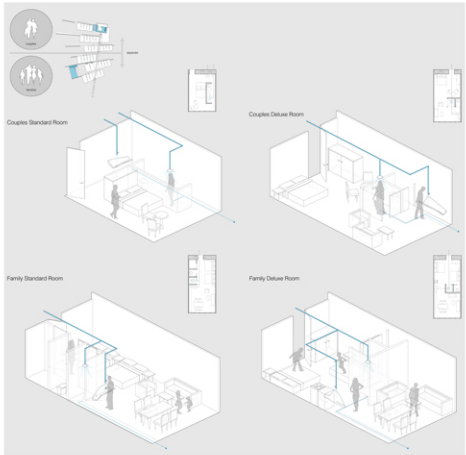
## Hotel and Natural Water Systems Integration



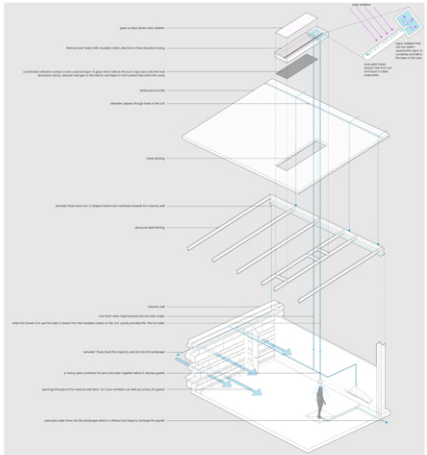


## Types of Guest Rooms

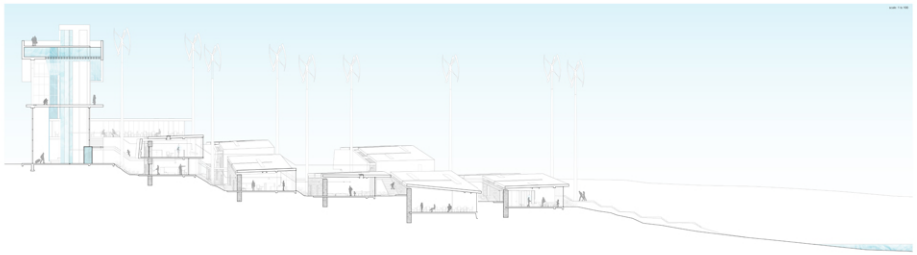





## Room Detail



## Longitudinal Section



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