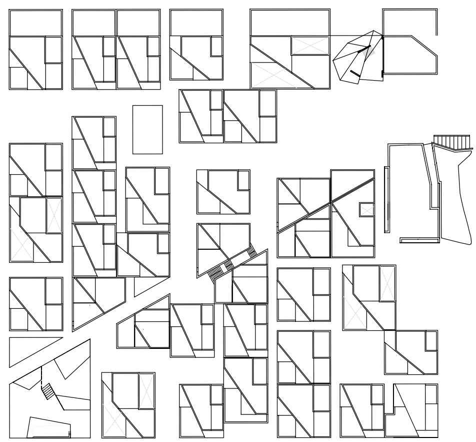
NEW HAITI VILLAGES

STEVEN HOLL ARCHITECTS

GUY NORDENSON & ASSOCIATES

MATTHIAS SCHULER, TRANSSOLAR

JEAN HÉNOCK BEAUCHAMPS & ARABY SMYTH



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Aerial view of Port-au-Prince and surrounding region

INTRODUCTION

STEVEN HOLL

The devastation from the January 12, 2010, earthquake in Haiti left a million people without shelter, water, infrastructure, schools, and basic human necessities. I was struck by the similarities between the terrain in Haiti and that for an unbuilt project we had developed for a site on the Aegean Sea in Turkey. This off-the-grid experiment was never realized. The concept of Dense-Pack Villages, small clusters of community-based housing for staff of this larger project in Turkey, could be a model for new housing outside of Port-au-Prince, the main urban center of Haiti.

Since our goal was to make these new villages hurricane- and earthquake-proof and completely energy-independent, we enlisted the help of structural engineer Guy Nordenson and environmental engineer Matthias Schuler. Guy developed an earthquake-resistant structural system of confined masonry, built from recycled concrete debris. Matthias proposed solar-powered desalination, for urgently needed freshwater, as well as covering the roofs of the houses with photovoltaic (PV) solar panels and providing solar cooking and compost toilets. Fellow architects Thom Mayne, David Adjaye, and Mark Mack—supportive of the plan—intend to design their own “dense-packs” following this basic model.

We are now trying to find sponsors for the Phase I Dense-Pack Village of seventy units. A professional cost estimator established a budget of 5.3 million dollars, which includes the infrastructure described in this book. We propose to find 10 sponsors at 530,000 dollars each.

—April 7, 2010


Airport
Port-au-Prince
Enriquillo-Plantain Garden Fault
5 km
N

HAITI: A HISTORICAL TIME LINE

1492

The island that today comprises Haiti and the Dominican Republic is discovered by Christopher Columbus and named La Espanola ("The Spanish Island"), later known as Hispaniola.

1501

Slave trade begins, and the indigenous Taino population is decimated by disease and abuse by 1517.

1697

Spain cedes Haiti, the western third of the island (then known as Saint-Domingue), to France, and the island is renamed Saint-Dominique. Based on its forestry and sugar-related industries, Haiti became the wealthiest country in the Caribbean, but only through the heavy importation of African slaves.

1791

A slave revolt begins—led by Toussaint L'Ouverture, Jean Jacques Dessalines, and Henri Christophe—and quickly becomes a war of attrition against the French.

1793

England invades Haiti.

1802

Napoleon sends punitive force to restore French rule, but is forced to withdraw.

A brutal massacre of three thousand French men, women, and children occurs under the supervision of Dessalines.

1804

Following the defeat of French general Jean Louis Ferrand, Haiti declares independence from France under the leadership of Dessalines, who calls himself the first Negro emperor. All remaining whites are expelled, and Saint-Dominique becomes the first Black republic, the result of the only successful slave revolution in history. The country is rechristened Haiti, from the Amerindian word *ayti*, meaning “mountainous lands.”

1825

Haiti, under Beaubrun Ardouin, negotiates purchase of its liberty from France as a “free, independent, and sovereign state,” and Faustin Soulouque is appointed as president.

1844

The eastern part of Hispaniola breaks away to become the Dominican Republic.

1848

Mulattos are massacred under Soulouque, who, following Dessalines’s and Napoleon’s examples, declares himself Emperor Faustin I.

1859

Soulouque is overthrown by Fabre Geffrard, after Soulouque’s unsuccessful attempt to reconquer the Dominican Republic.

A long period of political chaos—during which there are twenty-two changes of government—results in heavy international indebtedness, on top of burdensome reparation payments to France.

1905

Economic collapse causes Haiti to cede financial control to the United States.

1915

The resident U.S. naval commander dissolves the Haitian congress and dictates a new constitution.

1930

1934

The United States withdraws from Haiti, but security offered by the American occupation caused a huge increase in population, increasing friction with the neighboring Dominican Republic over scarce resources. Haiti remains the poorest country in the western hemisphere, with 80 percent of the population living under the poverty line and 54 percent in abject poverty.

1937

Dominican troops massacre between ten thousand and fifteen thousand Haitians.

1957

The dictatorship of the Duvalier family begins (first François, followed by Jean-Claude), ushering in an era of oppressive and authoritarian rule (as many as thirty thousand Haitians are estimated to have been killed by the government).

1986

1990

Jean-Bertrand Aristide is elected by a wide margin in a popular vote, but is overthrown one year later in a violent coup. General Raoul Cédras seizes power of the government.

Sources:
Colin Dayan, *Haiti, History, and the Gods* (Berkeley: University of California Press, 1995).
Columbia Encyclopedia
CIA World Factbook

1991

Haiti is governed by a de facto military regime.

1994

A United Nations resolution enables the restitution of Haiti's democratic government, under supervision of twenty-one thousand multinational forces. Aristide returns to power.

2000

Aristide is reelected in a disputed election.

2004

An armed rebellion forces the resignation and exile of Aristide.

2006

Successful democratic elections are held, leading to the inauguration of president René Préval.

2010

Earthquake strikes.

LAKOU: HAITIAN IDENTITY IN HOUSING

JEAN HÉNOCK BEAUCHAMPS & ARABY SMYTH

The structure of a home relates not only to functional and economic considerations, but also to the history and culture of its users. A house can illustrate the identity of a people.

Haiti took its independence on January 1, 1804, as the first Black republic in the world and the second free country in the western hemisphere, after the United States. Its identity has been formed through a long struggle against slavery and colonialism.

Haitian identity has been defined by the relationship between land and liberty. The question of land ownership was the first concern after the birth of the nation. Freedom not only meant the abolition of slavery, but also changes to the distribution and possession of land. Since the first revolt in 1791, the revolutionary ideal was to return the land to the ones who used it. It is in this context that lakou emerged.

A lakou is a community space composed of houses populated by several generations of one family, surrounded by a circular garden. Lakous are a patriarchal organization, and the met lakou (usually the oldest living male family member) is the owner of the land. The process of familial inheritance signifies the land's indivisibility. Selling a piece of land is a sign of economic difficulty.

The garden of the lakou is the basic unit of the Haitian agricultural world. A family cultivates the necessary foods for consumption by working together, and seasonal harvests from the garden allow the family not to be entirely dependent on outside resources. During the first years of independence, Haiti was restricted by embargoes from Europe and the United States, so this agricultural self-reliance extended outward from the family to the entire nation.

Lakous are also sacred spaces, where family members have intimate relationships with the spirit of Lakou, one of the gods in the voodoo religion—the African component of Haitian identity. The garden surrounding the house is enclosed to define private ownership. Strangers are advised not to pick fruit or cross the gardens of others without authorization, because this may provoke

the maleficent spirit of Lakou. The spirit plays a double role as protector and avenger. All three major religions in Haiti—Catholicism, protestantism, and voodoo—respect this sacred space, and gardens are cultivated according to religious rituals.

The stability and security that come from the garden allow individuals to accept or refuse work, alleviating some of the danger of exploitation. Lakou is an ethical expression of free workers who are masters of their time and bodies. The dream of every Haitian is to have a piece of land, and owning land is linked to the very idea of being Haitian because the land is a symbol of freedom.

The decline of agricultural autonomy in rural Haiti is due to many factors, too numerous to list here. For the last few decades, people streamed from the countryside to urban areas in search of educational opportunities and work. Sprawling shantytowns without order or comfort are the common image of everyday life in Haiti. Since the earthquake, many people have sought refuge in their ancestral homes outside of the cities. Unfortunately, the traditions of lakou have lost almost all potential to welcome them.

The movement for reconstruction must also repair the damaged Haitian identity. It is not enough to rebuild structures. Recovery efforts must consider the extensive environmental and economic questions facing Haiti and the entire region. Haiti set an example for the world as a pioneer nation, where a whole people rose from slavery to national freedom. Attention must be paid to the deep cultural importance of the land in this struggle.

When Haiti achieved independence, the new country offered a home to all of those suffering in the Caribbean and Latin America. Today, paradoxically, it is the Haitian population who are seeking shelter. Housing must bring sanctuary, stabilization, and hope to its dispersed population.


PORT-AU-PRINCE: CAPITAL OF PAIN

These images are courtesy of Michele Roohani from her website, Life is Short, Art is Long, where she posted "Port-au-Prince: Capital of Pain" on January 19, 2010, after the devastating earthquake. Michele includes a sequence of notes about the horror of calamity with vivid paintings of people in howling pain by Jean-Michele Basquiat—who was of Haitian descent—created before he died of a drug overdose. Michele writes, "I wonder how Basquiat would have seen all this suffering in his fatherland; he painted some prescient images in the 1980s." His paintings accompany photographs of the recent devastation in Haiti. She ends the sequence with a section of the poem "Parfait," by the French poet Paul Eluard, whose wife, Gala, later married Salvador Dali.

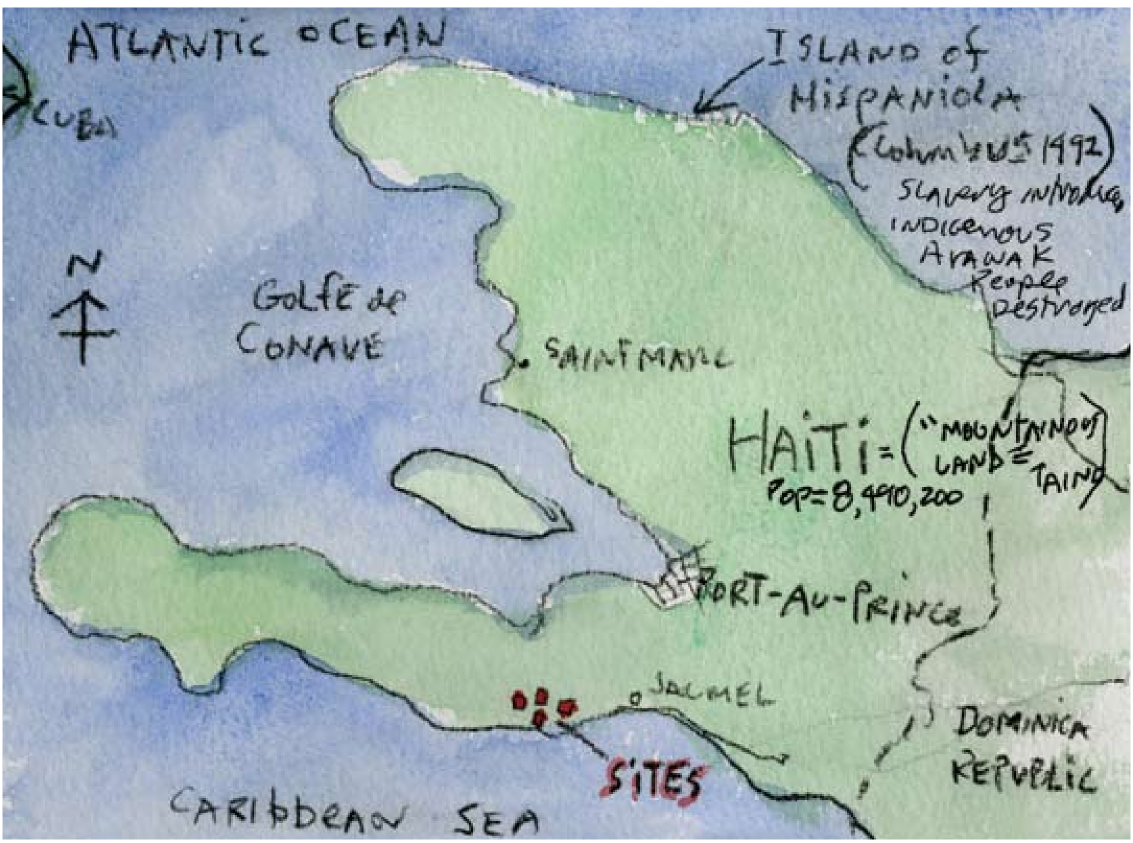
Tout est enfin divisé
Tout se deforme et se perd
Tout se brise et disparait
La mort sans conséquences

Everything is finally divided
Everything is deformed and lost
All breaks and disappears
Death without consequences

QUESTIONS

1. How should Haiti rebuild?
2. If the political corruption before the earthquake was problematic, what now?
3. Can urban/architectural expression be done by Haitians?
4. Will outside engineers build pragmatic, strong boxes?
5. Can the poetry of Haiti's wind, sea, colors, vegetation, and sky guide planners and architects?

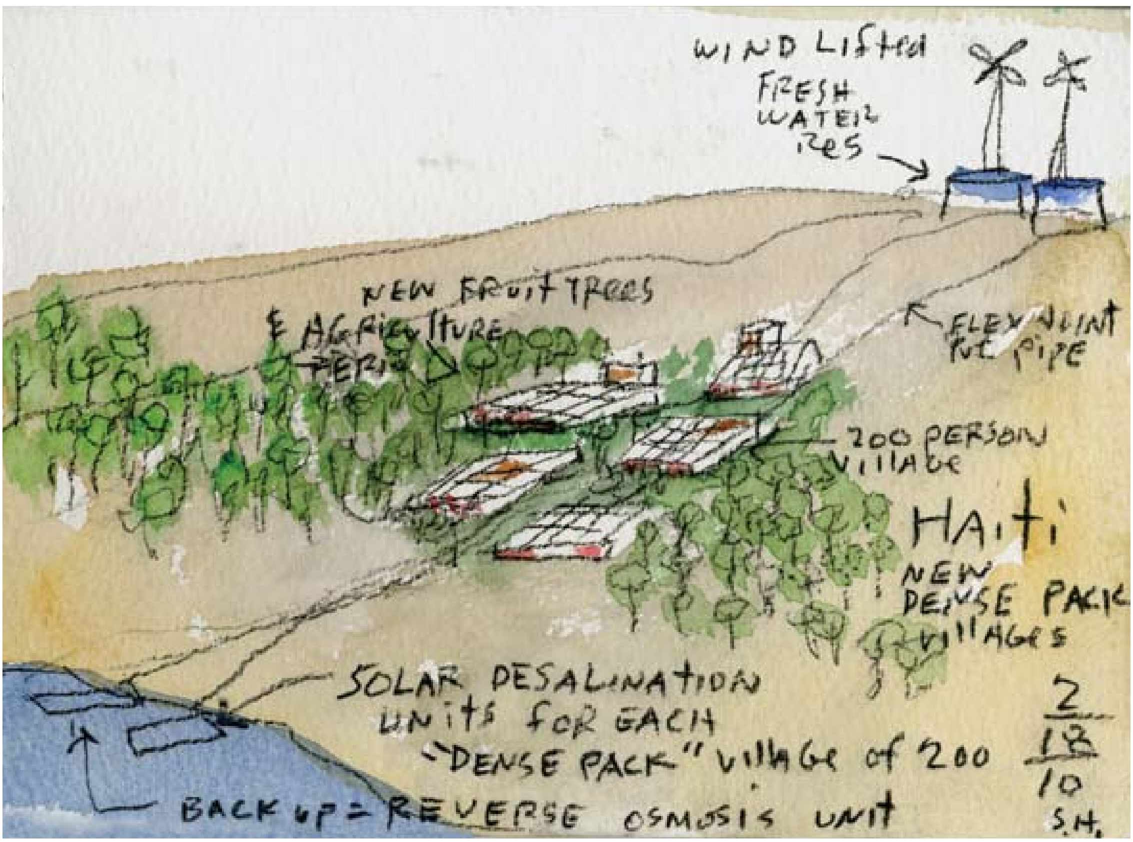
THE DENSE-PACK VILLAGE

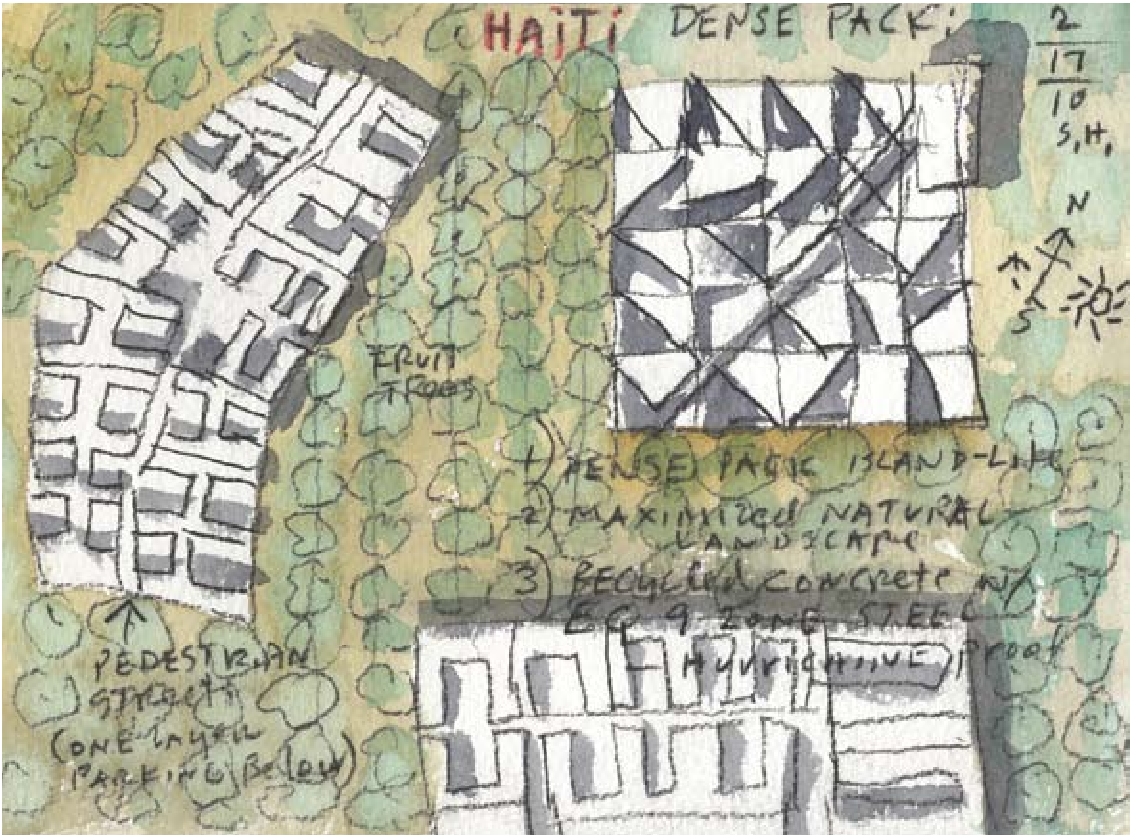


SITE

Rather than building in Port-au-Prince, where the cleanup project after the earthquake is already mired in political bickering, recovery could be sped up by constructing new housing settlements outside the cities. A new, self-sustaining, agrarian-based housing model—the Dense-Pack Village—could begin to accommodate some of the 600,000 people that have now flooded the countryside from the cities.

Currently, only 2 percent of Haiti's land is forested, due to a combination of natural disasters and logging operations. Port-au-Prince's rapid population growth, overgrazing, poor agricultural practices, demand for charcoal, and general lack of land have accelerated the problem. Efforts toward reforestation should be initiated.

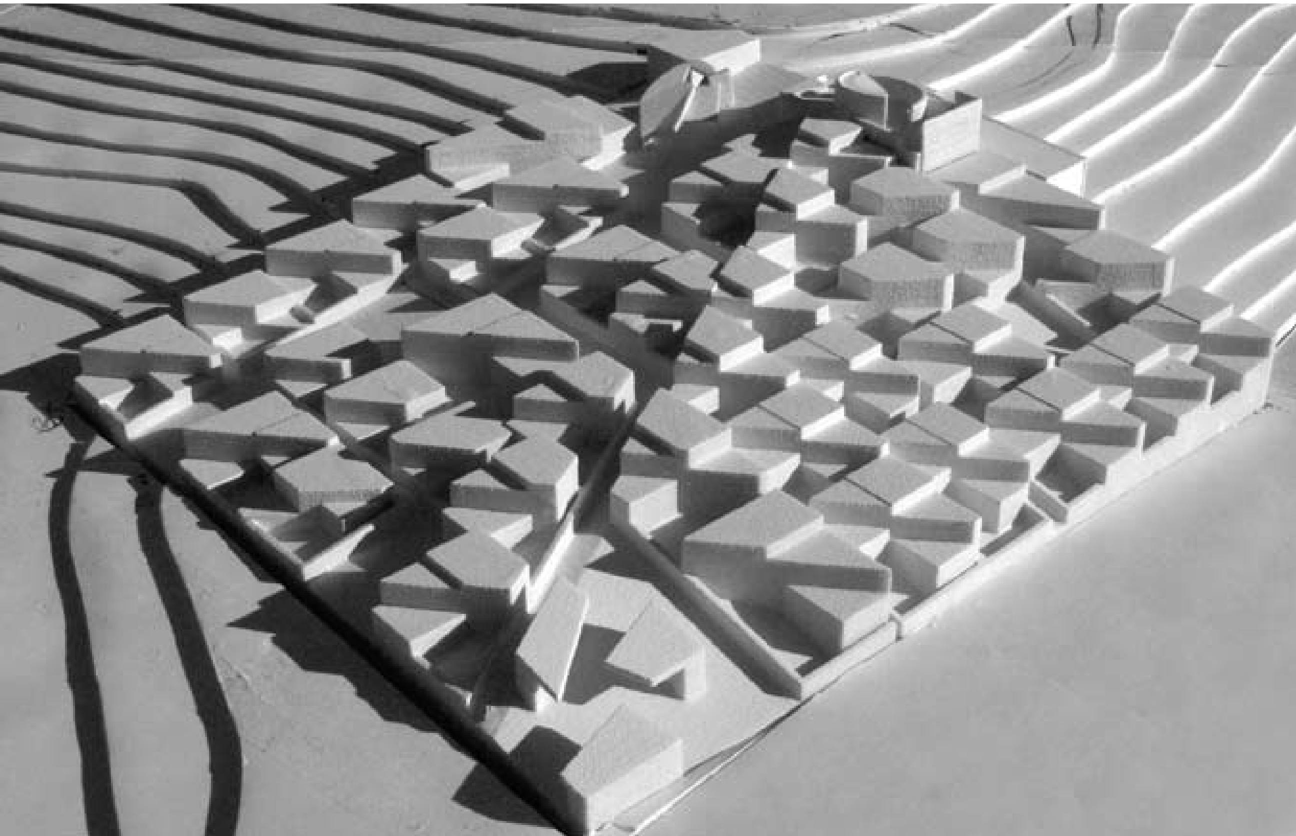


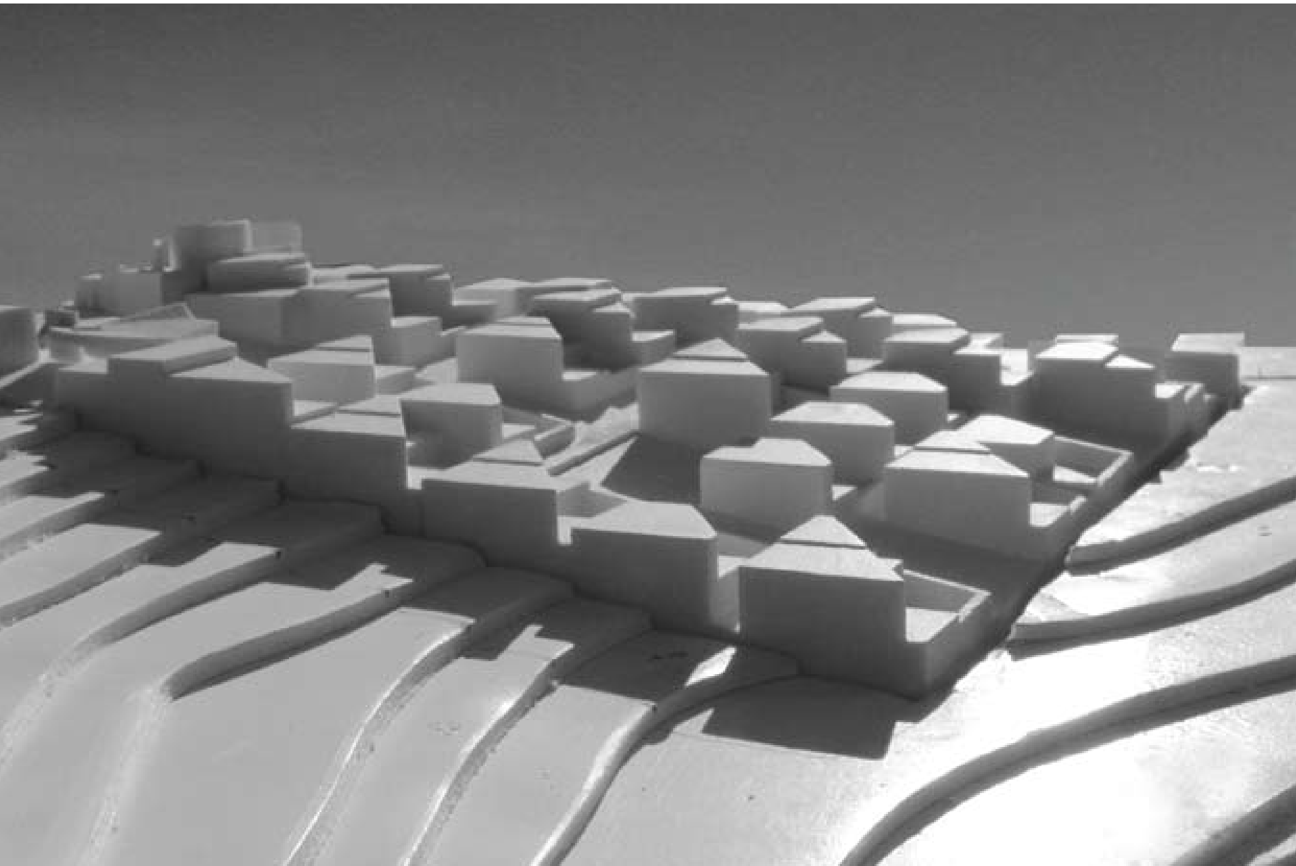

HAITI DENSE PACK:
2/17/10
S.H.
N
S
FRUIT TREES
1) DENSE PACK ISLAND-LIKE
2) MAXIMIZED NATURAL LANDSCAPE
3) RECYCLED CONCRETE W/ E.Q. 9 ZONE STEEL
– HURRICANE PROOF
PEDESTRIAN STREETS
(ONE LAYER PARKING BELOW)

ARCHITECTURE

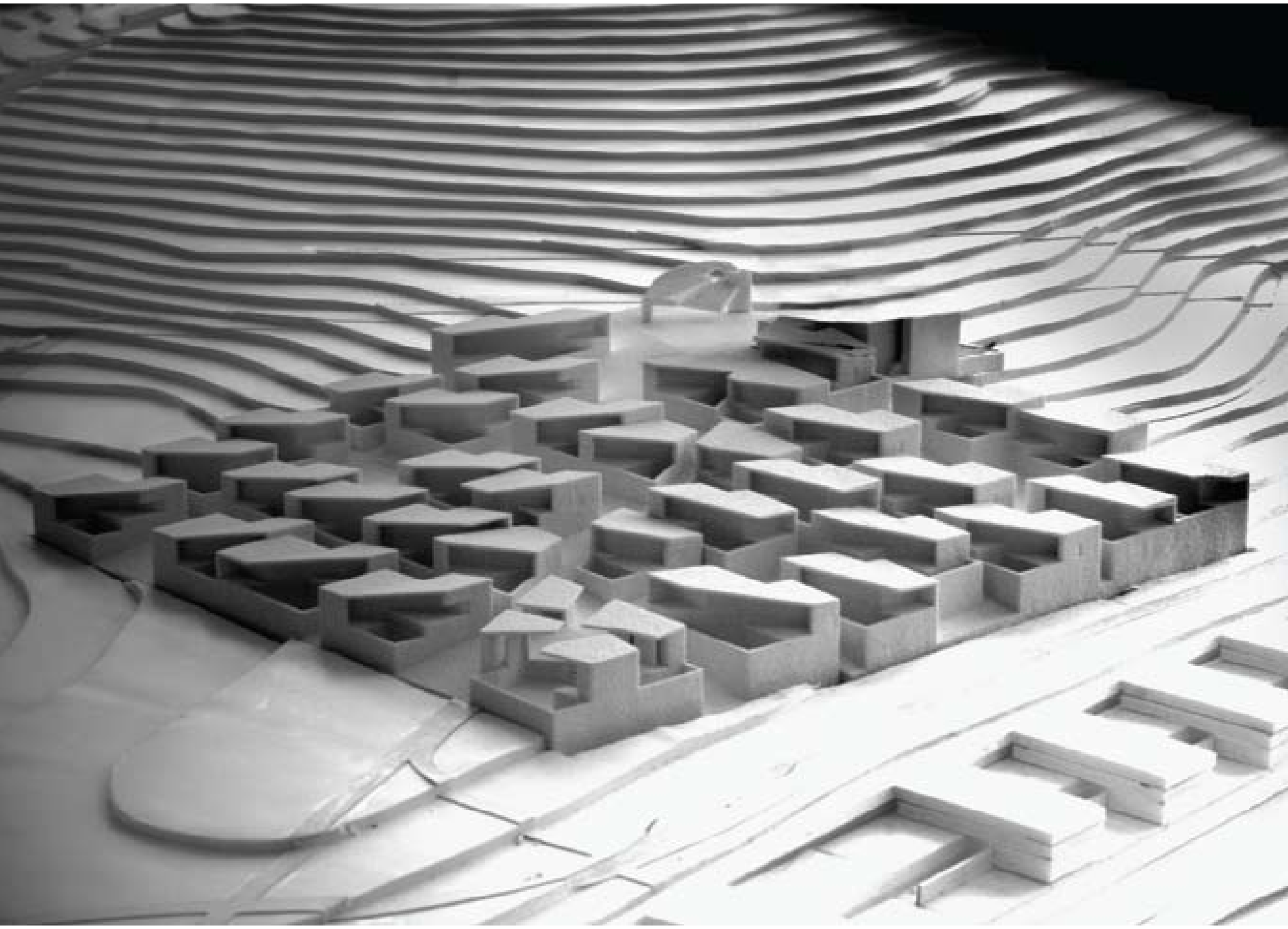
Dense-Pack Villages of courtyard housing can be constructed with concrete recycled from earthquake-damaged buildings and high-strength steel, which resists hurricanes and level 9 earthquakes. These houses can be built with local labor, and the inhabitants would paint the buildings' exteriors and interiors with custom colors. The houses would have fruit trees and vegetation between them, maximizing the natural landscape. The fruit trees could provide sustenance and income for each family, as tropical fruit production presents the greatest potential for economic growth in Haiti, and is already considered one of the country's most important exports.

Strengthening the local economy through the selling of goods produced from the grown material, each village has space for shops along its inner street and a public schoolroom or chapel and recreation space. Each village would have approximately 70 units—each 120 square meters (1,300 square feet) with a private outdoor garden—providing housing for an average population of 200 people. Each family would be responsible for maintaining and developing a parcel of land at the periphery of their house.

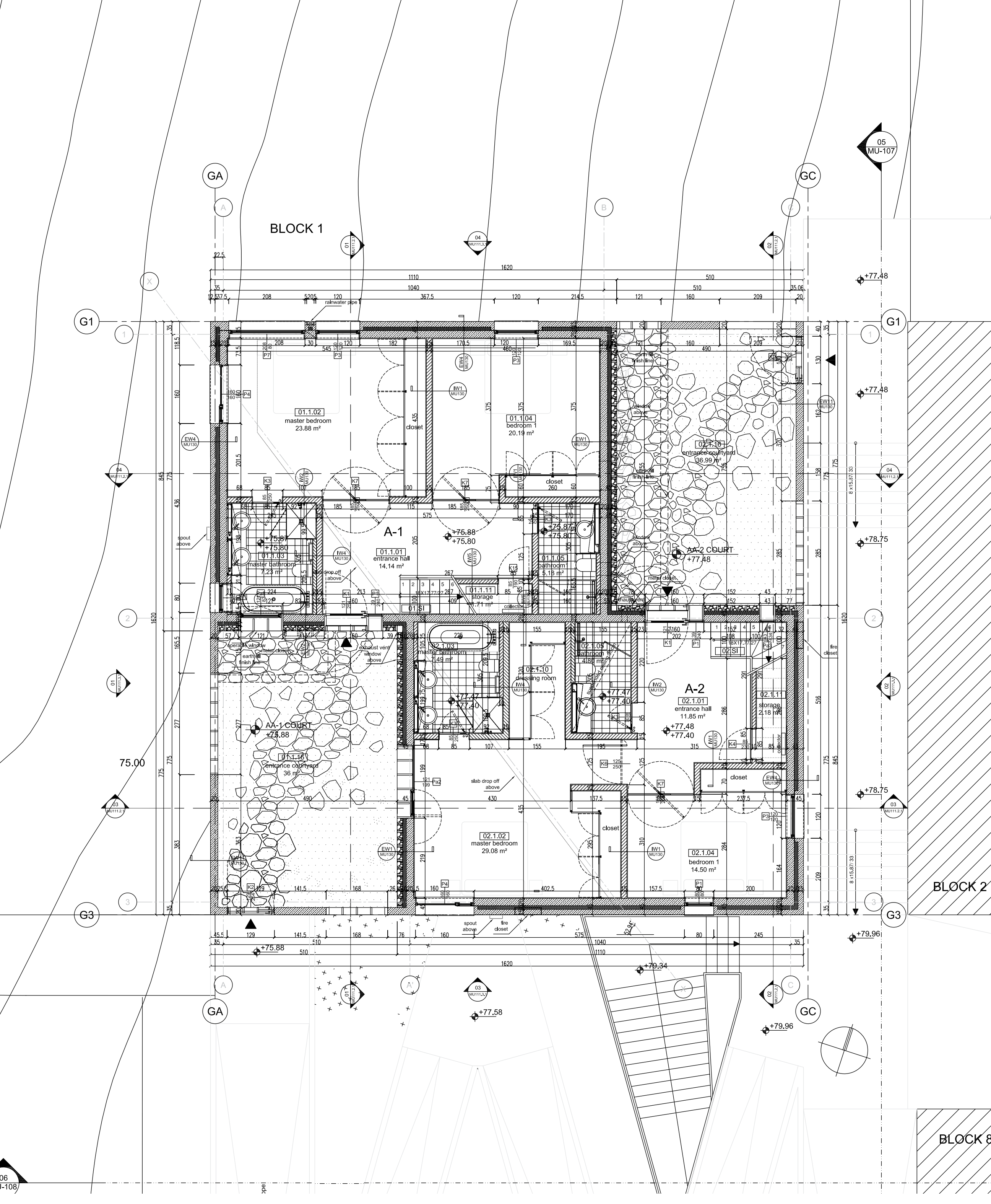




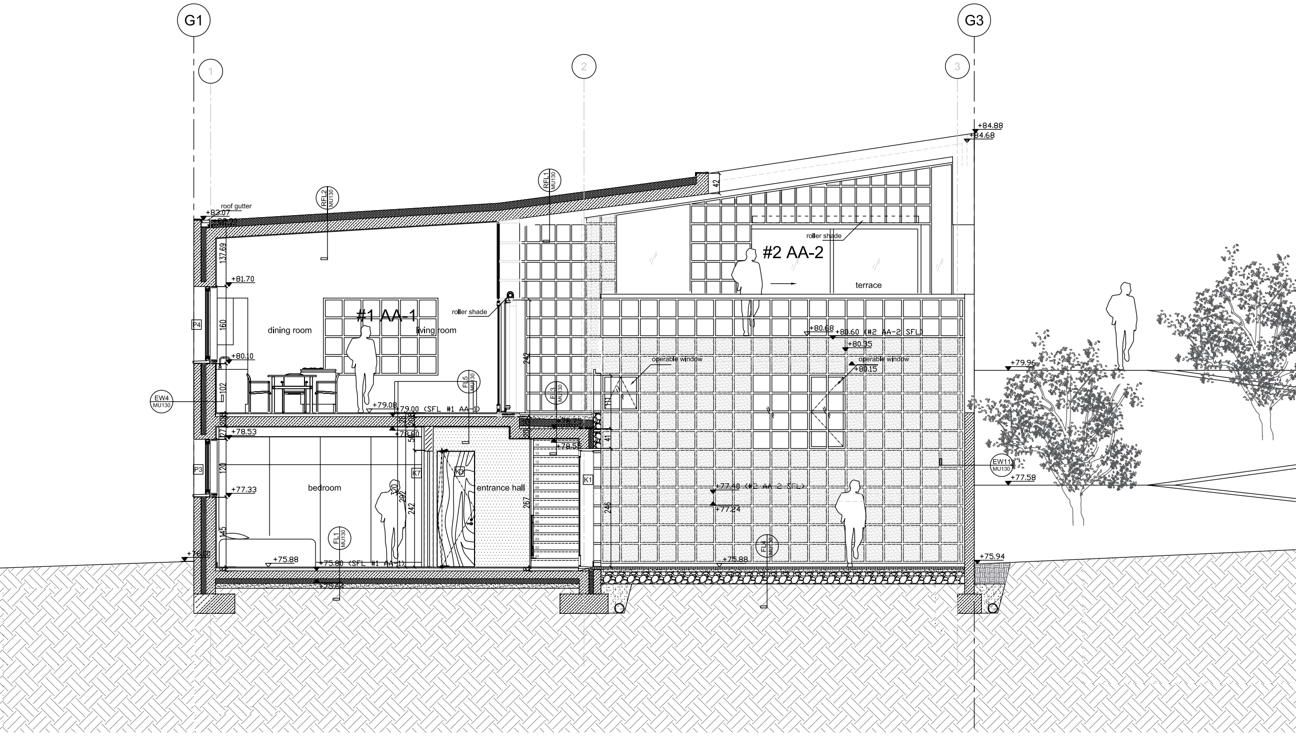
Ground Level 5m

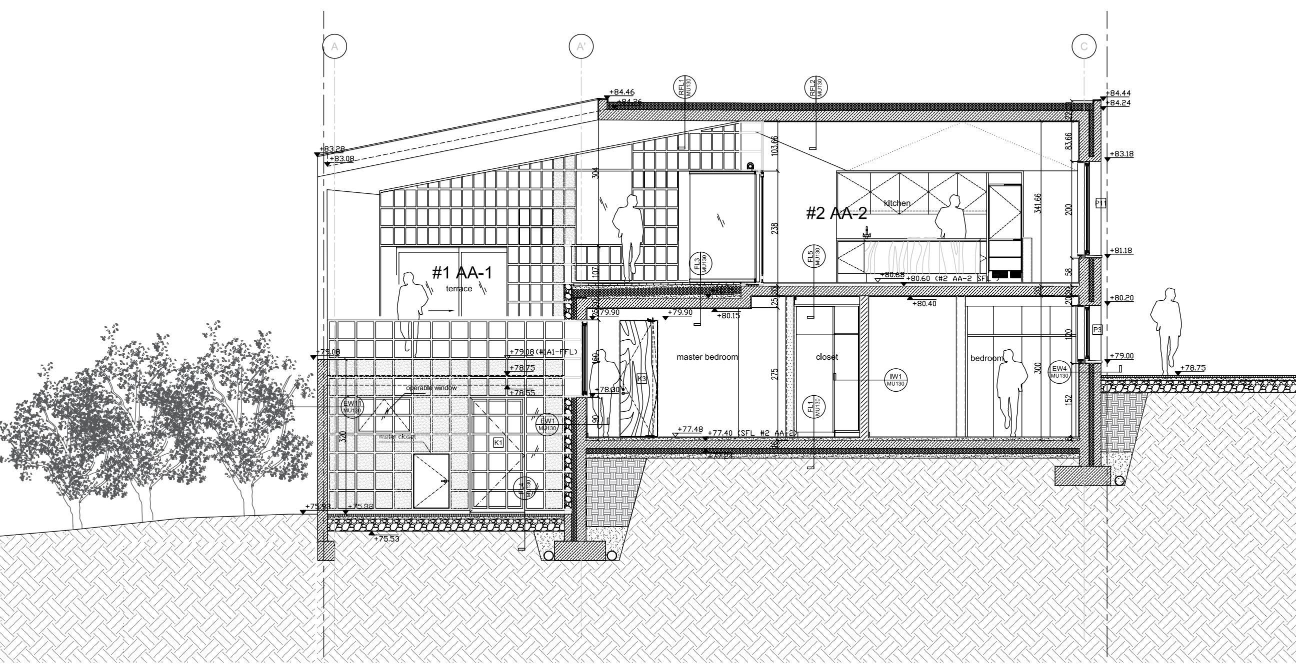


Upper Level 5m

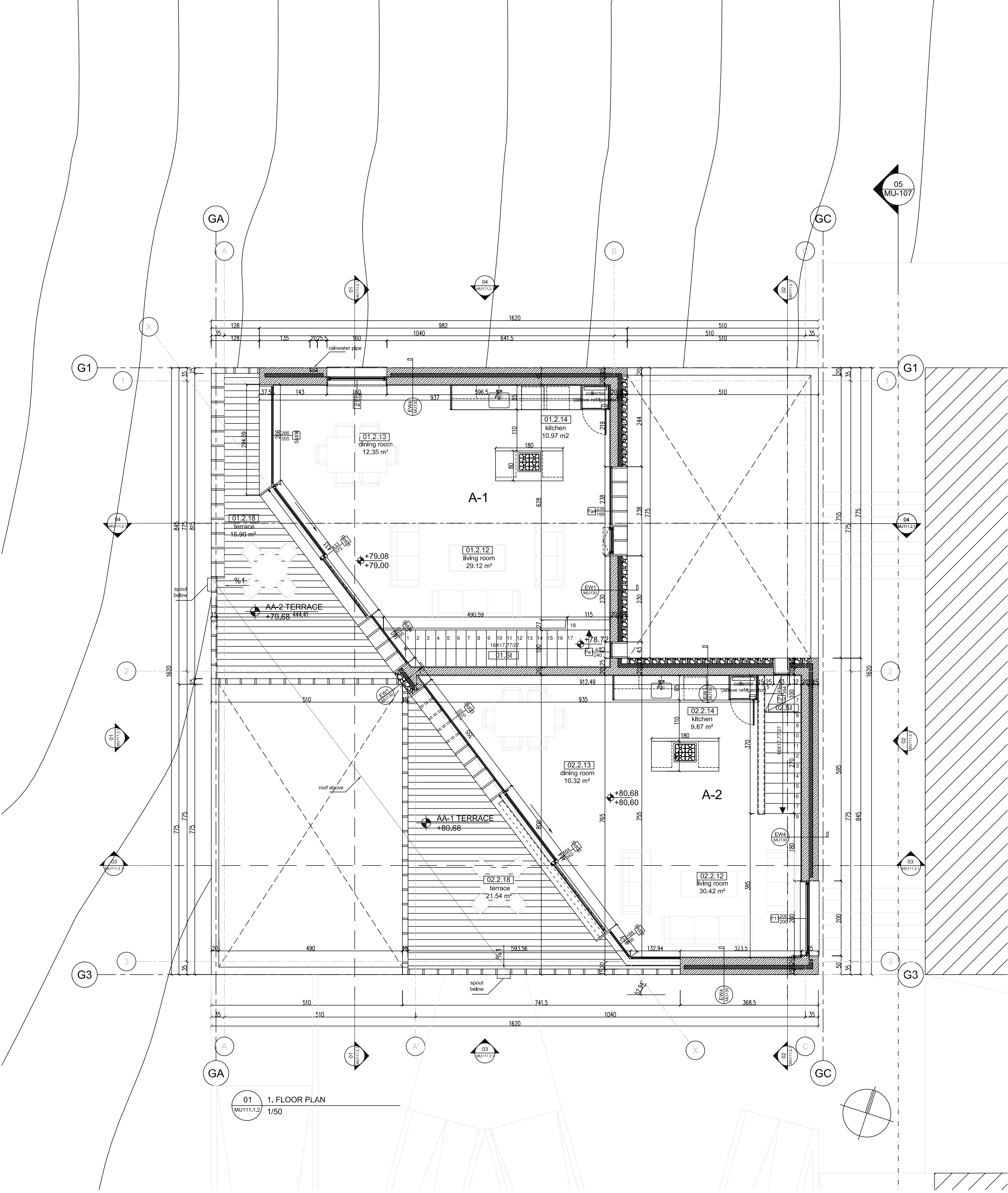

BLOCK 1
BLOCK 2
BLOCK 8
A-1
A-2
01.1.02 master bedroom 23.88 m²
01.1.04 bedroom 1 20.19 m²
01.1.03 master bathroom 7.23 m²
01.1.01 entrance hall 14.14 m²
01.1.05 bathroom1 5.18 m²
01.1.11 storage
01.1.16 entrance courtyard 36 m²
AA-1 COURT +75.88
02.1.16 entrance courtyard 36.99 m²
AA-2 COURT +77.48
02.1.03 master bathroom 7.49 m²
02.1.10 dressing room
02.1.05 bathroom 4.80 m²
02.1.01 entrance hall 11.85 m²
02.1.11 storage 2.18 m²
02.1.02 master bedroom 29.08 m²
02.1.04 bedroom 1 14.50 m²
closet
slab drop off above
rainwater pipe
spout above
fire closet
75.00

Plan 1m 5m

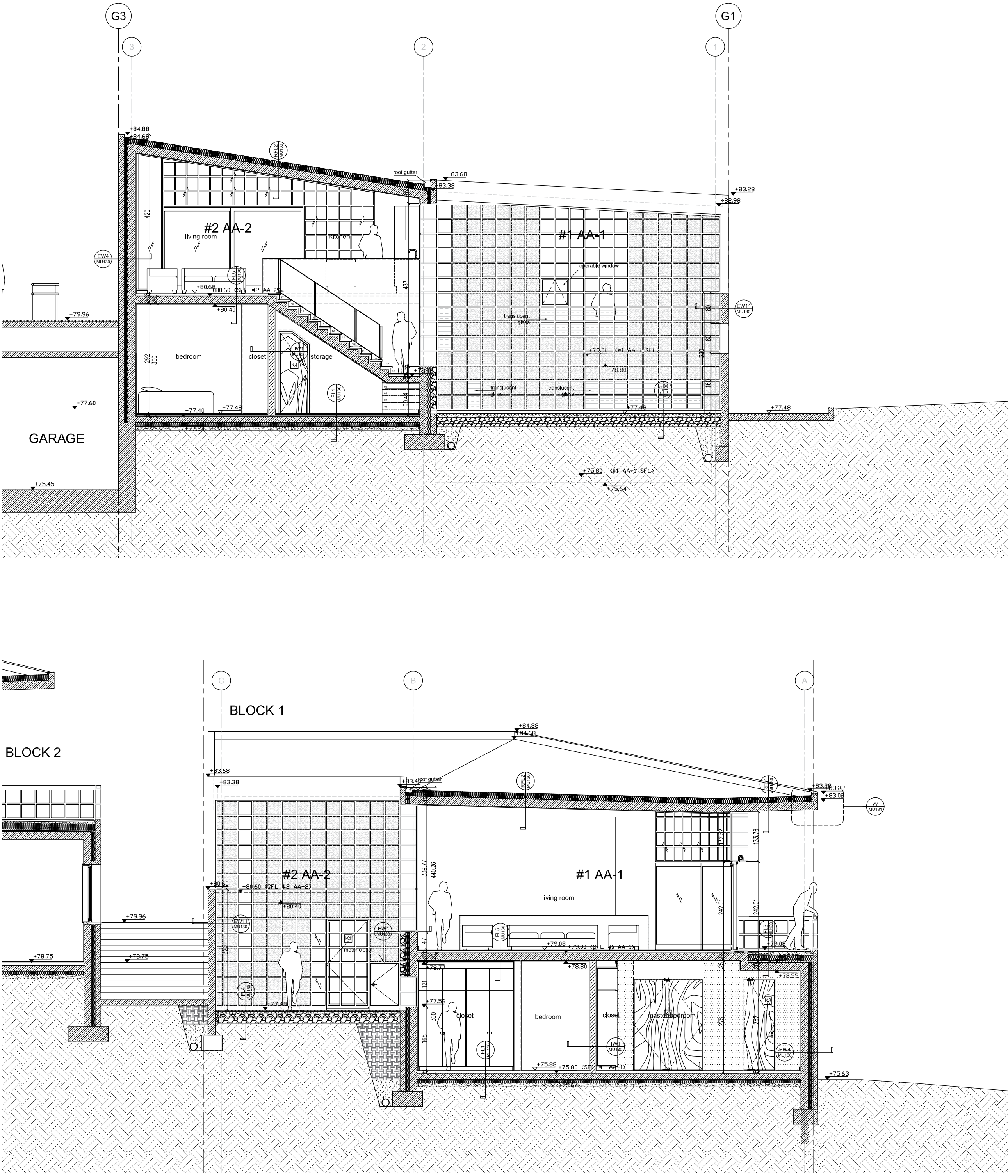




Section 1m 5m

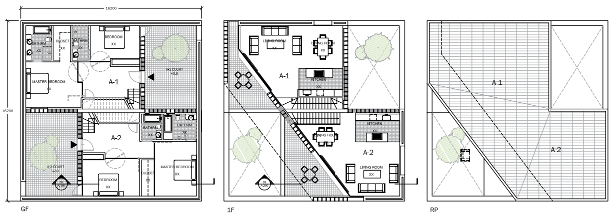

1. FLOOR PLAN
1/50
A-1
A-2
01.2.13 dining room 12.35 m²
01.2.14 kitchen 10.97 m2
01.2.12 living room 29.12 m²
01.2.18 terrace 15.90 m²
AA-2 TERRACE +79.68
AA-1 TERRACE +80.68
02.2.14 kitchen 9.87 m²
02.2.13 dining room 10.32 m²
02.2.12 living room 30.42 m²
02.2.18 terrace 21.54 m²
+79.08
+79.00
+80.68
+80.60
+78.72
01.SI
02.SI
rainwater pipe
spout below
roof above
collector (above refrigerator)
GA
GC
G1
G3
1620

Plan 1m 5m

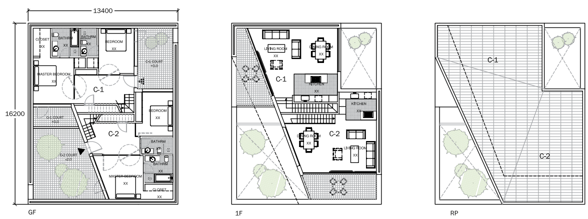


Section 1m 5m

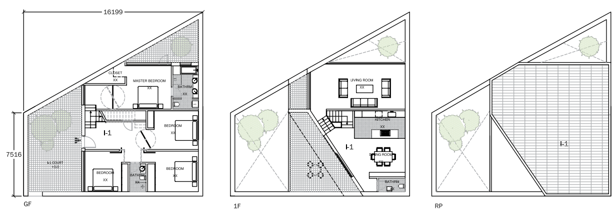

0
5m
10m
20m



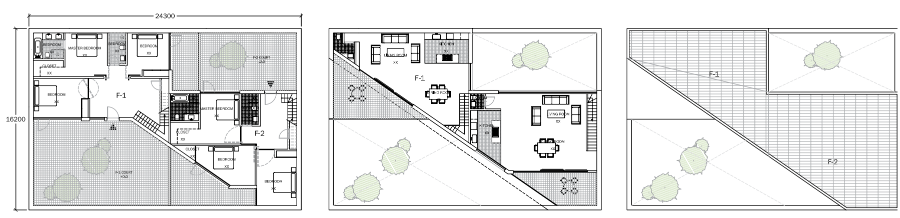
01 UNIT A PLANS SCALE = 1/100



03 UNIT C PLANS SCALE = 1/100



02 UNIT I PLANS SCALE = 1/100

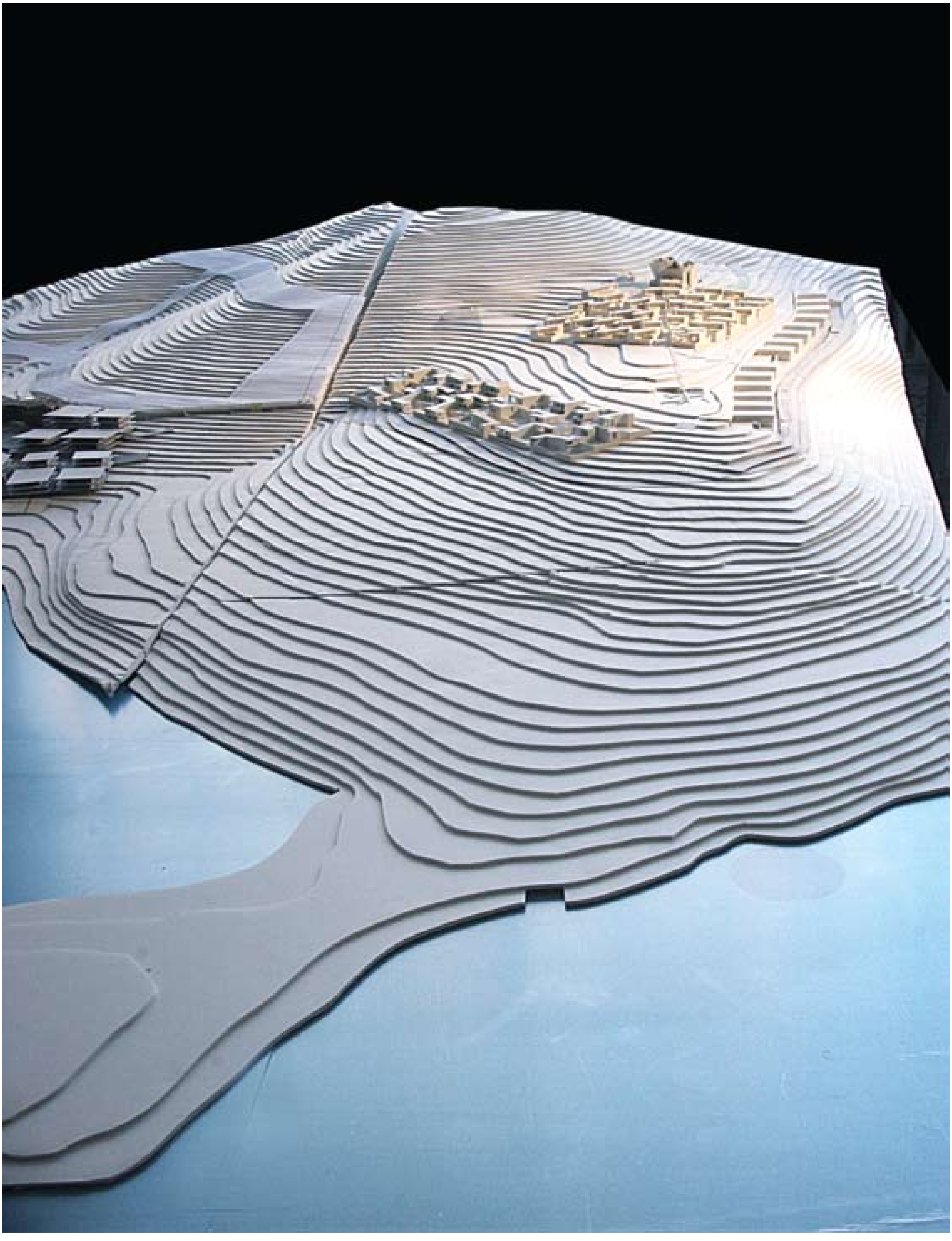


02 UNIT F PLANS SCALE = 1/100

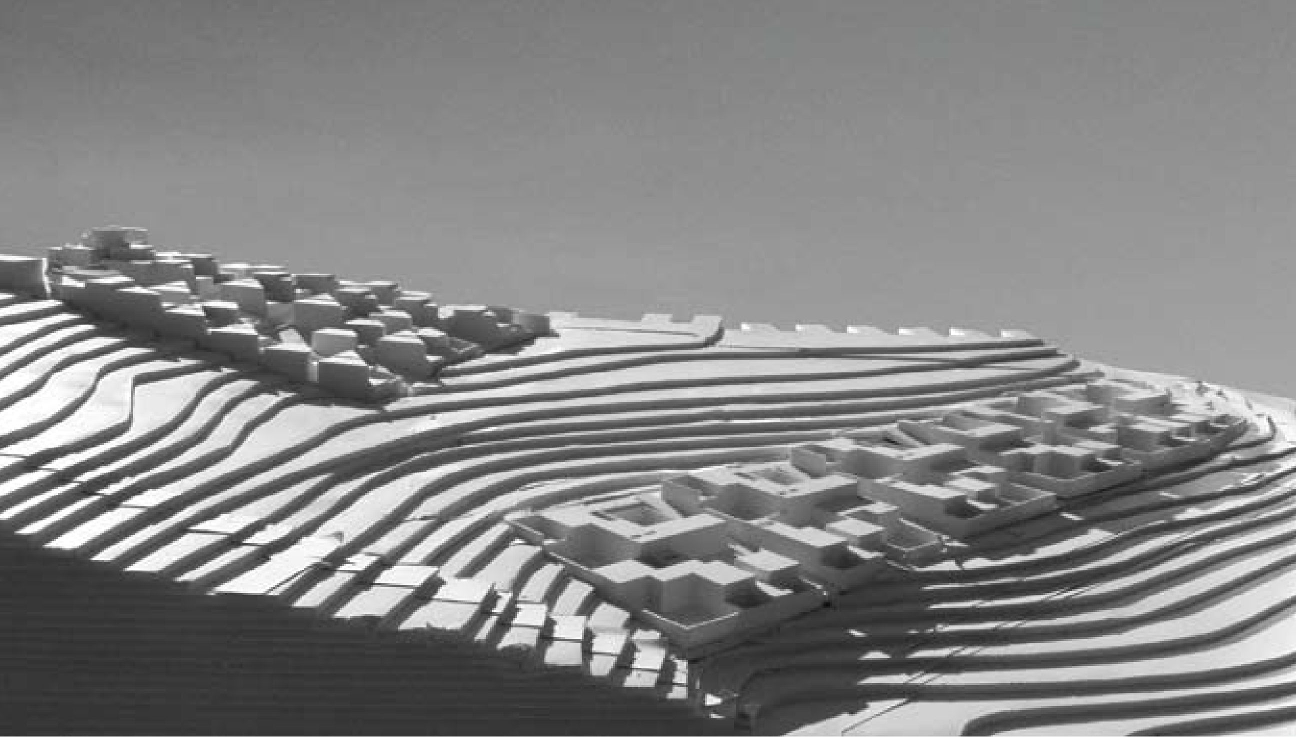
9 Unit Types / Size Examples

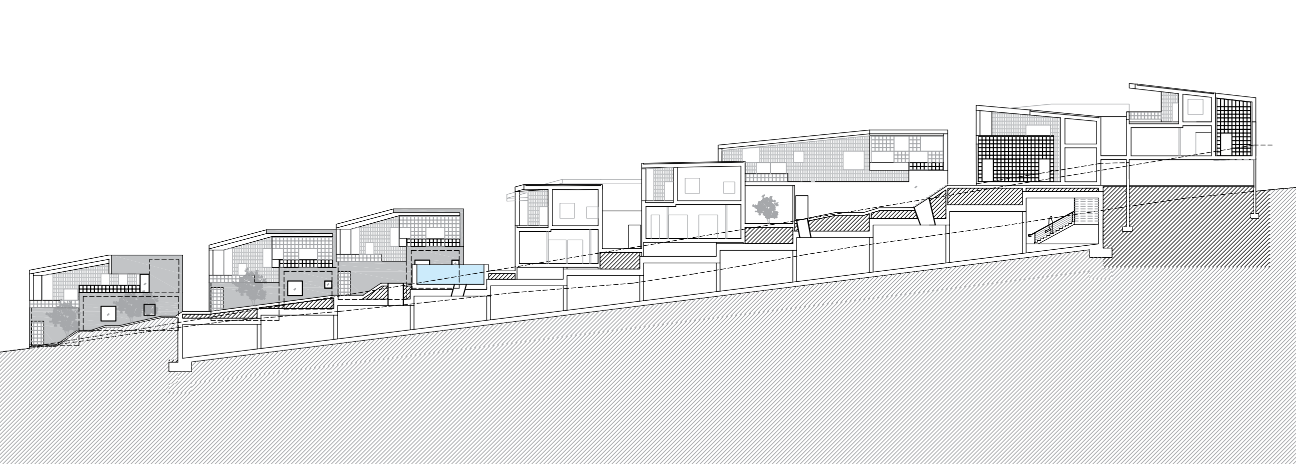
Two, three, and four bedrooms

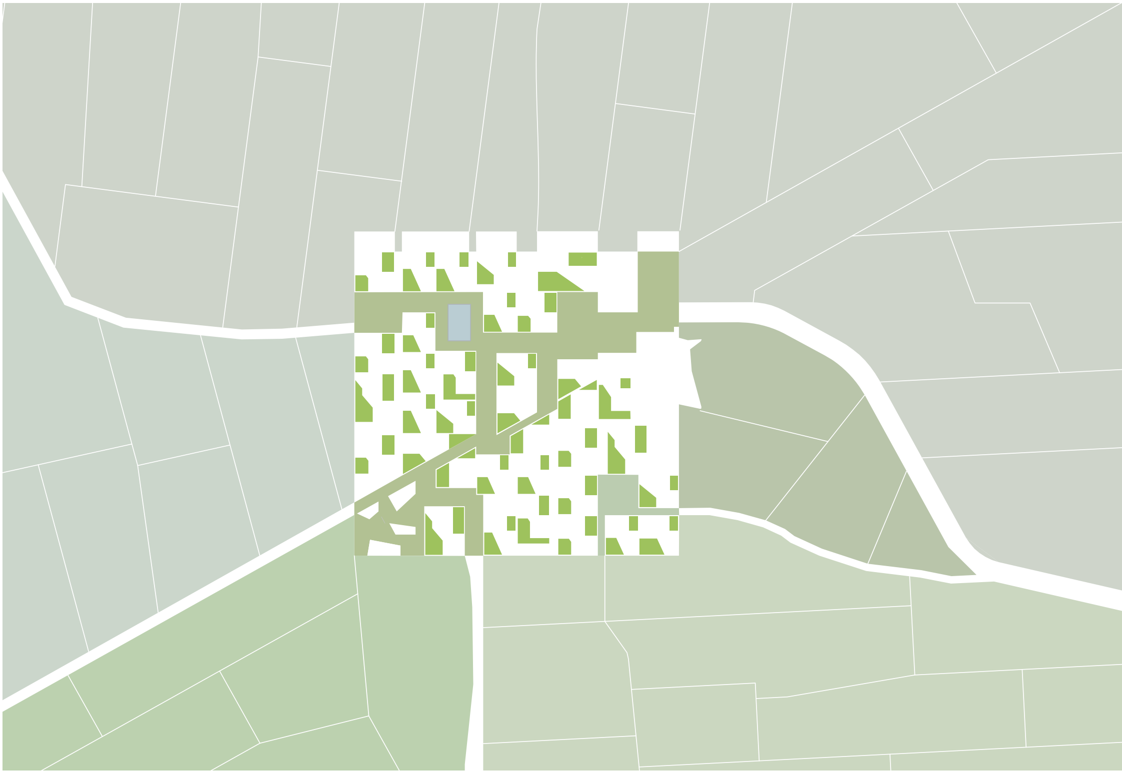
Unit	Area	Bedrooms
A	135m^2	2
B	112–118m^2	2
C	105m^2	2
D	124–130m^2	2
E	127–142m^2	2
F	160–164m^2	3
G	200m^2	4
H	116–134m^2	2
I	198m^2	4



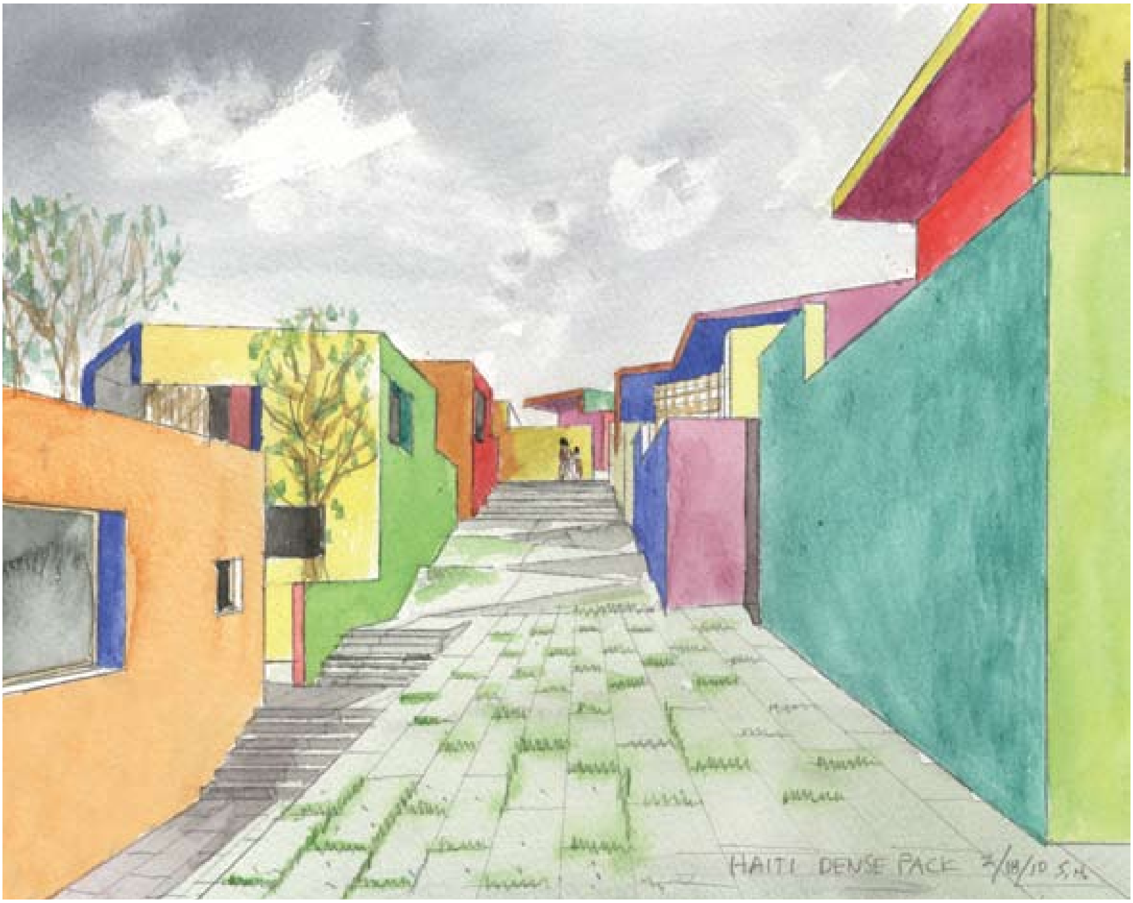
The Dense-Pack Villages should be sited on a south-facing slope, close to the sea for the desalination plants.



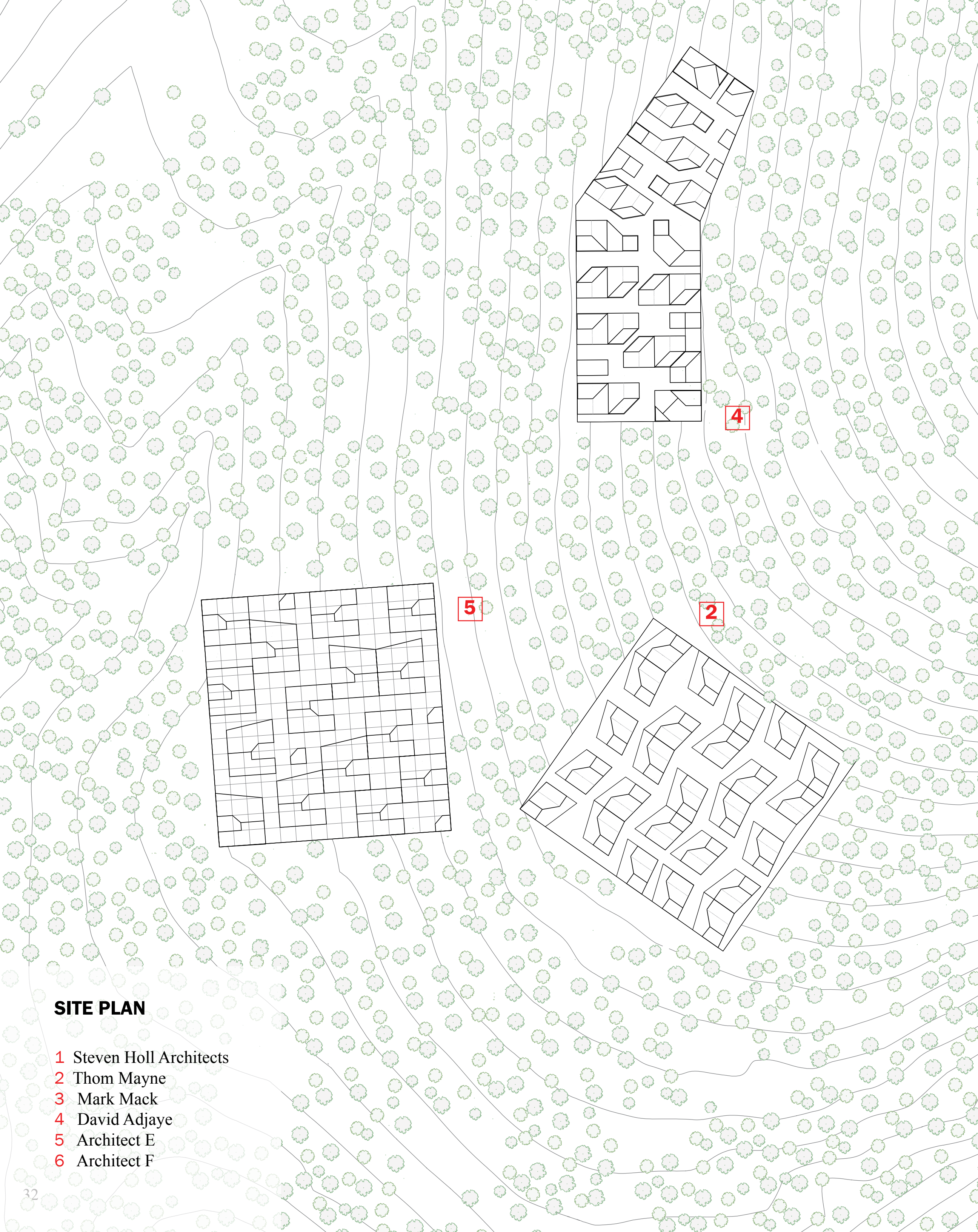




Main public space
Private courtyard gardens
Agricultural parcels

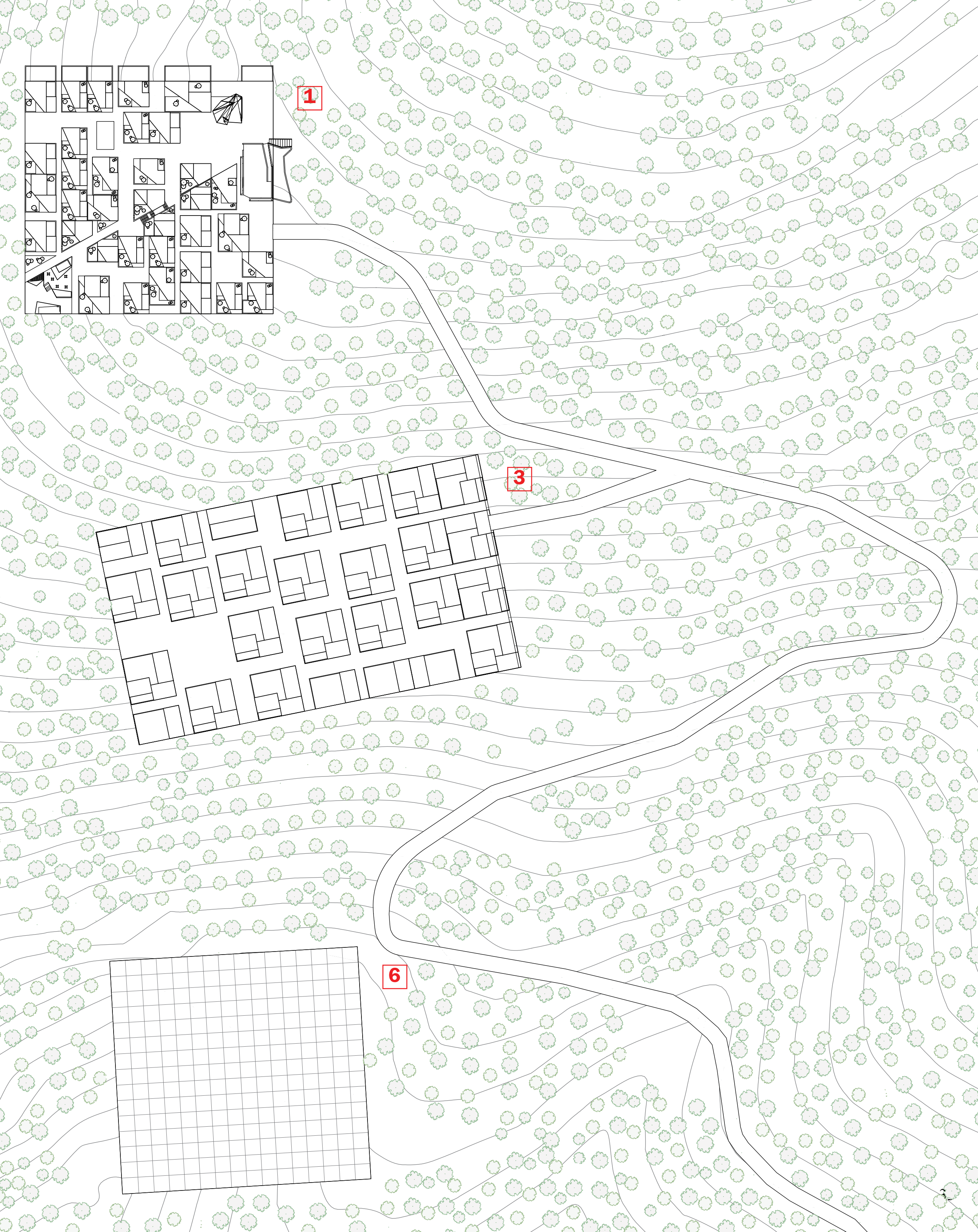


Colors for exteriors and interiors chosen and painted by inhabitants



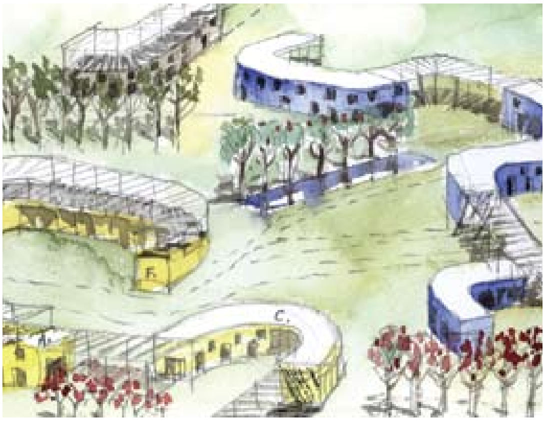
SITE PLAN

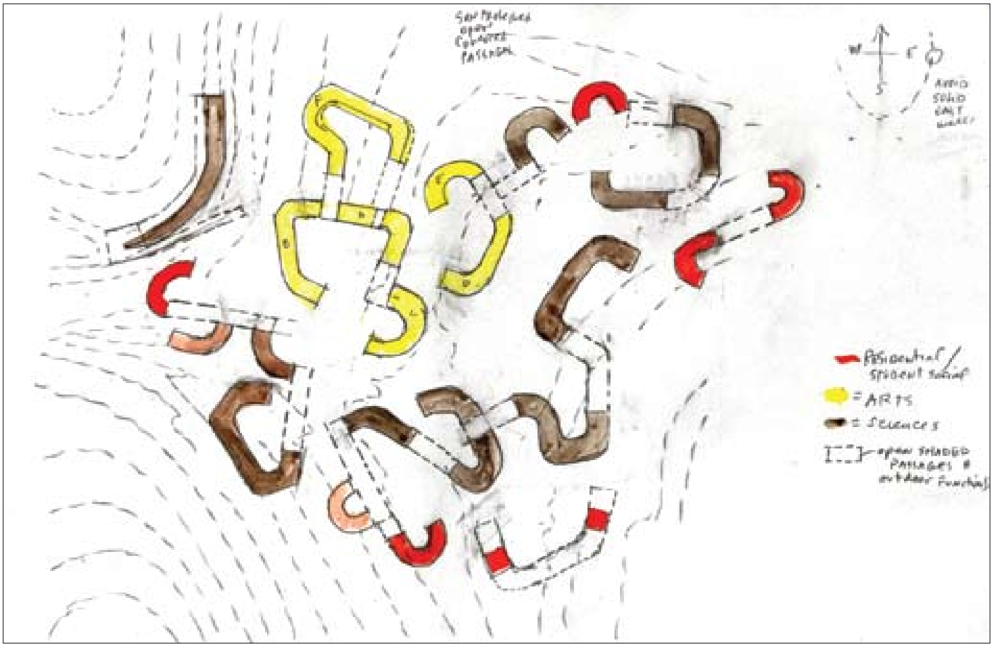
1 Steven Holl Architects
2 Thom Mayne
3 Mark Mack
4 David Adjaye
5 Architect E
6 Architect F

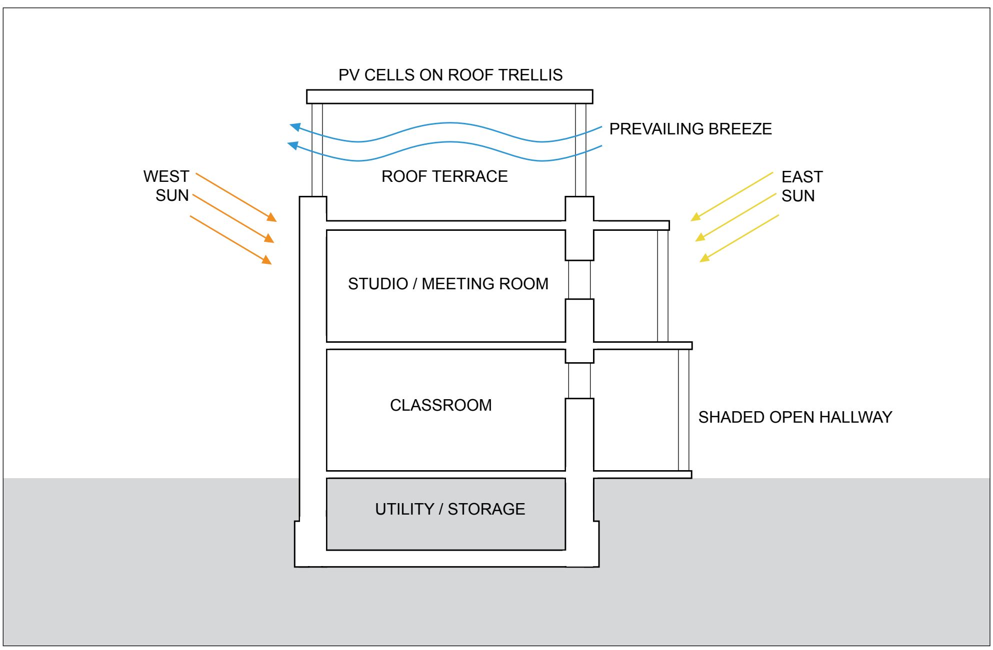

1
3
6

SCHOOLS

Over 90 percent of schools and universities in the earthquake zone have been destroyed, displacing more than 400,000 students. It is estimated that only 50 percent of students returned to the schools that were undamaged, which reopened in February. Therefore, the construction of educational space is a top priority, addressing the 50 percent of Haiti's population that is under the age of 18. A new campus made up of all types of education facilities can be sited next to the new villages—utilizing similar independent, off-grid infrastructural elements.





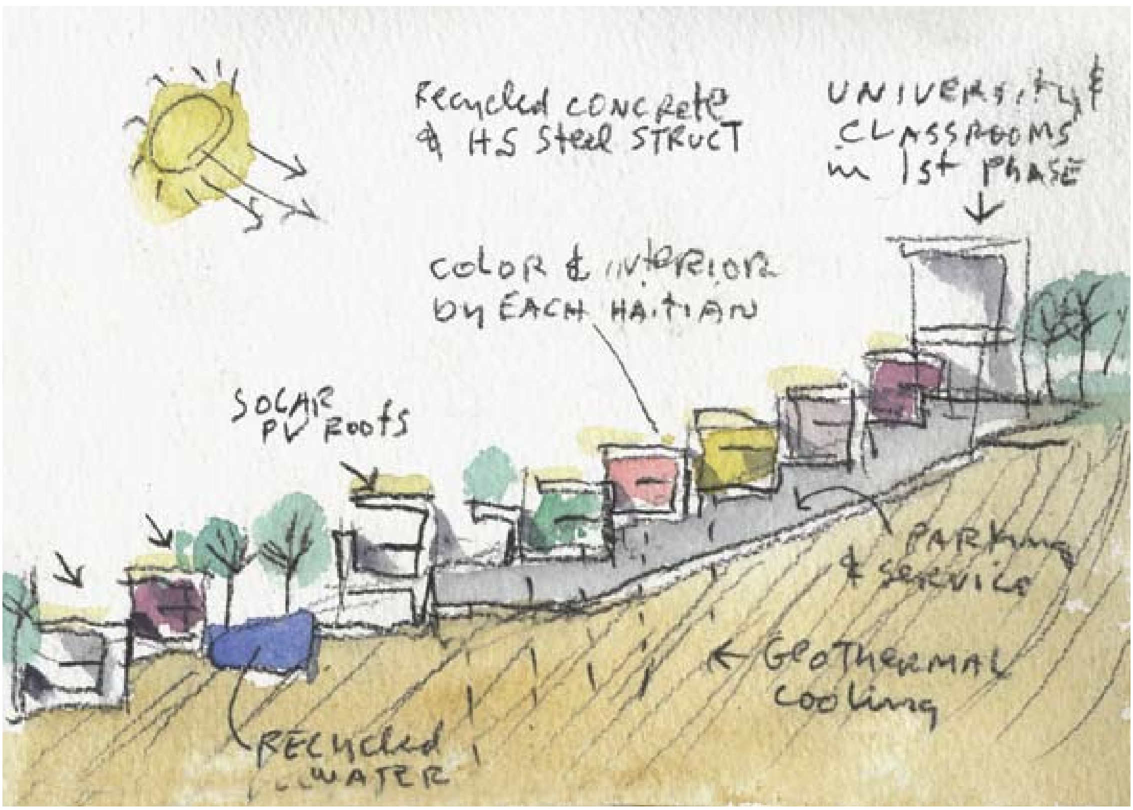


Classroom with university space shaping campus space

ENERGY CONCEPT

Solar photovoltaic (PV) cells line the roofs of the two-story courtyard houses, supplying all lighting needs. Solar cooking stoves can be utilized.

Haiti's inadequate water system, which only supplied 40 percent of Port-au-Prince's water, is now destroyed. On seaside sites, solar desalination plants for each Dense-Pack Village will be installed to supply water from new reservoirs uphill from the new villages, lifted via wind power. Likewise, a natural waste-disposal technology would service each 200-person Dense-Pack Village. Gray water and storm water are recycled for garden irrigation.



Demand for a typical family of 4 to 6 people:

Water
Freshwater will only be used for drinking, cooking, and washing.
Toilets will flush using gray water or will be compost toilets.

Freshwater for:	
Drinking	3 L/person/day
Cooking	5 L/person/day
Washing	10 L/person/day
Total	18 L/person/day
	90 L/family/day

Electricity for:	
Refrigerator (100 L)	200 kWh/a
Lighting	100 kWh/a
Radio/TV	100 kWh/a
Tools	100 kWh/a
Total	500 kWh/a

Cooking will be done with solar power instead of electricity or fire.

Village with 70 family units:

Water demand	6300 L/day (6.3 m^3/day)
Electricity demand	35,000 kWh/a
Gray water production	around 5 m^3/day

Freshwater pressure by 20 m elevated tank to create 2 bar pressure
Lifting 6.3 m^3/day therefore demands 350 kWh/day, or 127.750 kWh/a.

SOLAR THERMAL DESALINATION

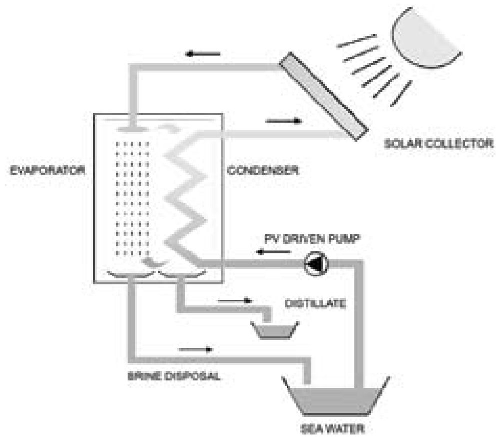
The desalination process is based on the evaporation of saltwater and the subsequent condensation of steam generated. This proprietary process is referred to as multiple-effect humidification (MEH).

The steam produced is virtually clear and does not carry any solvents. Following condensation, one can collect clear, salt-free, and healthy freshwater.

In the process, seawater is heated by the sun. The heat would be supplied via highly corrosion-protected heat exchangers. The heated saltwater enters an evaporation chamber produced from corrosion-free materials—an imperative for reliable long-term operation. Here, the saltwater evaporates from efficient antibacterial fleece surfaces. The produced steam is transported to the condenser in a second step—without any additional energy demand.

As in nature, convection enables the best performance in the water production process—optimized by the well-engineered geometric collocation of surfaces within the module. During condensation, the main part of the energy used for evaporation is regained, applying materials with extremely low heat-flux resistance.


Solar desalination for water



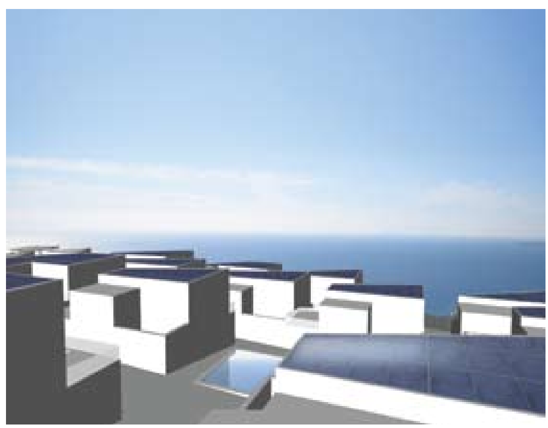
SOLAR ELECTRICITY

Haiti offers a good solar potential of around 1500 kWh/m² of solar radiation on a horizontal surface.

Using a typical solar photovoltaic (PV) panel with 12 percent efficiency, the system produces up to 180 kWh(el)/m² per panel per year.

This means the annual demand for one unit with 500 kWh/a can be produced by a 5 m² solar panel with a local battery.

Connecting all solar panels into one system has the advantage of load shifts between the units, but loses the identification and self-control of a unit-based system.


Roof PV cells

SOLAR COOKING

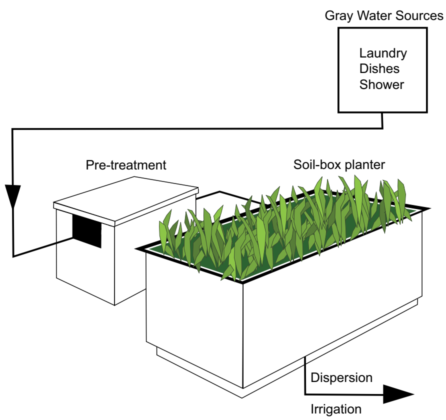
Firewood is the traditional energy source for cooking in many countries of the developing world. Many people suffer from the increasing scarcity of firewood, and further deforestation facilitates erosion and climate change.

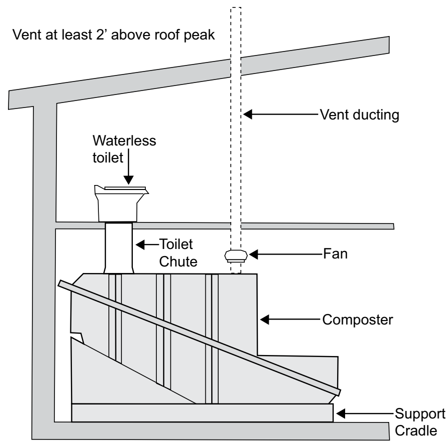
Solar cookers designed to allow extensive retention of present cooking and nutritional habits would appear to be a practical alternative to the presently employed means of cooking, but this requires that the models offered be safe, simple to use, and affordable for the ultimate users.

Based on the discoveries of the French expert Roger Bernard, the solar cooking unit Primrose offers two distinct advantages: firstly, it is unusually stable in windy conditions; and secondly, a more easy-to-use unit would be hard to imagine. The height of the work platform is comfortable and never changes. It is also possible to set up the unit so that the cook is always in the shade and not constantly exposed to the sun.

The reflector can be folded away, which allows for straightforward transportation or storage. In addition, this cooking unit combines the advantages of a parabolic cooker with those of a box cooker, in that it possesses a so-called heat-trap: the sun's rays are reflected by the mirror through a window into the cooking space. This space is also equipped with internal mirrors and is well-insulated. This ensures that the energy cannot dissipate and remains fully available for cooking.

The work-plate has a rectangular opening, into which one can place the desired insert—for example, for pots, fish-cookers, frying pans, and so on. If you order the pot together with the cooking unit kit, you will find the opening already cut out. The pot will fit perfectly in there.





GRAY WATER TREATMENT

Gray water is water that has been previously used for a primary purpose (washing dishes, laundry, showering) but is still clean enough to be used for a secondary purpose (landscape or agriculture watering).

Gray water treatment systems have their differences when it comes to setup. There are various stages and paths the gray water must go through to be ready for reuse.

A typical gray water treatment system includes a pre-treatment filter to catch larger objects. After the pre-treatment process, the water could go into a planter or reed area—2 m²/pers—via pipes.

COMPOST TOILETS

Composting is the breakdown of organic matter in the presence of aerobic organisms. This is the same process that happens whenever organic matter is exposed to oxygen and moisture: in forests, garden compost piles, lawns, and so on.

The composting toilet system allows human waste to break down into simple, stable compounds that have value as plant nutrients (i.e., fertilizer).

One toilet can accommodate up to 100 people a day, so all 70 units should have 4 or 5 central compost toilets.

EARTHQUAKE-, HURRICANE-, & FLOOD-RESISTANT HOUSING FOR HAITI

GUY NORDENSON & REBECCA NIXON, GUY NORDENSON & ASSOCIATES

Enriquillo-Plantain Garden Fault area

Earthquakes do not harm people—poorly designed, constructed, and sited bridges, buildings, and other structures are the cause of harm and misfortune.

As the recent earthquakes in Haiti and Chile have shown, there is a great difference between devastation in poor countries versus relatively prosperous countries. The February 27, 2010, earthquake in Chile had a magnitude of 8.8, many hundreds of times more powerful than the magnitude 7.0 Haiti earthquake of January 12, and yet 300 times more people died in the Haiti disaster.

Earthquakes spread ground by shaking away from the fault rupture, and the ground shaking in turn shakes structures. If a structure is sited on soft soil—on coastal landfill, in river valleys, in filled-in swamps—then the ground shaking can be amplified many times, with devastating effects. In some cases the land itself can fail—for example in landslides, or when sand turns to liquid and structures simply topple. Regardless of the actual ground shaking below a structure, it is the mass of the structure that is accelerated and causes damage or failure. Thus, heavy buildings on soft ground are the most dangerous and light buildings on rock sites are the safest.

This would seem to be at odds with the infrastructure needed to protect against hurricane winds and flooding, where a heavy building would seem better suited to withstand both winds and floods, and in particular, a heavy roof would seem more likely to survive both. But it is possible to reconcile these discrepancies and build safe structures through a careful combination of planning and design.

MICROZONATION

The first step in reducing risk is to review urbanization and settlement in relation to topography, geology, and soil conditions. This applies to earthquake risk as well as flooding (and indeed climate change), since lowlands are often also poor building grounds. By combining maps of population and construction, proximity to faults, exposure to flooding, and soil conditions, it is possible to identify the most vulnerable places and move construction away from these areas as much as possible.

SUSTAINABLE & RESISTANT CONSTRUCTION

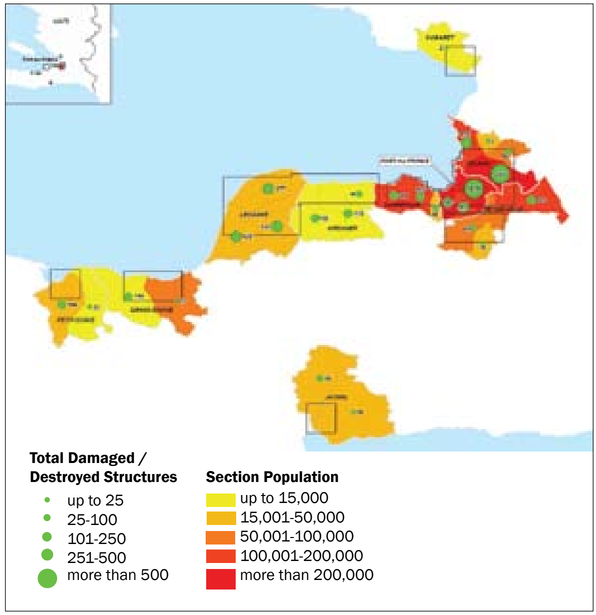
Building only on good soil of sufficient elevation is the most critical step, and if possible, construction of structures that are light, strong, and firmly tied together would ensure the safest outcome. This, however, requires light and strong materials, and in Haiti there is not enough steel or wood for construction. There is obviously a need to help the people of Haiti in the reforestation of their country, and with time this could hopefully lead to more sustainable harvesting of wood for lightweight construction.

For now, however, the solution is to improve the masonry and concrete construction that is typical in Haiti. This can be done in a few simple ways:

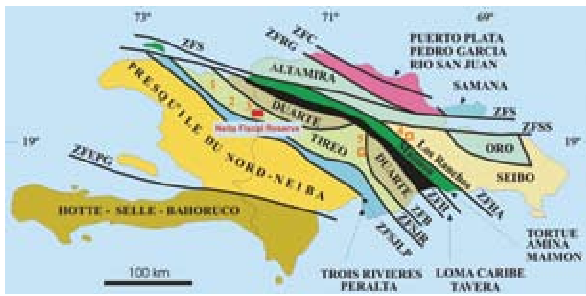
1. Control the quality of materials as you would medicine.

2. Build walls only of confined masonry.

3. Build low-rise structures and use lightweight roofs and reinforced concrete for slabs only.

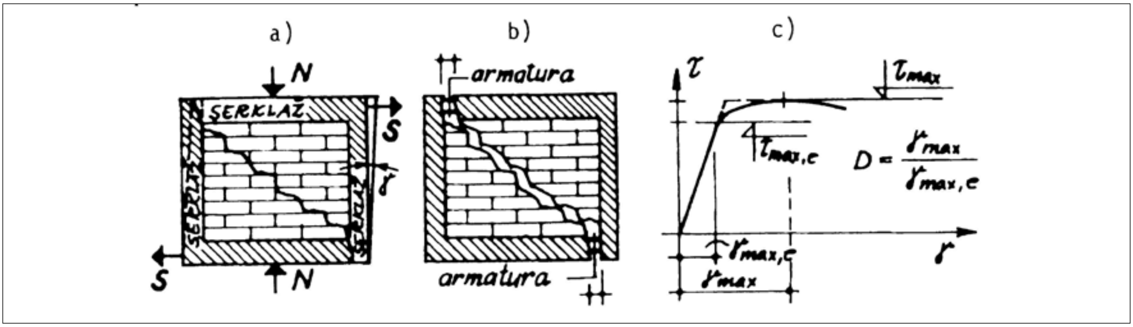


Earthquake damage assessment map, January 2010



Tectonic map of the island of Hispaniola

Hispaniola: Extant forests and mangroves

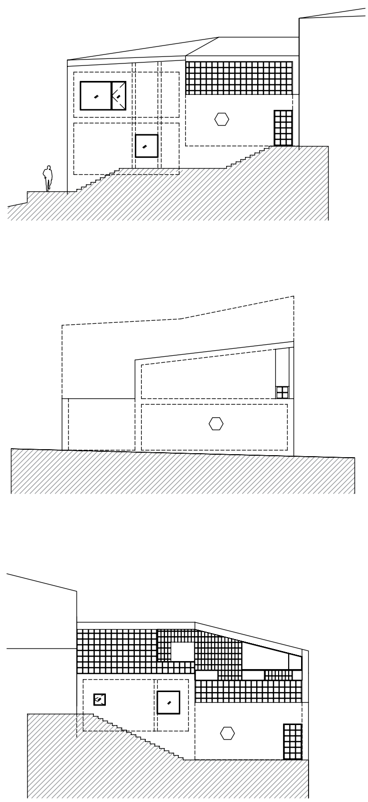


Principle of confined masonry

CONFINED MASONRY

Confined masonry construction is practiced in many countries of high seismic risk, including China, India, Indonesia, and Peru. It is frequently used for low-rise housing in both urban and rural areas because it can be made from locally available materials with minimally trained labor according to regional construction practices, and it is more economical than other earthquake-resistant structural types, such as reinforced masonry or reinforced concrete frame with infill.

Confined masonry construction consists of unreinforced-masonry, load-bearing walls, surrounded (or “confined”) by slender reinforced (RC) tie columns and RC ring-beams that provide a complete load path for seismic force transfer to the ground. The reinforced concrete elements provide in-plane strength and ductility to the unreinforced masonry walls as well as out-of-plane resistance to bending effects through a behavior known as arching. The masonry walls would be made of concrete block, as suitable clay is not available on the island of Hispaniola. The stone aggregate in the reinforced concrete elements may be substituted with concrete fragments recycled from building debris. The foundations and ground-floor slabs could also make use of recycled concrete debris.



Shear walls (with no openings in them) should be as symmetrically located as possible, and occur on each level in multiple directions. Openings should generally be surrounded on each side by RC columns or at the sides of a structure next to confining tie columns

FLOOR & ROOF STRUCTURES

If they are built with care and of sound materials, confined masonry walls will help improve the resistance of buildings to both earthquakes and hurricanes, provided they are well tied together with sturdy floor and roof structures.

Typically floors can be constructed either with wood joists and plywood or cast-in-place concrete and tile. Cast-in-place concrete is cast on either wood forms or, in some cases, on thin, prefabricated slab forms.

Because of their lightness, wood floors are a good choice, but for now this is not an option in Haiti. Cast-in-place tile and concrete floors—where the tiles form voids—are heavy and not always well tied together. However, if made with lightweight Styrofoam or other void materials, this construction can be made resistant. Prefabricated, thin-plank concrete forms have been used in the Dominican Republic, and could be a viable option in Haiti as well.

For roofs, the construction options are the same as the floors. Wood in this case may be the preferred approach for its lighter weight and, therefore, seismic load reduction. Since the roof experiences the greatest accelerations in an earthquake, lightness can be a great advantage, provided the wood structure is well tied together with a plywood or plank diaphragm. Metal roofs are also possible, though it is difficult to achieve secure connections between these and the wall structures.

There are other less conventional options for roofs, including domes made of tile, brick, or even fiberglass. John Ochsendorf of MIT and Theodore Zoli of HNTB New York, both MacArthur Fellows, have been investigating these options, and their work shows great promise.

Precast concrete integral forms

Mapungubwe Interpretation Center, South Africa

SOCIAL/ENVIRONMENTAL HISTORY OF SHA

Environmental Works, 2010

1969 SH studies under Richard Haag, landscape architect, at the University of Washington.

1969 SH is one of the five founding members of Environmental Works under the guidance of Professor Robert Small.

1970 First Earth Day occurs on April 22. Senator Gaylord Nelson, founder, had announced the proposed day in Seattle in September 1969.

1971 Environmental Works is given a disused firehouse on Capitol Hill in Seattle for a rent of one dollar per year.

1975 SH wins fourth place in the Daga Dagatan Manila Habitat Competition, presented at the international conference on housing for the poor in Vancouver, British Columbia.

1986 Social housing is made part of the Porta Vittoria project, Milan, Italy.

1999 Lake Whitney water treatment plant/park is designed to be geothermally cooled and heated.

2001 SHA wins first place in the Swiss Embassy competition (realized with "Minergy" Swiss standards.)

2002 SHA wins first place in the Natural History Museum of Los Angeles competition (aiming for the highest environmental demonstration in all HVAC systems).

2002 Green Urban Laboratory (New Town, Nanning, China) concept and design are developed.

2003 Linked Hybrid in Beijing, China, is geothermally cooled/heated with 660 geothermal wells 100 meters deep, the largest in China at that time.

2006 Horizontal Skyscraper (Vanke), Shenzhen China, is the first LEED Platinum building in China.

PROJECT CREDITS

STRUCTURE
Recycled concrete, confined masonry, lightweight recycled roofs, earthquake and hurricane resistant

SKIN
Painted in custom colors by inhabitants

WINDOWS
Locally built wood

ENGINEERING
Guy Nordenson and Associates: Guy Nordenson and Rebecca Nixon

ENVIRONMENTAL
Transsolar: Matthias Schuler

DESIGN
Steven Holl Architects: Steven Holl, Chris McVoy, Francesco Bartolozzi, Janine Biunno, Olaf Schmidt, and Ebbie Wisecarver

2008 mockup—with local, craftsman-built wood fenestration—in Akbuk, Turkey

p. 5	NASA Earth Observatory
p. 11	Hydro Cahos (left); Google Earth (right)
p. 12	Jean Michel Basquiat, 1982 © 2007 Artists Rights Society (ARS), New York / ADAGP, Paris (left); © 2010 Shawn Thew/EPA/Corbis (right)
p. 36	NASA
p. 38	MAGE Water Management GmbH
p. 40	Mercè Vila
p. 42	NASA Landsat Geocover
p. 43	European Union 2010 (top); Unigold (middle); The Nature Conservancy (bottom)
p. 44	Earthquake Engineering Research Institute (top)
p. 45	Studiebureau IBC (left); James Bellamy (right)
p. 46	Environmental Works, Seattle, WA

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