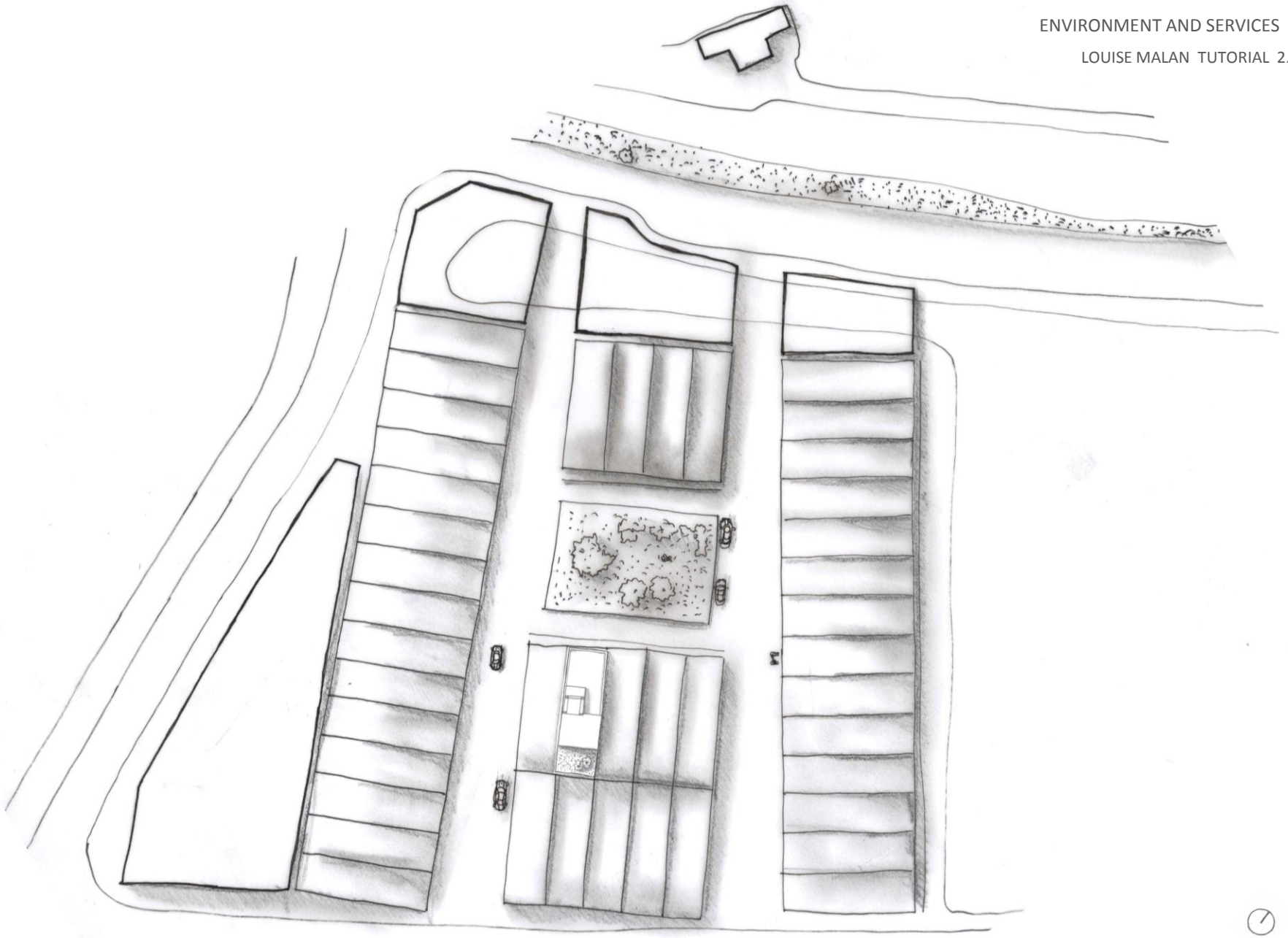
ENVIRONMENTAL STRATEGY FOR ROW HOUSE- CAPE TOWN

ENVIRONMENT AND SERVICES

LOUISE MALAN TUTORIAL 2.2



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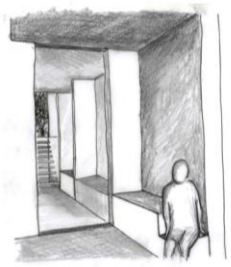
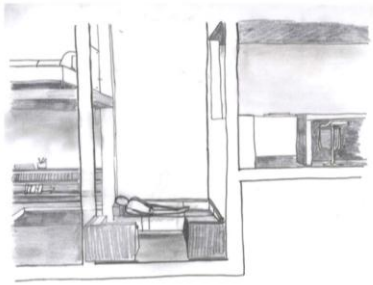
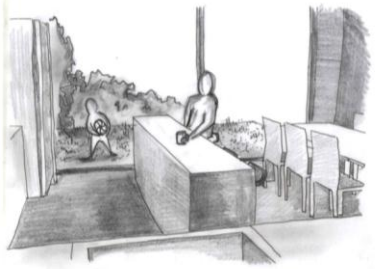


ENTRANCE



DEN/CHILL AREA



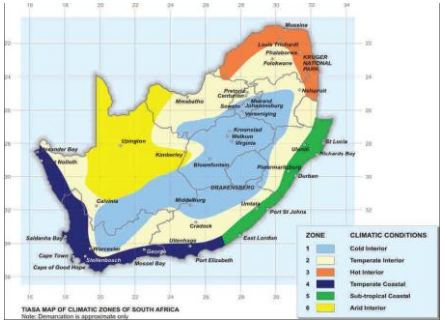
KITCHEN AND DINING ROOM

PART A
Climate Analysis

Cape Town has an ocean Mediterranean climate, with mild, moderately wet winters and dry, warm summers.

Winter, which lasts from the beginning of June to the end of August, may see large cold fronts entering for limited periods from the Atlantic Ocean with significant precipitation and strong north-westerly winds. Winter months in the city average a maximum of18.0 °C and minimum of 8.5 °C. The total annual rainfall in the city averages 515 millimeters .

Summer, which lasts from early November to March, is warm and dry with an average maximum of 26.0 °C and minimum of 16.0 °C. The region can get uncomfortably hot when the Berg Wind blows from the Karoo interior for a couple of weeks in February or early March. Late spring and early summer may sometimes feature a strong wind from the south-east.



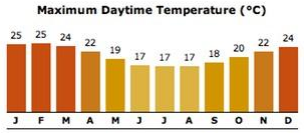
CLIMATIC ZONES OF SOUTH AFRICA

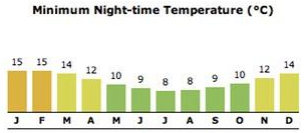
Energy measures will vary from location to location. The deemed-to-satisfy provisions are based on climate zones, including dry bulb temperatures, thermal neutrality, humidity and southern coastal condensation risk. The climatic zone map has six climatic zones as follows:

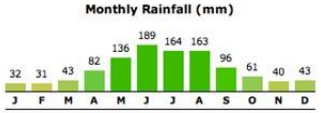
Climate Zone	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Description	Cold Interior	Temperate Interior	Hot Interior	Temperate Coastal	Sub-Tropical Coastal	Arid Interior
Climate	Warm summer Cold winter	Warm summer Cool winter	Hot dry summer Temperate winter	Warm humid summer Cold wet winter	High humidity summer Warm winter	Hot dry summer Moderate winter
Average January maximum temperature°C	30.7	30.7	31.9	26.1	27.8	35.5
Average July mean temperature°C	7.8	12.2	17.4	12.2	16.6	12.5
Average July minimum temperature°C	-1.8	3.6	10.2	7.0	10.5	4.1

Reference: D.Holm, H.M.Murray, C.J. Pauw, A.S van Niekerk (Temperatures obtained from Nova Project - climatic information).

In response to the climate, a house in Cape Town should accommodate these differences in temperatures. In the summer the house should be kept cool, with minimum sun entering in to the living spaces and well ventilated. In the winter the house should ideally be kept warm. This could be done through passive heating solutions such as thermal mass. These techniques are discussed later.







The psychometric chart shows the comfort zones in relation to temperature (x-axis) and humidity(y-axis).The psychometric chart shows the comfortable relationship between temperature and humidity.

Diagram 1 classifies the different zones of regarding the temperature and humidity. Cape Town falls in the moderate region.
Diagram 2 shows the comfort zone of a person referring to the climate and humidity.
Diagram 3 shows how the comfort zone is expanded by using passive design techniques.

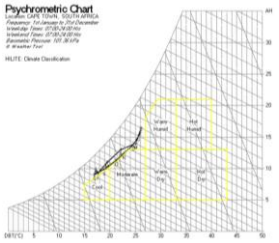


Diagram 1

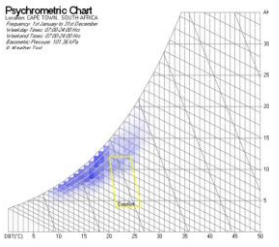


Diagram 2

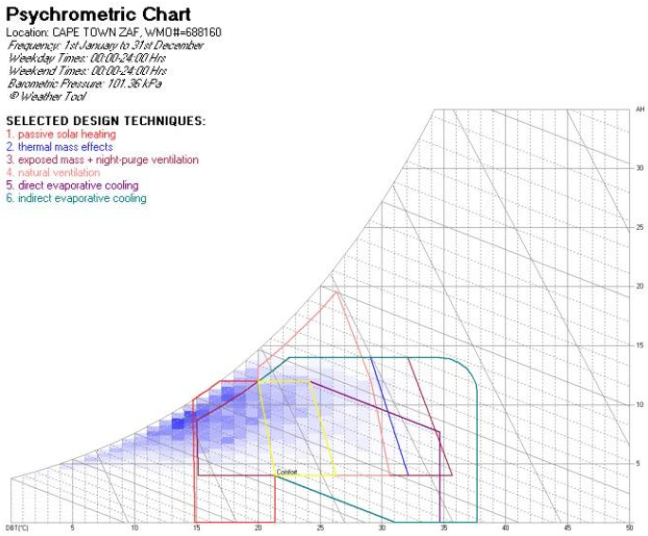


Diagram 3

A passive design model can be drawn up responding to the climatic data collected. These design techniques would be incorporated to create a passive row house and is discussed later. They are :

1. Passive solar heating
2. Thermal mass effect
3. Natural ventilation
4. Passive Cooling

This will enhance and make the comfort zone immensely bigger, as shown in the diagram 3.

DESIGN STRATEGY

The main idea is to keep the house cool in the summer and warm in the winter. **Double story houses (row house):**

1. Passive solar heating:

-Northerly orientation of daytime living areas.

-Floor plan zoning based on heating needs: Locate bedrooms upstairs in cold climates so they are warmed by rising air.

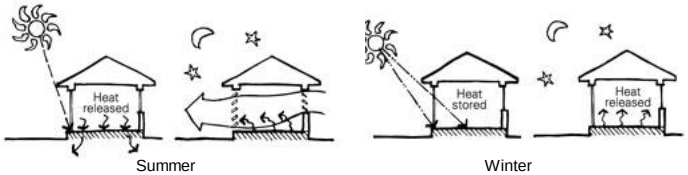
-Appropriate areas of glass on northern facades.

2.Thermal mass effect:

MATERIAL	THICKNESS (mm)	TIME LAG (hours)	AAC
200	7.0	Adobe	250
9.2	Compressed		
Earth Blocks	250	10.5	Concrete
250	6.9		
Double Brick	220	6.2	Rammed
Earth	250	10.3	Sandy Loam
1000	30 days		

-Thermal mass at the lower levels because heat rises.

-high insulation levels and lower (or no) thermal mass at upper levels.



Summer Winter

-upper levels can be closed off to stop heat rising in winter and overheating in summer.

-Maximize openable area of upper level windows for summer ventilation.

-Increase natural ventilation by reducing barriers to air paths through the building.

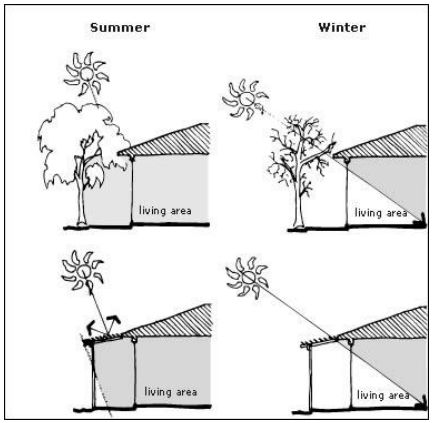
-Provide paths for warm air to exit the building.

4. Passive cooling

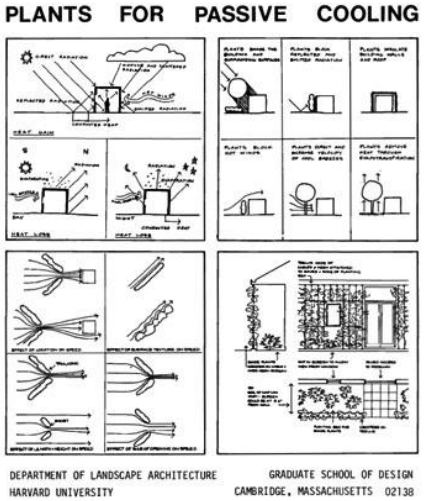
-Fixed shading and adjustable shading

-Using trees as shading- in the summer offers shade and the winter it loses it's leaves to let in sunlight

-Use of light colored roofs and walls to reflect more solar radiation and reduce heat gain.

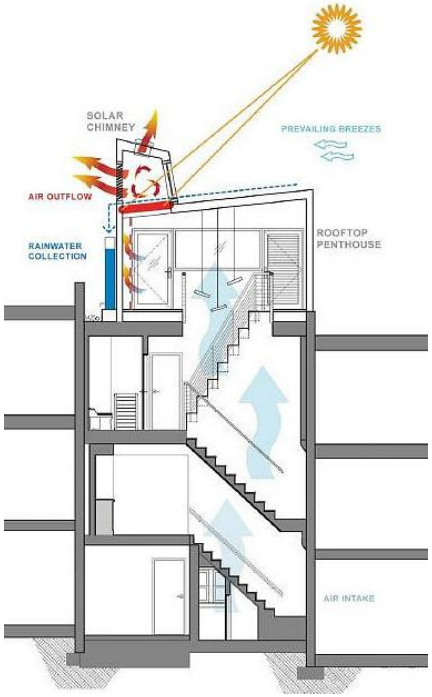


Passive cooling using plants



Precedent study 1:

Solar Chimney



Precedent study 2:

Richard Hawkes' Grand design passivhaus

The house uses an arch to minimize its mass. This arch received a passive design certificate in June 2010 because of its effectiveness. It has large thermal mass that provide a comfortable living space. It also includes passive solar gain.

All the materials used in the house is locally produced, like the clay tiles and the timber. This adds to the house as a sustainable building.

Materials are recycled and used in the building materials like newspapers, car tyres and crushed bottles are used in the lime mortar and in the polished ground floor are but a few of the recycled materials used.

Energy generating systems are used and store thermal energy. They also capture rainwater and on site waste treatment.

Not only does this house save energy but also produces energy and saves money.

SITE ANALYSIS

The site : District 6 in Cape Town.

The urban strategy or scheme for the Row House site and design is based on the idea of a courtyard or plaza. Rowhouses are built around this green courtyard, creating a public - green space in urban living conditions. There are 43 private owned plots, that are 6m x 20m. The houses are all 6m high on the street from and 9m high at the back. Each Rowhouse has to have its garage at the front and the garden at the back, to create a uniform urban layout.

Around the complex are commercial building as shown on the drawing on the right.

The courtyard creates eyes on the street, creating a safe community. This social aspect of the courtyard allows children to play and develop in a safe and natural environment.

Vehicles can access this urban environment and parking is provided on each plot. Sidewalks are along each road, creating a safe environment for walking.

Vehicle access the site from the North East. Sidewalks surround the site to make it accessible for travelers by foot.

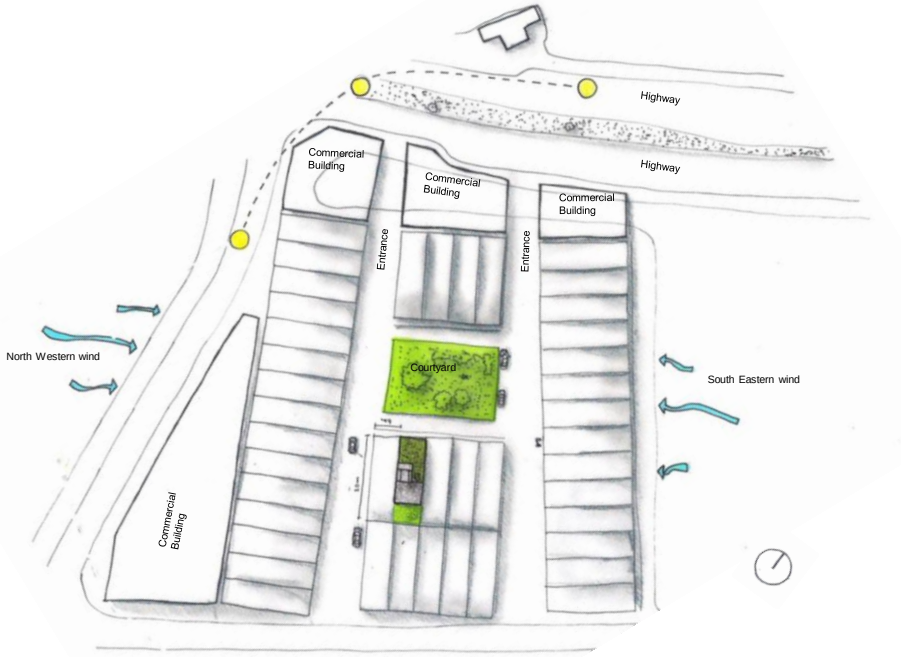
The particular plot of my rowhouse, faces North-East and is located in between two other rowhouses.

You enter the house via a stoep, that creates a transitional space between public and private. An open garage is provided. The first level consists of a den/chill area which is a double volume space. This allows light to penetrate from the top levels to the lower levels.

The use of a central staircase, acts as a light well and ventilation tunnel. Circulation then takes place at the centre of the house.

The kitchen and dining room connects with the den/chill area and living areas via split levels. The second level opens up on the garden. The social aspect if the split levels allows children to play in the garden with the parents keeping an eye over them, because the height of each floor is 1.5m.

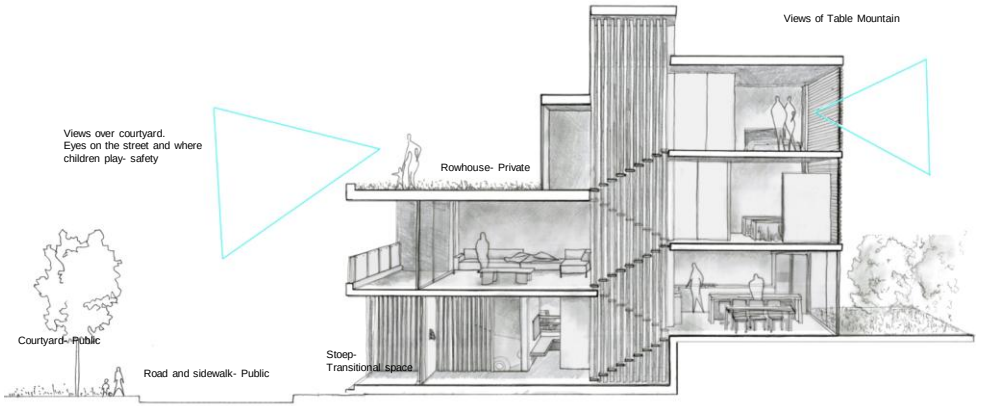
Bedrooms are located at the back of the rowhouse, for privacy and the view of Table Mountain.



Site plan- Urban Layout

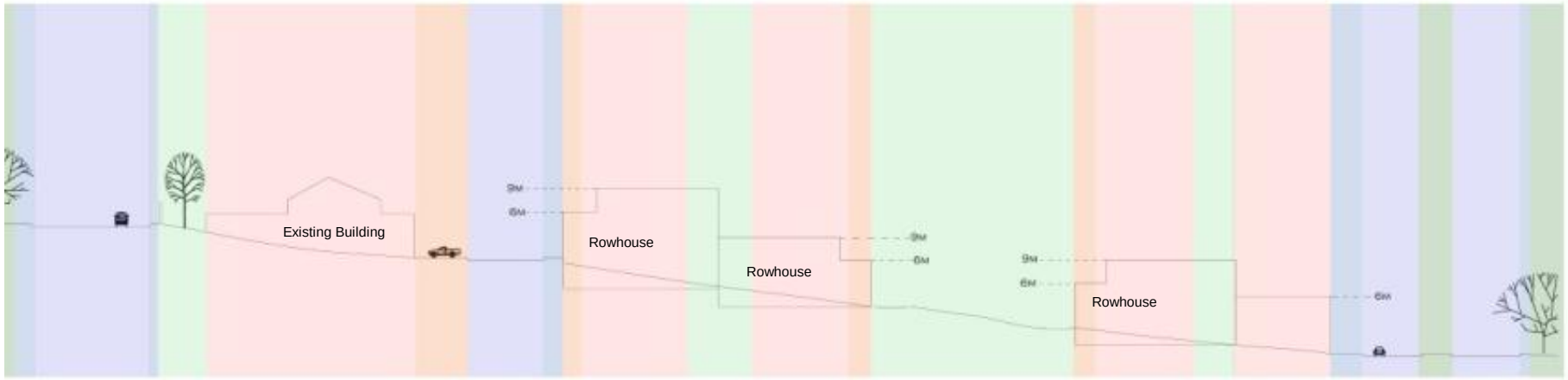
Arial Photo of the site- District 6 Cape town

Access to the site via roads and footpaths



Longitudinal section through Rowhouse

SITE ANALYSIS
Site section



VEHICLE ZONE
- Roads

PEDESTRIAN ZONE
- Side Walks

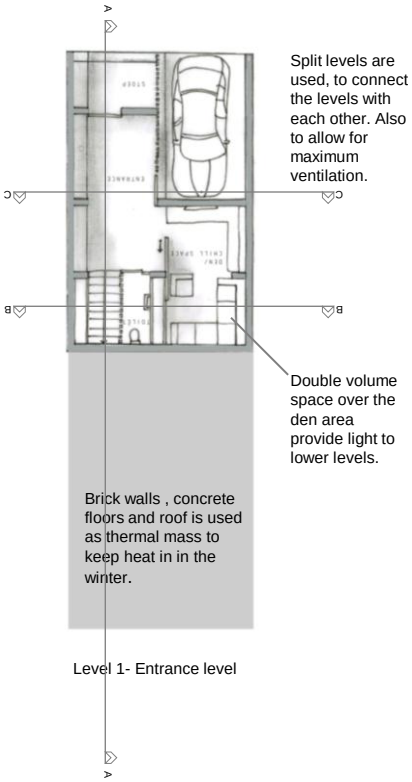
PUBLIC GREEN ZONE
- Vacant land that can be used for development in order to improve the value of the area
- Dangerous, as it is open. Unsurveillanced land

PRIVATELY OWNED GREEN ZONE
- Gardens

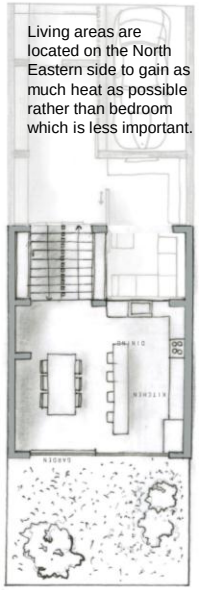
BUILT-UP ZONE
- Current Buildings

DEFENSIBLE ZONE
- Transitional zone between public and private

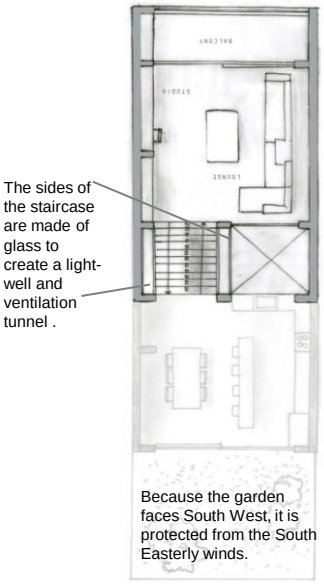
PLANS
Passive Design Strategy



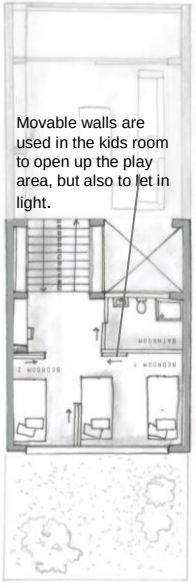
Level 1- Entrance level



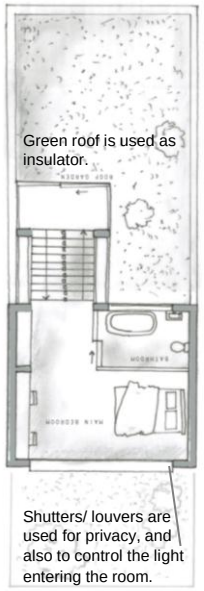
Level 2- Kitchen, dining and garden



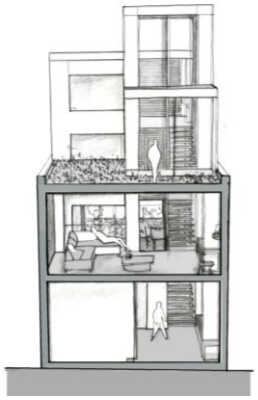
Level 3- Living Room



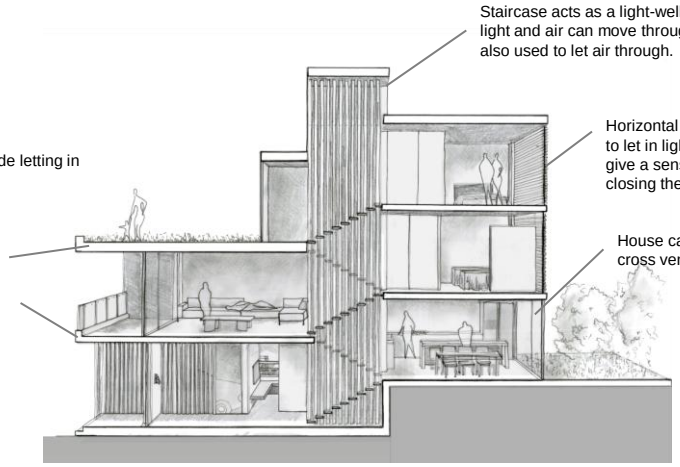
Level 4- Kids Bedroom and bathroom



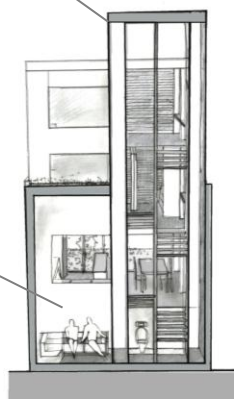
Level 5&6- main bedroom, bathroom and green roof



Section B



Section A



Section C

SOLAR ANALYSIS:

The orientation of the Rowhouse is 20 degrees North East.

The idea of the solar analysis is to determine overhangs that will keep out the sunlight in the summer and let in sunlight in the winter.

The solar analysis can be done electronically through Ecotect or manually by using the protractor. The electronic method is shown below with diagrams on the right.

CUT OF DATES AND TIMES

Dates are determined around the solstices.

Summer - 22 December 09:00
- 22 December 17:00

Winter - 22 June 12:00

Summer:

<u>22 December 09:00</u>

Azimuth: 93.4 °

Altitudes: 40.3 °

HSA: 73.4 °

VSA: 71.4

<u>22 December 17:00</u>

Azimuth: -97.3 °

Altitude: 33.9 °

HSA: -117.3 °

VSA: 124.2 °

Winter:

<u>22 June 12:00</u>

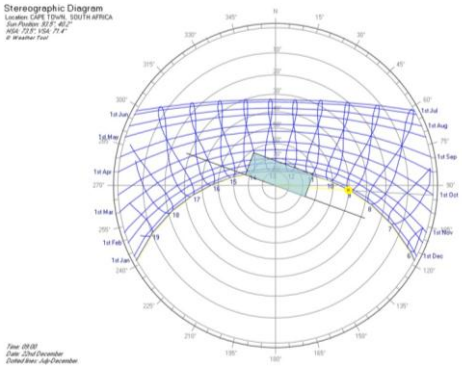
Azimuth: 13.0°

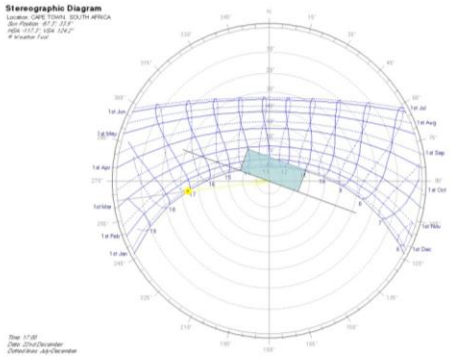
Altitude: 31.5 °

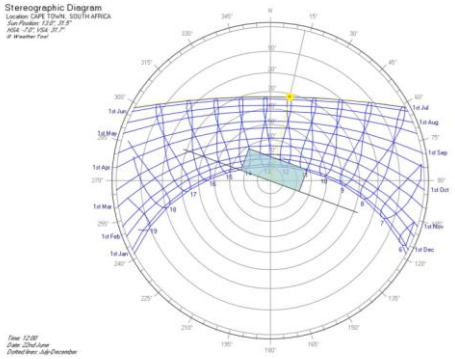
HSA: -7.0 °

VSA: 31.7°

The blue rectangle in the diagrams on the right signifies the building. Although the orientation of the rowhouse on the site is different, Ecotect always assumes that the length (longer side) instead of the breadth (shorter side) faces North.







Overhangs are needed over the stoep, balcony, roof garden entrance and light well. These are marked A, B, C, D. To calculate the length of the overhang, the VSA must be used. The VSA can only be used if the HSA is between –90° and 90 °.

Therefore the VSA of 09:00 summer and 12:00 winter is used.

height

Depth= tan (VSA)

2700

A: Ground floor stoep overhang (entrance glass door): tan(71.4) = 908.6 mm overhang

Existing overhang (roof)is sufficient as it is 2200mm

2700

B: Balcony overhang (glass sliding doors): tan(71.4) = 908.6mm overhang

The overhang made by the first floor is sufficient as a overhang as it is 2000mm. This will keep the harsh sun out.

2600

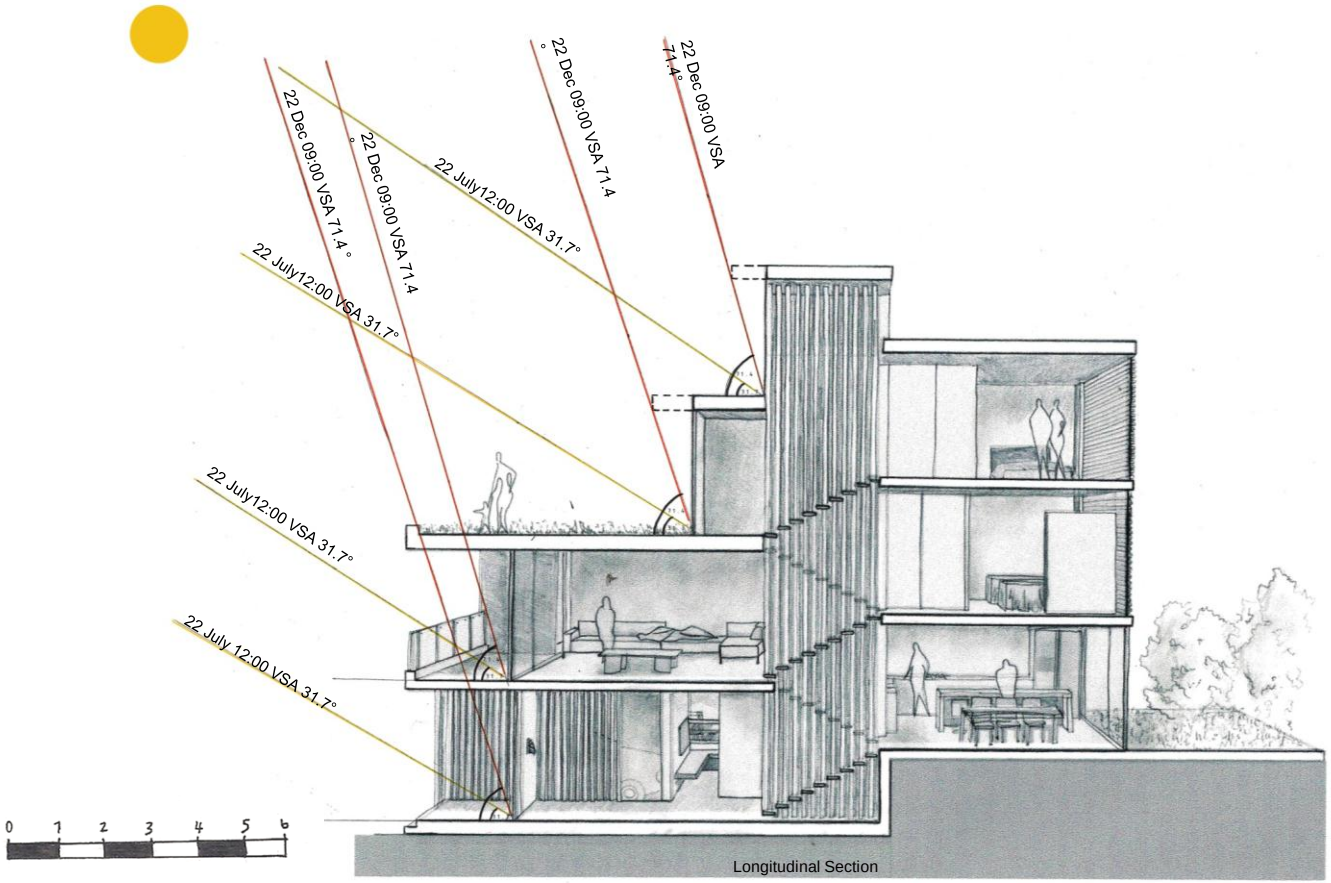
C: Roof garden entrance (glass sliding door): tan (71.4) = 874.99 mm overhang

I will make the overhang 900mm to be safe and to let no sun in

2400

D: Light tunnel (Glass window): tan (71.4) = 807.7 mm overhang

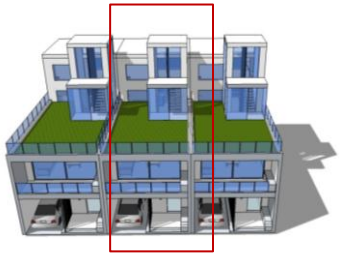
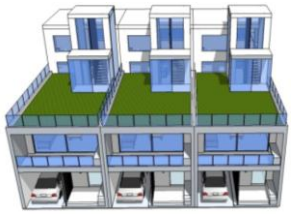
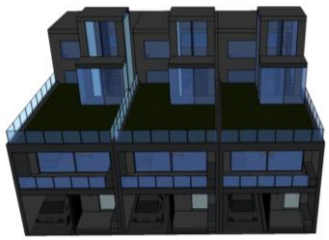
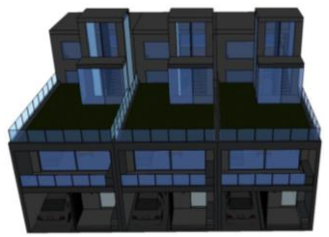
I will make the overhang 810mm to be safe and to let no sun in.



Longitudinal Section

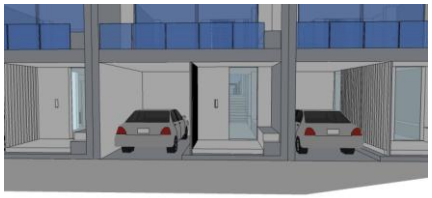
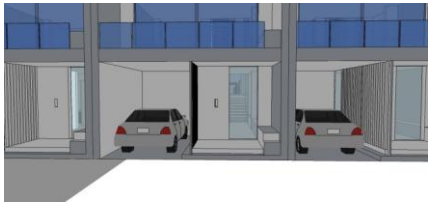
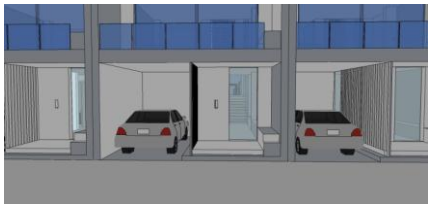
SHADOW ANALYSIS
North East Facade

The diagrams of the North East facade, indicate the suns penetration inside and outside the house in summer, autumn, winter and spring months. Overhangs are designed to keep the sun out in the winter, and to let the sun in in the summer. One can see the difference in shadows by looking at the diagrams of 12 noon in summer and winter.

	Summer – 12 December	Autumn – 12 March	Winter – 12 July	Spring – 12 September
9:00				
12:00				
15:00				
18:00				

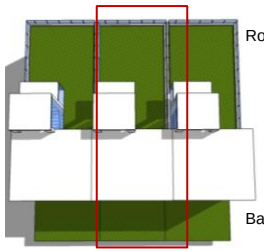
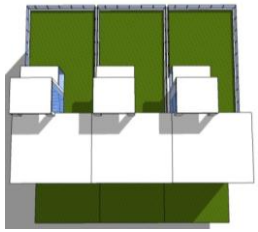
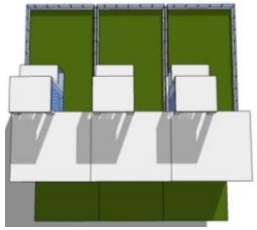
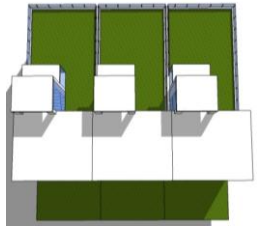
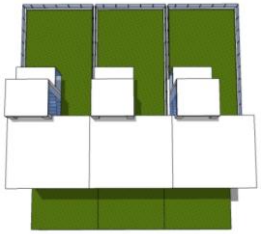
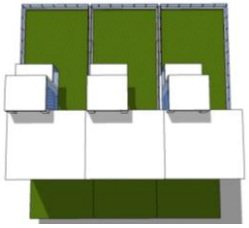
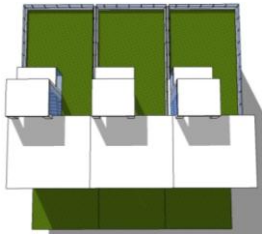
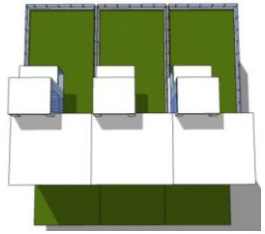
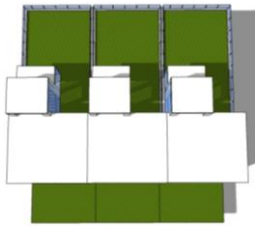
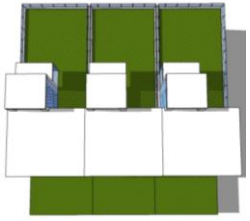
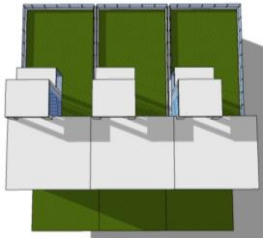
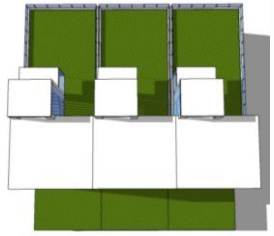
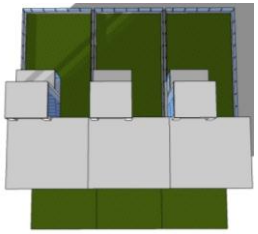
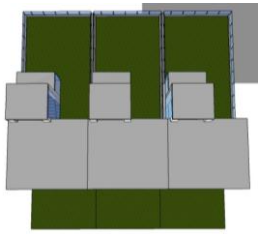
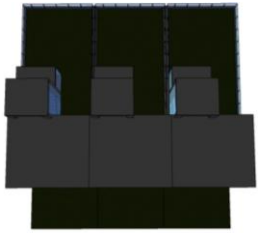
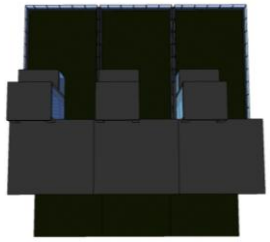
SHADOW ANALYSIS
North East Stoep

The diagrams on the right are a 3 dimensional analysis on eye level of the suns penetration on the stoep.
Once again one can see the sun entering the stoep area most of the year and less in the summer.
The stoep is seen all over South African architecture, especially in the Bo-Kaap. It has significant spatial and social qualities. It acts as a transitional space raised slightly above street level. By sitting on the street front, the streets are kept safe, and people can familiarize with their neigbours.

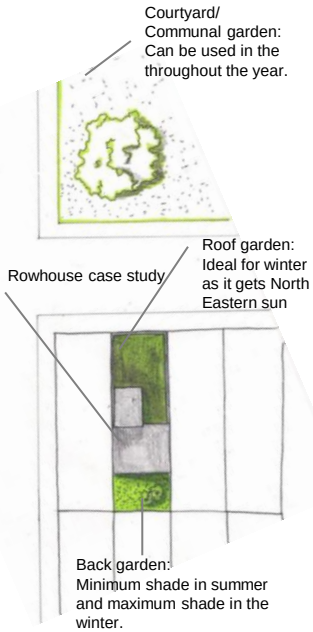
	Summer – 12 December	Autumn – 12 March	Winter – 12 July	Spring – 12 September
9:00				
12:00				
15:00				
18:00				

SHADOW ANALYSIS
South West garden

The diagrams of the South West garden indicate how the sun penetrates the garden. The back garden has shade in the morning all year, unlike the roof garden that has no shade in the morning. Notice that the back garden has minimum shade in the summer and maximum shade in the winter, This can be solved by using the roof garden in the winter, and the back garden in the summer. The sunny back garden in the summer is ideal to hang your washing but may be to hot for people to occupy. In the winter and summer people can also use the communal courtyard, with trees and open sunny areas.

	Summer – 12 December	Autumn – 12 March	Winter – 12 July	Spring – 12 September
9:00				
12:00				
15:00				
18:00				

Plan of rowhouse and courtyard



OPTIONS OF GETTING LIGHT IN THE GARDEN

Using a sloped roof insured of a flat roof does not add any sunlight to the garden. Figure 1 and 2 indicates the result of a sloped roof, and it is clear that it has no impact of the amount of shadow in the garden.

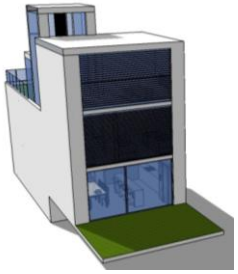


Figure 1

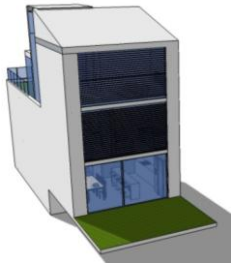


Figure 2

HORIZONTAL LOUVERS

A horizontal louver system can be used to let in sunlight in the winter, and keep out sunlight in the summer. These louvers are angled to let in sunlight, and also provides privacy to the occupants of the house. Thses louvers system can be manual, where you can controll the angle of the louvers itself, opening it up, or closing it completely. There would be a need for louvers on the North Eastern façade, but because on the large overhang above the balcony, there is no need for the louver system. The louver system is used in front of the windows of the children's bedrooms and main bedroom.

Figure 3 and 4 shows how a how a horizontal louver system is used to let in sunlight in the winter at noon. Horizontal louvers are angled to let in light and heat but is also to provide privacy to the occupants.

Figure 5 and 6 are at noon in the summer. This image shows that the louvers aren't needed in the summer because of the overhangs.

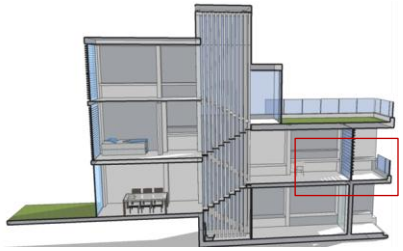


Figure 3 Winter noon

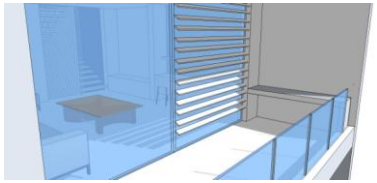


Figure 4

PASSIVE SOLAR HEATING ANF THERMAL MASS EFFECT

Double Glazing:

The windows on the North East façade are double glazed so that the building does not overheat in the summer. The South Western windows are also double gazed to prevent heat loss in the winter creating a comfortable environment inside the home. Double glazing also reduces noise that enters the house. This is ideal for urban dense houses such as rowhouses as they are built directly next to each other. and also to keep the heat in in the winter .

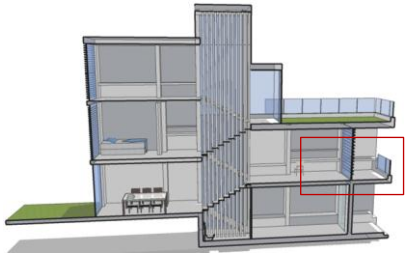


Figure 5 Summer noon

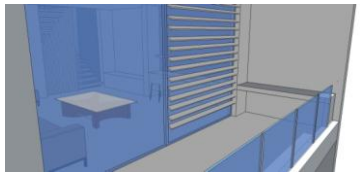


Figure 6

Insulation:

Insulation is used in roof and floors. The green roof acts as an insulated roof. Bricks and concrete is used and has a high thermal mass.

MULTIFUNCTIONAL LIGHT TUNNEL

Vertical glass members are used on either side of the staircase in the middle of the house. (Figure 7) This tunnel acts as a light well to bring light in to the middle and back of the house. This is also used as a ventilation system, where areas of the tunnel can open. The third aspect of this tunnel is to capture rainwater, and store it in a tank underneath the house.
The ventilation makes of the Venturi effect, North Eastern winter wind and South Western summer wind blows across the glass tunnels, pulling hot air out the house and cooling the air.

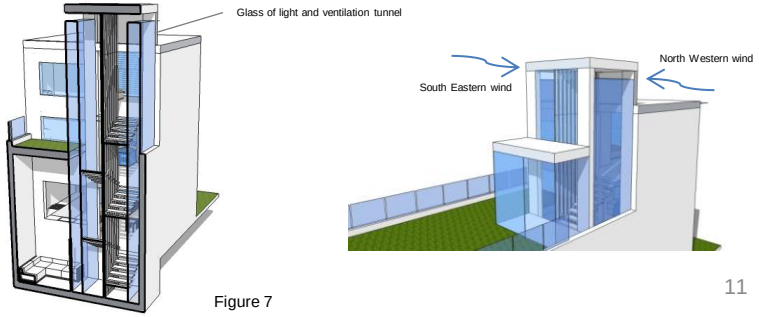
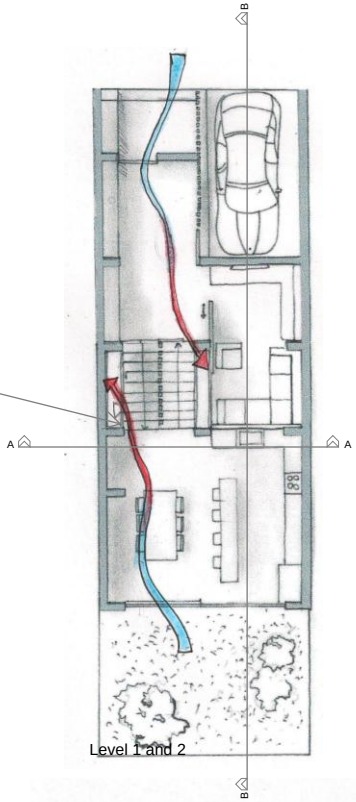


Figure 7

VENTILATION

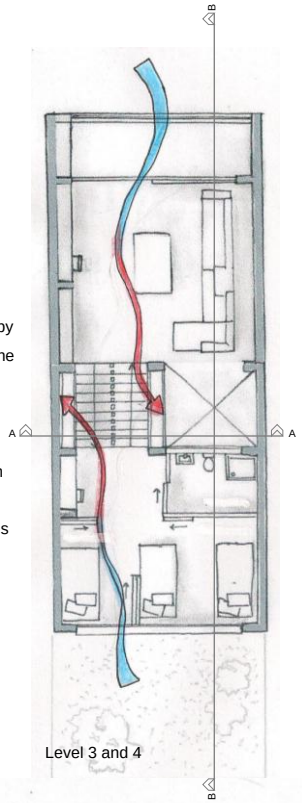
Main concerns:
1. Hot air rises
2. Let cool air ventilate through the building

A double volume space is found next to the staircase, and is ideal for the movement of cold air through the house, and the movement of hot air to move up and out through the ventilation tunnel.



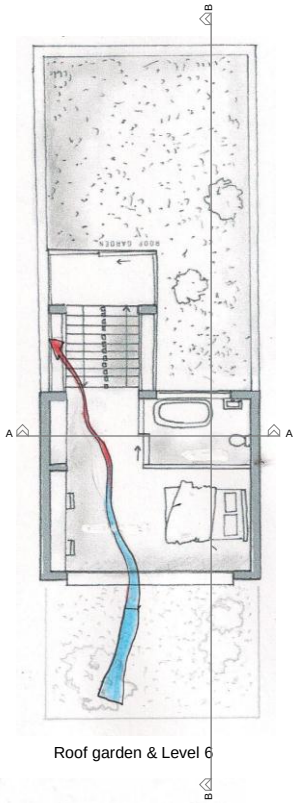
Level 1 and 2

Cross ventilation is possible by letting in air at the front and the back of the house through windows and sliding doors. Because of the row housing scheme, air can not flow from side to side because of the dense urban condition. That is why it is important to cross ventilate from front to back through the stairwell.



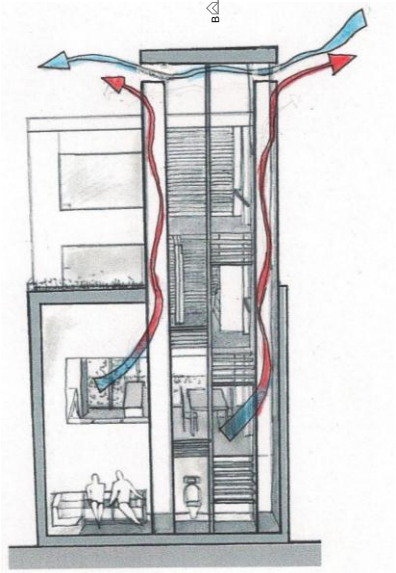
Level 3 and 4

The split level plans are ideal for ventilation as hot air can move up and out and cool fresh air can easily flow through the building.

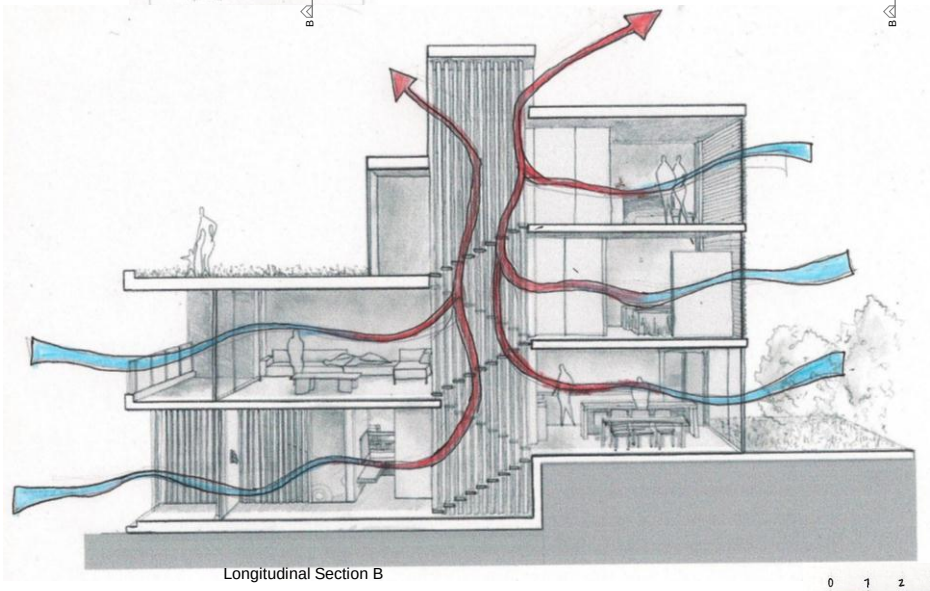


Roof garden & Level 6

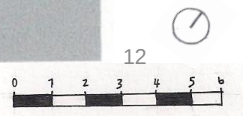
The central staircase moves air up and out through the glass tunnels. Because these tunnels are situated in the middle of the house, air can easily move out of the house in the summer and be kept inside the house in the winter. Windows can be opened in thie tunnel to control the ventilation throughout the house.



Transverse Section A



Longitudinal Section B



RAINWATER STUDY

NUMBER OF OCCUPANTS: 5 People

FACILITIES THAT NEED WATER:

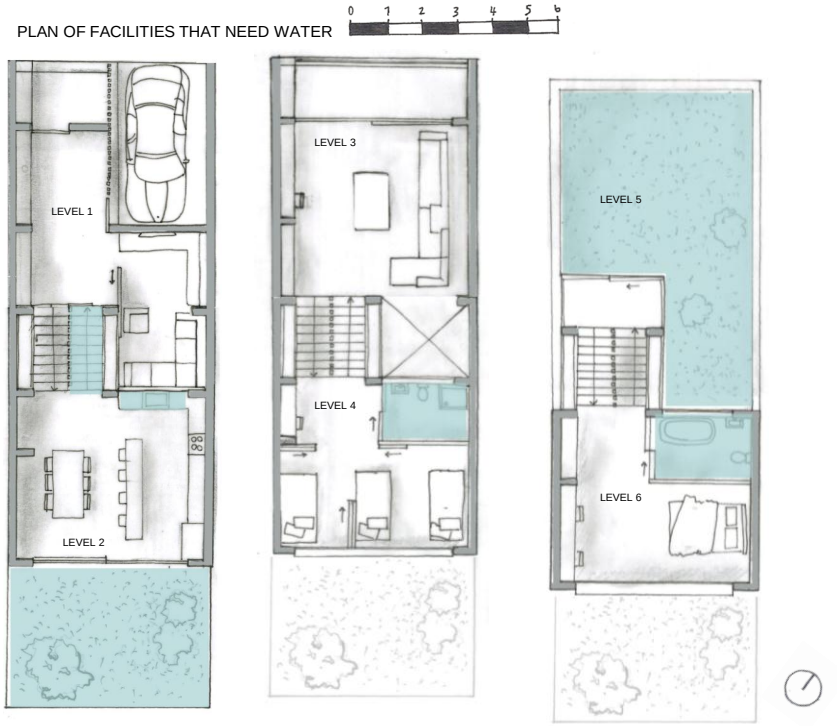
1. Kitchen: - Sink
   - Washing machine

2. Bathrooms: -1 Guest Toilet and WHB (under stairs)
   - 1 Bathroom with shower, toilet and WHB
   - 1 Bathroom with bath toilet and WHB

3. Garden: - Back South West Garden
   - Roof Garden

Rainwater is channeled off the roof through downpipes in the columns. They travel through these downpipes to the water tanks located underneath the ground in the back garden.

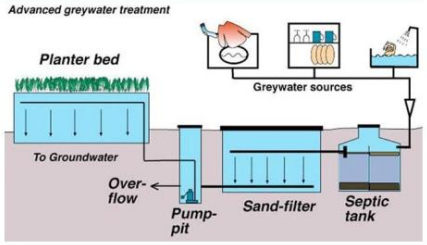
PLAN OF FACILITIES THAT NEED WATER



Rainwater calcs

Cape Town	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Rainfall mm	11	18	22	55	77	98	97	74	41	33	14	14	
Roof area m2(constant)	84	84	84	84	84	84	84	84	84	84	84	84	
Calculated potential water capture (litres)	924	1512	1848	4620	6468	8232	8142	6216	3444	2772	1176	1176	
Calculated actual capture (90%) (litres)	831.60	1360.80	1663.20	4158.00	5821.20	7408.80	7327.80	5594.40	3099.60	2494.80	1058.40	1058.40	**Annual total in litres=41877**
Calculated actual captured in m3	0.83	1.36	1.66	4.16	5.82	7.41	7.33	5.59	3.10	2.49	1.06	1.06	**Annual total in m3=41.9**

PRECEDENT STUDY GREYWATER SYSTEM:



Water Demand Calculations

	Flow/use rate	Time used	Total per use	Number of uses per day	Number of users	Total per day	Days per month	Total per month	Months per year	Total per year	Qty as M3	For greywater	Requires potable water (m3)	Non portable (m3)
Units		min	litres			litres	days	litres						
WHB (litres/min)	20	0.5	10	6	5	300	30	9000	12	108000	108	36	36	
Toilets (litres/flush)	6		6	4	5	120	30	3600	12	43200	43.2			43.2
Kitchen (litres/min)	20	1	20	5	1	100	30	3000	12	36000	36	36	36	
Irrigation (lumpsum)			500		1	0	30	2000	12	24000	24	24		24
Shower (litres/min)	10	7	70	1	4	280	30	8400	12	100800	100.8	100.8	100.8	
Bath (lumpsum)			100	1	1	100	30	3000	12	36000	36	36	36	
Washing machine (lumpsum)			45	2	1	90	30	2700	12	32400	32.4	32.4		32.4
Totals						990		31700		380400	380.4	265.2	208.8	99.6

RAINWATER STUDY

The month with the most rain is June and 7408.8 liters can be captured.

One 10000 liter concrete Underground Rainwater Tank is enough to capture all the rainwater.
Size of tank: Height- 2.7m
Diameter - 2.5m

This tank will be places underground in the garden.

Structure of the tank:
Precast concrete that is pre fabricated

Aesthetics:
The only part of the tank that is visible is a 600mm diameter manhole.

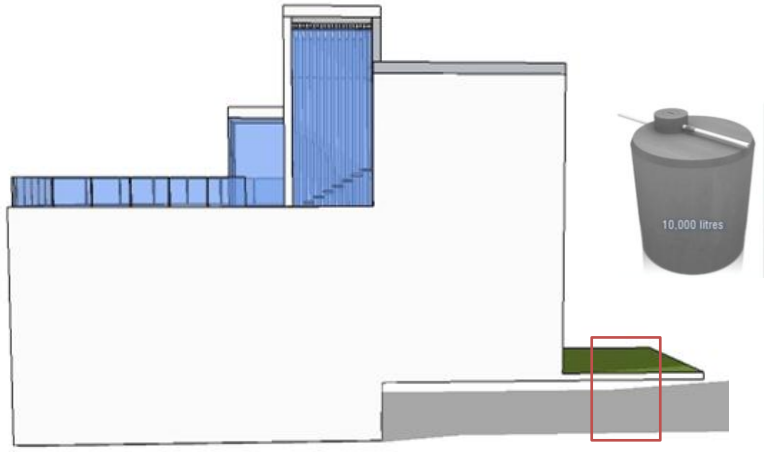
An other tank can be added for a greywater system.

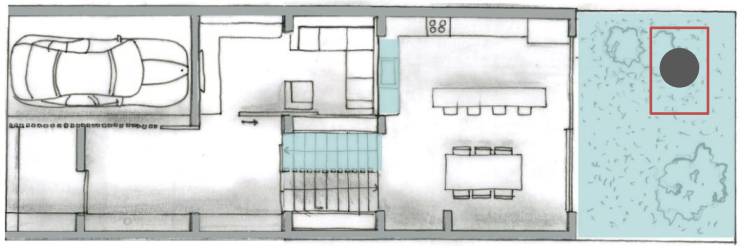
RAINWATERCALCULATIONS:

Water:
Total Water Consumption = 380400
Total water that can be used for greywater = 265.2
Total Captured Rainwater = 41877

Thus:
Total water consumption – total greywater –total rainwater = savings in liters
380400 – 265.2 – 41877 = 338257.8

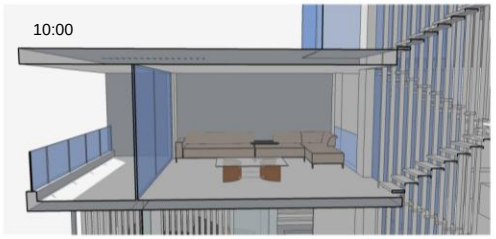
Total savings:
380400-338257.8 = R 42142.2

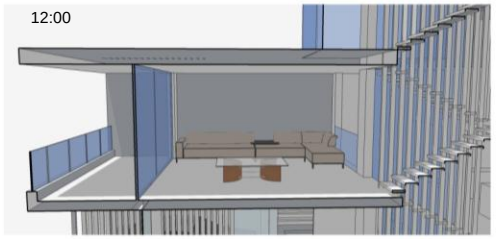


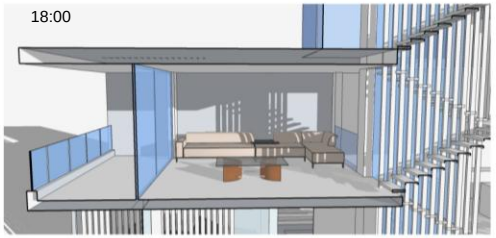


LIGHT STUDY
Living Room

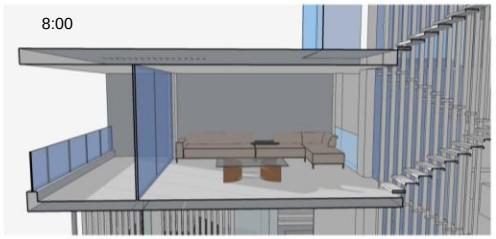
1 January (summer sun)

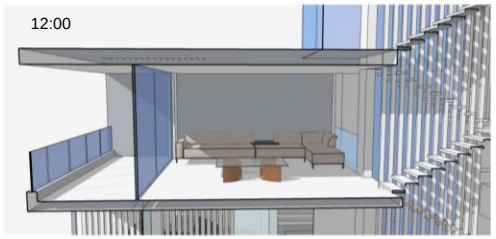


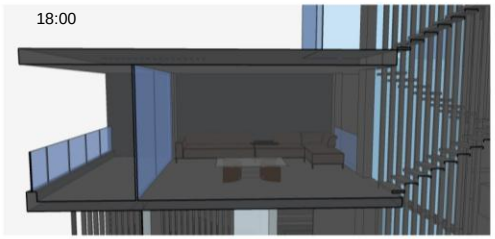




1 July (winter sun)







LIGHT STUDY

Figure 8 and 9 is a light study of the living space in winter and summer. Because the sun sets at different times, a unique ambiance is created in each.

Figure 8 shows a beautiful projection of shadows against the wall, imitating the timber slats of the stairs. Figure 9 shows the difference and contrast in light quality, being much darker that figure 8.

Precedent of row house design

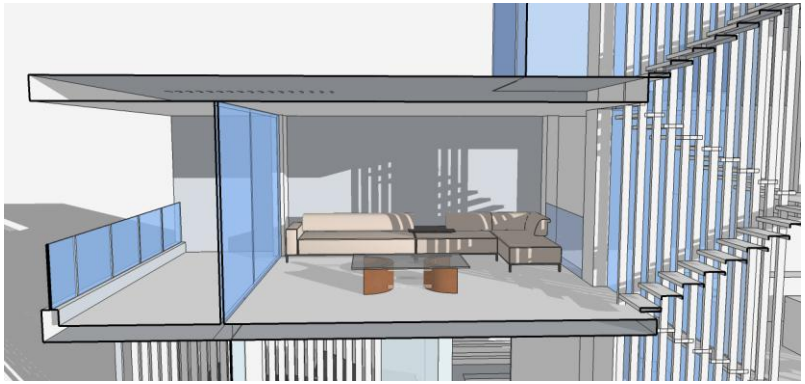


Figure 8 - January 18:00

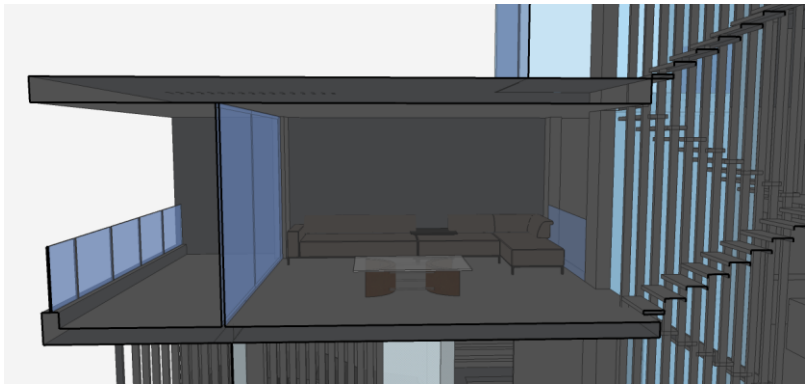
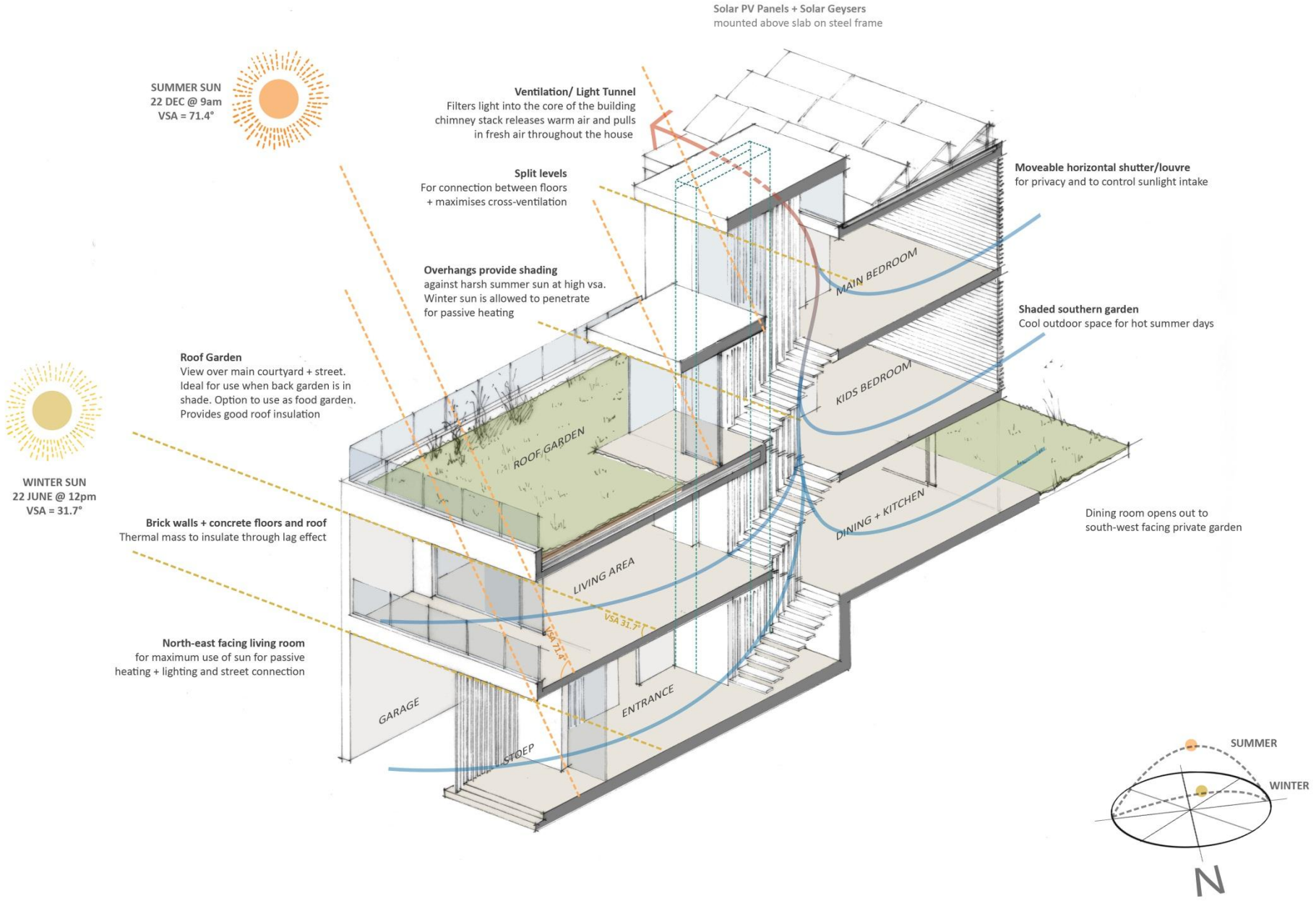


Figure 9 - July 18:00


Solar PV Panels + Solar Geysers
mounted above slab on steel frame
SUMMER SUN
22 DEC @ 9am
VSA = 71.4°
Ventilation/ Light Tunnel
Filters light into the core of the building
chimney stack releases warm air and pulls
in fresh air throughout the house
Split levels
For connection between floors
+ maximises cross-ventilation
Moveable horizontal shutter/louvre
for privacy and to control sunlight intake
Overhangs provide shading
against harsh summer sun at high vsa.
Winter sun is allowed to penetrate
for passive heating
MAIN BEDROOM
Shaded southern garden
Cool outdoor space for hot summer days
KIDS BEDROOM
Roof Garden
View over main courtyard + street.
Ideal for use when back garden is in
shade. Option to use as food garden.
Provides good roof insulation
ROOF GARDEN
DINING + KITCHEN
WINTER SUN
22 JUNE @ 12pm
VSA = 31.7°
Brick walls + concrete floors and roof
Thermal mass to insulate through lag effect
Dining room opens out to
south-west facing private garden
LIVING AREA
VSA 31.7°
VSA 71.4°
North-east facing living room
for maximum use of sun for passive
heating + lighting and street connection
GARAGE
ENTRANCE
STOEP
SUMMER
WINTER
N