Footprints

the building of a modern “mohalla”

a direction towards sustainable affordable housing

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Introduction

Group housing in India today is dominated by the real estate sector, rather than initiated by communities that want to live together. Living in communities that are secure, comfortable and affordable is what most people actually look for. Communities which will give them a sense of belonging and a place to put down roots, which have been lost in urban development.

The real estate response to the need for affordability has most often been to reduce the size and increase in the number of units to be built. The Floor Space Index is used as a magic number instead of a guideline, as intended. The result is that affordable housing has become a game of numbers; where the social, environmental and long term economic costs remain hidden-their impact not understood or anticipated.

One must question the quality of life as it is promoted and perceived in these environments. Spaces which do not relate to our culture and where water shortages, power cuts, and abysmal waste management are not unusual, as are uncomfortable living spaces that require artificial light and ventilation. Suicides, a high crime rate and lifestyle diseases are a growing reality here.

The environment is also a victim of this uncontrolled development. A depleting green cover, diminishing groundwater, and climate change are only the tip of the iceberg. While there is a growing awareness to conserve and care for the environment, this awareness has unfortunately been packaged into consumable "green" technologies, which have become marketing tools for developers, and solving problems that are created by the design rather than try to design appropriately.

►Does the diverse social, economic and cultural nature of our country not merit a befittingly rich response?

►Is the monoculture being promoted by most housing schemes of promising a "better" life, really suitable or a convenient camouflage to aid the numbers?

►Can design be a tool to create appropriate solutions, and respond to optimal numbers?

There is a need for architecture, to collaborate and make that difference, where decision making brings together all the stakeholders, from the architect, engineer, carpenter to the end user. Where it is not top down but shared and joint. This collaboration can illustrate that building sustainably, not only creates sensitive environments, but also makes business sense.

"Affordable housing is not about budget or substandard homes in isolated areas which compromise on connectivity, surrounding infrastructure, space, quality or facilities as required by the family. Affordable housing can be a vibrant community which enhances the quality of life, at a price point that is affordable by aspiring customers."

The Location and Context

Our project is located in Kengeri; a suburb of Bengaluru on the Bangalore Mysore road. Roughly 20 kms south-west of the city centre, it can be approached by two major roads: the Bangalore-Mysore highway (SH17) and the peripheral BMIC (Bangalore-Mysore Infrastructure Corridor) road.

It has a major bus station, a train station and the Metro line is expected to reach here. Essential services and amenities like educational institutions, health care centers, markets and entertainment are within reach comfortably.

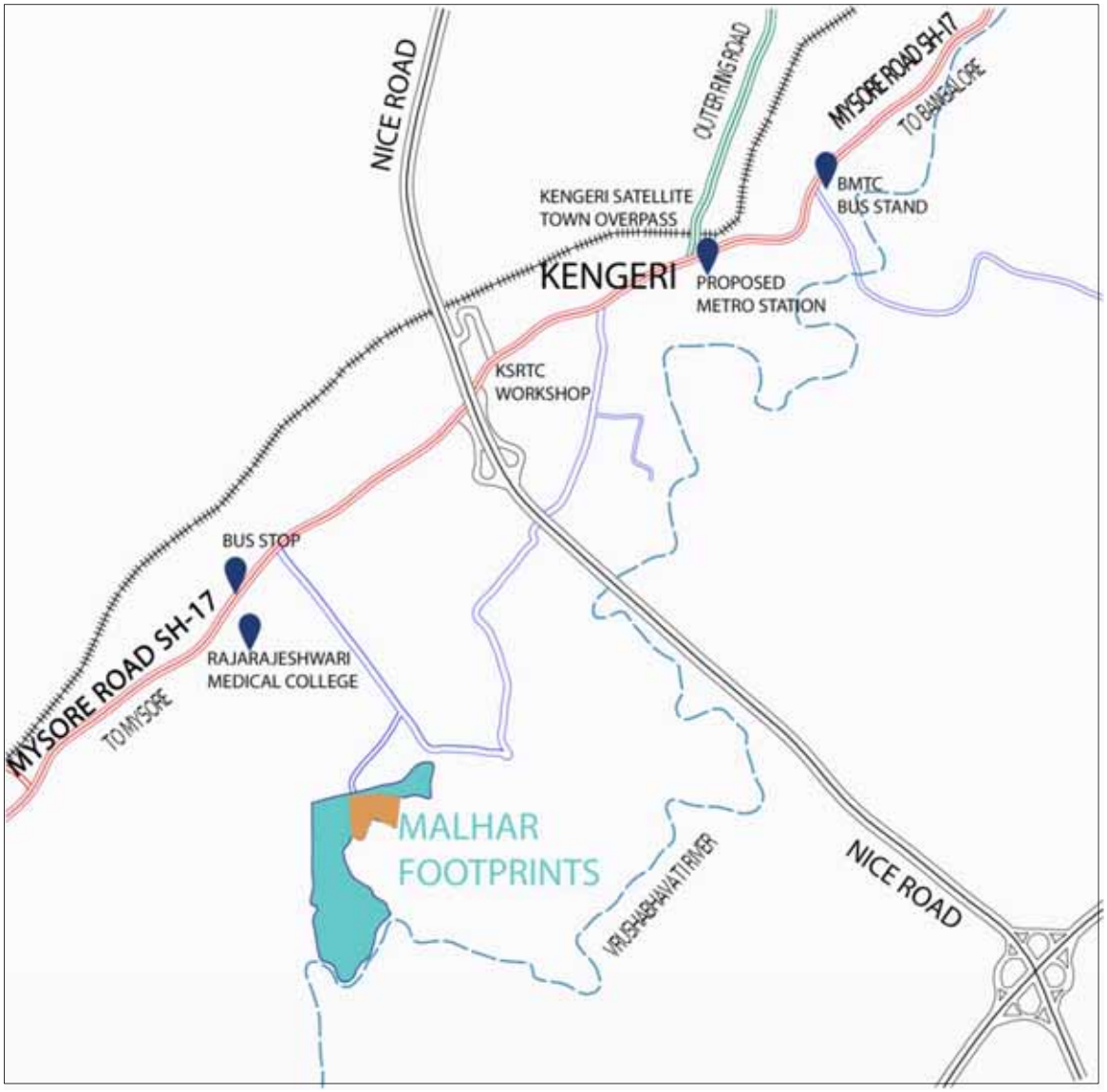
Cultural context: Kengeri is an old town, with a history from the time of the Cholas and Tipu Sultan. It was famous for sericulture and coconut farms. Unfortunately, not much remains of this rich past, and most of the town resembles any other small town turning into a suburb of a large city.

It is this anonymity that we feel should be countered with alternative developments, which will impart an identity to a place that responds to contemporary activities. Malls and high rise apartments are already taking over the landscape, lakes are being filled, and the old market may soon be taken over by the newest supermarket. Without romanticizing the older culture, one must admit that the smells, sights and sounds which they represent, should be replaced by equally sensuous and meaningful experiences.

Building and owning a house which is on an independent plot of land, is still an aspiration for many in Bengaluru. It is only in the last few years with the changing economy, that the option to build one's own home has become extremely difficult in terms of costs and availability. A culture of high rise apartments has taken over. Living in communities, has been a part of an older culture in Bangalore and there is a critical mass of people in the city looking for alternatives in housing. The cost of land on the outskirts is optimal and one gets true value for money, hence making the project affordable to a certain segment of users.

Location Map

Distances of infrastructure and amenities from the site	
Nearest Bus stop	1.8 Kms
Kengeri Bus Stand	4.3 Kms
Railway station	5.2 Kms
Proposed Metro station	5.0 Kms
Hospital	1.8 Kms
Restaurant	2.7 Kms
Primary School	3.2 Kms

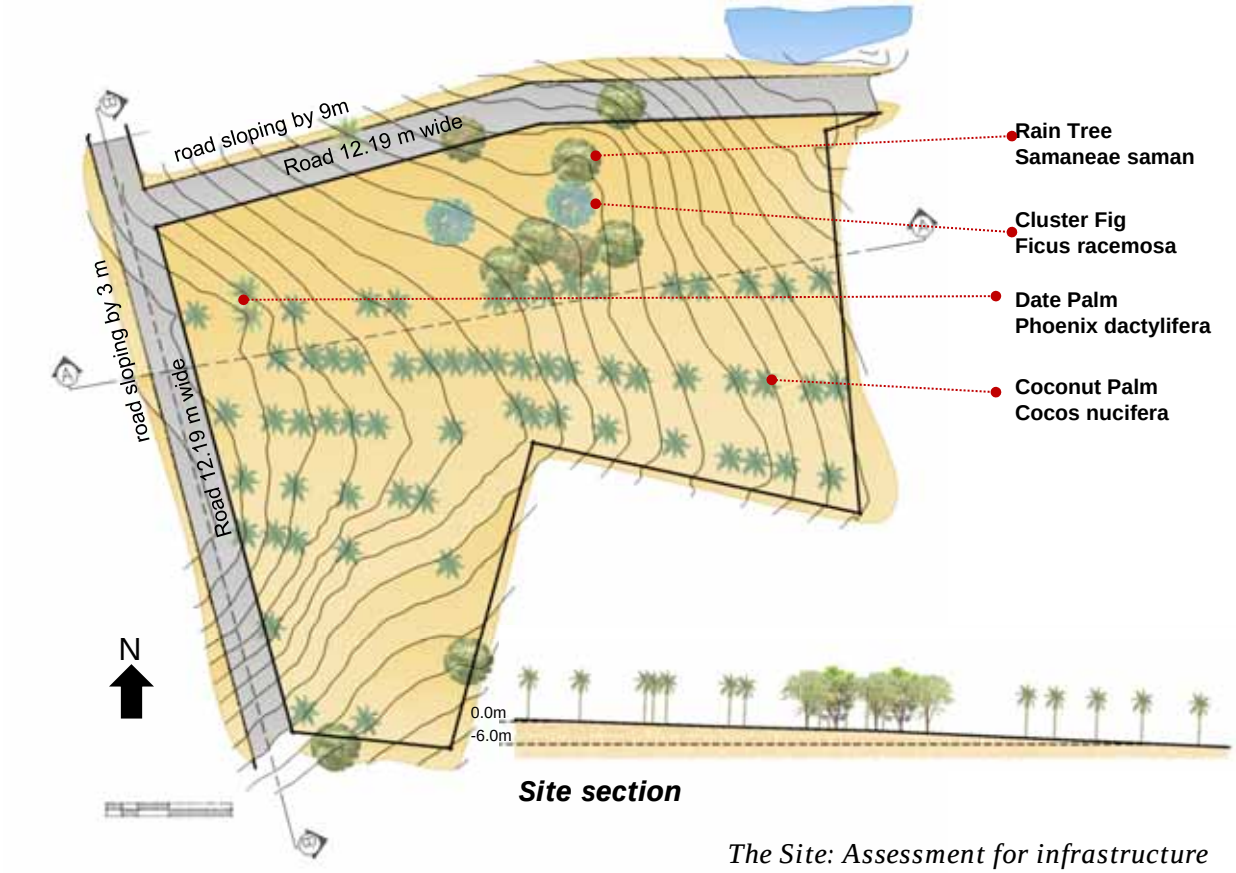


The Site: terrain and surroundings

- *Area: 28,121 sq.m. (7 acres)*
- *Surrounding: A newly developing residential area; the surrounding land parcels are large, mainly belonging to institutions.*
- *Terrain and orientation: The land is a hilly terrain and forms gentle hills and valleys. The natural water flow creates seasonal water bodies and channels, which drain into the nearby Vrishabhavati River. Our site has one such water body neighboring it on the north east corner and the river on the south. The L-shaped site is higher at the north west corner, and sloped towards the east and south, along the two arms of the L.*
- *The gradient along both the arms of the site had the potential for a stepped development.*

  This gradient created vistas of the as yet undeveloped surrounding.
- *Vegetation: A few trees; mainly coconut, date, teak and rain tree were scattered on the site.*

  This was used as a grazing ground for an old dairy farm.



Site section

The Site: Assessment for infrastructure

•A hydro-geological survey of the land indicated the underground aquifers and the zones suitable for recharging groundwater, as well as digging borewells.

•Transformers needed to be erected to draw power from the nearest Karnataka Electricity Board lines.

•Sewage had to be taken care of within the site itself.

•The soil was tested for its soil bearing capacity and was found suited for load-bearing construction.

The Project Brief and Objectives

•The site was to be developed as a community housing project, where the infrastructure and amenities were shared by the individual homes.
•The brief for the community was worked out balancing the aspirations of the users, the costs, the land, the environment, keeping the profits workable and emphasis being on the sufficiency of the design.
•The users were middle to upper middle class families, with compositions varying from nuclear families with young children to small joint families and retired couples who aspired to live in spaces where they could be connected to the land rather than an apartment - at a reasonable cost.
•Private land of 1200sq.ft. to 2000 sq.ft., along with homes which would measure 1500 sq.ft. to 2400 sq.ft., were found to be in the suitable range.
•60%of the land was to be demarcated as Private land, while 40% was shared land, that included amenities. A Floor area ratio of 0.75 was to be built up to make the project viable and affordable, considering the land costs and construction costs in the area at the time.
•The number of homes could vary from 90to 110, depending on the composition of units.

•The design had to encourage values of community living and spaces which enhanced this were desirable.

•The planning and landscape had to explore the potential of the natural terrain, orientation and microclimate.

•The project had to conserve and rejuvenate existing features like water bodies, streams, indigenous trees, bird and insect habitats, along with creating awareness about the importance of the environment.

• Water management and sewage treatment had to be integrated into the master plan.

•The architecture had to reflect a blend of the contemporary with the traditional.

•The scale had to respond to the human being and building low-rise was preferred over high-rise.

•The spaces within the homes had to be well lit, well ventilated and adaptive to the users'requirements.

•The choice of materials and techniques were to be based on the ease of sourcing, the ability
•of using them in their natural form and which used minimal energy in their production.

•Sustainability as a concept had to be reflected in all aspects of the design and not be treated as separate elements to be added on.

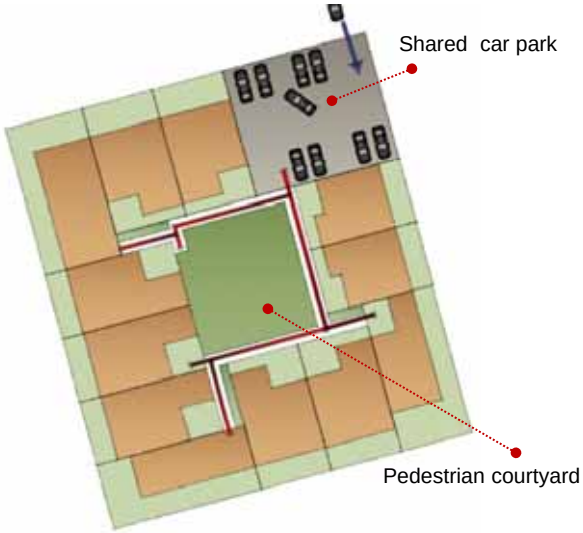
The Concept

The community of 96 homes evolved out of a process which explored the idea of an urban village. Was it possible to evoke the vernacular and the organic within an extremely structured requirement? Could one configure the arrangement of a 100 homes to feel spontaneous and yet organized?

Cluster planning with vehicular access

Row houses with off-street parking

	Private land dimensions		
	Private land Area	Dimension	
		width	length
1	1200	7.6m	15.3m
2	1500	7.6m	18.3m
3	1800	9.2m	18.3m
4	2000	10.15m	18.3m
5	2200	11.0m	21.3m



Cluster housing with shared car park

Cluster Planning

•Plot sizes measuring 1200sq.ft. to 2000 sq.ft, were configured with constant lengths and varying widths; to enable a variety of arrangements and house designs.

•The houses were designed to share common walls with a setback of 5m in the rear; keeping with the building bye laws.

•Multiple arrangements of plots as rows with off-street parking and in groups with car parking within the home were explored. These were either lacking in the desired character or did not match up to the required number.

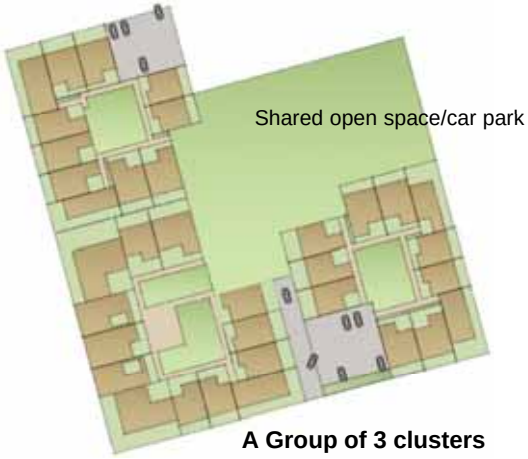
•Car parking in the ratio of 1.5 car parks per unit was designed for.

•9-16 houses in a group were considered optimal, in terms of interaction with immediate neighbors and as well as scale.

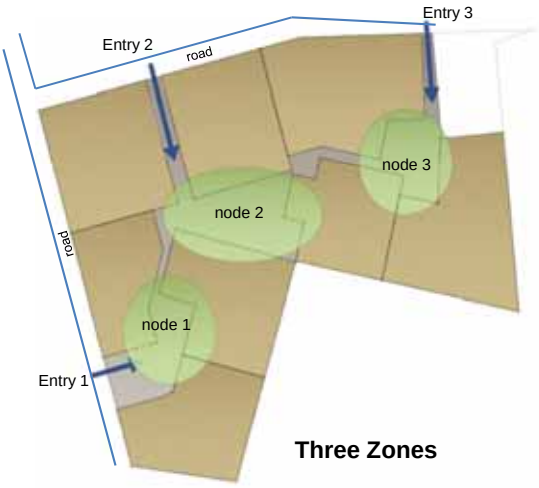
•The plots were small and an arrangement of this number was developed into a large courtyard that was shared by these units. The scale of the courtyard was not conducive to the car, as the open space would have shrunk due to the road width required for vehicular access.

•The cluster plan emerged as a pedestrian only space that was human in scale with a shared parking lot.

The Concept



A Group of 3 clusters



Three Zones

Zoning

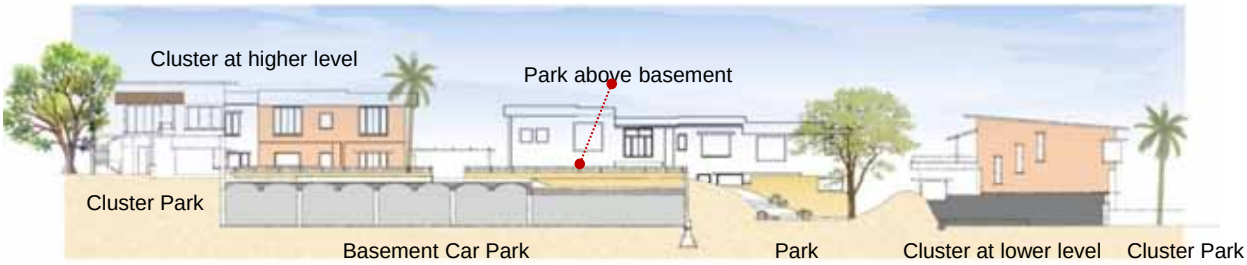
• *Groups of clusters shared a common car parking. This car parking occupied a very large area due to the number of cars that had to be accommodated.*

•*The site gradient made it possible to design the clusters at different levels. The car parks followed a stepped pattern where the basement roof could double up as a park for one cluster and parking for another.*

•*The site had roads on two sides which made the idea of the car parking on the periphery, convenient to implement.*

•*However, the required number of clusters did not fit along the periphery, so some vehicular roads had to be worked out into the layout.*

•*Three zones were designed, with groups of clusters working around three larger spaces (car park+terrace open space) These had three separate entries.*



Sustainability

•*The design of the basement car parks and various levels, generated a lot of excavated earth to be used for the production of Stabilised Soil cement blocks with which all the 96 units could be built.*

•*The basement top parks were planned to be planted, thereby reducing the heat emitted from the concrete slab and reducing the ambient temperature. Increasing the soft-scape and green cover to the maximum extent possible, also created a preferred microclimate.*

•*The scale of the cluster parks and the proximity of the buildings would shade most of the walls; reducing the heat absorption by the walls.*

•*Air corridors created in the transitions between clusters would draw breeze into the layout; keeping it well ventilated.*

•*The design followed the natural lay of the land, and percolation pits along the drainage path would reduce the run-off of rainwater, thereby increasing percolation.*

The Concept

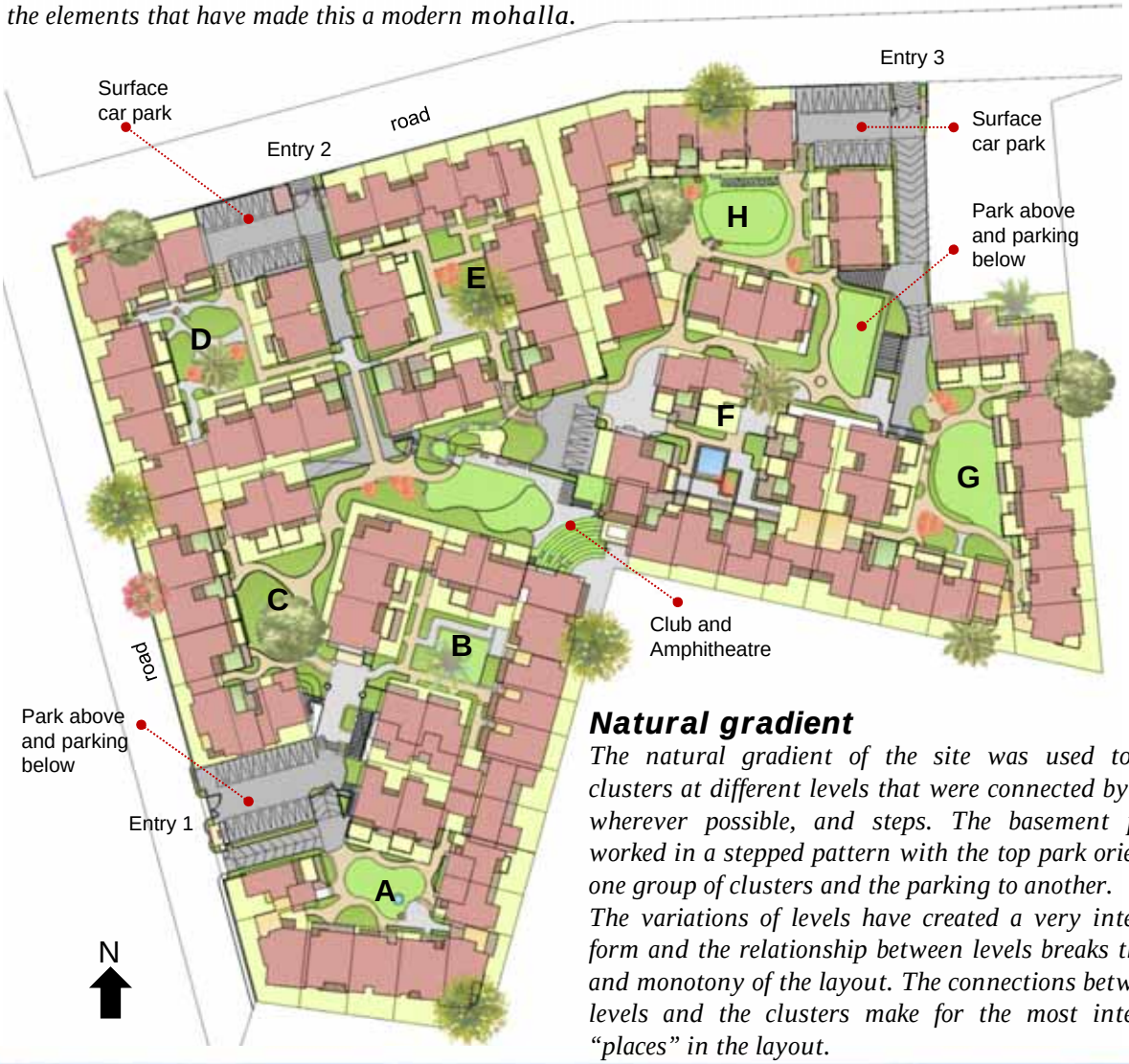
Aesthetics and craft

•The intention was to work with aesthetics that were honest in the expression of the materials and techniques used, along with blending traditional materials and craft with contemporary industrialized products as a reflection of our modern culture. The two need to evolve and innovate together, as newer patterns of living emerge and create a new language for aesthetics.

•Art and craft are to architecture what poetry is to literature. They are the finer nuances of the language that appeal to our emotions. There must be a conscious effort to integrate these crafts and involve the crafts-persons in the design and building process. Many details that are specific to the material and craft should be designed and implemented by the craftsperson. This also challenges the craft to engage with contemporary contexts and lets it evolve. Human resource takes a priority over material resource and care of the labor force is an important element in the building process.

The Layout Plan

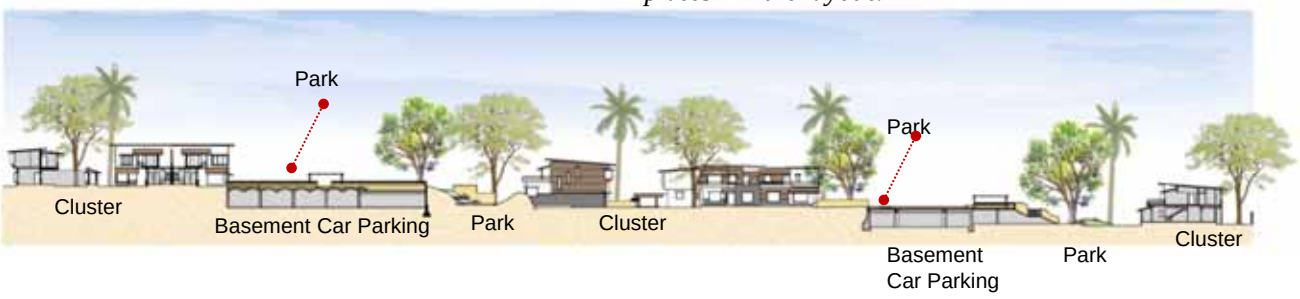
The 96 homes formed a composition of eight clusters and three large parks. A variety of spaces in the courtyards, streets and plazas have created an intimate and rich ambience. Children using the cluster parks to cycle, elders sunning themselves in the park and hands waving as you pass by some verandahs are all the elements that have made this a modern mohalla.



Natural gradient

The natural gradient of the site was used to create clusters at different levels that were connected by ramps, wherever possible, and steps. The basement parking worked in a stepped pattern with the top park oriented to one group of clusters and the parking to another.

The variations of levels have created a very interesting form and the relationship between levels breaks the scale and monotony of the layout. The connections between the levels and the clusters make for the most interesting "places" in the layout.

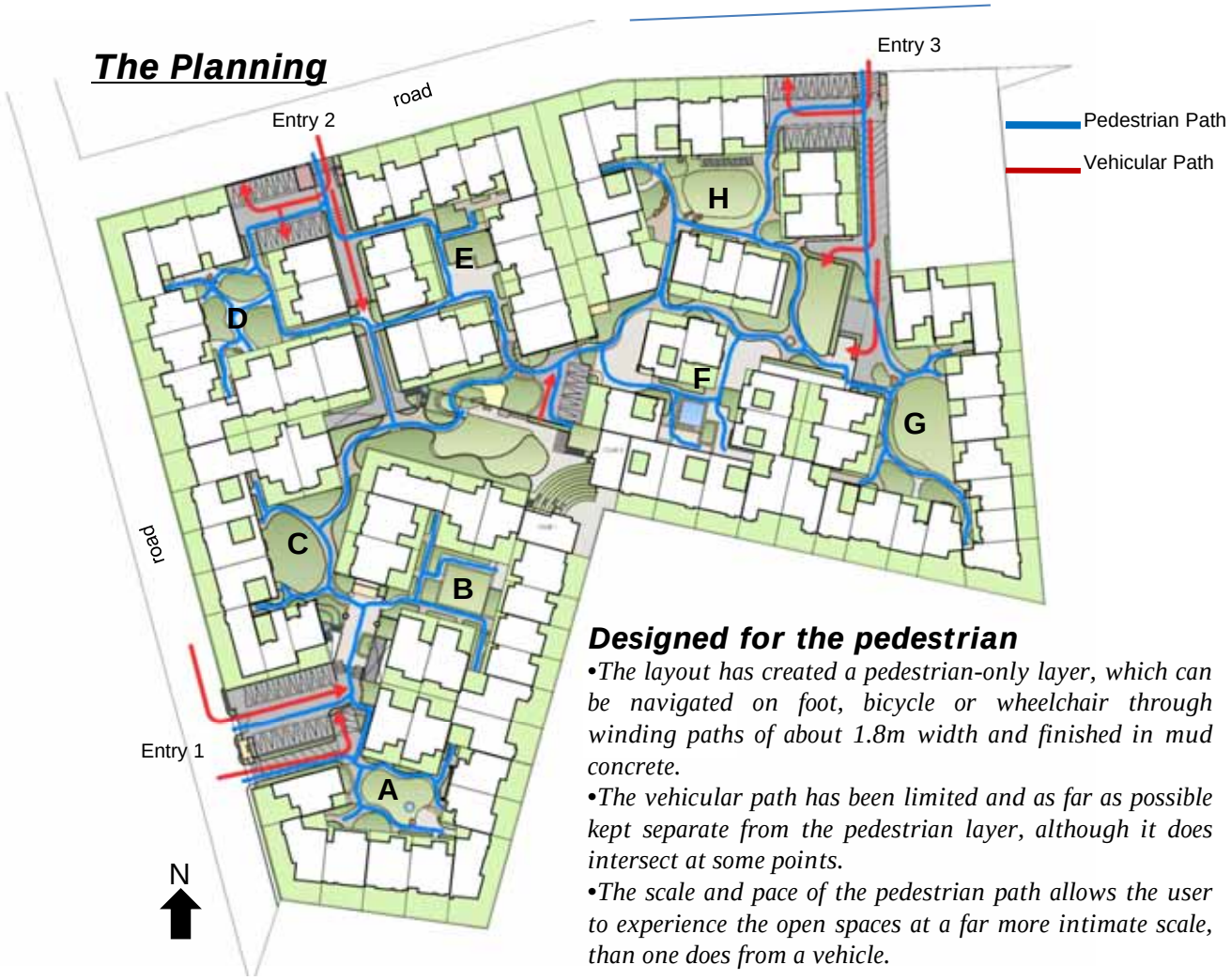


The Layout plan

Profile of Area distribution			
Item	area	unit	Percentage
Site Area	28121.5	sq.m	100%
Private land	16606	sq.m	59%
Shared land and amenities	11515.5	sq.m	41%
Built up area	20328.6	sq.m	72%

Cost of Units in 2011				
	Land Area	Built up area	Car park cost	Cost of unit
1	112 sq. m	140 sq.m	Rs 3.0 lakhs	Rs 55 lakhs
2	140 sq.m	168 sq. m	Rs 3.0 lakhs	Rs 61lakhs
3	168 sq.m	185 sq.m	Rs 3.0 lakhs	Rs 71lakhs
4	185 sq m	220 sq.m	Rs 3.0 lakhs	Rs 80 lakhs
5	205 sq.m	220 sq.m	Rs 3.0 lakhs	Rs 85 lakhs

The Planning



Designed for the pedestrian

•The layout has created a pedestrian-only layer, which can be navigated on foot, bicycle or wheelchair through winding paths of about 1.8m width and finished in mud concrete.

•The vehicular path has been limited and as far as possible kept separate from the pedestrian layer, although it does intersect at some points.

•The scale and pace of the pedestrian path allows the user to experience the open spaces at a far more intimate scale, than one does from a vehicle.

Microclimate

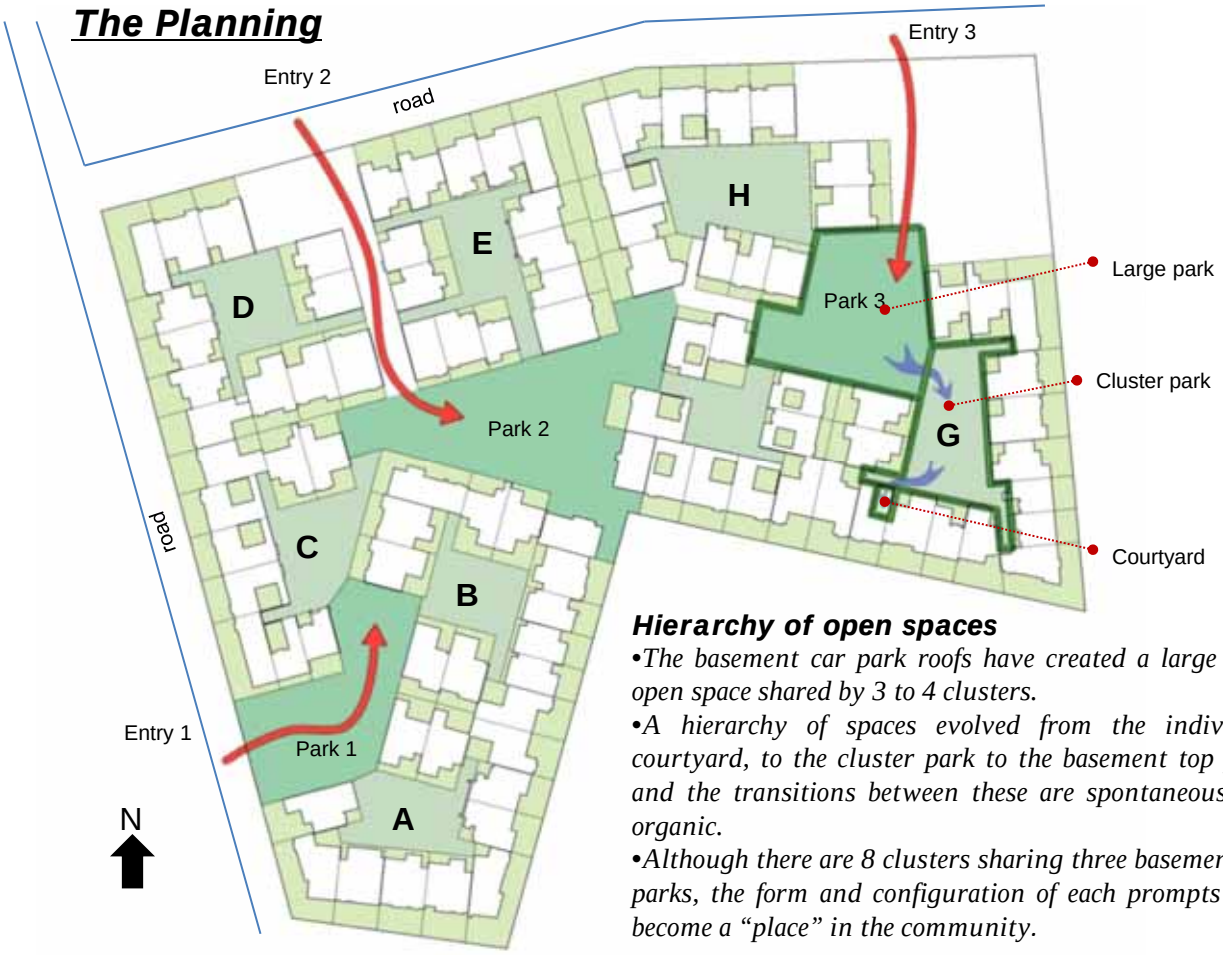
•The total open space in the Project is 60% of which the Basement top parks comprise 13%.

•The basement top parks are planted, thereby reducing the heat emitted from the concrete slabs.

•Increasing the soft-scape and green cover to the maximum extent possible reduces the heat island effect.

	Percentage of open space on the site		
		Area	unit
1	Site Area	28121.5	sq.m.
2	Building Footprint	9902.75	sq.m.
3	Car Parking Area (surface and basement)	3151.46	sq.m.
4	Car parking roof as open space	2078.6	sq.m.
5	Total open space (1-(2+3)+4)	17145.89	sq.m.
6	Total percentage of open space	60%	

The Planning



Hierarchy of open spaces

•The basement car park roofs have created a large scale open space shared by 3 to 4 clusters.

•A hierarchy of spaces evolved from the individual courtyard, to the cluster park to the basement top park, and the transitions between these are spontaneous and organic.

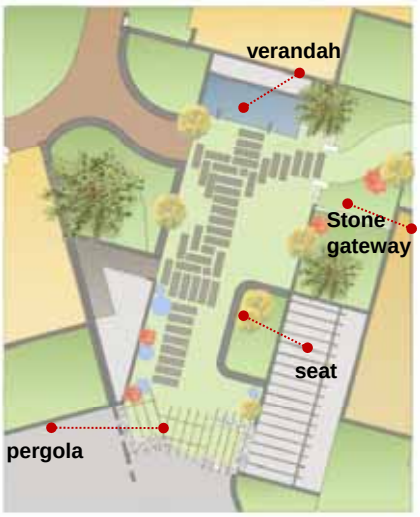
•Although there are 8 clusters sharing three basement car parks, the form and configuration of each prompts it to become a "place" in the community.

The Planning

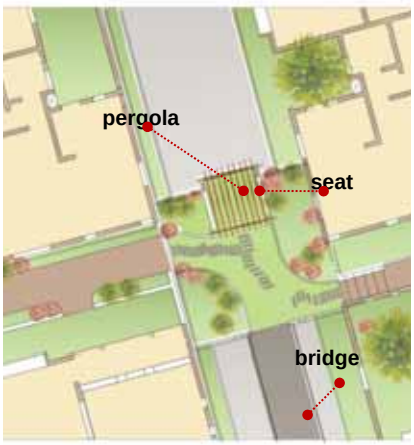
Place-making

•"Place making" in the scale of the community was important in order to to create an identity and sense of belonging to each space.

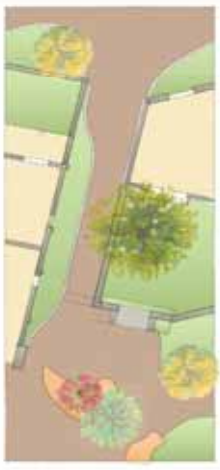
•The places in the layout respond to community activity and interaction. The variation of colour, texture and scale in the material and the planting, make each place a memorable one.



Plaza at Entry 1 of the layout

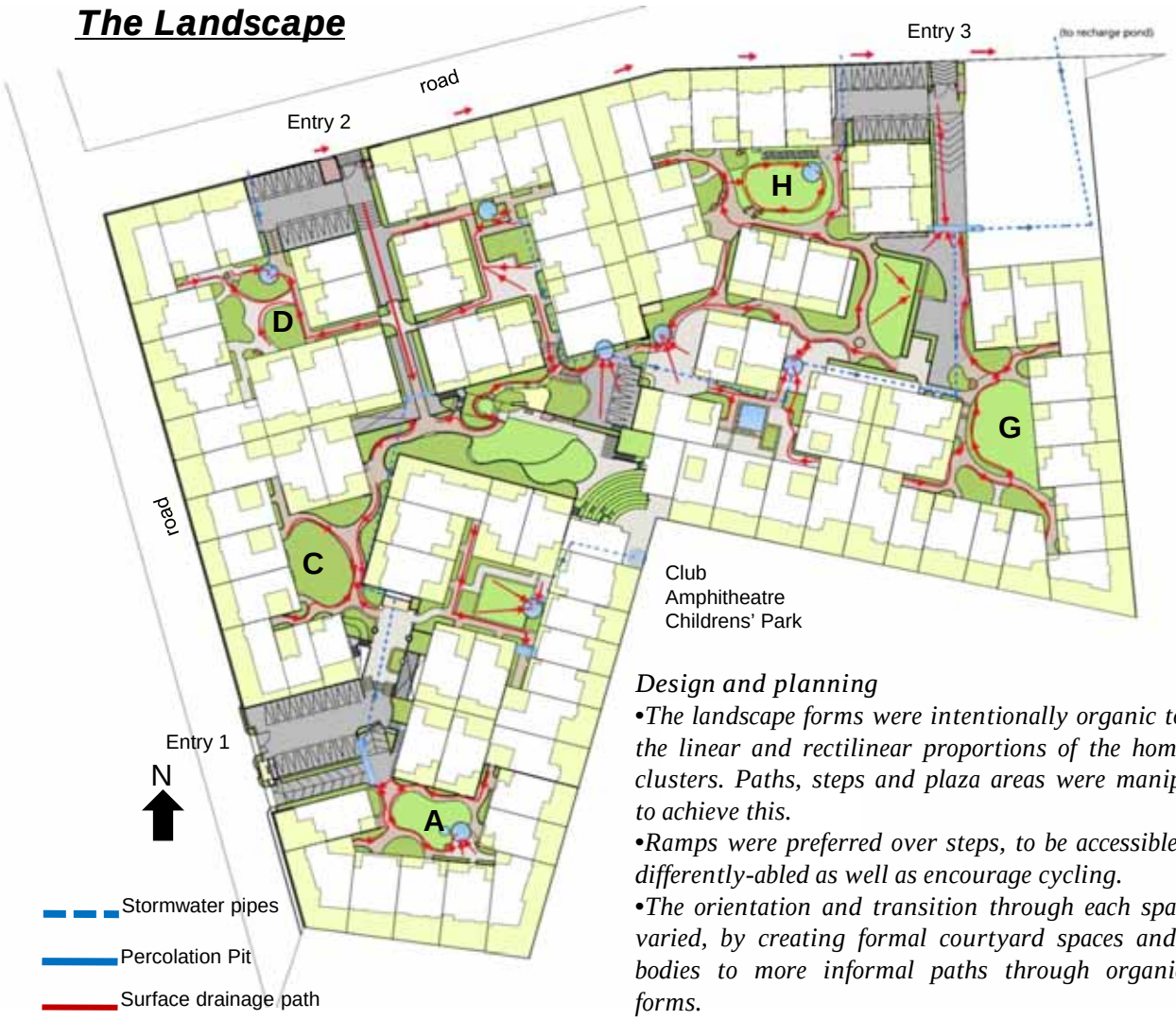


Pavilion at the junction of Clusters D and E



Street

The Landscape



Design and planning

•The landscape forms were intentionally organic to break the linear and rectilinear proportions of the homes and clusters. Paths, steps and plaza areas were manipulated to achieve this.

•Ramps were preferred over steps, to be accessible to the differently-abled as well as encourage cycling.

•The orientation and transition through each space was varied, by creating formal courtyard spaces and water bodies to more informal paths through organic land forms.

•Creating a sense of identity for each space, either through features in the form or through the planting, was an important aspect of the landscape design.

•The surface drainage and percolation pits were integrated into the plan.

•The hard surfaces were kept to a minimum and soft surfaces maximized.

•Service structures like tanks were built under existing hard surfaces; freeing up green spaces for tree planting.

•The large parks atop concrete slabs were waterproofed and planted; reducing the heat emission from the slabs.

The Landscape

Detail

•Structures in the landscape like pergolas and verandahs were designed to overlook the large spaces and at transitions.
•The pedestrian pathways were finished with a mud concrete - a combination of local mud, surkhi, cement, sand and aggregate. The length was broken with strips of local stone and a drainage detail was also integrated into the pathway.
•Cement urns were used to collect and direct rainwater to percolation pits, as well as used on top of slabs to plant small trees.
•Local granite stone wasused for steps and some walls.
•Cuddapah stone slabs wereused with grass joints as pathways.

The Landscape

Planting

•The planting plan was an extension of the architectural plan. The forms and behavior of the trees and plants created spaces in the landscape. The positioning of trees, was used as a focal point in a space, as a screen, as a composition in the transition through the cluster, and went towards creating a different dimension. One that was more dynamic, with seasonal variations of flowers and fragrance, daily variations of birds and insects - an ever evolving, somewhat unpredictable form.

•The landscape created thematic landscapes of fruit trees, culinary herbs and trees, a vegetable garden, bird and butterfly host species, plants and trees of medicinal value and traditional species; reflecting sometimes forgotten cultural values.

•Interactive planting, where children pick berries and climb trees, flowers plucked for rituals and herbs, fruits and vegetables shared by the community - A platform for community building.

•The emphasis was on native species and creating biodiversity within the layout.

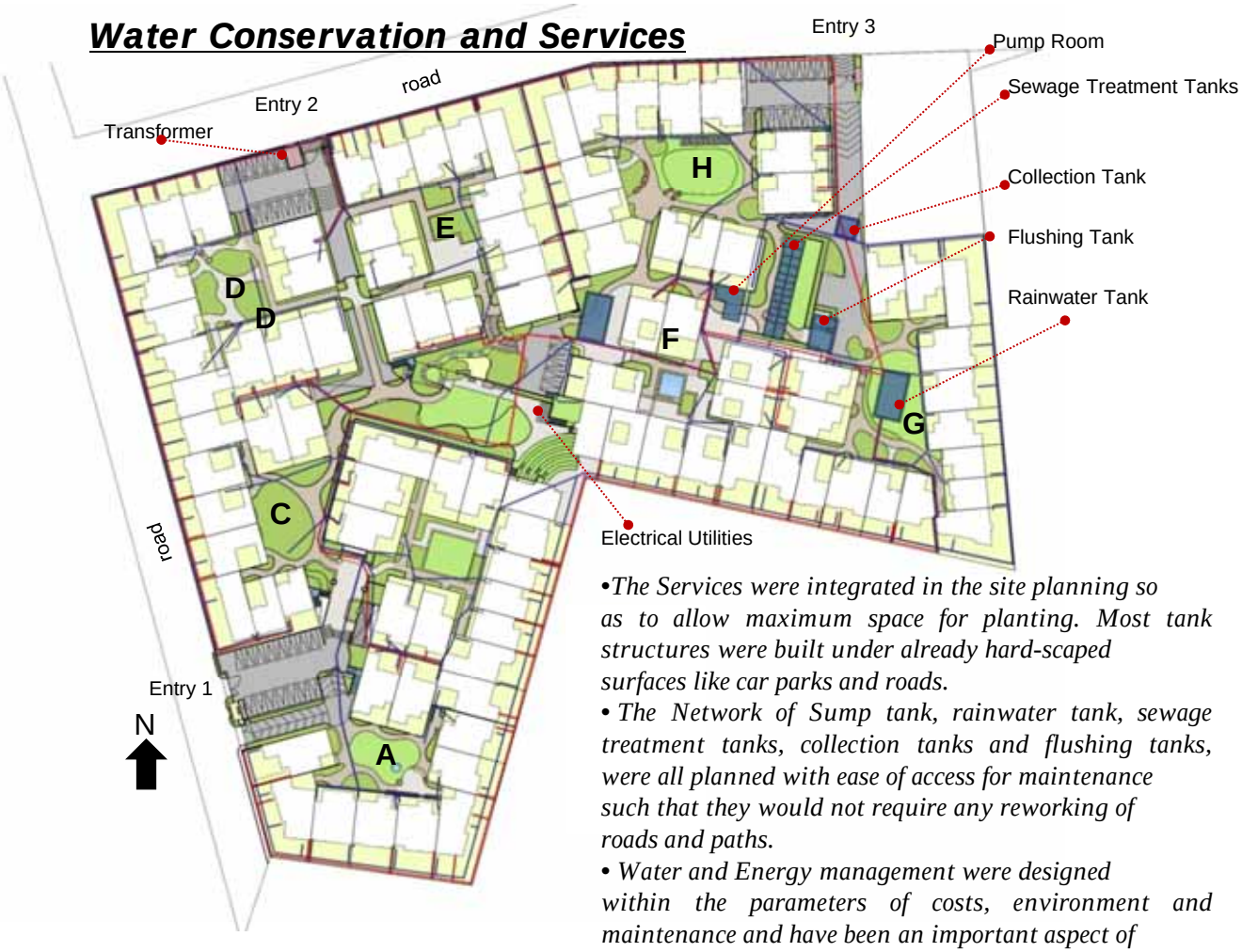
Percentage of hard and soft surfaces			
	Area	unit	Percentage
Site Area	28121	sq.m.	100%
Building Footprint	9902	sq.m.	35%
Car parking, roads and mud concrete paths	4778	sq.m.	17%
Planted area on ground	3920	sq.m.	15%
Private gardens	6819	sq.m.	33%
Total soft-scape area (33+15)	10739	sq.m	48%

The Landscape

Tree list: A list of some of the tree species planted at footprints

No	Tree	Botanical name
1	Neem	Azadirachta indica
2	Blackboard tree, Indian devil tree,Saptaparni	Alstonia scholaris
3	Soursop	Annona muricata
4	Coralwood, Red beadtree,Manchadi(malyalam)	Adenanthera pavonina
5	Jackfruit	Artocarpus heterophyllus
6	Carambola, Starfruit	Averrhoa carambola
7	Yellow orchid tree	Bauhinia tomentosa
8	Orchid tree/buterfly tree/hong kong orchid (kachnar:hindi)	Bauhinia variegata/purpurea / blakeana
9	Scarlet Flame Bean, West Indian Mountain Rose	Brownea coccinea
10	Sultan Champa,balltree, Indian-laurel	Calophyllum inophyllum
11	Amaltas, Golden shower tree, Indian Laburnum	Cassia fistula
12	Apurva champaka (kannada), Ylang Ylang	Cananga odorata
13	Cannon Ball Tree, Nagalinga(hindi)	Couroupita guianensis
14	Colville's Glory	Colvillea racemosa
15	Gulmohar	Delonix regia
16	Elephant apple	Dillenia indica
17	Peepal tree, bodhi tree	Ficus religiosa
18	Tree of life, Lignum Vitae	Guaiacum officinale
19	Snapdragon, Gamhar(hindi)	Gmelina arborea
20	Kokam, Goa butter tree, Mangosteen	Garcinia indica
21	Indian Elm	Holoptelea integrifolia
22	Jacaranda	Jacaranda mimosifolia
23	Guest tree	Kleinhovia hospita
24	Sausage Tree	Kigelia africana
25	Queen of flowers, Rose of india,Crape myrtle	Lagerstroemia speciosa
26	Mango	Mangifera indica
27	Markhamia, Siala	Markhamia lutea
28	Cork tree	Millingtonia hortensis
29	Spanish cherry	Mimusops elengi
30	Champak	Michelia champaca
31	Mahua, Indian Butter Tree	Madhuca indica
32	Horseradish tree,Drumstick tree	Moringa oleifera
33	Kadam	Neolamarckia cadamba
34	Avocado	Persia americana
35	Badminton Ball Tree	Parkia biglandulosa
36	All spice	Pimenta dioica
37	Buddha Coconut	Pterygota alata
38	Guava	Psidium guajava
39	Putranjiva, Lucky Bean Tree	Putranjiva roxburghii
40	Gooseberry tree	Phyllanthus acidus
41	Frangipani	Plumeria alba/rubra
42	Asoka Tree	Saraca indica
43	Sandalwood	Santalum album
44	agati or hummingbird tree/scarlet wisteria	Sesbania grandiflora
45	African tulip tree	Spathodea campanulata
46	Malay apple	Syzygium malaccense
47	Wild Mango,Indian hog plum, Amate(kannada)	Spondias pinnata
48	Paradise Tree, Aceituno, and Bitterwood	Simarouba glauca
49	Reetha, Chinese Soapberry, Soapnut	Sapindus mukorossi
50	Portia tree	Thespesia populnea
51	Arjuna tree	Terminalia arjun
52	Pink trumpet tree	Tabebuia avellanedae
53	Rosy trumpet tree, Basant rani	Tabebuia rosea
54	White trumpet tree	Tabebuia pallida
55	Chaste tree	Vitex altissima
56	Doodhi, sweet indrajau	Wrightia tinctoria

Water Conservation and Services



•The Services were integrated in the site planning so as to allow maximum space for planting. Most tank structures were built under already hard-scaped surfaces like car parks and roads.

• The Network of Sump tank, rainwater tank, sewage treatment tanks, collection tanks and flushing tanks, were all planned with ease of access for maintenance such that they would not require any reworking of roads and paths.

• Water and Energy management were designed within the parameters of costs, environment and maintenance and have been an important aspect of the design of the community.

Water supply and Rainwater harvesting

•The main sources of water supply on the site were two borewells and rainwater.

•The borewell water was hard and needed treatment. A treatment plant was situated in one of the basements, and the water was treated through a filtering and softening process and pumped to the homes through a hydro-pneumatic pressure pump.

•The rainwater was collected from all the roofs through a system of gutters and pipes and fed by gravity into a rainwater tank. It was pumped to the homes, through the same system.

•Keeping in mind the annual rainfall pattern of Bangalore, the size of the tank was optimised. The usage of water from the rains reduced the dependency on sources like municipal water and bore wells.

•Water efficient low flow plumbing and sanitary fixtures were used

Sewage treatment

•The sewage was collected through a network of PVC pipes and fed into a treatment plant located under one of the basements.

•The wastewater stream was conveyed to a DEWATS (Decentralized waste water treatment System) unit.

•The fundamental criteria for choosing the DEWATS was that it was an environment friendly and low maintenance waste water treatment option for treating the domestic black and grey water. The system was not dependant on electricity for its treatment and its installation cost was comparable to a conventional STP. The treated effluent conformed to the KPSCB norms and was utilized for secondary use like toilet flushing and irrigation of the landscape.

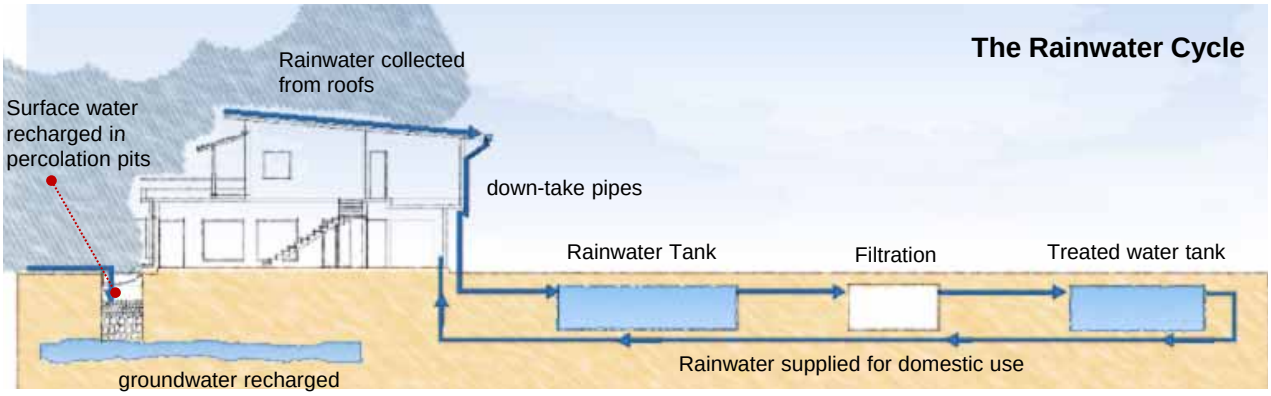
Water recycling

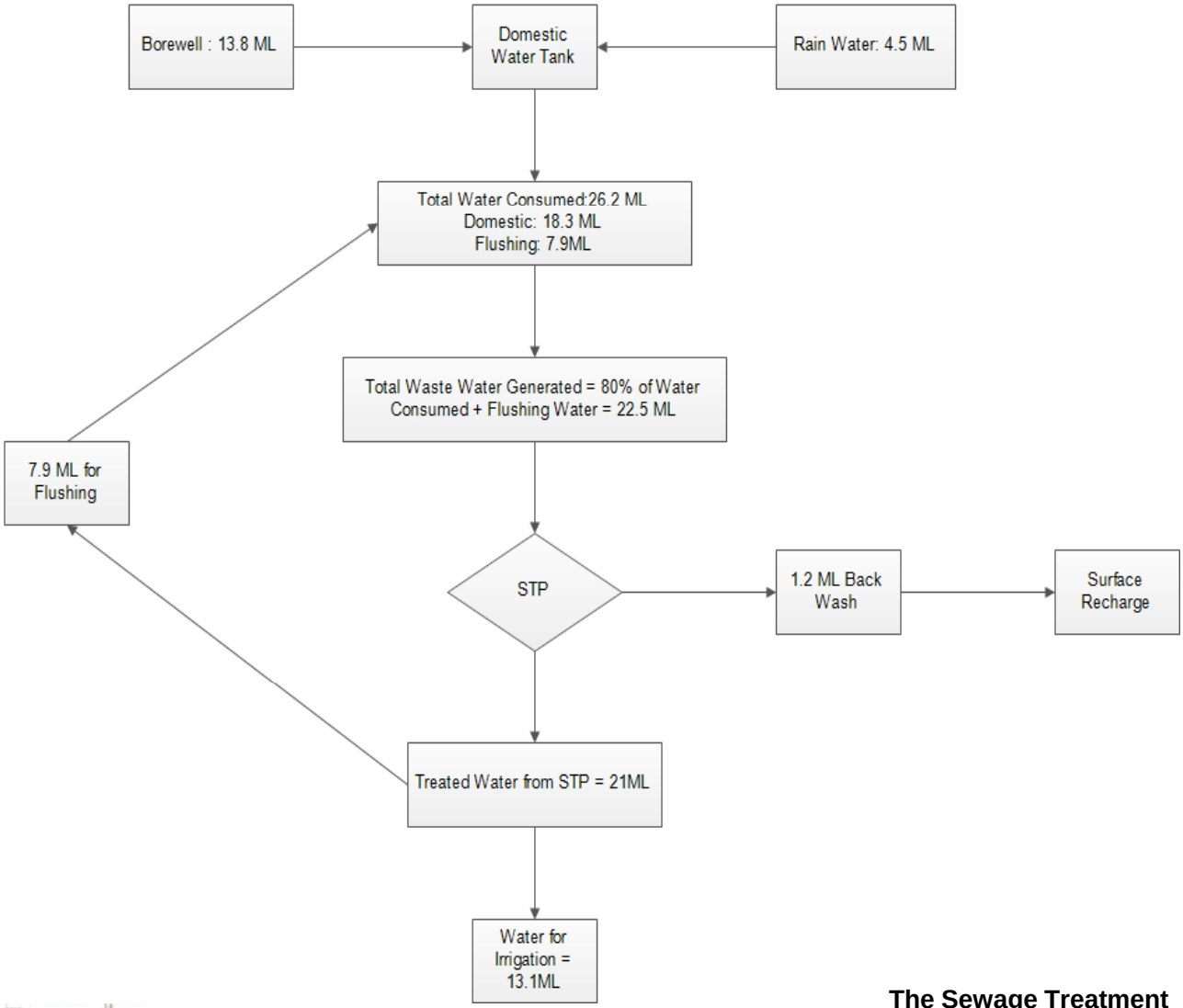
•The water emerging from the Sewage treatment plant underwent further treatment through an aeration tank and a series of carbon and sand filters.

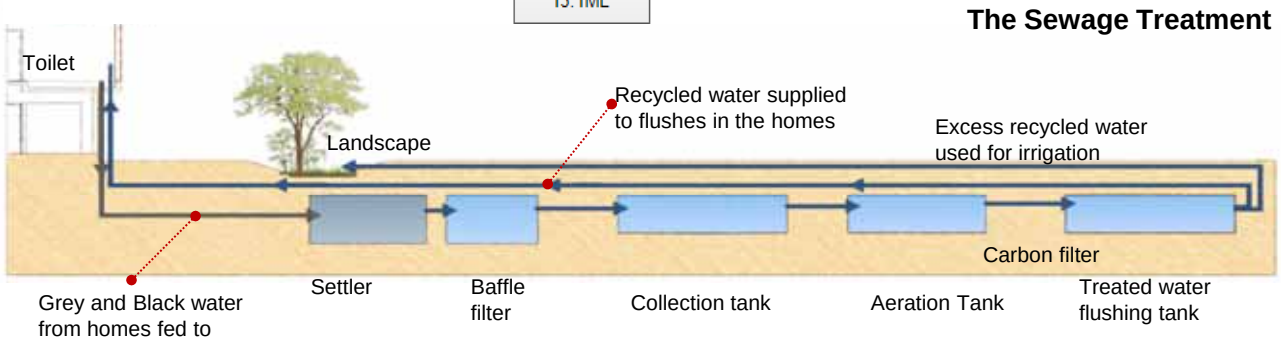
•This water was pumped back to the homes through a dual plumbing system and used in the toilet flushes. Excess water was used in the landscape for irrigation.

•The irrigation was managed through a system of drip lines and sprinklers.

Water Conservation and Services







Water Conservation and Services

Water Management
Data sheet for One year

Type of Source	Ref	Input	use	Output
Borewell	A	13.8 ML		
Rainwater	B	4.5 ML		
Consumption Treated Water	D=A+B	18.3 ML	18.3 ML	
Consumption - Flush Water	C	7.9 ML	7.9 ML	
Total Consumption of Water	E=D+C		26.2 ML	
Waste Water Generated	F=E*0.8			22.5 ML
STP	F	22.5L		
Backwash for STP	G			1.5ML
Water for Irrigation and Flush	H=F-G	21 ML		
Water for Irrigation	I			13.1 ML
Water for Flush	C=H-I			7.9 ML

Water Management
Analysis

	Item	Value	Remarks
1	Percentage of Rainfall water used:- 4.5/26.2	17%	Almost 2-3 months in a calendar year is fully serviced by the rainwater with no dependence on borewell water. Also less treatment required.
2	Percentage of Reused Water used for Flushing:- 7.9/26.2	30%	Almost a third of the raw water has been supplemented by grey water recycling.
3	Percentage of Reused Water used for Flushing:- 13.1/26.2	50%	Almost half the quantity of the raw water has been supplemented by grey water recycling.
4	Percentage of Water lost in the System:- 1.5/26.2	5%	Only a marginal quantity is lost in the water management system, which is also routed to a surface reservoir or recharge
5	Total percentage of Water Reused:- 21/26.2	80%	Most literature on sustainable water practices specify around 50% reduction of water use.

Surface Run off

Data

Item	Value
Green Area	4000 sqm
Coefficient of Recharge	0.5
Rainfall in Project	900mm approx per year
No of Percolation Pits	8
Size of Percolation Pits	2cum

Analysis

Item	Ref	Value	Remarks
Volume of Surface Water : 4000 x 0.9	A	3.6 ML	
Volume of Runoff : 4000 x 0.5 x 0.9	B = A* 0.5	1.8 ML	
Volume of Direct Percolation	C = A - B	1.8 ML	recharged into the GWT
Total Volume of Percolation Pits: 8 * 2 cum	D	0.016 ML	recharged into the GWT
Total Overflow	E = B - D	1.784 ML	routed to natural reservoir adjoining the property

Energy efficiency

Passive solar

•Bangalore is climatically in the temperate zone, and does not have extreme temperatures. The climate is comfortable, although the growth of the city has increased the heat present in the city.- The buildings were designed for passive cooling.

•The buildings were designed with adequate light and ventilation, and did not require air conditioning. The indoor air and light quality was sufficient and reduced the need for artificial light during the day, and the need for artificial ventilation (fans) for most part of the year.

•Provision of a double roof (a sheet over the reinforced concrete roof) reduced heat gain and the temperature within the home was approximately 4- 5degrees cooler than the outside temperature.

•Skylights in the home which are double glazed, reduced the heat entering into the home through the skylight, and air vents at the higher end of the roof allowed the hot air to escape.

•An adequate tree cover around the buildings shaded them and reduced the absorption of heat.

Solar Energy

Provisions were made in individual houses for converting to solar power as and when desired.

The internal house wiring was linked to an inverter which has a conduit laid to the roof. Solar panels could be installed on the roof and connected through this conduit.

Solar geysers are mandatory and were installed on the roofs, individually.

Energy efficiency

Day lighting in some of the homes

The open plan home

Space type	Average lux level measured	Daylight factor	NBC recommended daylight factor
Living- Dining (GF)	171	1.71	0.625
Bedroom (GF)	265	2.65	0.625
Bedroom 1 (FF)	335	3.35	0.625
Bedroom 2 (FF)	345	3.45	0.625
Family living (FF)	603	6.03	0.625
Kitchen	200	2	2.5

The courtyard home - small

Space type	Average lux level measured	Daylight factor	NBC recommended daylight factor
Living- Dining- kitchen (GF)	493	2.7	2.5
Bedroom (GF)	304	1.7	0.625
Bedroom 1 (FF)	330	1.8	0.625
Bedroom 2 (FF)	274	1.5	0.625

The courtyard home - large

Space type	Average lux level measured	Daylight factor	NBC recommended daylight factor
Living- Dining (GF)	192	2.7	0.625
Kitchen (GF)	148	2.1	2.5
Bedroom (GF)	330	4.7	0.625
Family living (FF)	209	2.9	0.625
Study	368	5.2	1.9
Bedroom 1 (FF)	329	4.7	0.625
Bedroom 1 (FF)	330	4.7	0.625

Energy efficiency

Embodied energy of Materials

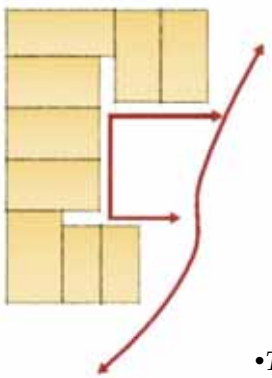
Materials low in embodied energy have been used in the project. The main building material has been compressed stabilized earth blocks, which have been made with 5%cement, and soil obtained from the site itself. The use of Steel and cement has been reduced, and replaced by stone, mud and timber.

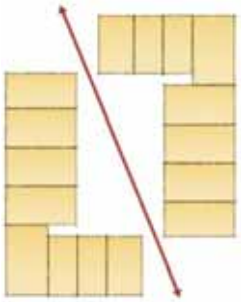
Comparison of Materials and Techniques used in the project vs the conventional.

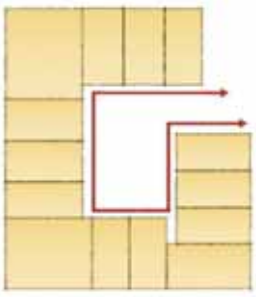
		Materials Used	Quantity	Unit	Alternative	comment
1	Foundation	stone (load bearing)	205098	Nos.	Cement and Steel (framed structure)	A load bearing foundation is lower in embodied energy and consumes less fossil fuels than the framed structure.
		cement	4052	Bags	Steel	
		steel	101776	Kgs.		
2	Walls	Cement Stabilised mud blocks	25343	Sq.mts	Concrete Blocks	Mudblocks are lower in embodied energy than concrete blocks
		stone masonry - stones	19242	Nos.		
		stone masonry - Chappadi	10251	Cu.ft		
		stone masonry - Cement	490	Bags		
3	Roofs	RCC	4111	Cu.mts	RCC with overhang	The RCC roofs have been restricted to the walls, and do not form the overhang, thus reducing the quantity of RCC by 40%
		Mangalore tile with Steel beam and wooden rafters	2825	Sq.mts	RCC	The tile roofs, add to the aesthetic value and have lower embodied energy than RCC which might have been used in conventional buildings
		Onduline roofs	10173	Sq.mts	RCC	Onduline sheets are lower in embodied energy than RCC
4	Finishes-Flooring	Terracotta tiles	1108	Sq.mts	Ceramic Tiles	The use of ceramic tiles has been reduced, and users are encouraged to use natural materials. However the natural floors pose a challenge in manitaining quality while construction, and to meet the expectations of users.
		Attangudi Tiles	2786	Sq.mts		
		Kota Stone	3230	Sq.mts		
		Recycled Wood	319	Sq.mts		
		Ceramic Tiles	14548	Sq.mts		
		Jaisalmer	598	Sq.mts		
		Cuddapah	265	Sq.mts		
5	Finishes-Paints and Polishes	distemper for walls	7200	Sq.mts	Emulsion	The choices of paints and polishes have reduced the impact on the environment
		Cashew shell oil and linseed oil	2310	Sq.mts	enamel paint	
		Polyurethane coating	604	Sq.mts	Polyurethane coating	
		Enamel paint	2847	Sq.mts	enamel paint	
6	Landscape paving	Mud concrete	819	Sq.mts	Concrete blocks	Mud concrete and Cuddapah are low in embodied energy as compared to concrete blocks
		Cuddapah with grass joints	282	Sq.mts	Concrete blocks	

The Cluster

•*The clusters were designed using different configurations to create an identity depending on the profile of the site. The experience through a multitude of open spaces of similar proportions was dynamically different with a change in navigation pattern. Interactions with these spaces also changed with the circulation.*







•*The corners of these clusters as well as the transition between clusters created streets which depending on their dimension and use became the most lively and interactive spaces, as compared to cluster parks which initiated interactions of a different kind.*

Cluster A – Ground Floor

Cluster corner

•*The space in the individual plot was used optimally.*

• *The homes were built by using shared walls. This had a lot of advantages. Firstly, the open space which would have been at the side of the home, between homes , was moved from there to the front or rear yard making the yards larger. The side open space as specified by the bye laws for the plot sizes designed was extremely narrow and was usually, not of much use. It was not private, and did not give much light and ventilation. On the other hand, with the shared walls, the profile of the houses was designed, to enhance privacy, light and ventilation.*

The Cluster

•*A variety of homes and open spaces were designed to meet the challenges of logistics and to retain the need for individuality. This was achieved by designing a large variety of "type designs", which allowed for some flexibility. Arranging them in different permutations, with minor changes, which responded to the position or climatic context made very interesting spaces and created a WOW factor. In this way, we avoided the need to resort to "cookie cutter" ideas, even at the large scale.*

Ramp entry to Cluster D

Cluster D– Ground Floor

The type designs were generated, not only keeping in mind the requirement of spaces in the house, but also the orientation. The houses were designed to be inward or outward looking. Within this we played with the front and rear orientation; creating different emphases in each. These concepts also naturally led to the positioning of these homes within the cluster- the inward looking homes naturally along the street areas and the outward ones along the park. The cluster corners were a challenge and generated interesting plans, as they had L-shaped open spaces.

The Cluster

Section

Cluster D– First Floor

•The fine balance between needing to design for privacy and encourage interaction was a challenge. Orienting the public spaces of the home like the living room and terrace towards the more public front and the bedrooms and private spaces to the rear, was one way of addressing it.

Creating multiple verandahs which allowed for choices, also worked.

• Softer boundaries with planting was a good solution, as it was flexible and the degree of privacy required could be adjusted, depending on the residents of the homes and the neighbors they might have!

The Housetypes

C-01	BUA(SMT)
GROUND FLOOR	72.83
FIRST FLOOR	76.43
TOTAL	**149.26**

The open plan home: The spaces within this house flow seamlessly from the entrance verandah through the living and dining areas to the rear verandah and into the rear garden. This creates a sense of spaciousness in an otherwise compact plan.

The courtyard home: These houses are designed around an inner courtyard. The courtyard is open to sky and is suited to Bangalore's moderate weather. The living and dining overlook this court, making this intimate garden space a part of the house.

F-01	BUA(SMT)
GROUND FLOOR	95.75
FIRST FLOOR	59.13
TOTAL	**154.88**

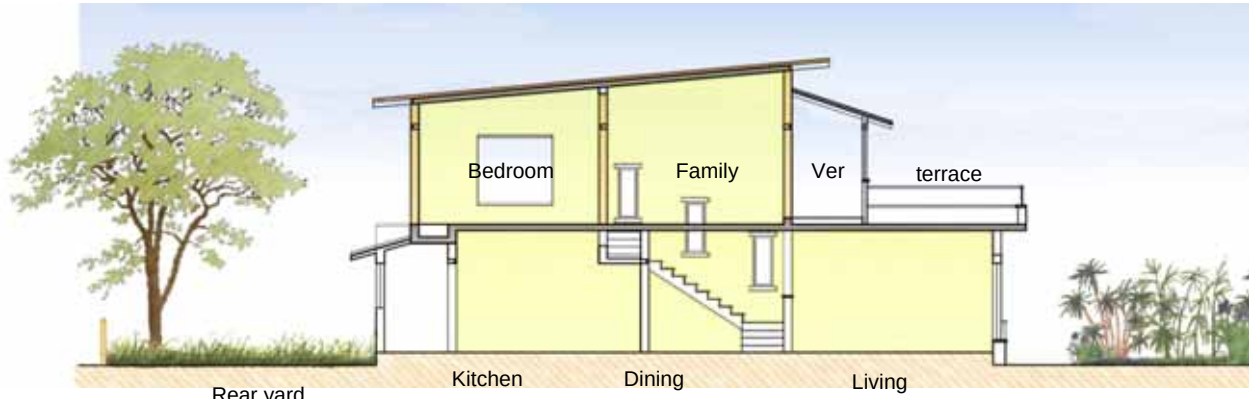
D-10	BUA(SMT)
GROUND FLOOR	98.85
FIRST FLOOR	98.02
TOTAL	**196.87**

The Corner home: Affording more privacy than the others, they have larger open spaces within the plot; either an L shaped yard, or a spacious backyard, or an entrance court with a large backyard.

The Homes

Ground Floor Plan

First Floor Plan



Section

•The architecture advocated comfort without opulence.
•The Spaces responded to the requirements, encouraged multi use and were culture sensitive. They prompted values of conservation through adequate light and ventilation and economy of design.
•The homes were planned to have minimum walls with no corridors. Depending on the orientation of the house, the private and semi private zones were worked out. For example, in a front oriented home, the living room was oriented to the common open space and the kitchen and bedroom towards the more private rear. Here the rear yard was more likely to become a kitchen garden and the front a space for interaction with the community. The spaces were vertically and horizontally connected through courtyards and stairwells enabling interaction within the home.

The Homes

•The form of the home was kept simple with the terrace on the first floor and the roof defining the form.
• The roof was intentionally kept sloping. There were a number of reasons for this. Firstly, the form of the ground and one storey kept the scale lower and more horizontal; which was the intention. Secondly, the elimination of the second flight staircase, terrace parapet wall and a staircase room on the roof reduced cost. We felt that the roof as the space to be used was not really necessary looking at the profile of the families that will use the space.- The cost did not justify the use. Looking at future energy requirements, the roof would be used for installing solar panels and a sloping roof was adequate for that. Providing accessibility for servicing was sufficient. Thirdly waterproofing is easier on a sloping roof than on a flat terrace.

•Natural light and ventilation was planned through adequate doors, windows, skylights and jaalis. Windows or openings in the stairwells or near the skylights helped the hot air to escape and kept the entire house well ventilated. Skylights over courtyards and stairwells create a beautiful quality of light within the home. The proportion of the skylight was important: Very large ones could trap heat and very small ones insignificant. They contributed in a big way towards making the home bright and airy.

•A terrace at the first floor level was an integral part of most designs as it served as an open space which flowed out of the house through a verandah. It was well connected to the common open space, yet keeping a distance from it.
•The parapet walls were worked as a combination of privacy and openness.

The Homes

Verandahs as transitions between the interior and the exterior were an important element of the design and we experimented with their proportions and scale. Verandahs which served as entries, others that worked for dining and still others for lounging were created. As the verandahs were used as transition spaces, windows or doors overlooking them needed to be detailed carefully. Larger fixed glass openings and shutters which open against the wall so as not to reduce the usable space in the verandah were used. In Bangalore, light is a more relevant requirement than ventilation, due to less humidity. Hence a combination of fixed glass and open-able shutters, worked well for the climate.

Balconies also speak to the open spaces; some cheerfully to be perched on, while others rich in their detail, allowed one to relax, work or connect to the outdoors.

Bay windows, which enhanced and extend the spatial quality of any room, were integrated into the design.
We explored a few variations in the design of these windows and observed how they impacted the experience and use of the space.

Materials and Techniques

The materials and techniques with which we build are our language, our song. Selected from a wide palette, a composition of textures and colour, articulate the space and form. While communicating through the romantic, the decisions made have been based on sound economic, environmental and structural considerations. The skill and language to use the material, focuses on human and natural resource over technology. Minimal processing, renewability, the practical aspects of durability and maintenance, cost and availability, all form the matrix of values, through which a particular material is decided upon. The decision has been collectively made, involving all stakeholders in the process.

The Foundation-Load bearing vs. Framed structure: The foundation is a load bearing, built with locally available granite stone. A plinth beam acts as a tie above this and is a precautionary measure for seismic stability. For the spans of the spaces, a load bearing structure is more than sufficient. A framed structure may be overdesigning, as the outer walls would still have to be 200mm, which are adequate to take the load. A load bearing building also reduces the use of cement and steel, which are high in their energy consumption.

The Walls: are combinations of local stone and compressed stabilized mud blocks, used in a variety of compositions.

- *The composite stone wall- is a combination of waste pieces of local stone, built by stacking, along with a compressed stabilized mud block on the internal edge. This serves many purposes.*
- *The stone creates a high plinth, above which the exposed mud blocks can be built and are protected from back splashing water.*
- *The internal mud block wall is convenient to take services through, as it can be cut easily.*
- *A more horizontal proportion is created, and enhances the experience of the campus.*

Materials and Techniques

The Compressed Stabilized Mud block Wall:

The most amazing thing about building with stabilized mud blocks has been the awareness that the building is built from the very earth that it is sited on. Almost as if, it has grown out of the earth.
The compressed stabilized earth block is made with the help of a manual machine, and uses cement as a stabilizer. We found it to be working well, when applied to larger scale construction, as the quality of production became viable to monitor. As did the logistics. Different colours of earth used, made different blocks and bring in a lot of character to the walls built.
Experimenting with additives for better colour and strength was like an exercise in baking, to achieve the perfect colour, using the correct ingredients in the right combination.

Parameters we worked with to develop the CSEB to our context and requirement.

- *We used manufactured sand, instead of river sand, as river sand is a depleting material. This made the brick a grayish colour, instead of the warm mud that was also present in it.*

- *We attempted to create a brick that was pleasing in colour and appearance. It was important for us to work on the appearance and colour, even though the other qualities of the brick remained unchanged, to add to our palette of materials. The need to appeal to a wider audience, as being aesthetic, economical, durable and ecological and a solution which can inspire mainstream development.*

- *We worked to ensure that the costs were comparable, to any mainstream material, like concrete blocks, of the same strength, to demonstrate that mud blocks are an extremely viable material in the building industry, and can make a major impact on the environment.*

- *To achieve a balance between the cost, the availability of skilled masons, and the aesthetics, we arrived at a combination of plastering some of the block walls and exposing the "colored" ones.*

- *The details took care of protecting the walls, with adequate overhangs, the exposed walls needed a coat of transparent silicon, to prevent erosion over the years.*

Materials and Techniques

Stabilized Mud Block

Mud blocks are composed of Soil, sand (M sand), cement, Mettur mud(for colour) and Surkhi. Here cement is the main stabilizing/binding agent which prevents themud from softening by action of water. With this mix the soil is subjected to adequate pressure with a suitable moisture content. This compaction is done inside a mould to produce the required size of mud block. The mix is prepared in such a way that the cement content should always be 50% of clay content and clay should not go beyond 15%

Mix

A regular block of 230 X 204 X 90 (mm) has the following composition. This is a mix by weight. 100 kg is the reference weight.

Cement 9%
Soil and sand (dust or m sand in this case) ratio of 1:1
Mettur 10%
Surkhi 5%
water 8 to 10%

Mettur is essentially what is use to get that deep red for our exposed blocks.
With this mix we are able to get a dry density of 1.9 to 2.05 g/cc after compaction. And a compressive strength of 8 to 10 Mpa . This, without employing an energy intensive technique like brick burning where the country block strengths are seen only up to 3 Mpa

The Machine

The stabilization is done in a Mardini press. A press developed by ASTRA, Indian Institute of Science. It has a frame, an interchangeable mould, a reverse toggle lever, scoops, bottom plates and other accessories.

The Process

The process involves preparing the soil with sand, mixing soil and cement, adding moisture, weighing of soil in scoop, compaction in the machine, ejection, stacking and curing. We prepare the soil by sieving through 5 mm sieve. Remove all the gravel, lumps of clay and other visibly large impurities. Now, mix it with sand and cement in the aforementioned ratios with water. Use the scoops to weigh the mix, empty the scoops into the Mardini and pull the lever, there is a loud click, now you know the soil is compacted and we have a Mud Block. Eject and stack it in close lines to prevent immediate moisture loss. This shall be cured for 21 days with hose pipes and gunny bags. Sent for testing, loaded and transported for use.
Currently we have 2 teams who make about 1500 blocks a day. They work for about 10- 12 hours. Each team has about 5 to 7 people including the team leader.

Materials and Techniques

The Roof

The roof is cast in reinforced cement concrete with a sheet as a double roof, over the house and as the overhang. The sheet has been used innovatively with steel brackets, creating a newer aesthetic. This evolved as a result of being an appropriate solution for waterproofing and heat insulation are some, quality control at larger scales, being another. The light roof also makes the form lighter and makes for an interesting element in the layout.

Verandah roofs use a structure which is a combination of a steel beam, wooden rafters and terracotta Mangalore tiles. This ensures a balance of cost, aesthetics and space.

Doors and Windows*: Using optimal sections of wood and simple grill designs, the doors and windows, are a combination of plantation timber and commercially available timber. A combination of fixed and openable panels, reduces the amount of wood used, and is adequate in the climate of Bangalore.*

The Staircase*: has been designed to be the centre piece of the home. Constructed in wood, with a metal railing, it is light, and expands the space in the home.*

The flooring: *Users were given various options of Natural stone, recycled wood, terracotta and attangudi tiles to choose from. The balance of achieving comfort, while needing to maintain the floor was communicated, and many opted for the natural floor.*

Paints and polishes*: The walls were finished in water based distemper, which is lime based, and does not have any harmful chemicals. It is also economical. The external windows and doors were finished with a combination of cashew shell oil and linseed oil, to retain the natural look of the wood and ensure its durability. The internal doors were finished with a polyurethane coat.*

The process of Design and Construction- at a glance

No	Process		Implementation	Impact
1	Integrated Design approach		The design process and decision making involves all the members of the team, from architect, engineers, project managers, carpenters, masons and technicians. Each member is valued for the experience and ideas they bring to the table. Craft is integrated into the design process.	Ensured a good spirit during design and construction, and conserves craft.
2	Selection of the Site		The site is selected on the outskirts of the city, to keep the costs lower. Public transport and main arterial roads are accessible, as are essential services like schools, hospitals and marketplace. The site was a neglected grazing ground, of a nearby dairy farm.	Costs were affordable, water table was good.
3	Zoning and Bye laws		The project is located in a residential zone, as per the latest Masterplan of Bangalore city, and the sanction has been obtained from the Bangalore developemnt Authority	
4	Preservation of the site		The top soil at the site was collected and preserved for planting. Most of the exisitng trees were integrated into the design, and protected during the construction process	
5	Conserving the Natural levels and Drainange		The houses were designed, using the existing levels and basements integrated into the design. The earth excavated was used to make mud blocks. The natural drainage of the site was maintained.	No added costs towards managing the drainage, and cost saving to make the mud blocks
6	Passive Architecture	a	All the interior spaces have an excellent quality of Daylighting, and do not required to be artificially lit.	saving on electrical energy
		b	The spaces are well ventilated, and do not require to be air conditioned. Use of fans is sufficient.	saving on electrical energy
		c	The roof is double layered with an air cavity, which reduces the heat inside the house. Provision for solar water heater, fixing of solar PV cells has been made. A gutter to collect rain water is fixed on the edge	conserving water and energy.
		d	chhajas for windows and verandahs to shade walls	reduces heat
7	Universal Design		Ramps and paths accessible by wheelchair for most of the project.	
8	Materials in construction			
		a	Load Bearing stone foundation	low embodied energy
		b	Compressed Stabilised cement earth blocks for walls	low embodied energy
		c	Use of "Mettur mud", a by product of aluminium production, as an additive in the producttion of mud blocks	
		d	Recycled wood for main door	low embodied energy
		e	Use of clay in cement tiles in flooring	low embodied energy
		f	Optimising the steel in reinforced cement concrete	reduce energy consumption
		g	use of filler slabs for some floors	reduce energy consumption
		h	Use of clay mangalore tiles for roofing	reduce energy consumption
		i	Use of cashew shell oil for protecting windows and distemper for walls	

The process of Design and Construction- at a glance

No	Process		Implementation	Impact
9	Landscape: Hard and Soft surfaces and Surface drainage		48% of the site is planted or paved with pervious paving. Percolation pits are planned at strategic locations after studying the hydrogeological report. Storm water over flow is directed to a natural pond.	saving on material, and enhances the water table, reduction of heat isalnd effect
10	Materials and features in the landscape	a	Earth berming	Natural material to create interesting design
		b	Mud concrete -which gave the effect of a mud road, but easy to maintain. Uses mud in the mix	reducing the use of sand
		c	Cuddapah	Natural material and low embodied energy
		d	Rammed earth boundary walls	low in embodied energy
		e	Water features	cools down the microclimate
11	Planting in the landscape		Rich variety of plants and trees, with emphasis on native, edible, medicinal species. Mulching with sawdust, to pervent soil erosion.	conservation of the natural environment
12	Water Management	a	Rainwater harvesting- 1.75 lakh litre tank, water collected from roof tops through gutters	water conservation
		b	Percolation of surface drainage through a system of percolation pits and grass swales	water conservation
		c	Sewage treatment plant using DEWATS and recycling sewage water	non- chemical, no energy treatment
		d	Recycled water used for flushing and irrigation.	water conservation
		e	Water efficient sanitary fixtures used in the project	water conservation
		f	Irrigation through a system of drip lines and sprinklers through recycled water.	water conservation
		h	Solar water heaters provided for each unit on the roof top	energy conservation
		i	Water meters installed in each house to monitor the water consumption	
		j	Quality of water is assured through a treatment sysem of softeners and filters	
13	Solid waste management		Organic waste to be segregated and composted at source, through pits in the backyard	manure in backyard
			Inorganic waste to be collected by an authorised agency for recycling	
14	Outdoor lighting systems		The outdoor lighting systems has been designed to be at a low level, and does not pollute the nocturnal environment	
			Three circuits are planned, to enable better control of the amount of electricity used and the amount of illumination required	
15	Services		The services are planned with easy access for maintenance. Tank structures located under hard surfaces wherever possible	

Looking further...

Footprints has been an experiment with urban housing and it has been a learning process for all of us who have been involved in the design and construction.

We have learnt that…
• It is possible to create sustainable alternatives in urban housing balancing the aspirations, costs and design.

• This alternative can be adapted to suit different economic levels if the specifications are altered, to suit the budget required.

• Although initial investments in water and energy conservation may be relatively higher, they have long term benefits, which must be promoted.

• The impact of this kind of housing needs to be studied at a urban planning level, especially in smaller towns which are still developing.

We dreamed of a community,
That lived with the land,
Where the shared spaces were like children,
To be enjoyed and cared for together,
Where driving the car, was not as important,
as slowing down and smiling at the neighbors on the street was,
Where privacy did not mean exclusion
and security meant neighbors and not electronic systems.
Where the residents
Valued water and the need to conserve it,
Recycled waste, and understood the need for renewability.
Learned about the seasons, through the flowering of the trees,
Delighted at the birds, insects and other visitors,
Where the natural homes, blended into the landscape,
And into the lives of the community.
We hoped, that what we built,
Would inspire families to put down roots, in the growing city,
Where their children would be free and safe,
The elders cared for.
Where people would be in touch with themselves and nature,
Life, revered and celebrated,

We believe that design has the power to change the way we live. It enhances and reinforces the intention of any community. It is a tool to create environments that are responsive to climate, location and human needs. Spaces that enhance the level of visual and thermal comfort and comprise of materials that are non- toxic and natural can positively influence the health of its users. Design must symbolize who we are and express what we hope to be. A strategic response has the potential to change what we become.