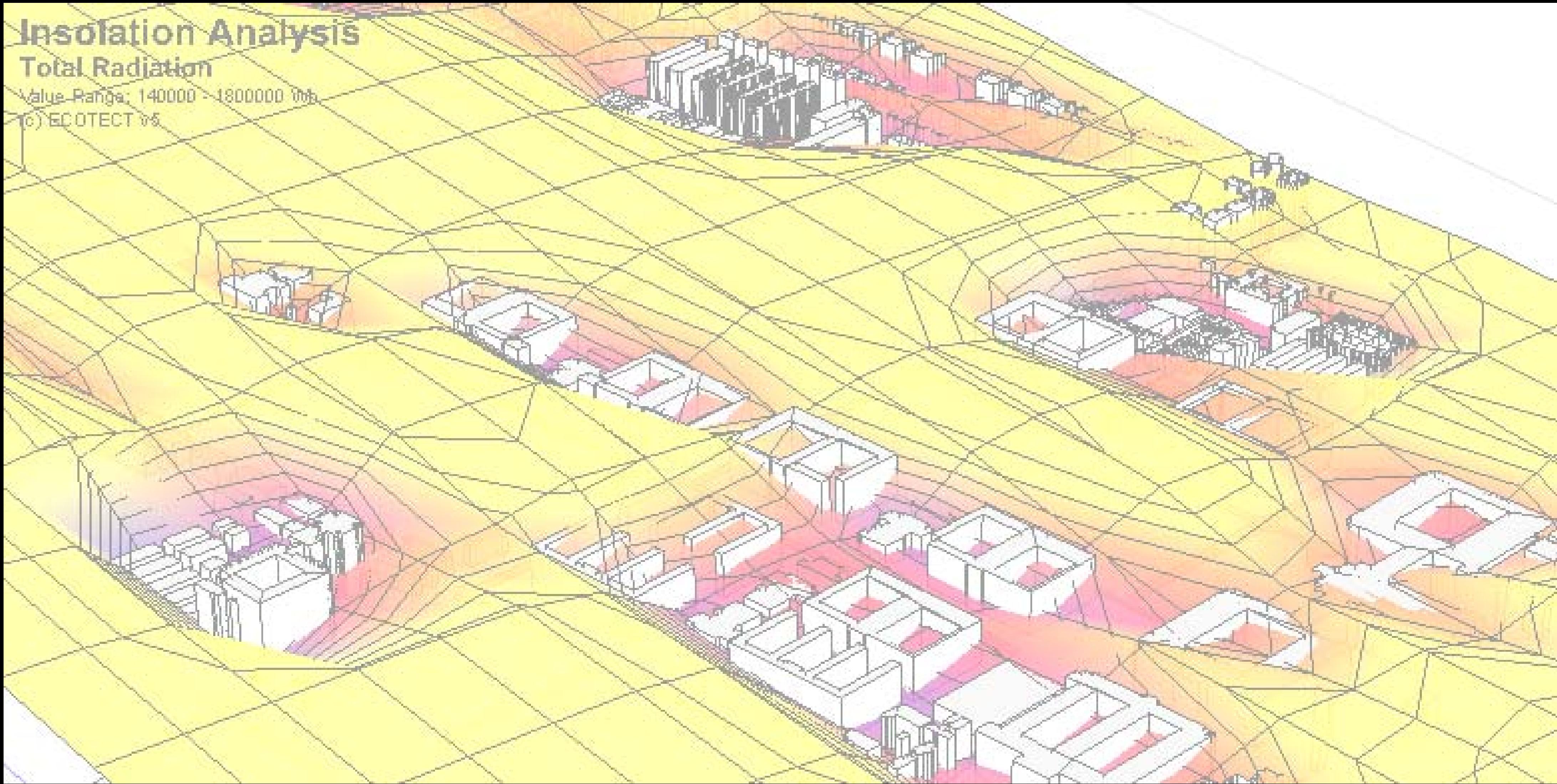


Microclimate and Landscapes

Issues and Amelioration

Technical Session 5

Air quality in healthy built environment

6th GRIHA Regional Conference on 'Accelerating Sustainability in Built Environment'

February 2015, Bangalore

MOHAN S RAO

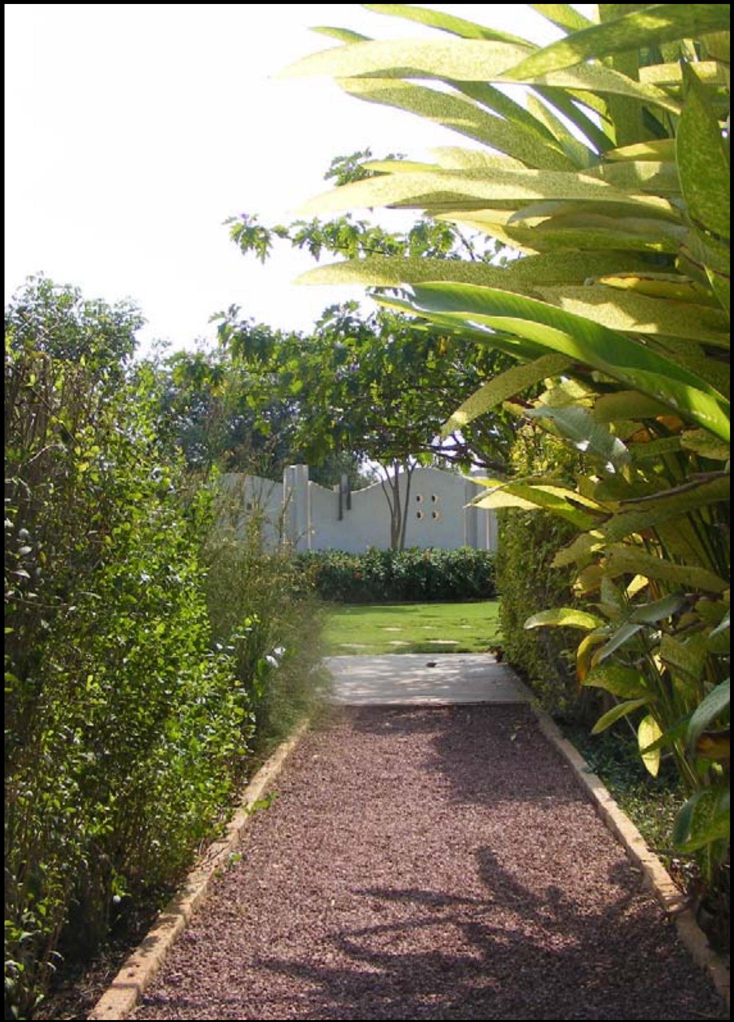
Landscape Design - TRANSCENDING THE NOTION OF A GARDEN

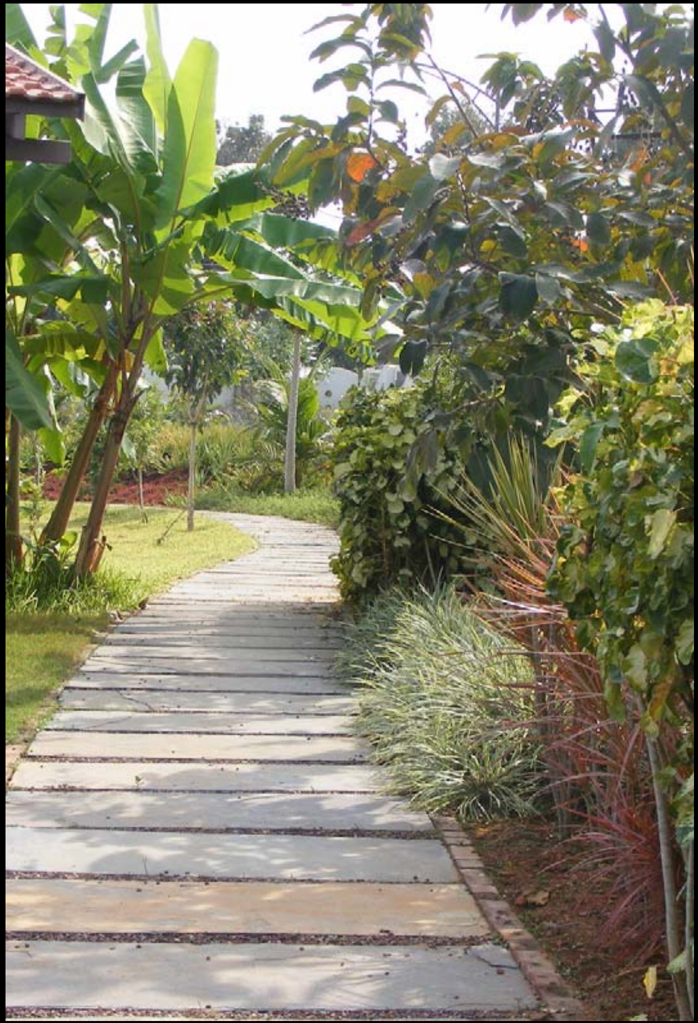
SCALES OF SUSTAINABLE LANDSCAPE DESIGN

It is critical to understand that unlike *architectural guidelines,* the approach to sustainable landscapes cannot follow specific formulae or implementation rules; it is determined by the SCALE OF OPERATION

1. SOFT CONSTRUCTION TECHNIQUES

2. MATERIAL PALLETE

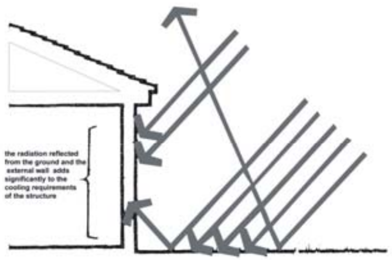


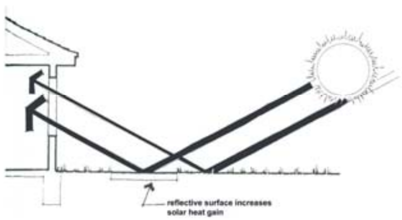


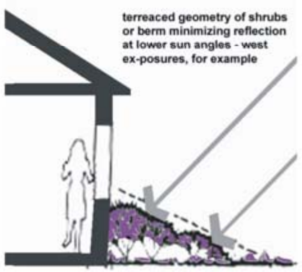
3. ENHANCING BIODIVERSITY AND INDIGENOUS SPECIES

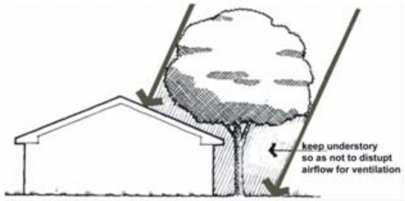
Absorbent and reflective materials

Groundcover and/or turf also have a cooling effect from evapo transpiration (the loss of water from the soil by evaporation and by the transpiration of the plants growing therein). The temperature above a groundcover will be 10 to 15 degrees cooler than above a heat absorbent material such as asphalt or a reflective material such as light colored gravel or rock. A heat absorbent material like asphalt will also continue to radiate heat after the sun has set. It is best to either minimize the use of heat absorbent and reflective materials near a house and/or shade them from any direct sun.









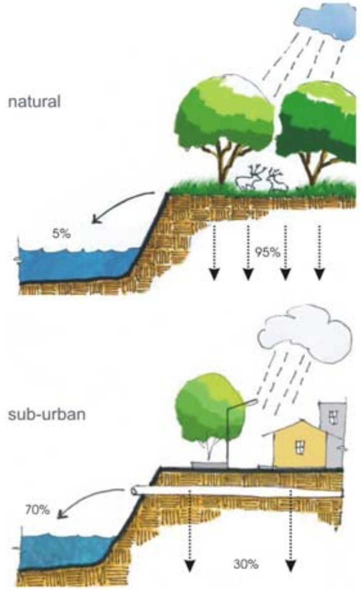
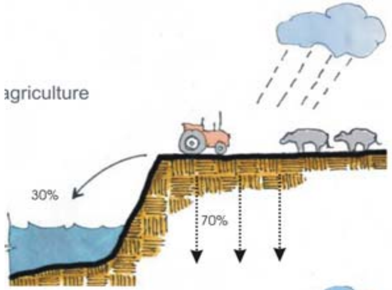
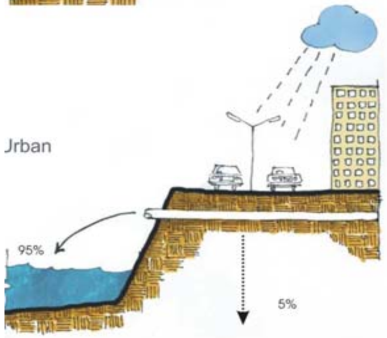
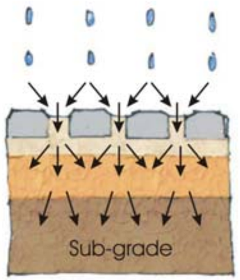


Fig. Infilteration on different surfaces

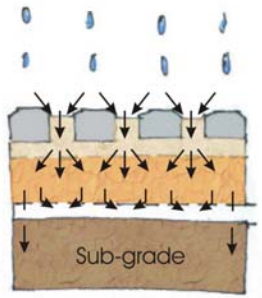






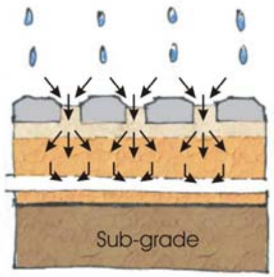
Total infiltration

This system allows all water falling onto the pavement to infiltrate down through the joints or voids between the blocks, passing through the constructed layers below and eventually into the sub-grade. Some retention of the water will occur temporarily in the sub-base layer allowing for initial storage before it eventually passes through. This is sometimes known as 'Zero Discharge', as no additional water from the new development is discharged into traditional drainage systems, therefore the need for pipes and gulleys are eliminated resulting in cost savings.



Partial infiltration

This system allows some water to infiltrate through the pavement, as with total infiltration, but a series of perforated pipes or fin-drains is also introduced at the formation level to allow the remaining water to be drained to other systems such as sewers, swales or watercourses. This system can be used in situations where the existing sub-grade may not be capable of absorbing all the water. This system can, therefore, prevent the existing soil from losing its stability.



No infiltration

This system allows for the complete capture of the water using an impermeable, flexible membrane placed on top of the formation level. It is used in situations where the existing sub-grade has a low permeability or low strength and would therefore be damaged by the introduction of additional water. A series of perforated pipes or fin-drains is placed on top of the impermeable membrane to transmit the water to sewers, watercourses or treatment systems.

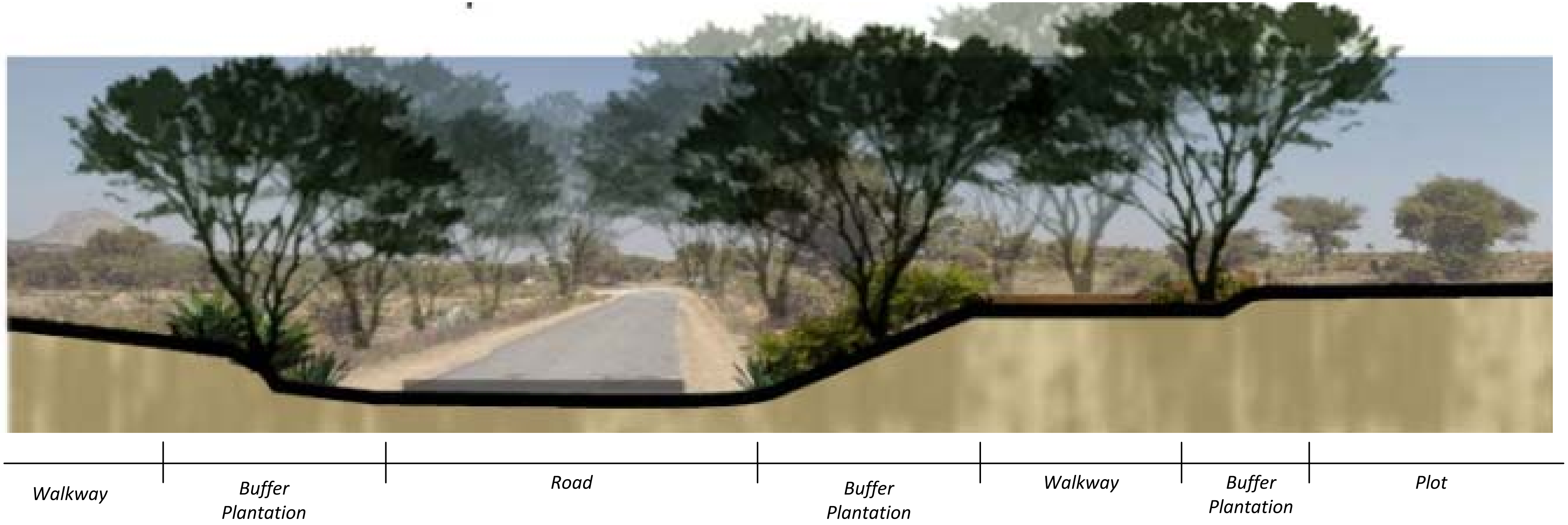
This system is particularly suitable for contaminated sites, as it prevents pollutants from being washed further down into the sub-grade, where they may eventually be washed into existing natural water systems. Another advantage is storage capability, as stored water can eventually be released into existing systems at times of low-flow by mechanical means, preventing overloading at times of heavy rainfall.

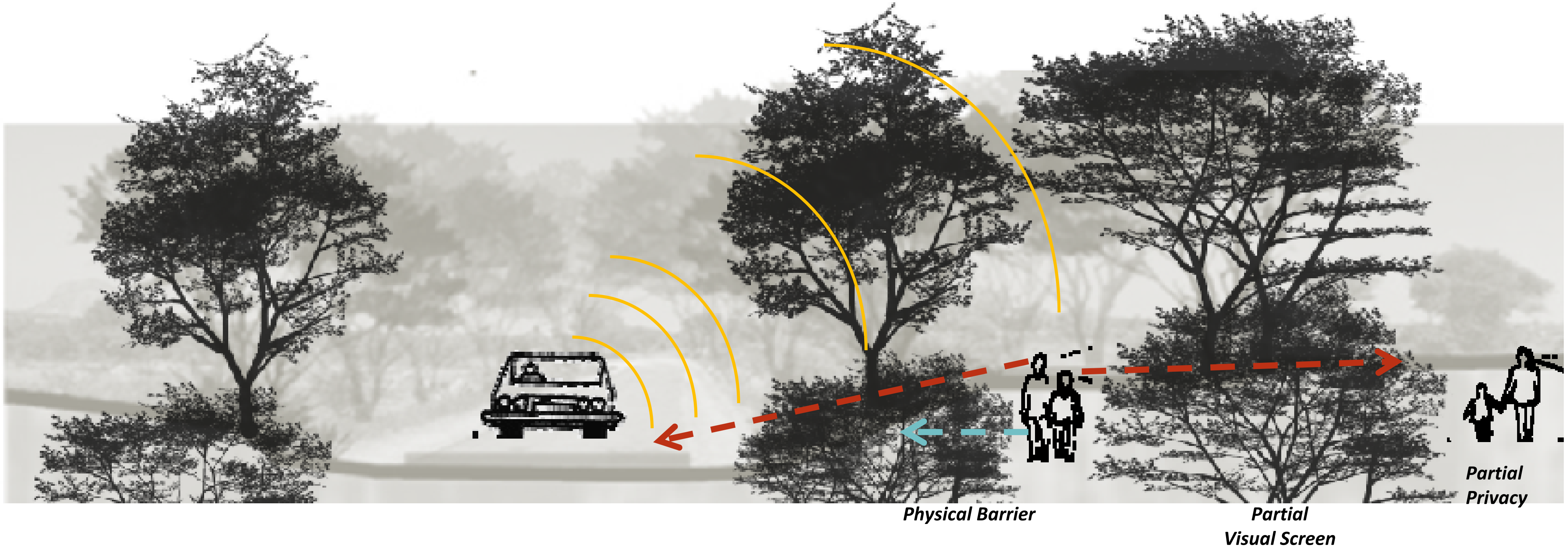
4. MINIMIZING PAVED SURFACES IN THE LANDSCAPE

5. DESIGNING SPACES BASED ON SOLAR ORIENTATION

6. INTEGRATED VEGETATED / SHADED STRUCTURES

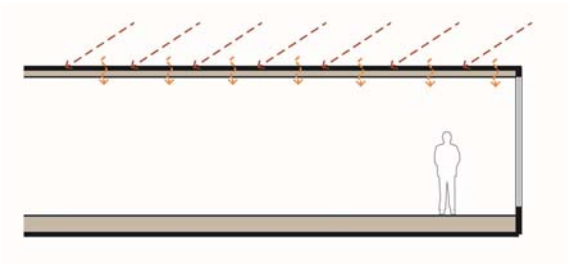
7. STREETSCAPE


Walkway
Buffer Plantation
Road
Buffer Plantation
Walkway
Buffer Plantation
Plot

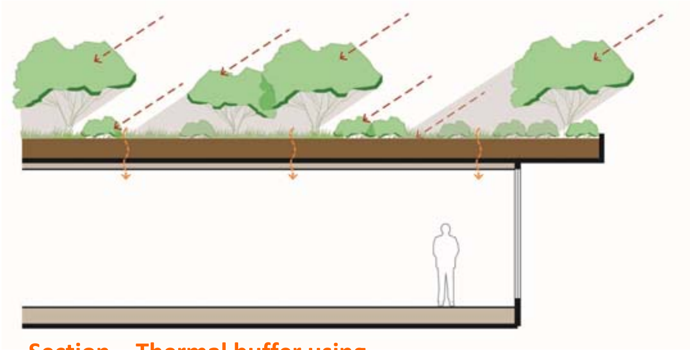

Physical Barrier
Partial Visual Screen
Partial Privacy

8. SHADING ROOFTOPS

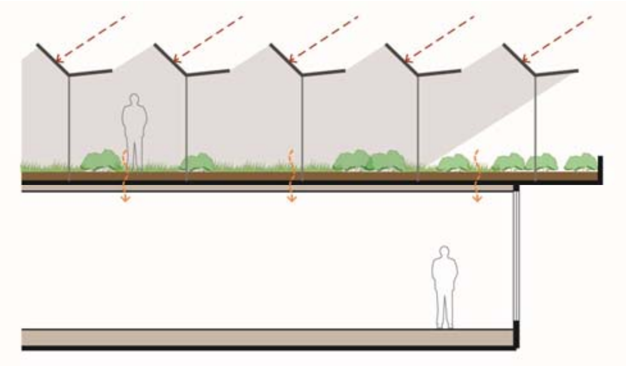
9. VEGETATED ROOFS



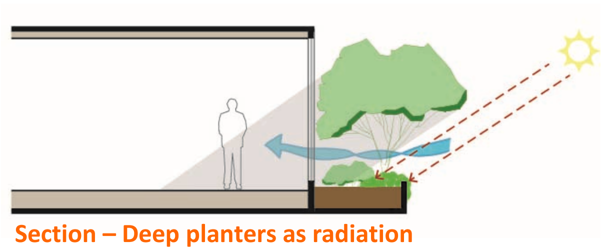
Section – Direct heat gain from exposed roof slab



Section – Thermal buffer using vegetated roof slab



Section – SPV array over vegetated roof for increased efficiency

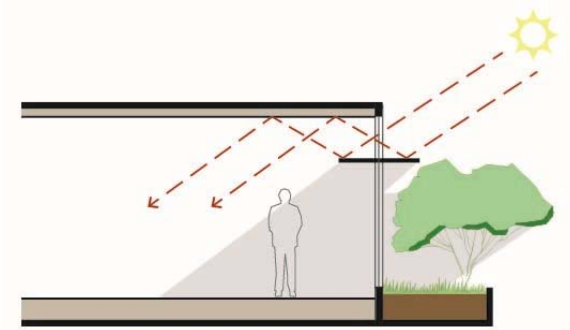


Section – Deep planters as radiation blankets and positive aesthetics

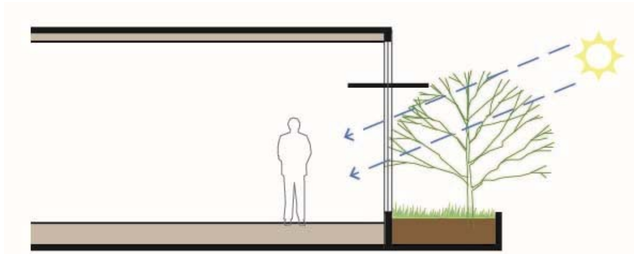
Thermal comfort + Productive landscapes + Net-Zero

- *To minimize heat gain, the roofs are treated as either black (SPV) or green (vegetated).*
- *Shading the vegetated roof space with SPV over raised framework creates shade and increases health of the vegetation.*
- *Evaporative cooling of under surface of SPV due to presence of vegetation below increases its efficiency.*
- *Water from washing the SPV directed along drip lines to irrigate vegetation below, further increasing water efficiency.*

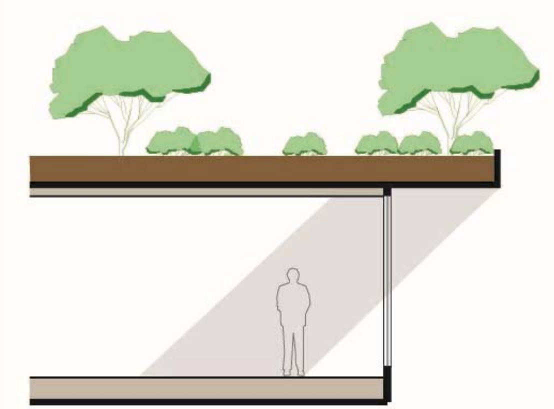
10. FAÇADE ARTICULATION



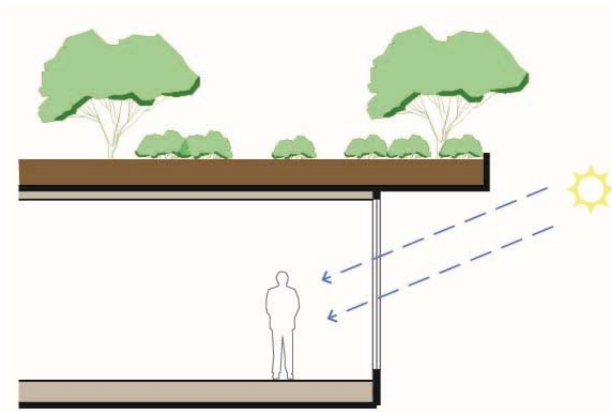
Section – Light shelves for reflection and dispersion of summer sun.



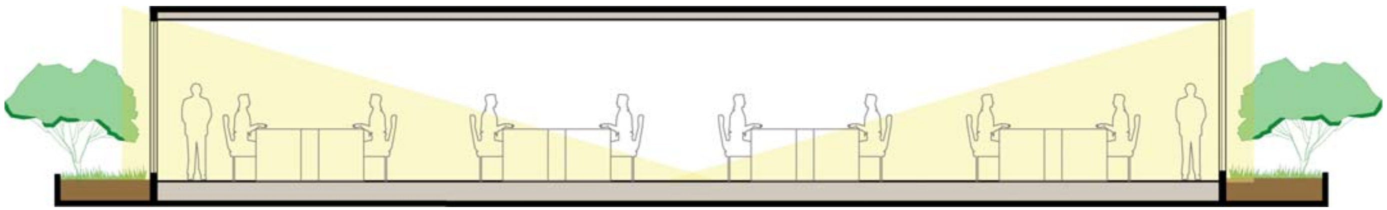
Section – Light shelves and penetration of winter sunlight.



Section – Extension of terraces to provide protection from summer sun.



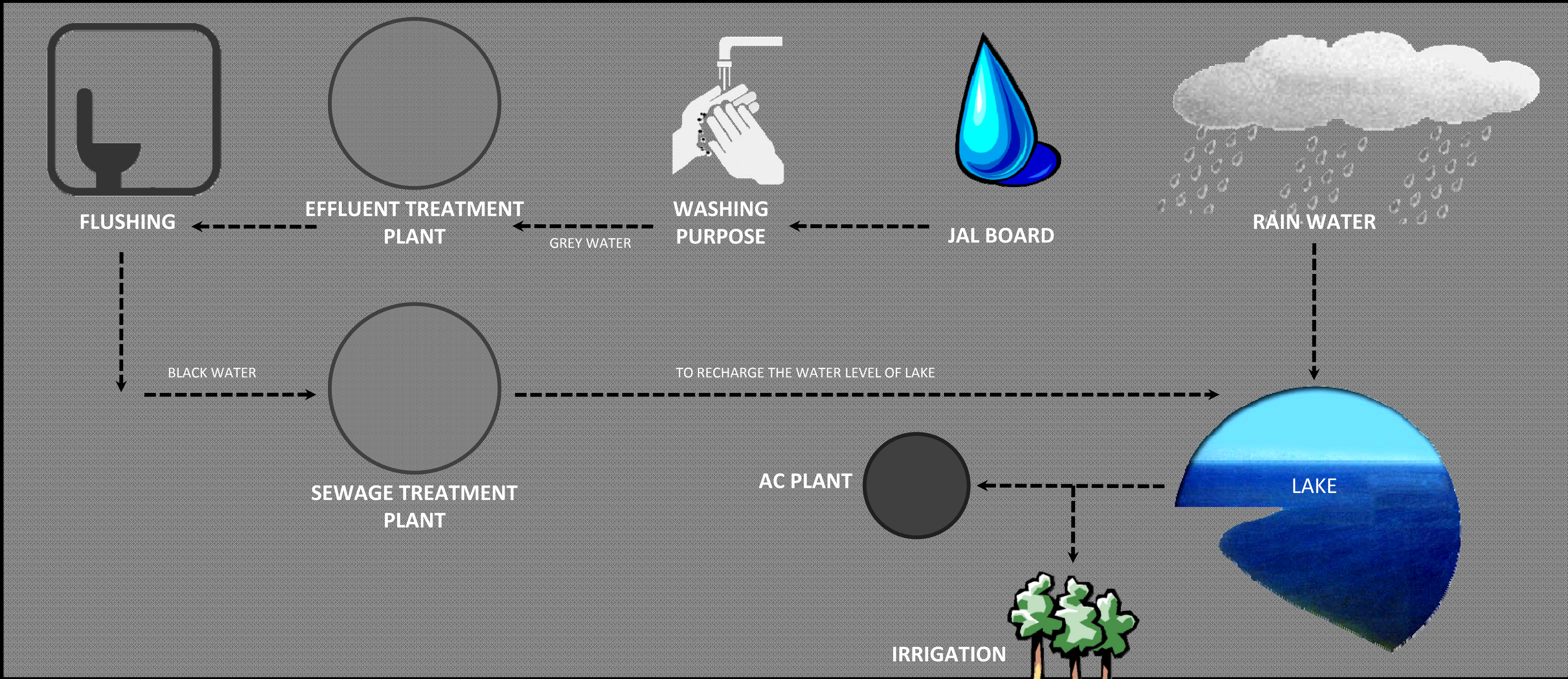
Section – Extension of terraces to allow penetration of winter sun.



Daylighting and Shading interventions

- *To reduce glare and increase penetration of daylight into the building interiors, light shelves and extended roof slabs are used.*
- *They provide shade from the summer sun and allow penetration of winter sun.*
- *The elements reflect and disperse sunlight to to maximize penetration of diffused sunlight.*
- *To ensure all building interiors are day-lit, the maximum width of buildings is limited to 23 m.*

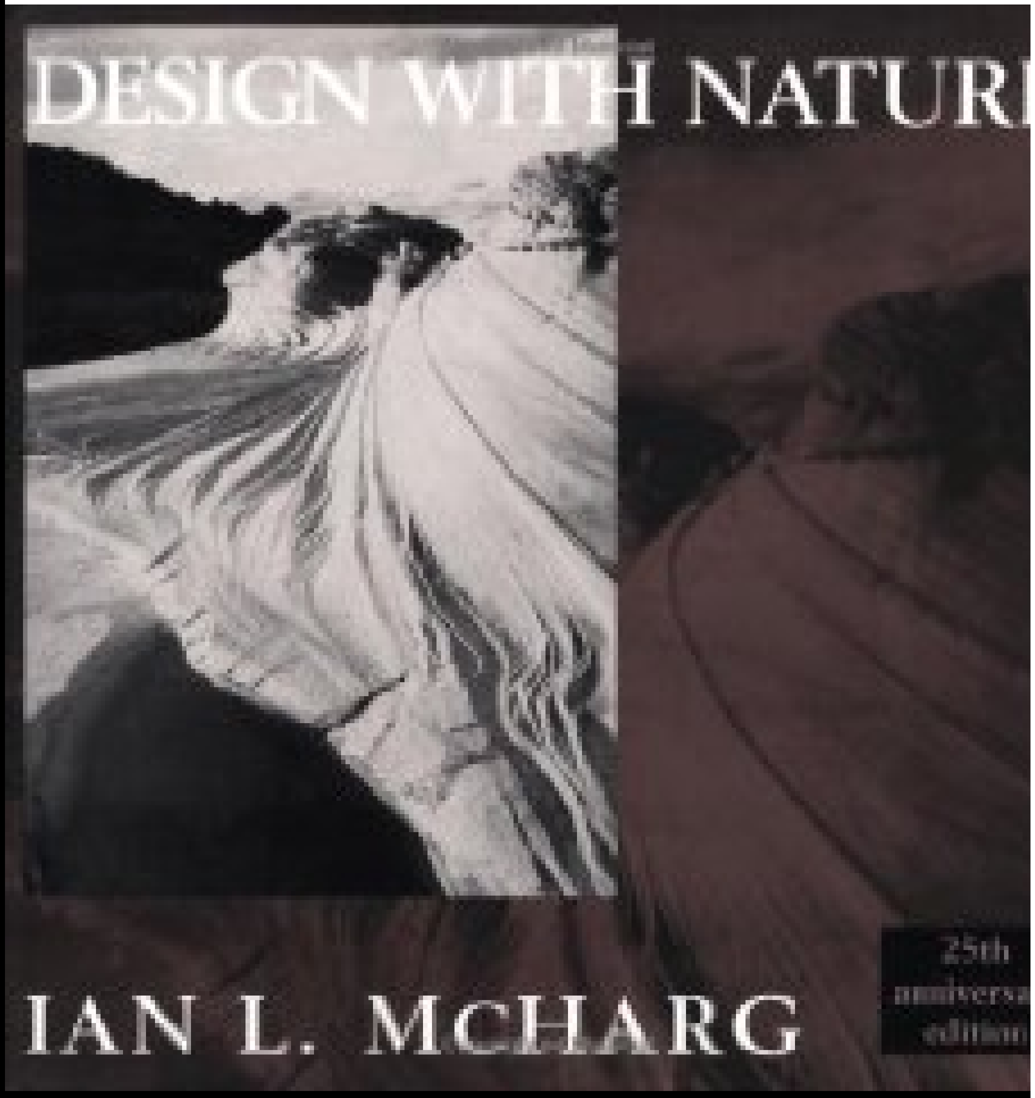
11. INTEGRATING SITE SERVICES



12. INTEGRATING THE WATER CYCLE

13. REPLACE PIPED SERVICES WITH NATURAL SYSTEMS

TRANSCEND BEYOND DESIGN AND THE SITE



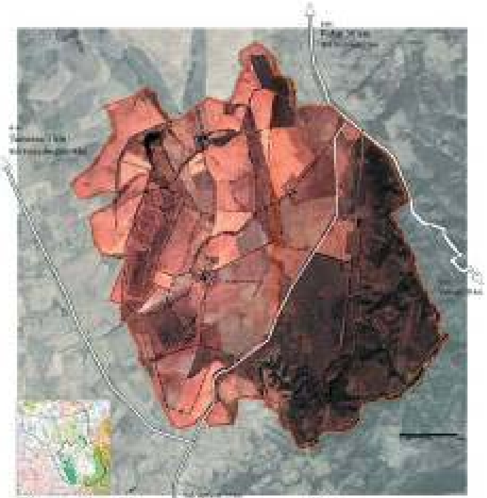


Figure 1 : Site and its surrounding

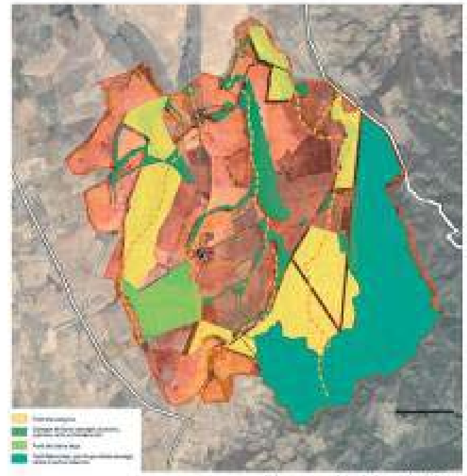


Figure 4 : Vegetation

Figure 2 : Topography and open landscape

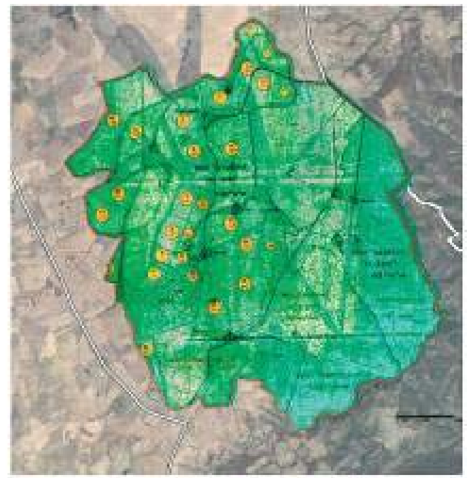
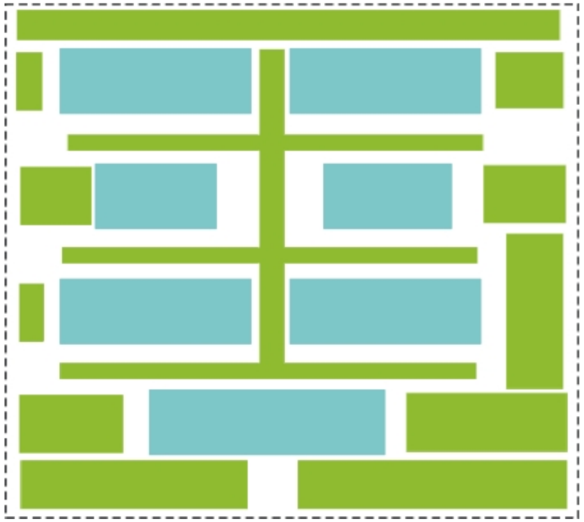


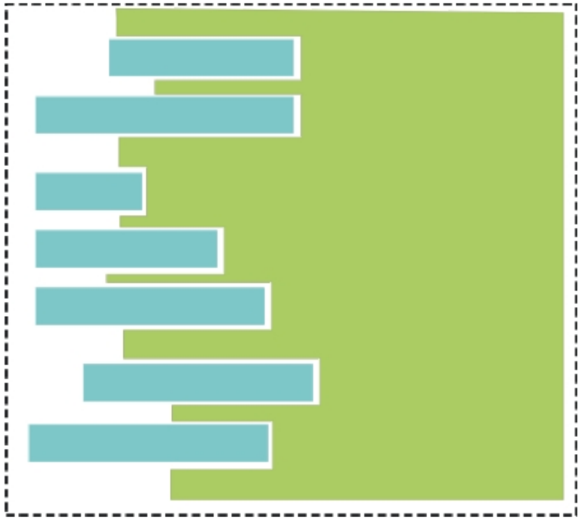
Figure 5 : Agricultural patterns

TOWARDS A MORE HOLISTIC, ECOSYSTEM-BASED APPROACH

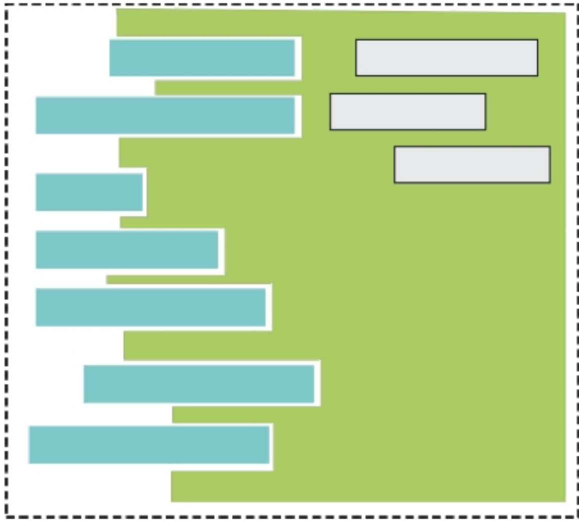
ACHIEVING PERCENTAGE OF MANDATORY OPEN SPACE



High-rise developments tend to create fragmented open spaces due to service and access needs.



Controlled low-rise, high density massing allows for large, consolidated open spaces.



Such a typology also allows for modular expansion possibilities

EFIFICIENT SITE UTILIZATION

Current Practice

Built form scattered across the entire site.

For an equivalent density, high rise typology creates sharp fragmentation of the site and site systems, rendering them sterile for any function save the decorative.

While the percentage of open space may remain similar, its utility is severely limited due to fragmentation through buildings, access for services and circulation.

Recommended Practice

Consolidation of built form leaves precious natural landscape in its pristine state.

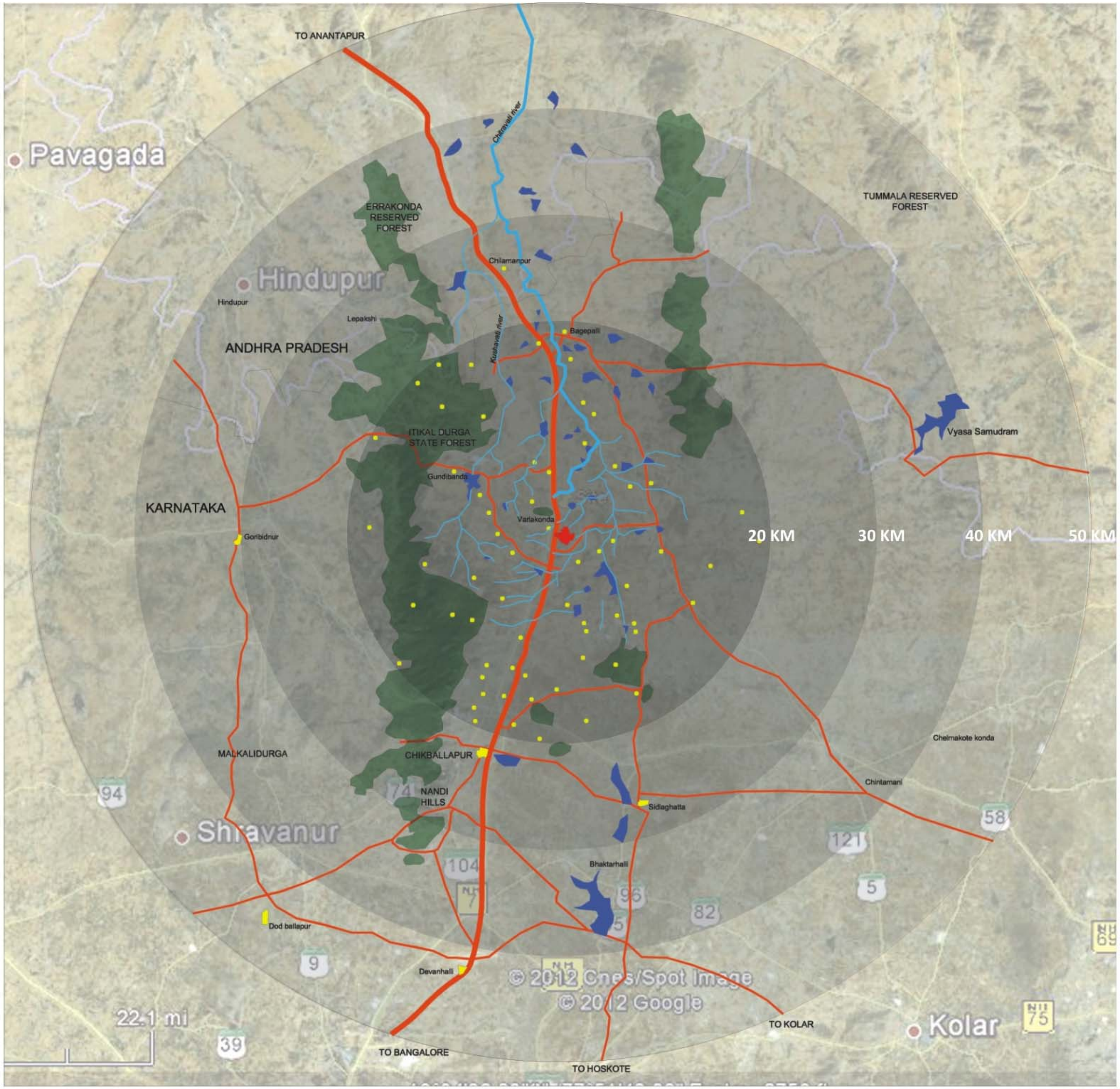
Opportunities for future expansion / intervention without compromising continued functioning of facility are immense.

Creative potential of the open space for productive functions – be they ecology, nutrition, energy or recreation driven are highly valuable.

10% COVERAGE

90 % OPEN LAND

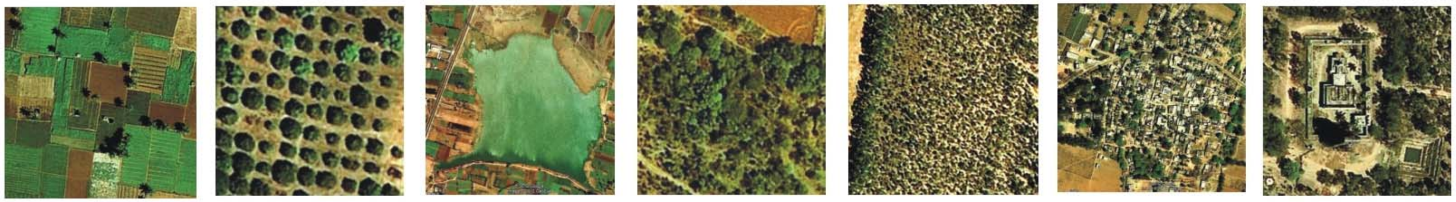
THE BUILT OFTEN OCCUPIES ONLY FRACTION OF A SITE; ESPECIALLY IN LARGE SCALE DEVELOPMENTS

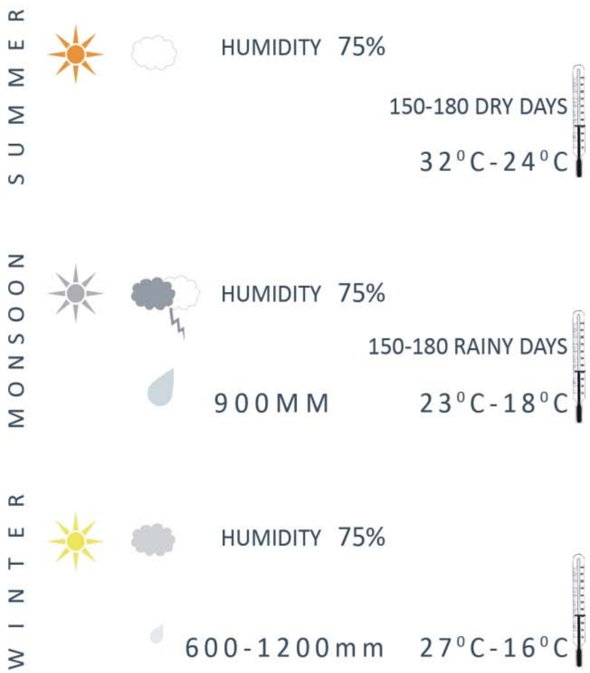


SITE PROXIMITY -50KMS

The city nearest to the site is Chikballapur at about 20 km distance. The northern part of Bangalore city comes within 50 Km distance from the site. The national highway #7 is adjacent to the site and several state highways run at close proximity to the site. Within a 20 km radius, the site boasts of state forest land and several seasonal and perennial lakes.

Regional Character





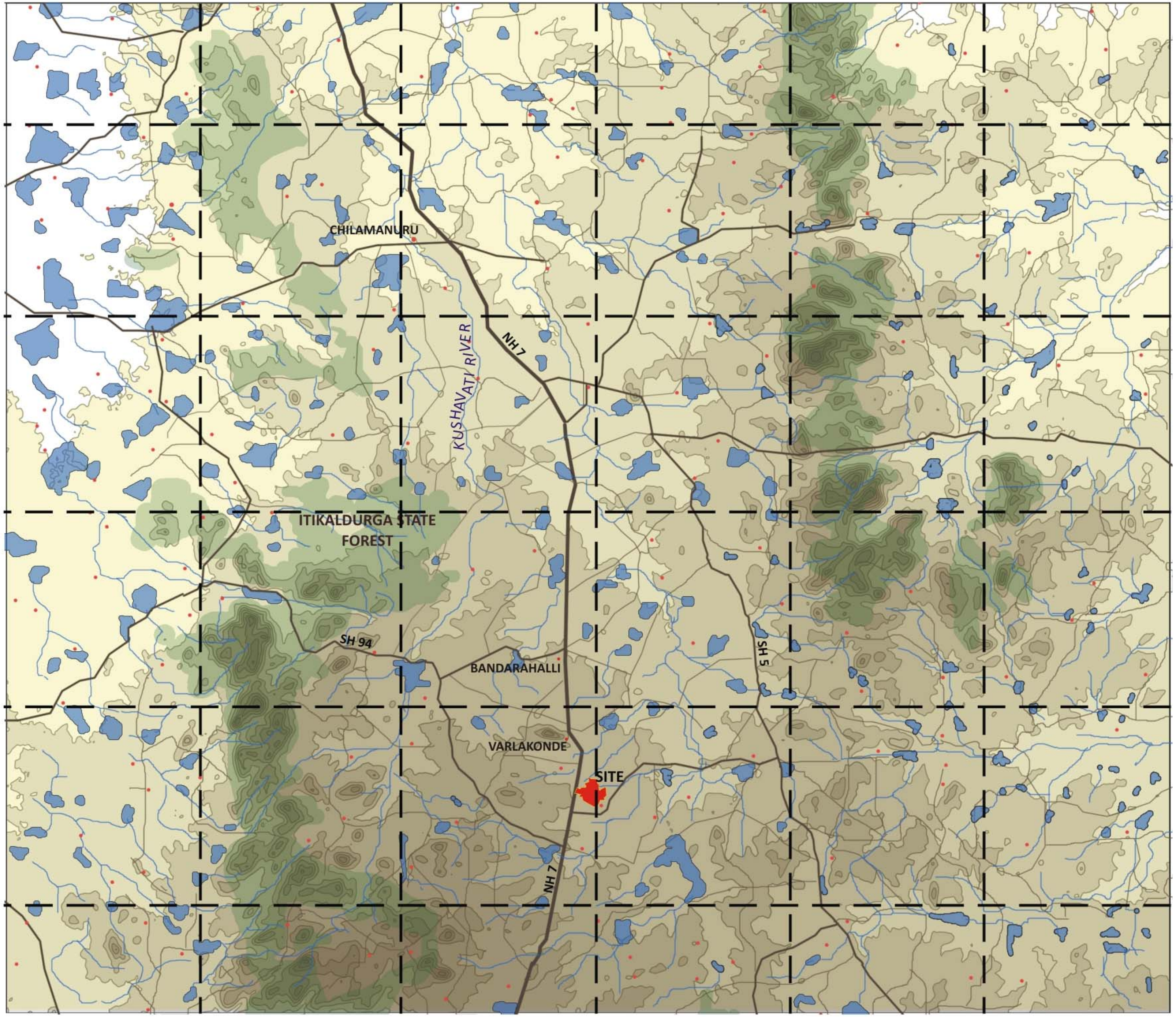
Climate:
The region falls in the Eastern dry agro climatic zone. It experiences semi-arid climate, characterized by typical monsoon tropical weather with hot summers and mild winters. September and October are the wettest months with over 100mm monthly rainfall. **April** is generally the hottest month and **December** is the coolest month of the year. During summer is Max temperature is 32°C & Min temperature is 24°C. In winter, Max temperature is 27°C & Min temperature is 16°C. The average annual rainfall is 773 mm in the region. Annual Rainfall: 650 to 847.3mm

Physiography:
Pediment, valley, laterite mounds, rolling land
Landform: South Deccan plateau
Situated in the Southern Deccan plateau, the topography is a rolling terrain at an elevation 900m above msl, as part of the Pediment of the Nandi hills.

Hydrology:
Surface water: There are no perennial rivers in the region. The region is dotted with several ancient irrigation tanks some of which are in a degraded condition. The drainage pattern is highly dendritic in nature. The region is the basin of river North Pinakani, which originates from Nandi hills.

Land use:
Major part of the region is cultivated land, with small size rural settlement dotting the landscape. Only in the hilly terrain there are few patches of forest left.

Regional LAND section



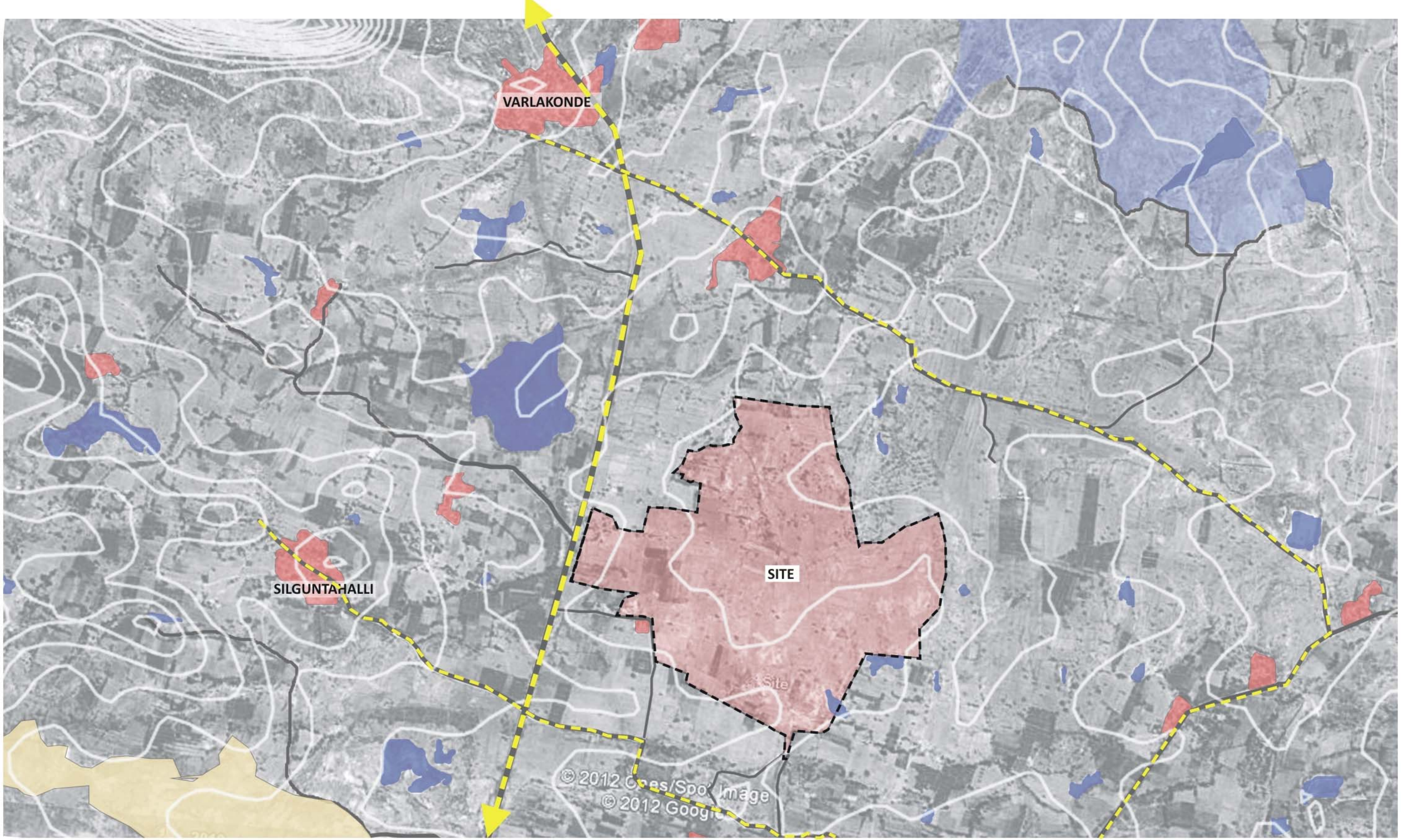
ELEVATION LEGEND

1150 M
1050 M
950 M
850 M
750 M
650 M

GRID 10000M X 10000M

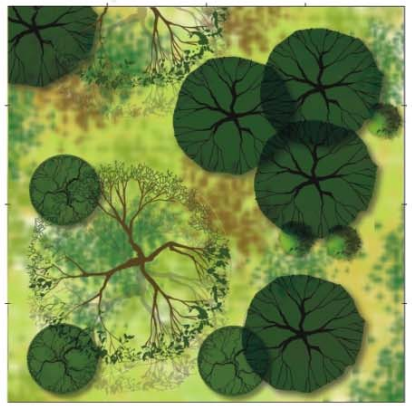
REGIONAL SETTING

The site sits amidst a rich agricultural belt with a rich tradition of horticulture. Numerous lakes dot the landscape constructed over centuries to cater to both irrigation and domestic needs; the general slope of the land is northward and the lakes form a inter connected network through a an intricate system of valleys and channels.



The general slope of the site is northeast, towards where is the largest water body in the proximity. Towards north west is a lone spur belonging to the range of Nandi hills. An excavated granite mine lies towards the south-east direction. Towards the west are two villages with population more than 10,000. Smaller settlements are spread along the roads and highway, mostly consisting of workers on agricultural fields encircling the site from all sides.

SITE SURROUNDINGS



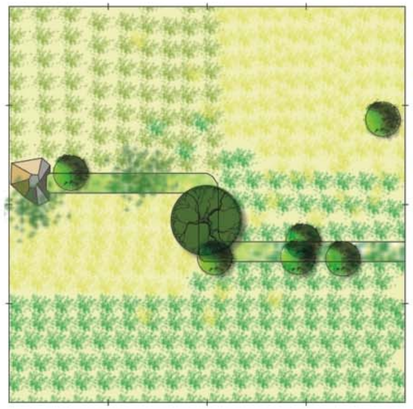
The woody species that are recorded from the 30m X 30m quadrat in the climax stage accounted for 37 species of tree canopy and storey level. The dominant species in the region under climax are *Hardwickia binate, Anogeissus latifolia, Chloroxylon swietentia, Albizia Amara.* But hardly these spices can be spotted due to the degradation.

The vegetation stratum is composed of Tree stratum (about 10 m high), Undergrowth of bushy shrubs and Graminaceous ground cover.

These degradation stages are the result of abusive and continuous exploitation of wood which has practically removed the tree stratum. The resulting increase in dryness at the level of the undergrowth and overgrazing favour the growth of thorny species.

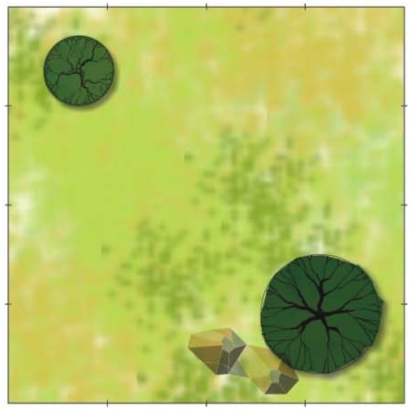
Among the most common species may be cited:

Acacia latronum
Albizia amara
Anogeissus latifolia (shrub form)
Cassia auriculata
Chloroxylon swietenia
Cymbopogon martini
Dodonaea viscosa
Euphorbia antiquorum
Ixora arborea
Lantana camara
Maytenus emarginata
Ziziphus oenoplia



Under intense biotic pressure, these dense thickets are reduced to discontinuous thickets whose shrubs are separated by large barren areas. In the ultimate stage, only a few shrubs which are inedible for animals are left on the denuded sites.

Bushy growth. It is very open formed of;
Cassia auriculata
Dichrostachys cinerea
Dodonaea viscose
Ixora arborea
Maytenus emarginata
Mundulea sericea
Xeromphis spinosa
Ziziphus xylopyrus
Climbers;
Abrusp recatorius
Acacia pennata
Butea superba
Calycopteris floribunda
Ziziphus oenoplia
Herbaceous;
Heteropogon contortus
Cymbopogon species
Aristida species
Eragrostis species



The abandoned patches of land are immediately covered with pioneering species of grasses.

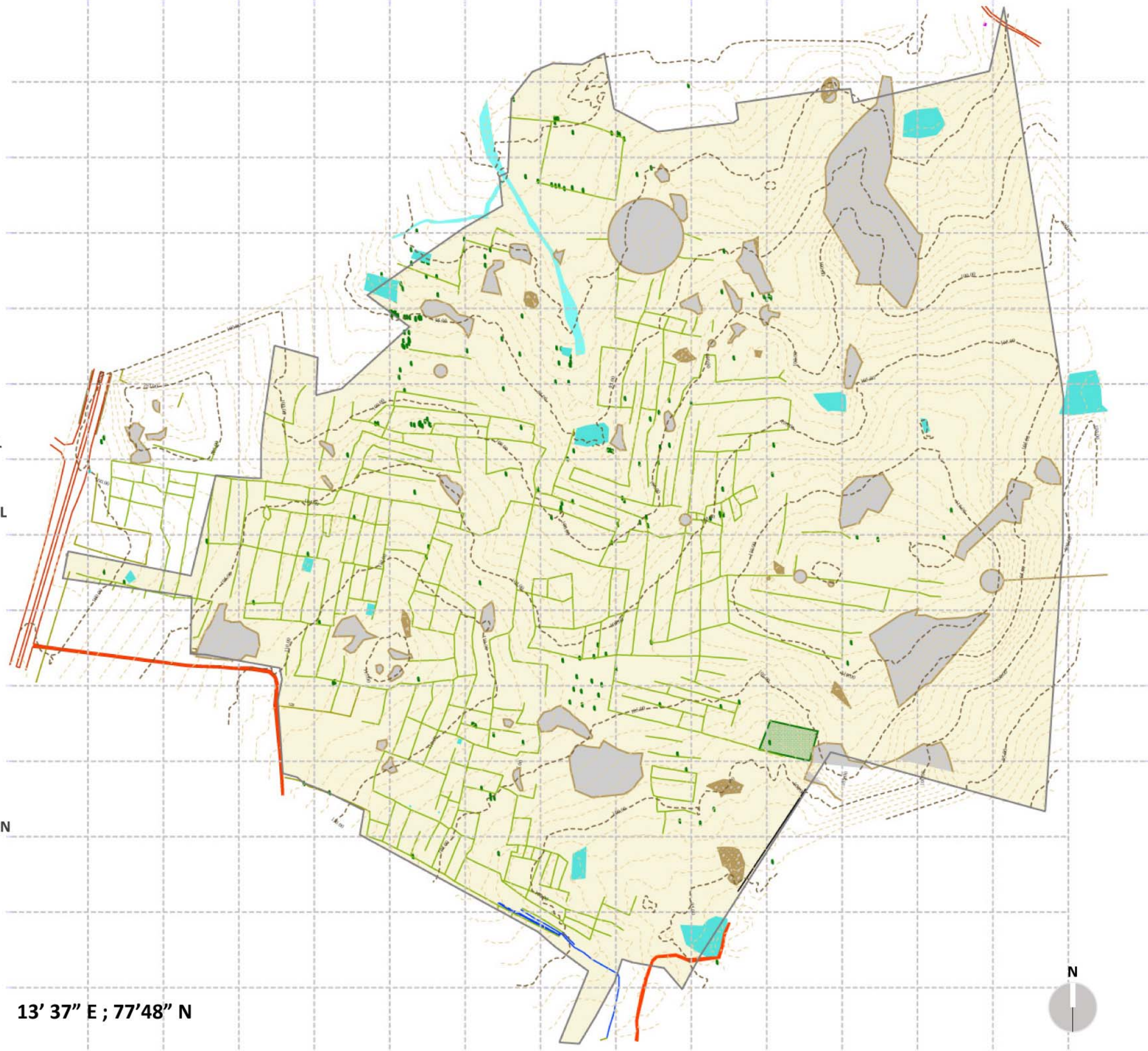
Some of the species identified are:

Alloteropsis cimicina
Arundinella pumila
Dactyloctenium aegyptium
Dichanthium annulatum
Eleusine coracana
Melinis repens
Oryza sativa
Pennisetum glaucum
Pennisetum orientale
Perotis indica
Phragmites karka
Saccharum officinarum
Sorghum bicolor
Sorghum halepense
Zea mays

QUADRAT STUDY

LAND SURVEY PLAN

NOTE: *All the following analysis diagrams prepared as part of this document, is based on the current available survey plan. All missing data/ features that have not been documented in this plan need to be additionally integrated in the final survey plan drawing.*



EXISTING FEATURES

MINOR CONTOUR @ 1M INTERVAL

MAJOR CONTOUR @ 10M INTERVAL

BUND FORMATION DUE TO AGRICULTURAL PRACTICES

ROCKY OUTCROPS

WATER FEATURES ON SITE

TREE PLANTATION AND VEGETATION

NATIONAL HIGHWAY 7

TOTAL SITE AREA : 244.50 Acres

13' 37" E ; 77'48" N

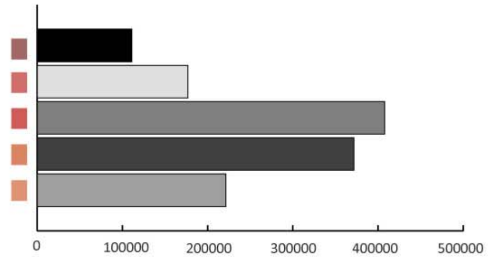
LAND ELEVATION CHARACTERISTICS

ELEVATION RANGE LEGEND

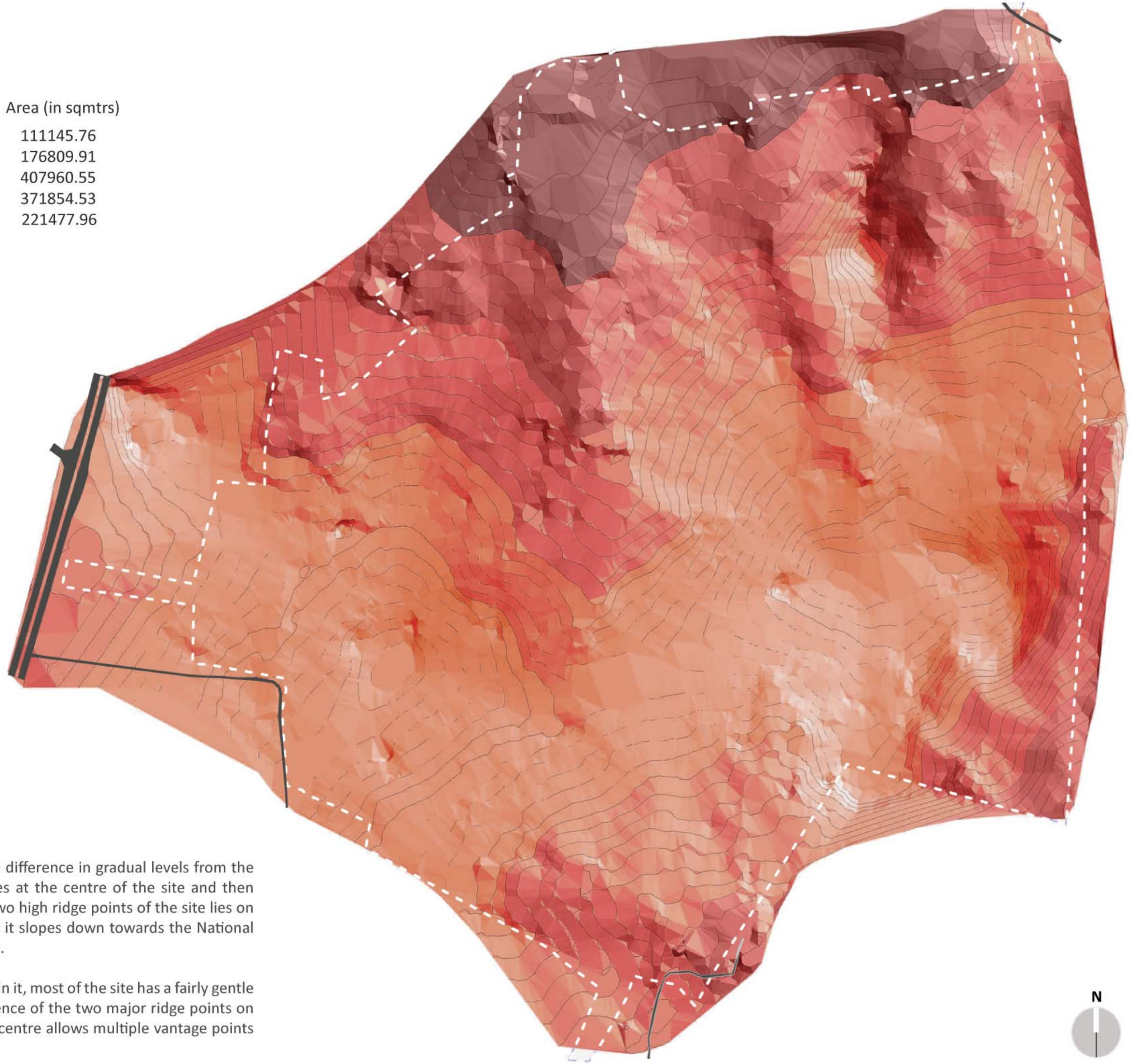
Color	Range Beg.	Range End	Percent	Area (in sqmtrs)
	83.00	89.00	8.6	111145.76
	89.00	95.00	13.7	176809.91
	95.00	102.00	31.6	407960.55
	102.00	108.00	28.8	371854.53
	108.00	115.00	17.2	221477.96

NATIONAL HIGHWAY 07

EXISTING MUD ROAD APPROACH



DISTRIBUTION OF ELEVATION RANGE IN AREA

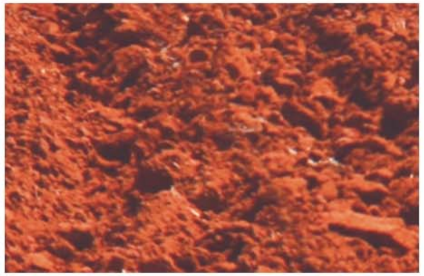


EXISTING CONDITIONS

The site lies on a gently sloping terrain with a 30 metre difference in gradual levels from the northern edge of the site till the highest point that lies at the centre of the site and then further slopes down towards the southern edge. The two high ridge points of the site lies on the Eastern and Western edges of the site, from where it slopes down towards the National Highway on the west and towards the valley on the east.

Though the site has a 30 metre elevation difference within it, most of the site has a fairly gentle slope with steep slopes almost non-existent. The presence of the two major ridge points on the East and the Western edges with the saddle in the centre allows multiple vantage points within the site with fairly distinct landscape terrains.

SOIL PROFILE



Red loamy soil: fertile soil, good for agriculture when tilled.

Red sandy soil: found near the ridges with vegetation

Sandy soil : found over water channels, minimal vegetation

Gravelly soil : found on ridges, well drained. Encourages certain species of grass and groundcover

Rocky outcrop: scattered throughout the site, well drained and hosts a few pioneer species of vegetation

SOIL MAPPING

SOIL TYPOLOGY A

A Yellow sandy gravel soil: Highly degraded due to erosion and no vegetation cover. Excessively drained.

SOIL TYPOLOGY B

B Sandy soil: associated with rocky outcrops; shallow, somewhat excessively drained, gravelly clay soil on ridge, severely eroded.

SOIL TYPOLOGY C

C Sandy clay soil: Associated with; shallow, somewhat excessively drained, gravelly clay soil on ridge, severely eroded.

SOIL TYPOLOGY D

D Clayey gravel soil: Found on ridges, well drained. Encourage certain species of grass and groundcover.

SOIL TYPOLOGY E

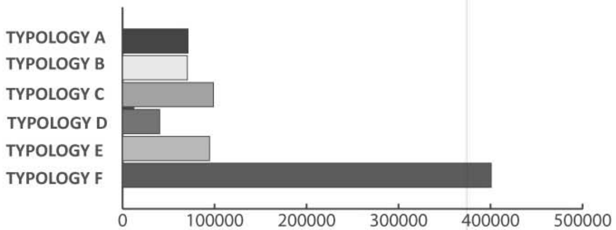
E Red sandy loam soil: Found over water channels in the form of sandy deposits due to sedimentation.

SOIL TYPOLOGY F

F Red loam soil: Fertile soil with good moisture availability and organic matter in it.

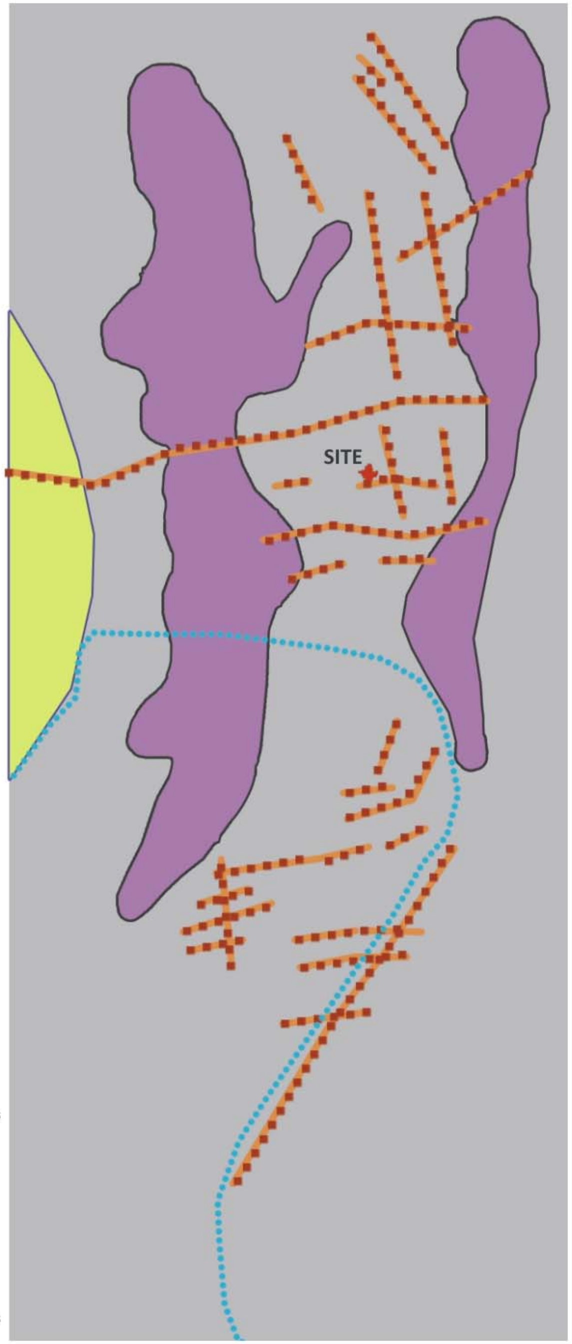
NATIONAL HIGHWAY 07

AREA DISTRIBUTION - SOIL TYPOLOGY



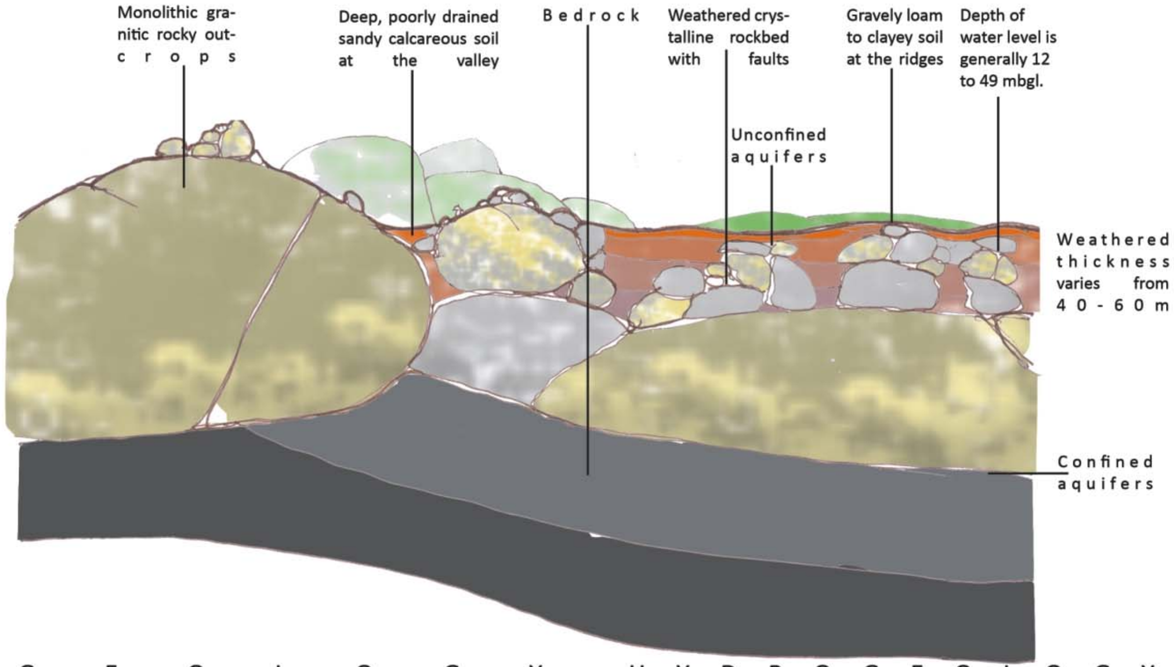
EXISTING CONDITIONS

Being a semi-arid area the district is drought prone.The soil is classified as Ustic (deficient in water). The soil is rich in P2O5 with composition of Lime (0.1-0.8 %), Nitrogen (0.1 %) and Fe & Al (30-40%). The ridges of the rolling terrain is covered by gravelly loam to clayey textured soil and in the valleys the soil is deep, poorly drained, sandy and calcareous in nature.



LEGEND

- Archean Peninsular gneiss and undivided granites
- Archean supracrustal belts
- Closepet batholith
- Proterozoic mafic dykes
- Mean groundwater level is 6.41m BGL



GEOLOGY

Archean complex / Peninsular gneiss

Oldest geological formation covering around 60% of the state. They consititute unfossiliferous, crystalline, contrasted and faulted rocks.

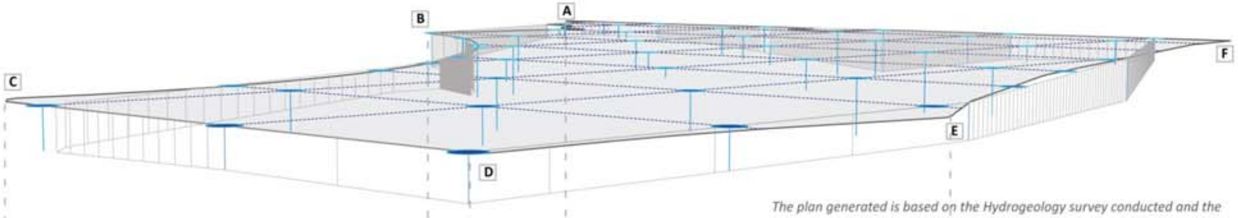
.The chief rock formation is granite which in intruded by dykes.

HYDROGEOLOGY

Major water bearing formation are Weathered and fractured granite rocks. Fractures or lineaments occupy well defined structural valleys.

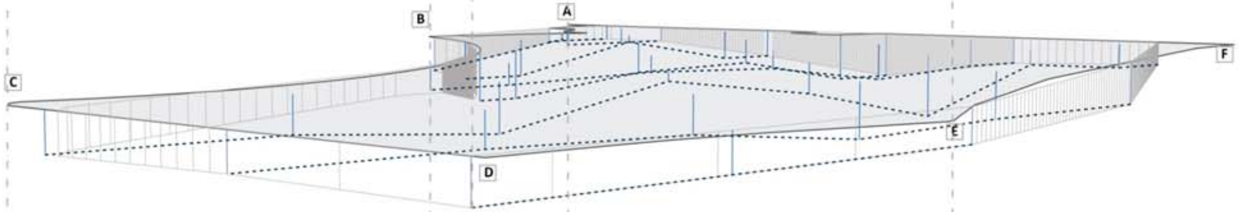
The occurrence and movement of groundwater is controlled by weathered zone and fractures and fissures that exist in hard rocks in the phreatic, semi-confined to confined conditions.

Geology



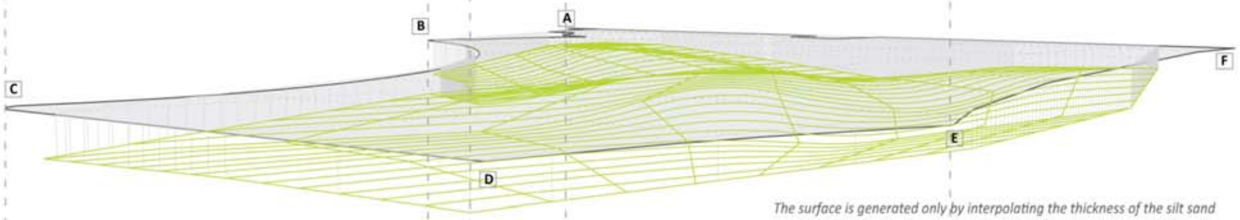
The plan generated is based on the Hydrogeology survey conducted and the grid points thus established during the survey. The depth of the silt sand layer have been given a vertical scale factor of 3 for visual representation.

1.SUBSURFACE LITHOLOGY GEO ELECTRIC POINTS



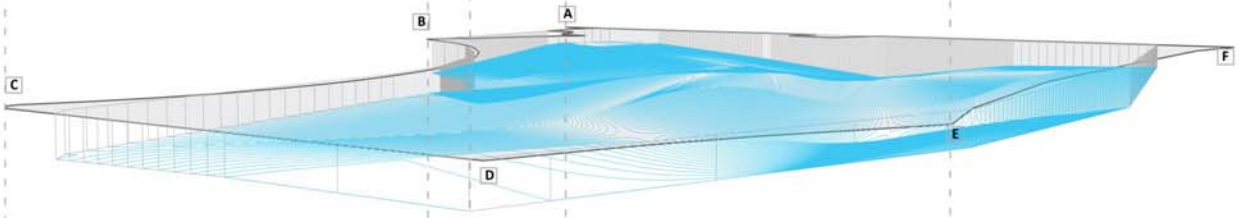
The diagram only shows the weaving and the interconncetion of the silt sand layer for the site and does not represent the further lithology layers. For all detailed Lithology layers, please refer Annexure.

2.LITHOLOGY - SILT SAND WEAVING



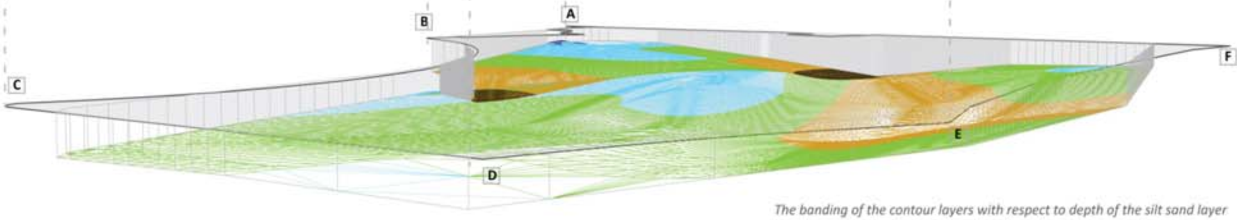
The surface is generated only by interpolating the thickness of the silt sand layer in the E-W axis. Due to non avaliabilty of geo station points along the periphery of the site,each point along the site edge has been assigned the same depth as its nearesr geo station point value.

3.LITHOLOGY - SILT SAND DEPTH SURFACE



The contou profile generated is with a contour interval of 0.25 m. Due to certain non -availibilty of data, certain edges of the site are seen to be clear without any assigned contour value

4.LITHOLOGY - SILT SAND LAYER CONTOUR FORMATION



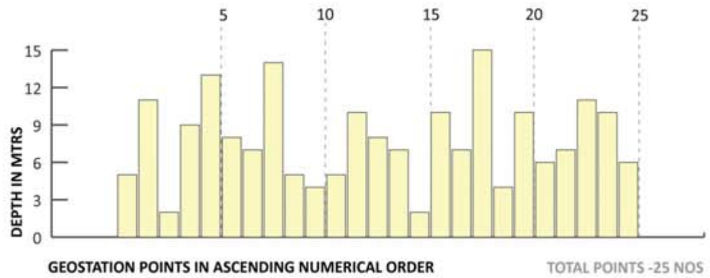
The banding of the contour layers with respect to depth of the silt sand layer has been categorized into 5 layers based on the maximum and minimum value of the depth. Due to a very insignificant portion of Layer 5, the same is not visible in the plan above.

5.LITHOLOGY - SILT SAND DEPTH RANGE

GEO ELECTRIC STATION POINTS AND DEPTH WEAVING

Based on the hydrogelogical data shared , geo station points are translated with depths as per the assigned values. The value of the silt sand layer, that is most crucial from the Master Planning perspective for this region is only evaluated.

To understand the sectional variation of the silt sand lithology layer, the depths of each of the geostation points are interconnected or weaved along the grid. This reflects a variation in profile across the at different segments of the site profile



SILT SAND LITHOOGY SURFACE FORMATION

Though the sectional variation along one grid generated the necessary varition,to use the information as aparmerter for sustainable development especially from the water managment perspective for this region it was important to built the entire profile of the lithology layer for the entire site.

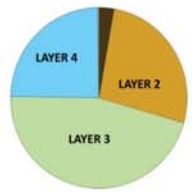
Based on the sectional variations of each grid, the values were interplotaed between each consecutive grid to arrive at the profile of this lithology that provided the varying morphological depths of the lithology layer.

SILT SAND LITHOLOGY CONTOUR PROFILE AND DISTRIBUTION

The next stage of analysis based on the surface formed, was to evaluate the distribution of the depth of the silt sand lithology layer across the entire site surface and not just geo station points as had been determined in the survey.

This was necessary to interpret the lithology layer as a tool to determine land use, and the Master Plan structure based on its distribution of depth as assigned from the generated contour profile. The distribution was categorized into 5 categories based on the range betweem its maximum and minimun depths. This revealed that depths along the centre are comparitively lower than its edges and the average dpeht ranges between -0.90m to -0.60m that spans the maximum area on site

LAYER 1		-15.0 M	-12.0 M	02.8 %	16795 sqm
LAYER 2		-12.0 M	-09.0 M	26.7 %	162542 sqm
LAYER 3		-09.0 M	-06.0 M	46.1%	280066 sqm
LAYER 4		-06.0 M	-03.0 M	24.3 %	147565 sqm
LAYER 5		-03.0 M	00.0 M	0.2%	1209 sqm



DISTRIBUTION OF SILT SAND LITHOLOGY LAYER ON SITE

MICRO WATERSHED MAPPING

WATERSHED LEGEND

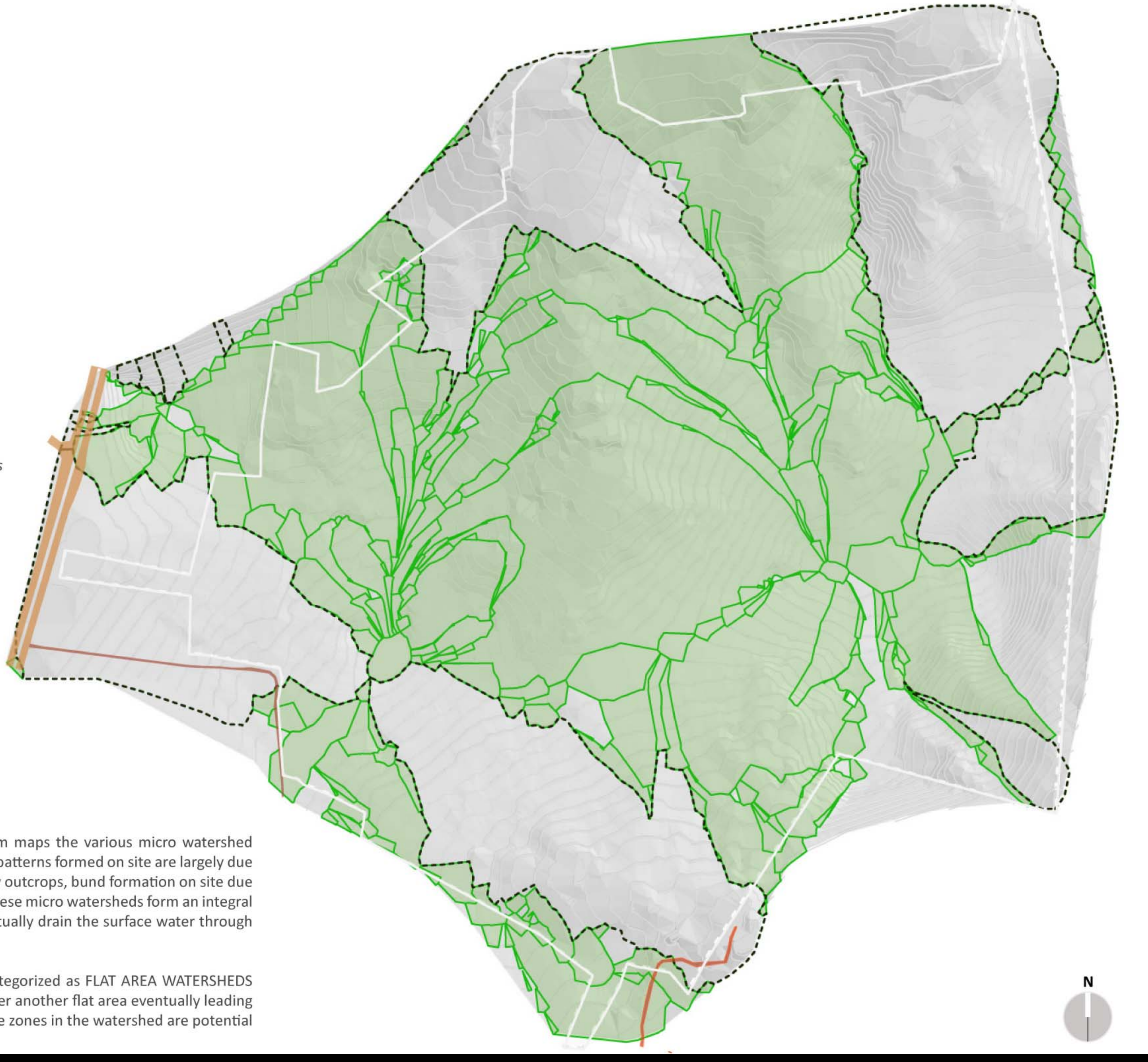
WATERSHED FLAT AREA

WATERSHED DEPRESSION AREAS

NATIONAL HIGHWAY 07

EXISTING MUD ROAD APPROACH

WATERSHED: n: *an area or ridge of land that separates waters flowing to different rivers, basins, or seas.*



EXISTING CONDITIONS

Based on the contour profile of the land, the diagram maps the various micro watershed patterns that are formed on site. The micro watershed patterns formed on site are largely due to the local level ground conditions comprising of rocky outcrops, bund formation on site due to past agricultural activity and large loose boulders. These micro watersheds form an integral part of the major watershed pattern on site that eventually drain the surface water through the valleys.

The micro watershed pattern identified on site are categorized as FLAT AREA WATERSHEDS -these areas receive the water and then drain into either another flat area eventually leading up to the depression areas - DEPRESSION AREAS - these zones in the watershed are potential harvesting zones on site

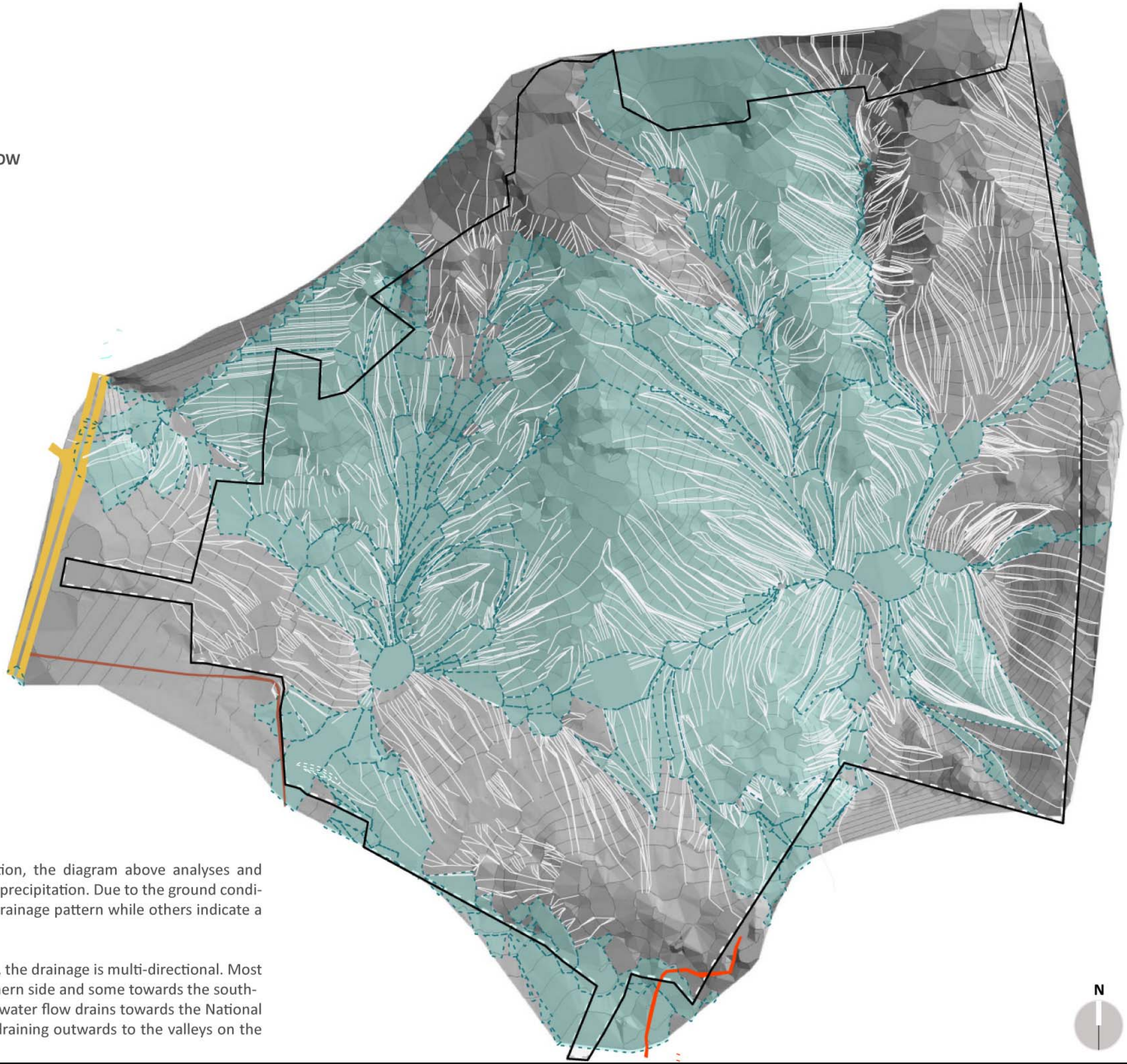
DRAINAGE FLOW PATTERN

DRAINAGE LEGEND

DIRECTION OF SURFACE WATER FLOW

NATIONAL HIGHWAY 07

EXISITNG MUD ROAD APPROACH



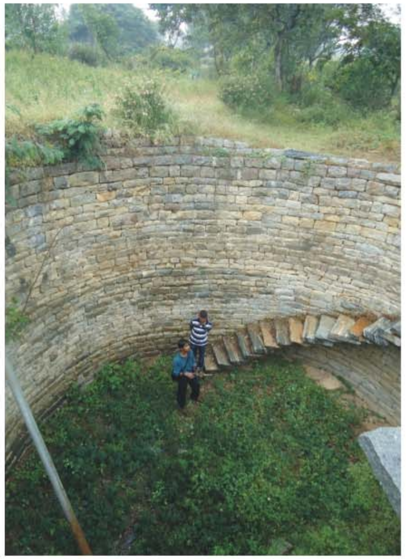
EXISTING CONDITIONS

Understanding the Micro Watershed pattern formation, the diagram above analyses and documents the surface run-off pattern of the incident precipitation. Due to the ground conditions on site, certain areas indicate a more sporadic drainage pattern while others indicate a contiguous flow pattern.

Based on the land layout and the ridge pattern on site, the drainage is multi-directional. Most of the surface water flows centrally towards the Northern side and some towards the south-eastern edge, leading to the existing lake. Substantial water flow drains towards the National Highway to the west; all other edges indicate water draining outwards to the valleys on the east and beyond the site boundaries.

WATER SYSTEMS

Water collection pond with rocky bed.



Large, dry open well adjacent to the site boundary now used through a bore-well

Check dam built of naturally available materials to control soil erosion and direct the flow of water.

Detention pond collecting storm water run-off. The water is muddy with the eroded soil carried by run-off.

Naturally vegetated swale that carry water from the catchment to collection ponds.

Streams carrying overflow from the ponds on the site.

Dam formed with boulders from the site to collect storm water run-off

Pond formed to capture water from the underground spring.

MAJOR WATERSHED ZONES

WATERSHED LEGEND

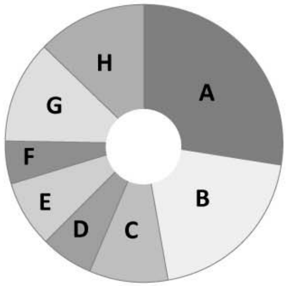
SL NO.	AREA(IN SQMTRS)
WATERSHED A	302294
WATERSHED B	216481
WATERSHED C	99344
WATERSHED D	67321
WATERSHED E	85028
WATERSHED F	55470
WATERSHED G	128972
WATERSHED H	138288

WATERSHED A ; WATERSHED D

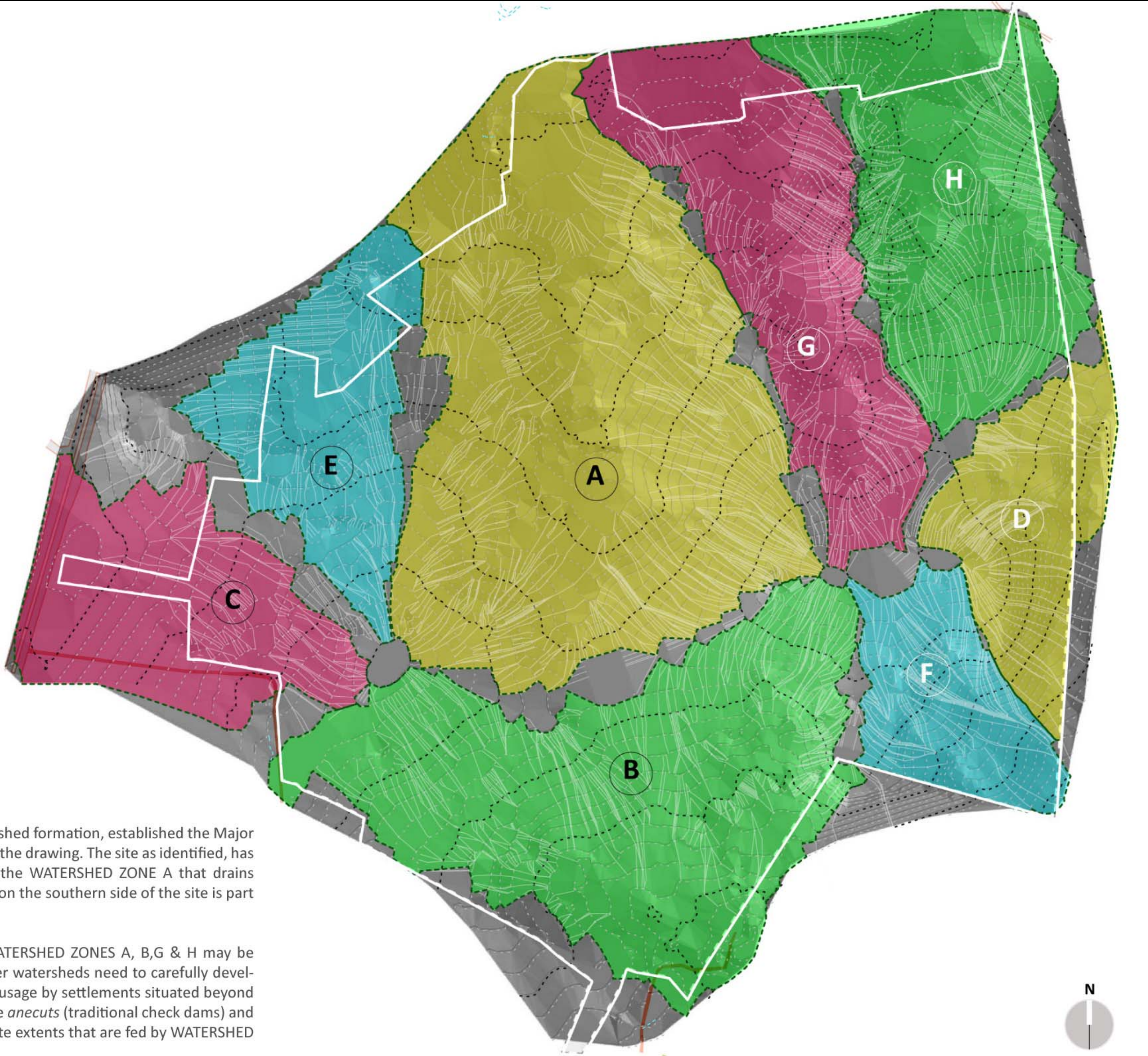
WATERSHED C; WATERHSED G

WATERHSED E; WATERHSED F

WATERHSED B; WATERHSED H



DISTRIBUTION GRAPH OF WATERSHED ON SITE

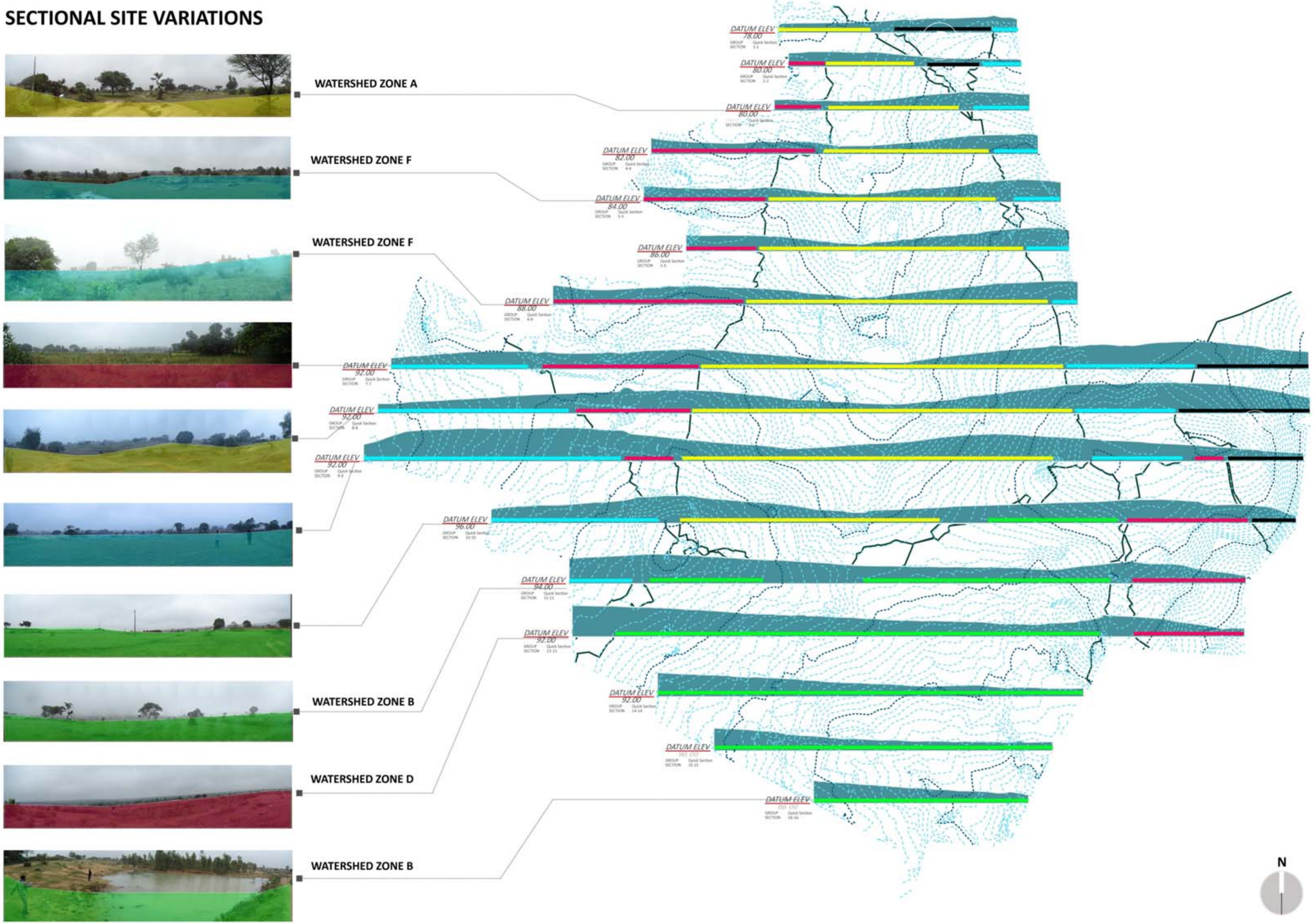


EXISTING CONDITIONS

The profile of the drainage pattern and the micro watershed formation, established the Major Watershed areas of the site which are as demarcated in the drawing. The site as identified, has 8 MAJOR WATERSHED AREAS with the largest being the WATERSHED ZONE A that drains towards the northern side of the site. The existing lake on the southern side of the site is part of WATERSHED ZONE B.

Though most of the surface water flow flowing in WATERSHED ZONES A, B,G & H may be harvested on site as part of the development, the other watersheds need to carefully developed so as to not affect the water rights and potential usage by settlements situated beyond the site extants. This is especially important as there are *anecuts* (traditional check dams) and water harvesting structures documented beyond the site extents that are fed by WATERSHED ZONE C& E

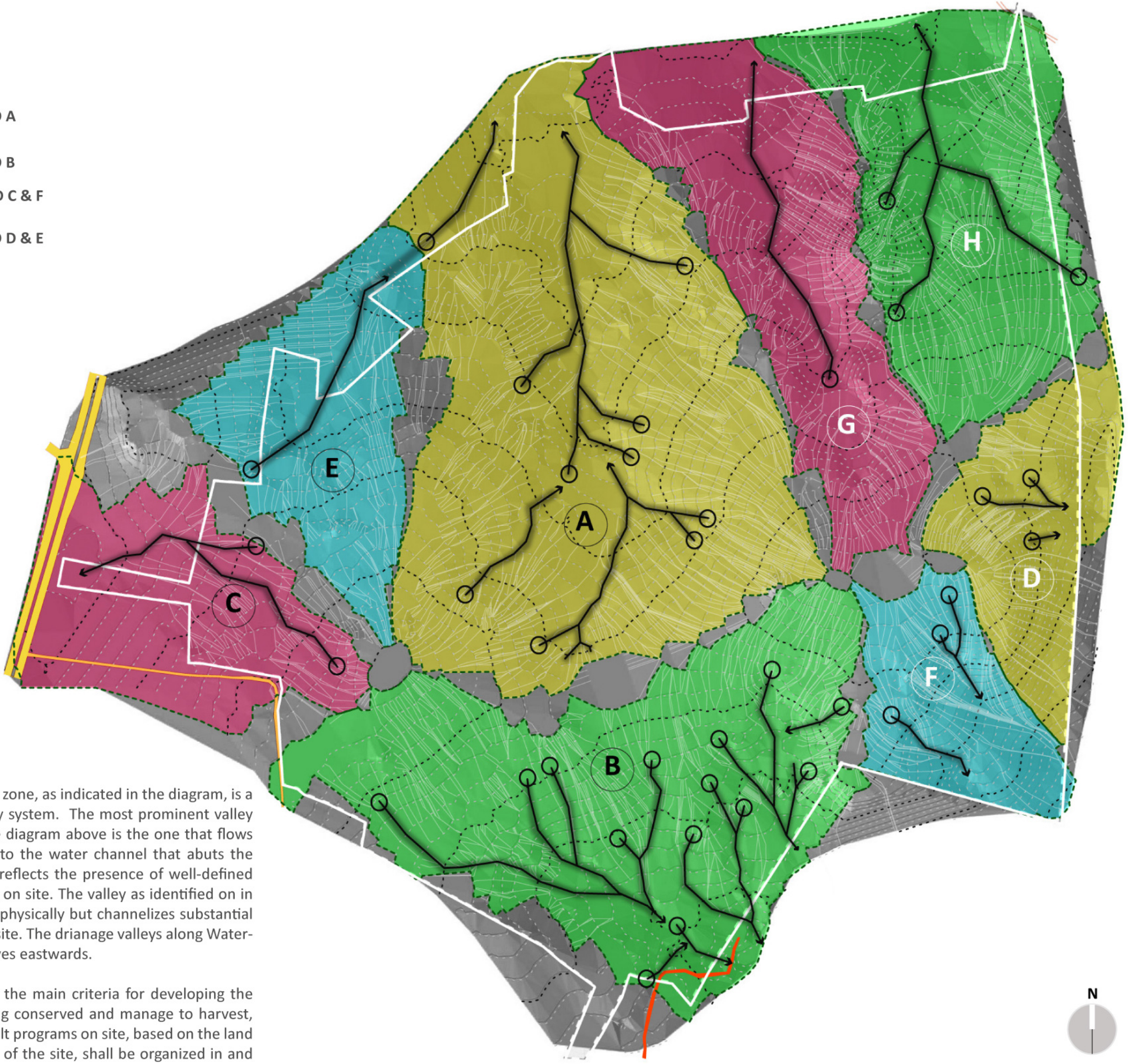
SECTIONAL SITE VARIATIONS



VALLEY PATTERN FORMATION

VALLEY LEGEND

- VALLEY DIRECTION FOR WATERSHED A
- VALLEY DIRECTION FOR WATERSHED B
- VALLEY DIRECTION FOR WATERSHED C & F
- VALLEY DIRECTION FOR WATERSHED D & E
- VALLEY FLOW DIRECTION PATTERN
- VALLEY FLOW START POINT
- NATIONAL HIGHWAY 07
- EXISTING MUD ROAD APPROACH



EXISTING CONDITIONS

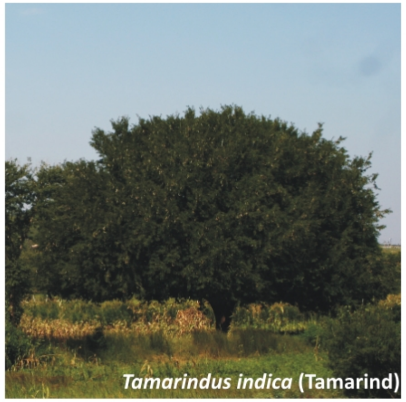
The valley pattern identified on site for each watershed zone, as indicated in the diagram, is a reflection of the regional 'DENDRITIC' pattern of valley system. The most prominent valley pattern on site as seen on ground and reflected in the diagram above is the one that flows within WATERSHED ZONE A and eventually connects to the water channel that abuts the northern edge of the site. WATERSHED ZONE B also reflects the presence of well-defined drainage channels which mostly feed the lake existing on site. The valley as identified on in WATERSHED ZONE C is not very prominent on ground physically but channelizes substantial water towards the water body beyond the edge of the site. The drianage valleys along Watershed E, A G & H eventually drain in to the nala and moves eastwards.

s

All the valley zones and watersheds identified will be the main criteria for developing the structure of the Master Plan; these critical zones being conserved and manage to harvest, retain and recharge the natural balance of land. The built programs on site, based on the land capacity of each Watershed along with visual qualities of the site, shall be organized in and


Azadirachta indica (Neem)


Acacia nilotica (Babool)


Tamarindus indica (Tamarind)


Pongamia glabra (Indian beech)


Acacia farnesiana (Sweet acacia)


Cocos nucifera (Coconut)


Eucalyptus spp. (Eucalyptus)


Butea monosperma (Flame of the forest)


Dalbergia sissoo (Indian rosewood)

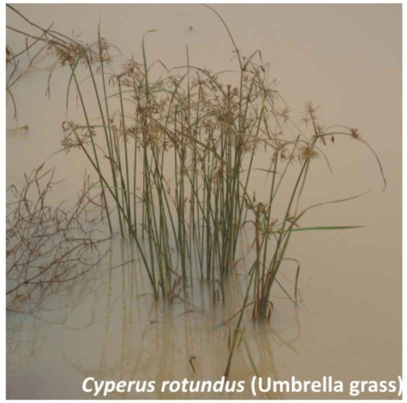

Anacardium spp. (Cashew)


Cassia auriculata (Tanner's cassia)


Dodonea viscosa (Dodonea)

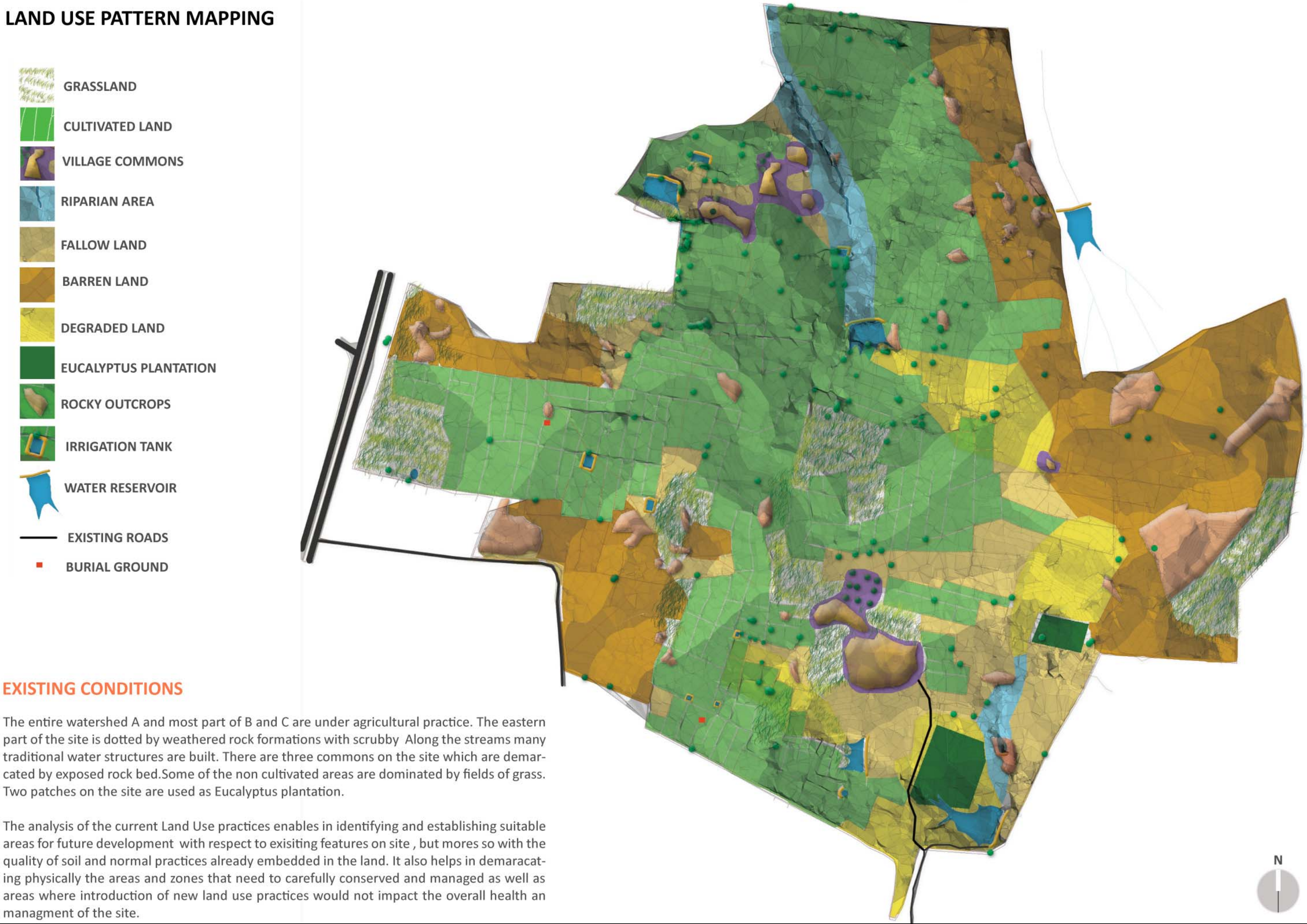

Lantana camara (Lantana)


Agave americana (Agave)


Cyperus rotundus (Umbrella grass)

FLORA -Trees and Shrubs

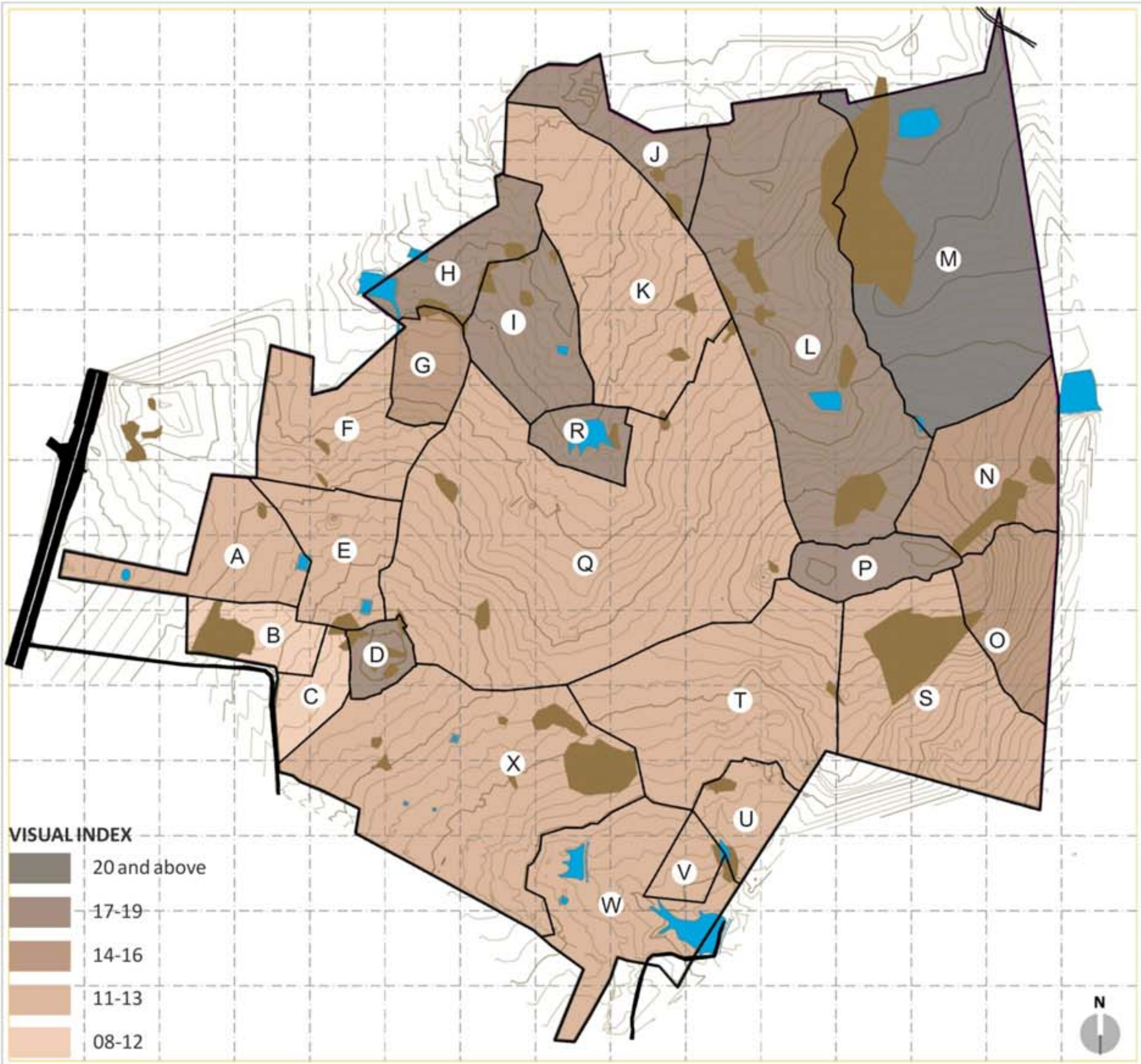
LAND USE PATTERN MAPPING



EXISTING CONDITIONS

The entire watershed A and most part of B and C are under agricultural practice. The eastern part of the site is dotted by weathered rock formations with scrubby Along the streams many traditional water structures are built. There are three commons on the site which are demarcated by exposed rock bed.Some of the non cultivated areas are dominated by fields of grass. Two patches on the site are used as Eucalyptus plantation.

The analysis of the current Land Use practices enables in identifying and establishing suitable areas for future development with respect to exisiting features on site , but mores so with the quality of soil and normal practices already embedded in the land. It also helps in demaracating physically the areas and zones that need to carefully conserved and managed as well as areas where introduction of new land use practices would not impact the overall health an managment of the site.



LANDFORM

Highly eroded formations, rocky outcrops, rows of high hills **5**

Steep slope, variety in size and shape of landforms, interesting features though not dominant **3**

Low rolling hills, foot hills, flat valley bottom, detailed landscape features. **1**

VEGETATION

A variety of vegetation types, dense vegetation, textures and patterns **5**

Specific type of vegetation, one or two types **3**

Sparse vegetation, contrast in vegetation **1**

WATER

Clear and clean appearing still, flowing, cascading, white water, dominant factor overall **5**

Flowing or still water but not dominant in landscape **3**

Not noticeable **0**

COLOR

Rich color combination, pleasing contrast, variety of vivid colors in landscape elements. **5**

Some color intensity or variety in colors, not a dominant scenic element. **2**

Subtle color variation, contrast or interest, generally muted tones. **1**

SCARCITY

One of a kind, very rare in/ within region, memorable presence of wildlife or wild flowers **6**

Distinctive though somewhat similar to others within that region **2**

Interesting within its setting but fairly common within the region. **1**

CULTURAL MODIFICATIONS

Free from aesthetically undesirable or discordant sights or modifications, add favourably to visual variety. **2**

Scenic quality is depreciated by inharmonious or modification, add little or no visual variety to the area **0**

Modifications are so extensive that scenic qualities are mostly nullified or substantially reduced **-4**

VIEWSHEDS	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
LANDFORM	1	5	5	5	1	5	5	1	5	5	5	5	5	5	5	5	3	5	5	3	5	1	1	5
VEGETATION	3	3	3	3	3	3	5	3	5	5	3	5	5	3	3	3	3	5	3	3	3	3	3	3
WATER	3	0	0	1	3	0	0	3	5	3	0	5	5	3	3	1	0	5	0	0	0	0	5	0
COLOR	1	1	1	5	1	1	1	1	1	2	1	1	2	2	2	5	2	1	2	2	1	1	1	1
SCARCITY	1	1	1	2	1	1	1	1	1	1	1	1	2	1	1	2	1	1	1	1	1	6	1	1
CULTURAL MODIFICATIONS	2	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
TOTAL VISUAL INDEX	**11**	**10**	**10**	**18**	**11**	**12**	**14**	**17**	**19**	**18**	**12**	**19**	**21**	**16**	**16**	**18**	**11**	**19**	**13**	**11**	**12**	**13**	**13**	**12**

VISUAL ANALYSIS

LAND USE CHARACTER

GROVES OF TREES WITH A FRAGMENTED VIEW OF THE SURROUNDING

PLANTATION OF EXOTIC VEGETATION WITH DEGRADED SOIL CHARACTER

ROCKY LANDSCAPE WITH UNDERSTOREY VEGETATION, OVERLOOKING THE REGION

FALLOW LAND WITH FEW WEED AND GRASS PATCHES AND MOSTLY WITH EXPOSED TOP SOIL

HIGHLY DEGRADED LAND WITH NEGLIGIBLE VEGETATION COVER AND SEVERE SOIL EROSION WITH GULLY FORMATIONS

PATCHES OF GRASSLAND DOMINATE THE LANDSCAPE

CRITICAL CATCHMENT WITH EXISTING NETWORK OF TRADITIONALWATER SYSTEMS

RIDGE AREA AS VANTAGE POINT WITH A WIDE OPEN VIEW OF THE REGION

ROCKY OUTCROPS AS VILLAGE COMMONS WITH CHARACTERISTIC THATCH MOUNDS

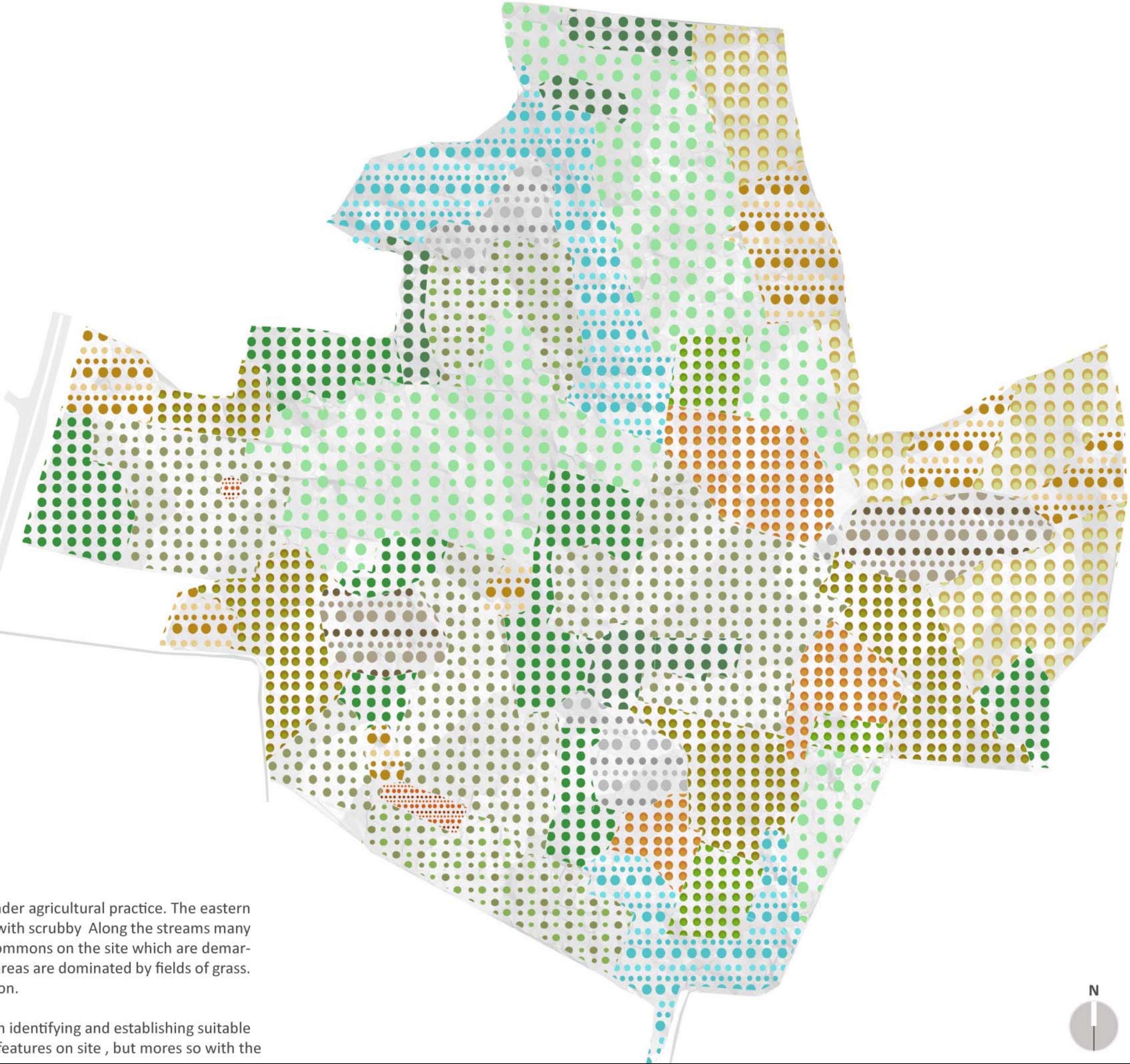
BURIAL GROUND AND IRRIGATION TANKS AS VILLAGE COMMONS

BOULDER FORMATIONS DOMINATE THE LAND-SCAPE

CULTIVATED LAND WITH MIXED CROPPING PRACTICE

CULTIVATED LAND WITH MONO CROPS AND DEGRADED SOIL CHARACTER

TERRACED FIELDS WITH GOOD SOIL CONDI-TION



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LAND CAPABILITY ANALYSIS

BUILDABLE FEASIBILITY

B I: Based on high visual quality, gentle slope, existing site features and soil character the land is suitable to be built on.

B II: Moderate visual quality, slightly degraded soil, fallow landscape and the influence of existing site elements.

B III: Not feasible to build due to terrain, presence of elements like rocky outcrops and burial ground and dense groves of trees.

RECREATIONAL FEASIBILITY

R I: Elevated ridges, village commons, rocky outcrops, dense groves and water systems along with high visual quality makes the space potential for Recreational activities.

R II: Non productive, moderately buildable, high to medium visual quality of space .

PRODUCTIVE LANDSCAPE FEASIBILITY

P I: Existing agricultural practices on terraces with good soil condition and to retain the regional character is defined as Productive zone I.

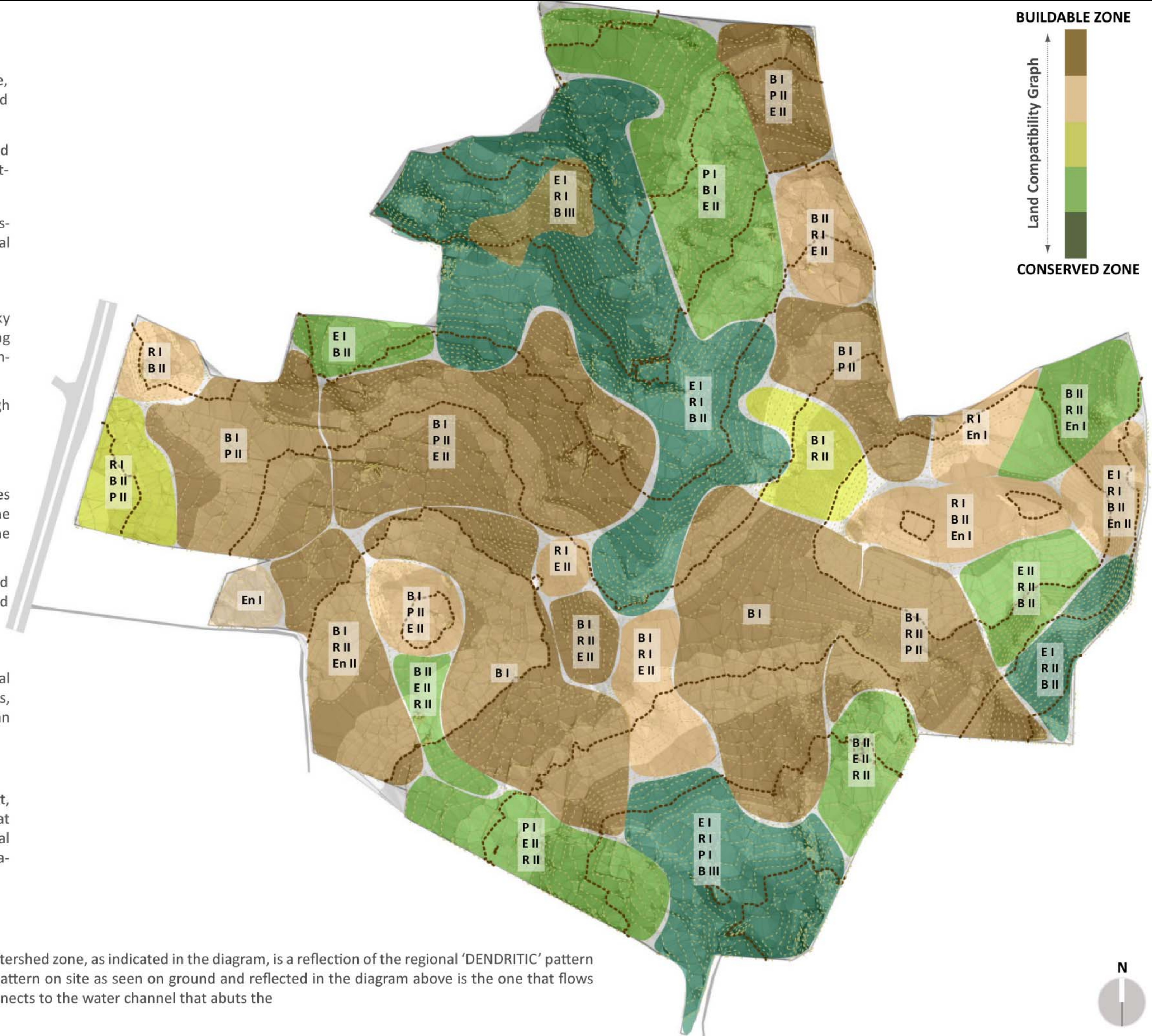
P II: Fallow lands, with average soil condition and few rocky outcrops have the potential to be build on and productive too.

ECOLOGICAL FEASIBILITY

E I: Critical zone for water, soil and ecological conservation. Elements like existing trees, streams and indigenous vegetation makes it an Ecological zone I.

ENERGY FEASIBILITY

En I: For the self sufficiency of the settlement, renewable source of energy can be harvested at areas with high elevation, devoid of any physical obstruction and non buildable and non cultivable areas. Which makes this as Energy zone.



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STORMWATER MANAGAMENT REQUIREMENT

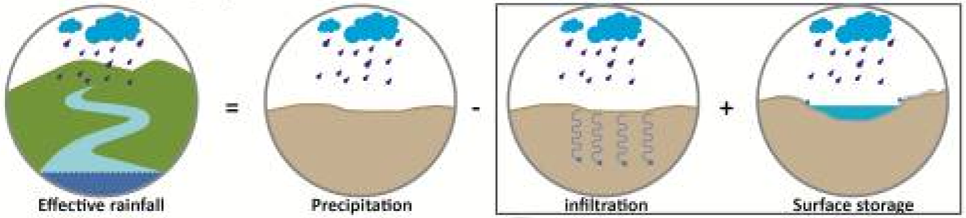
If rainfall intensity exceeds the infiltration rate, and all other abstractions are sated, runoff will occur. The amount of rainfall that becomes runoff during a storm is called the effective rainfall. Abstractions other than infiltration and surface storage can be ignored in a storm event. So, effective rainfall equals precipitation less infiltration and surface storage.

Effective rainfall, or runoff, is expressed by units of length. One cm (inch) of runoff is the runoff produced by one cm (inch) of effective rainfall over a specified site.

Curve number approach to estimating runoff

The curve number (CN) is a characteristic of soil type and cover.

Soil is divided into four hydrologic soil groups (HSGs) based on their infiltration capacity. Group A soils have the most rapid infiltration, and group D have the slowest. Generally, A soils are sandy, and D soils are heavy clays. The CN represents the potential for a soil to produce runoff from a given rainstorm.



The site belongs to the hydrologcal soil group D.

In the CN method, effective rainfall or runoff is estimated by the relationship:

$Q = (P-0.2S)^2 / P + 0.8\,S,\ P > 0.2S$

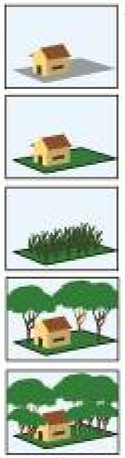
Q is the effective rainfall or runoff in inches or mm, P is precipitation, and S is a parameter given by:

$S = (1000/CN) - 10$

Precipitation (P) in inches = **5**

The following calculations provide the volume of storm water that has to be ameliorated with Integrated Management Practices.

IMPs are distributed, multifunctional, small-scale controls, selected for their ability to achieve the site design water quantity and quality objectives in a cost-effective manner. Clearly, BAU practices would require more IMPs than LID.



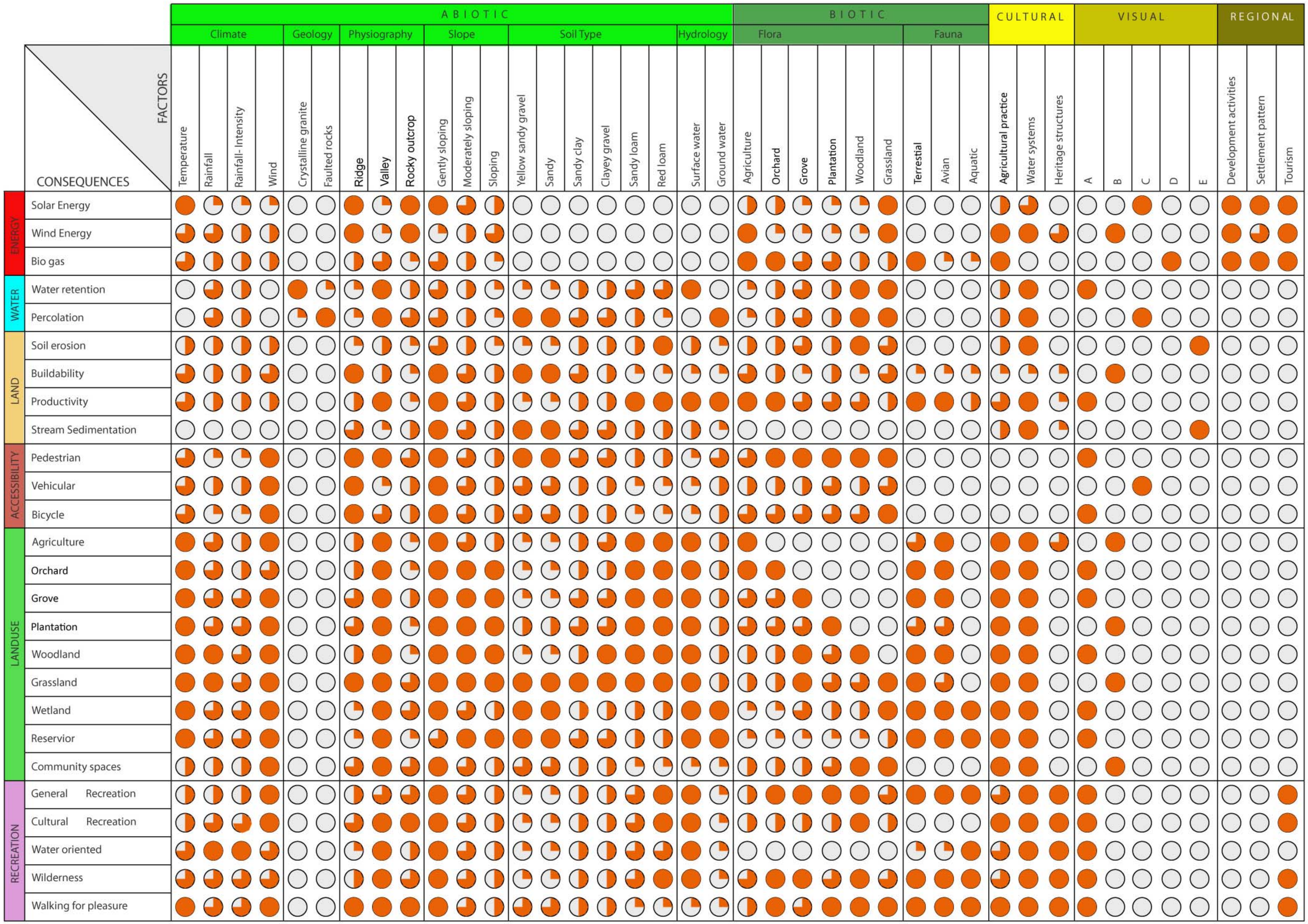
Groundcover / Curve number CN	The site in Vasind used to be forest with dense undergrowth	The site in Vasind is covered with pastures and fallow land at present	If Business as Usual (BAU) is carried out on the site	Low Impact Development (LID)
Hard paved, roofs etc 98	0%	0%	30%	10%
Turf 89	0%	0%	30%	10%
Row crops 84	0%	100%	0%	20%
Wood with light undergrowth 79	0%	0%	40%	40%
Wood with dense undergrowth 77	100%	0%	0%	20%
Composite curve number (CN)	77	84	87.7	82.5
S	2.99	1.90	1.40	2.12
Effective Rainfall in inches (Q)	**2.62**	**3.27**	**3.64**	**3.13**
The retention volume in cubic m. (area of site in sq.m. multiplied by the difference in effective rainfalls of any case-study and the virgin landscape)		**15.57**	**24.42**	**12.11**

Table for Curve Number (CN) for various groundcovers given in Annexure 2

	Rainwater Management		River Edge		Open-Space		Mobility		Water Management		Waste Management	
	Soft rainwater management	**Drained rainwater management**	**Soft River Edge**	**Hard River Edge**	**Productive**	**"Un-Productive"**	**Soft**	**Motorized**	**Decentralized**	**Centralized**	**Recycled**	**Non-recycled**
Design												
Principles	-Bio-swale, - Permeable parking surface, - Infiltration System	- Storm-water drainage system	- Flood plain with streamside wetland, - Gabion placement, Joint Planting	- Embankment of the river edge, - Built canal	- Urban Farming - Community sharing open-space	- Park and Playground (natural or impervious ground)	- Dedicated and secured pedestrian and cycle paths - Proximity with public Transport	- Road widening	- Phytoremediation and treatment plant, - Artificial wetland	-Piped water supply and drainage	- Compost of organic waste	- Centralised Waste Disposal at City Level
Objectives	- Promote natural infiltration of rainwater, - Limit impervious surface	- Collect rainwater in drains	- Leave natural space to allow water spread	- Raise an artificial bank to contain / redirect water	- Plant open spaces, grow food + animal husbandry - Create non-built space	- Create non-built space for social and collective usage	- Dedicate space for pedestrian and cyclist	- Increase performance of motorized transport	- Treat and recycle water closest to its usage	- Collect and drain waste water away from source	- Recycle organic waste as a nutrient for urban farming	- Collect Solid Waste for distant disposal
Time of implementation *(1=long, 2 = medium, 3=short)*	2	3	3	1	2	1	1	1	2	2	2	2
Cost of implementation *(1=high, 2 = medium, 3=low)*	3	1	3	1	2	3	2	1	3	1	3	2
Skills Required *(1=high, 2 = medium, 3=low)*	2	1	2	1	3	1	2	2	1	1	3	2
Implementation Index (100)	**78**	**56**	**89**	**33**	**78**	**56**	**56**	**44**	**67**	**44**	**89**	**67**
Frequency of maintenance *(1=high, 2 = medium, 3=low)*	3	1	2	3	1	2	2	2	2	1	2	2
Cost of maintenance *(1=high, 2 = medium, 3=low)*	2	1	1	2	2	1	2	2	2	1	2	1
Skills/Materials *(1=high, 2 = medium, 3=low)*	2	3	3	2	2	2	3	3	2	1	2	2
Maintenance Index (100)	**78**	**56**	**67**	**78**	**56**	**56**	**78**	**78**	**67**	**33**	**67**	**56**
Run-Off Volume *(1=High, 2=medium, 3=low)*	3	1	3	1	3	1	2	1	3	1	-	-
Resilience *(1=High, 2=medium, 3=low)*	3	1	3	1	3	1	3	1	2	1	3	1
Velocity *(1=High, 2=medium, 3=low)*	3	1	3	1	3	1	2	1	3	1	-	-
Flexibility of the system *(1=low, 2=medium, 3=high)*	3	1	3	1	3	1	3	1	3	1	3	1
Downstream Impacts *(1=High, 2=medium, 3=low)*	2	1	2	1	2	1	2	1	3	1	-	-
Flood Mitigation Index (100)	**93**	**33**	**93**	**33**	**93**	**33**	**80**	**33**	**93**	**33**	**100**	**33**
Increased biodiversity *(1=low, 2=medium, 3=high)*	3	1	3	1	3	1	3	1	3	1	-	-
Erosion Prevention *(1=low, 2=medium, 3=high)*	3	1	3	1	3	1	-	-	3	1	-	-
Water Recycling *(1=low, 2=medium, 3=high)*	2	1	2	1	3	2	-	-	3	1	-	-
Waste Recycling *(1=low, 2=medium, 3=high)*	2	1	2	1	3	1	-	-	2	1	3	1
Absorption/Reduction of Pollution *(1=low, 2=medium, 3=high)*	3	1	3	1	3	1	3	1	3	1	3	1
Environmental Index (100)	**87**	**33**	**87**	**33**	**100**	**40**	**100**	**33**	**93**	**33**	**100**	**33**

LAND COMPATIBILITY MATRIX

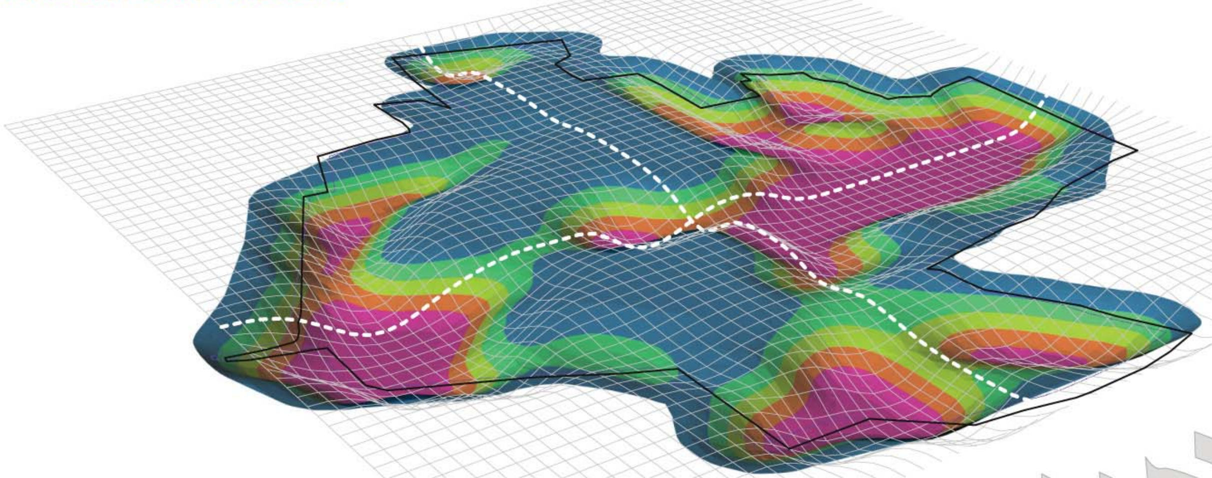
MAXIMUM COMPATIBILITY · MEDIUM COMPATIBILITY · LOW COMPATIBILITY · INCOMPATIBLE · NOT RELEVANT

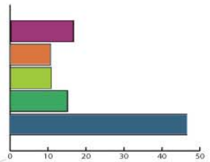


LAND CAPABILITY - CONTOUR GRAPH

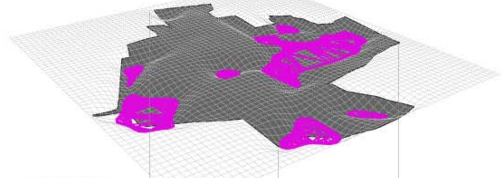
BUILDABLE BAND ◄ Land Compatibility Graph ► CONSERVED BAND

LAND CAPABILITY BANDING



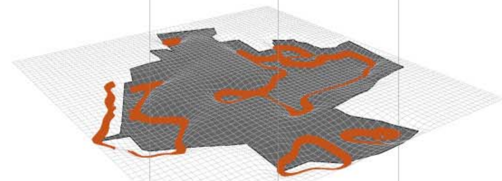


BANDING DISTRIBUTION (IN %)



LAYER 1

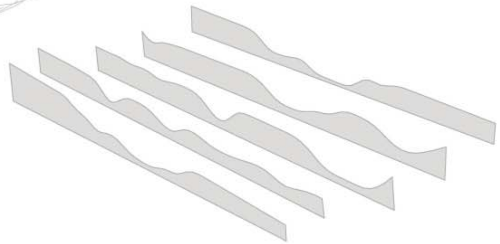
E1 > En 1> P2 >R1 >B3 CONSERVED >> BUILDABLE



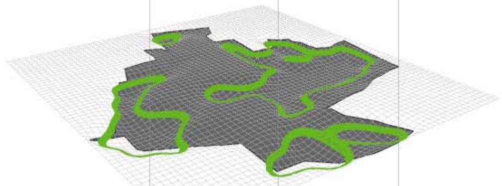
LAYER 2

RII = En1 =P2 > E1 > B3 CONSERVED > BUILDABLE

En I: For the self sufficiency of the settlement, renewable source of energy can be harvested at areas with high elevation, devoid of any physical obstruction and non buildable and non cultivable areas. Which makes this as Energy zone.En I: For the self sufficiency of the settlement, renewable source of energy can be harvested at areas with high elevation, devoid of any physical obstruction and non buildable and non cultivable areas. Which makes this as Energy zone.



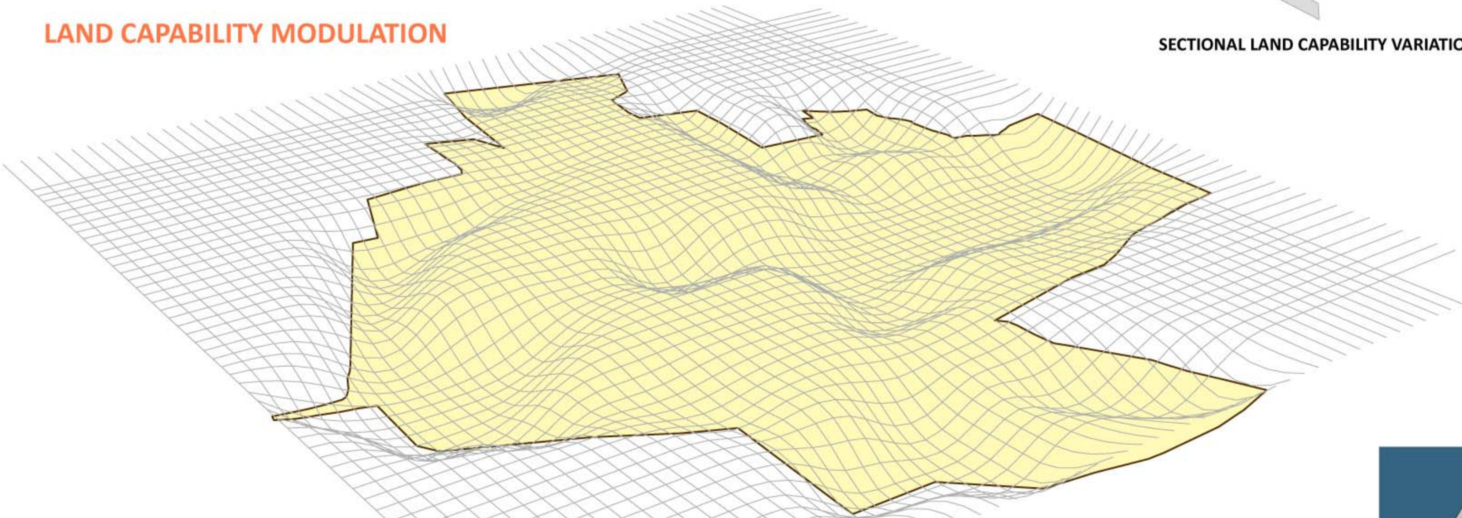
SECTIONAL LAND CAPABILITY VARIATION

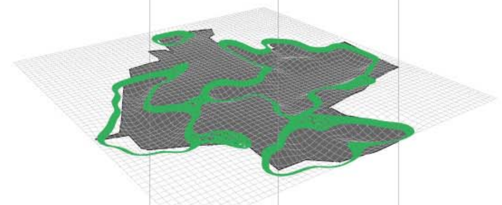


LAYER 3

RI = BI = P2 > E1 > En 1 CONSERVED = BUILDABLE

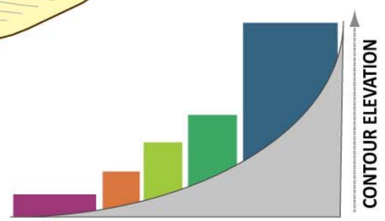
LAND CAPABILITY MODULATION



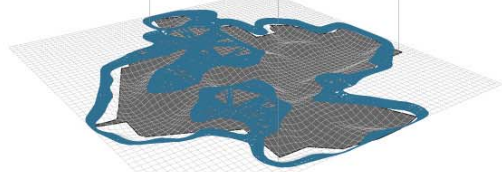


LAYER 4

BII = RI > P1 > E1 > En 1 BUILDABLE > CONSERVED



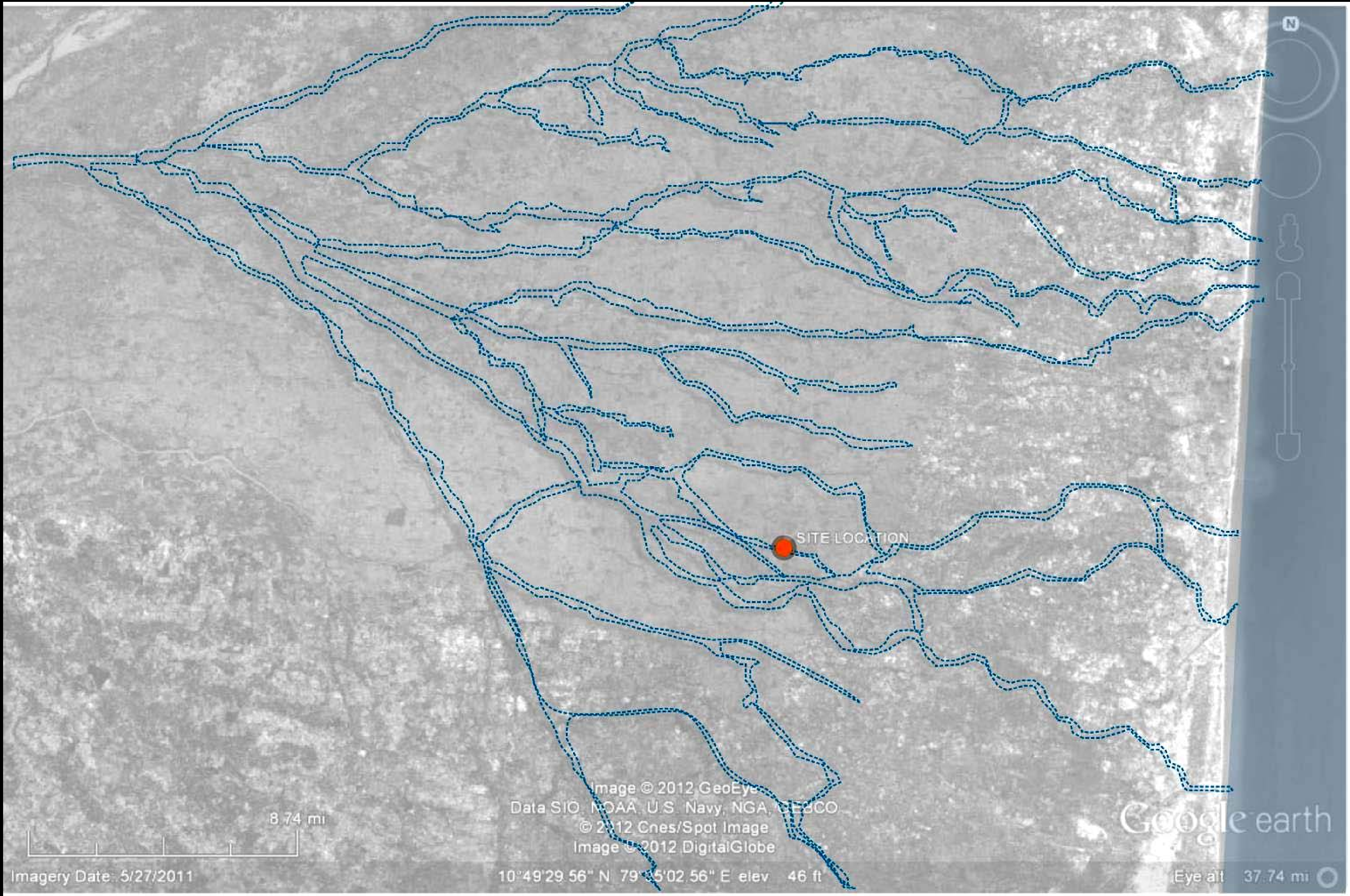
BANDING GRAPH



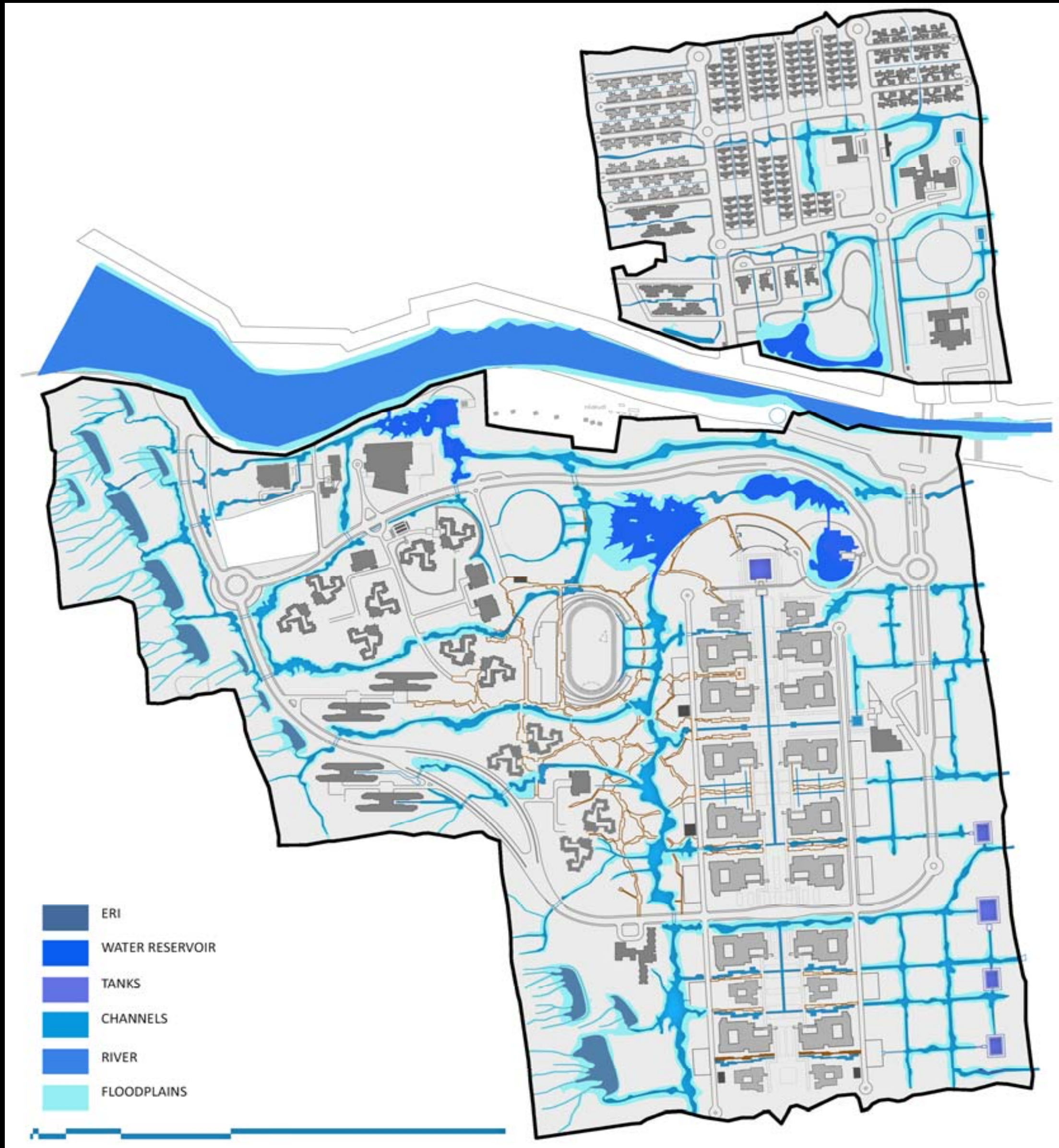
LAYER 5

B1 > RI > P1 > E1 > En 1 BUILDABLE >> CONSERVED

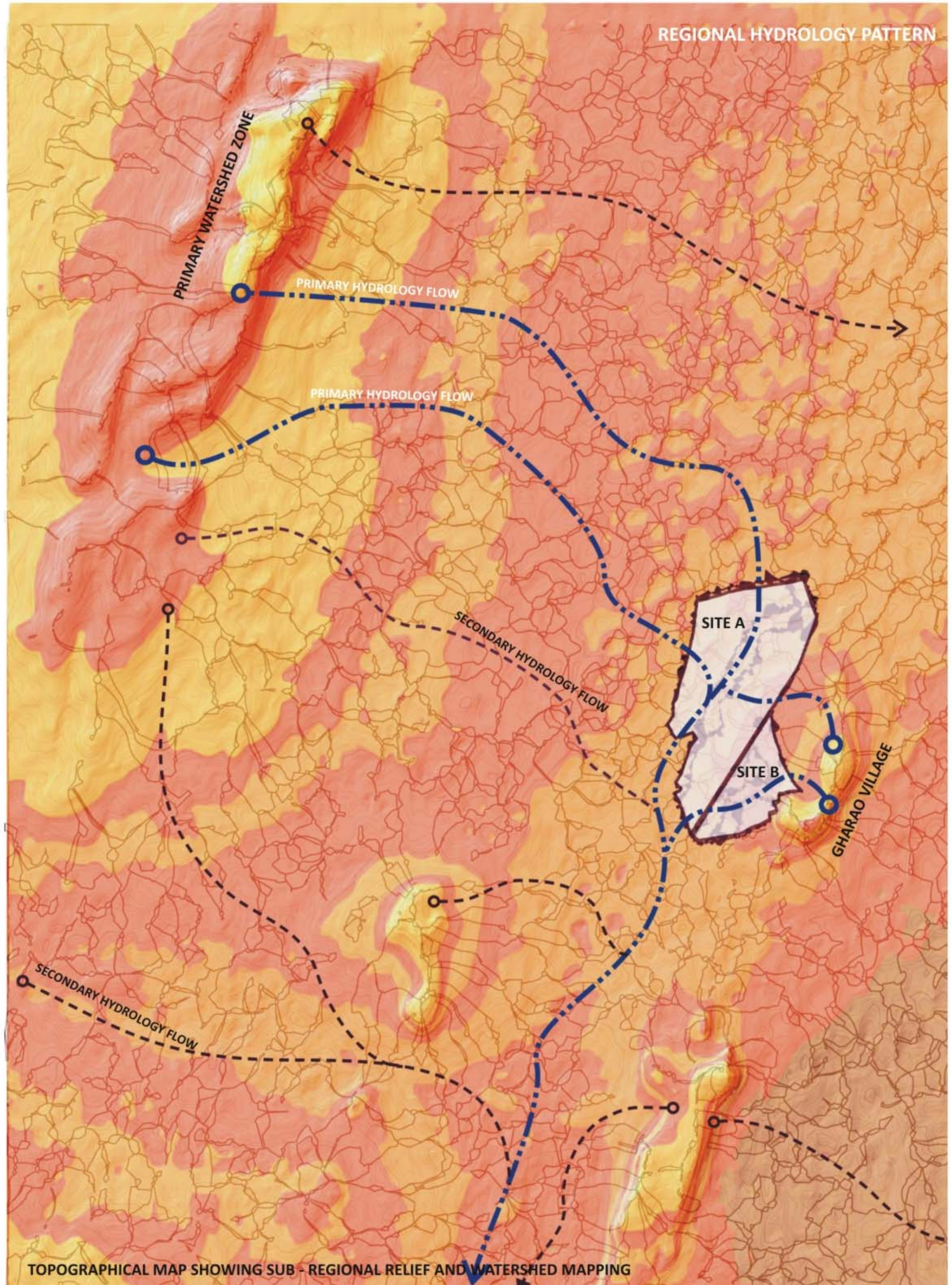
En I: For the self sufficiency of the settlement, renewable source of energy can be harvested at areas with high elevation, devoid of any physical obstruction and non buildable and non cultivable areas. Which makes this as Energy zone.En I: For the self sufficiency of the settlement, renewable source of energy can be harvested at areas with high elevation, devoid of any physical obstruction and non buildable and non cultivable areas. Which makes this as Energy zone.


SITE LOCATION
8.74 mi
Imagery Date: 5/27/2011
Eye alt 37.74 mi
Google earth

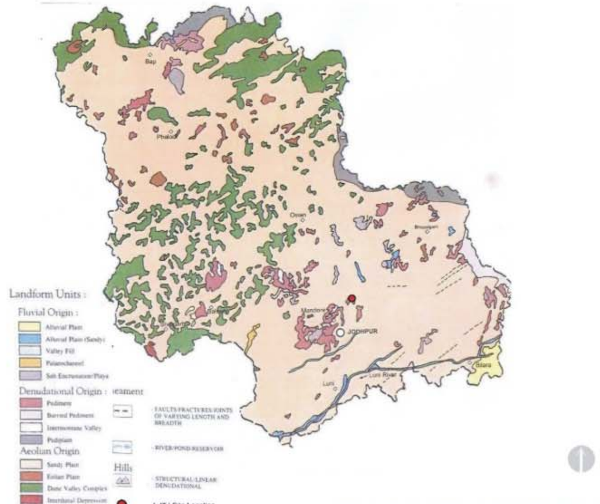
Avudaiyarkoil
Pandipathiram, Tamil Nadu, India
Pandipathiram
26
Avudaiyarkoil Mimisal Rd
Semmanampottal Kottaippattinam Rd
© 2012 Google
Image © 2012 GeoEye
© 2012 Cnes/Spot Image
Google earth
9812 ft
Imagery Date: 8/6/2009
2002
10°03'55.97" N 79°04'59.70" E elev 83 ft
Eye alt 42605 ft



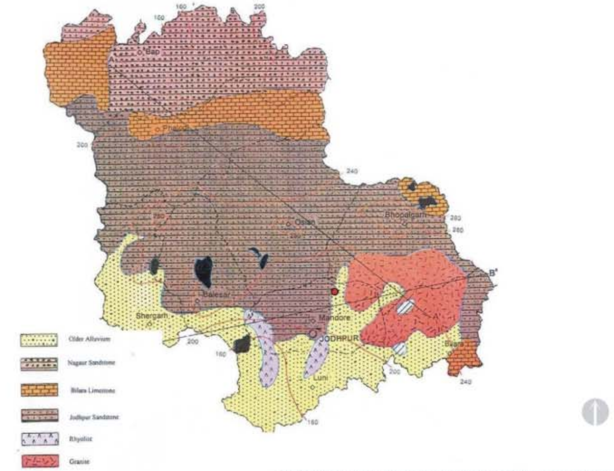
EVOLVING A STRATEGY BASED ON TRADTIONAL INTELLIGNECE



ELEVATION RANGE



JODHPUR GEOLOGY PATTERN



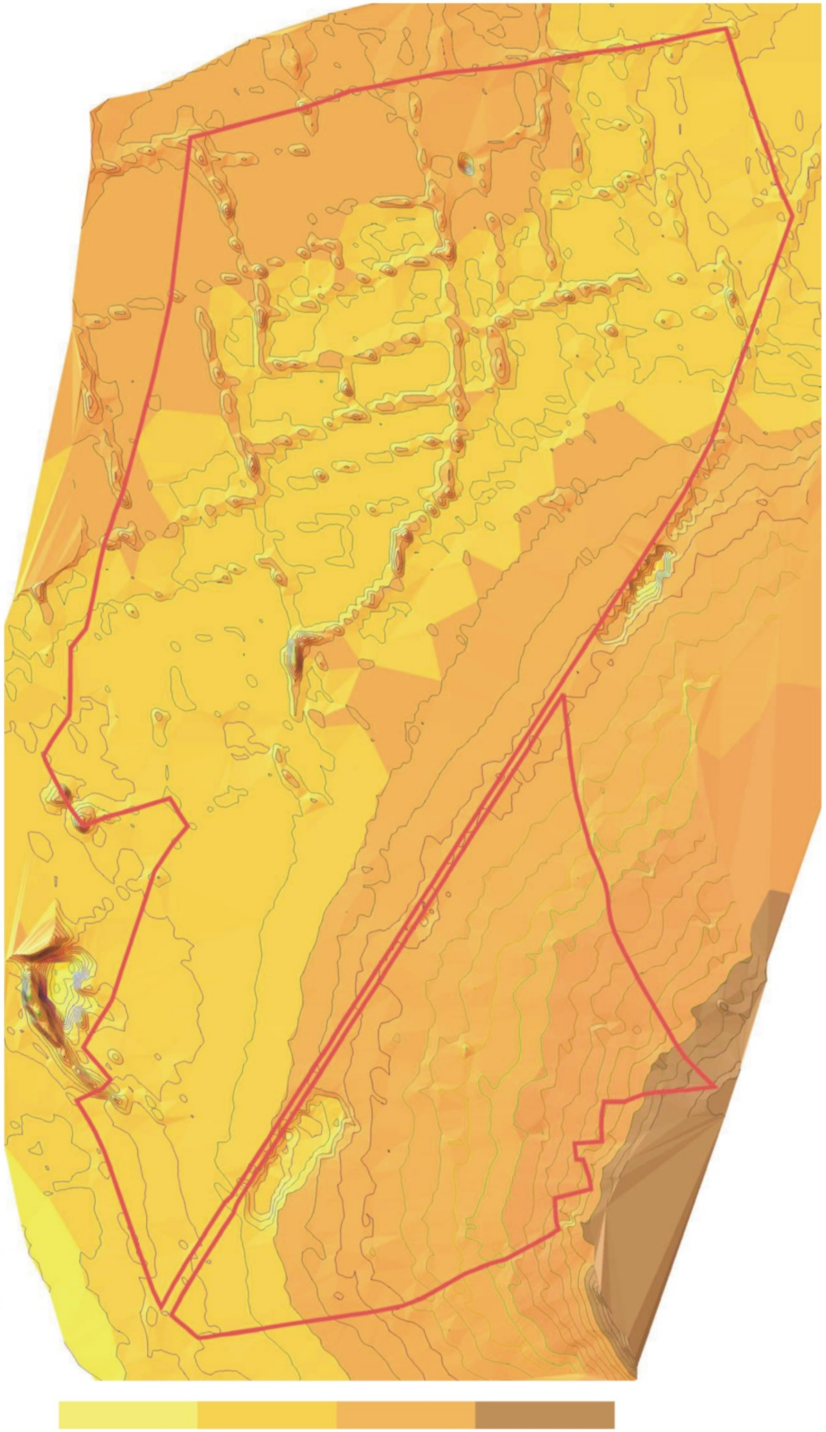
JODHPUR HYDROGEOLOGY PATTERN

Site Watershed mapping and Surface hydrology

The region has a general slope towards the south-east direction (refer Fig based on Digital Elevation Model and Hill Shade Map for the region by National Remote Sensing Agency, (NRSC), Hyderabad.. The hilly outcrop towards the west of the site standing 247m (above M.S.L.) high comes down to 233m at the site. The topography elevates again to reach a height of 247m at the peak of another hilly outcrop beyond Gharav village to the east of the site. The run-off from the region flows into the two seasonal rivers that flank the river on the north and south of the site. It Is also observed that the major flow of water from the hilly outcrop in the west should be towards the south-east, but the presence of smaller outcrops to the south of the site divert the flow in a way that it flows southwards.

1.SITE SOIL PROFILE

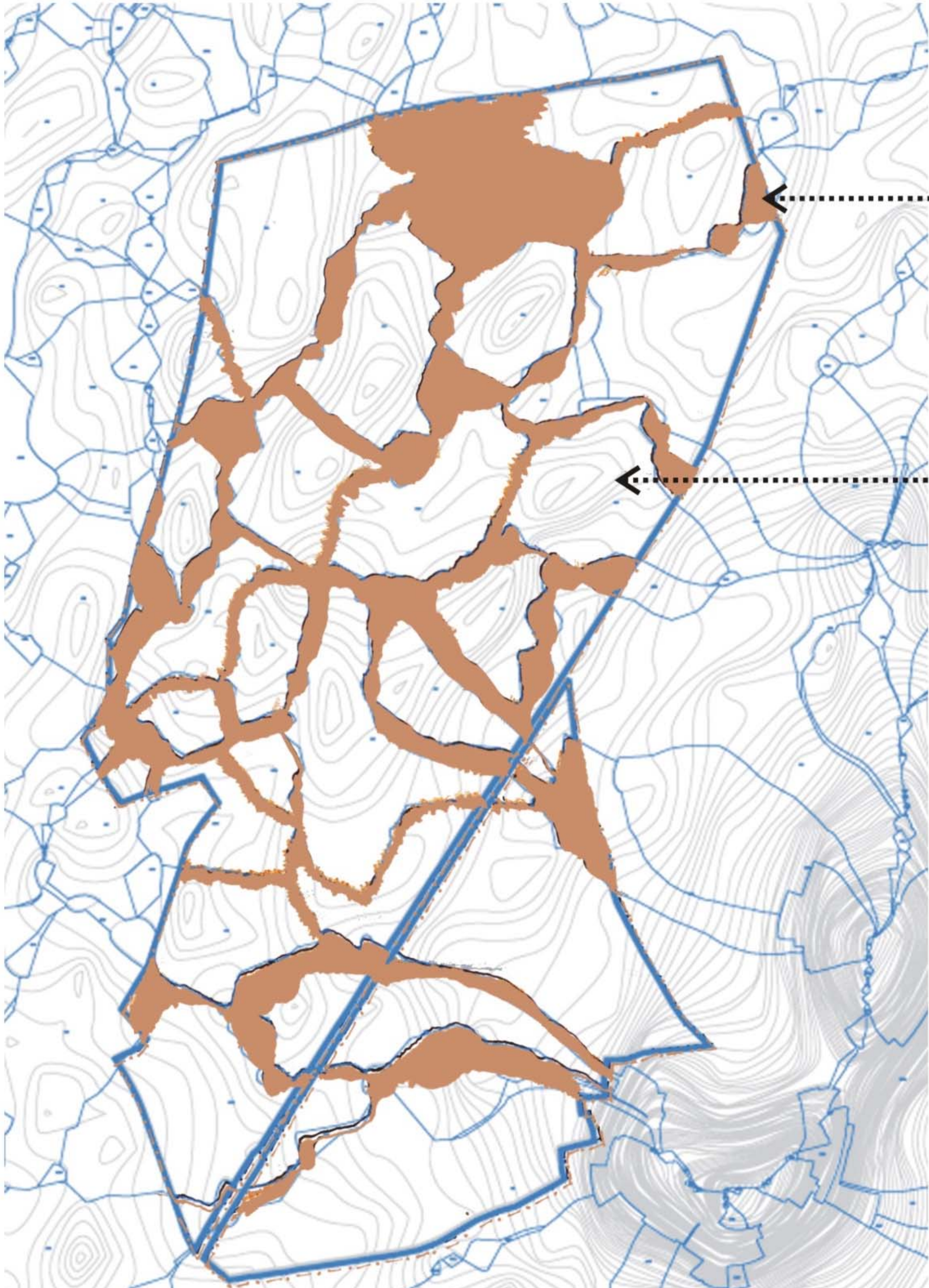
2.EXISTING VEGETATION PATTERN



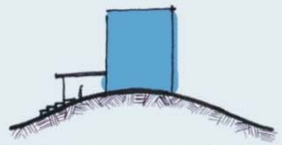
EXITING SITE PHYSICAL AND GEOLOGICAL CONDITIONS

The general topography of the part-site A has been modified greatly by agricultural bunds with a general site slope towards south. Part-site B shows a slope towards the highway. The pediment of hill outcrop to its east receives runoff from the hill, the flow being disrupted by the highway. Part-site C is largely flat.

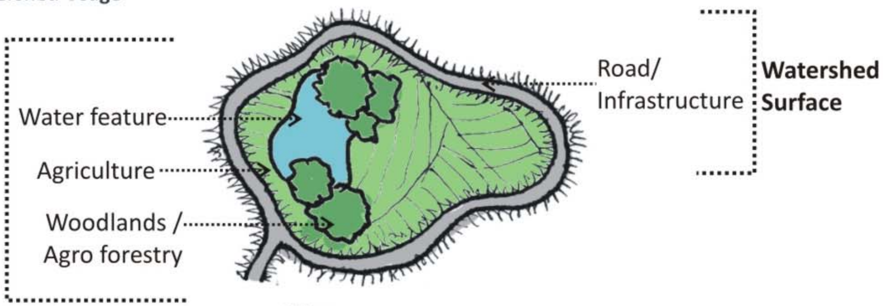
Texturally, soils are sandy to sandy loam with silty clay-loam and the soils are salty. Very shallow soil-depth (less than 25cm) exists along edge of the Highway (Ref. Fig. B.4.1.c). Shallow soil-depth (25-50cm) exists along the central zones of Site A and Site B. Moderately Shallow soil-depth (50-100cm) lies towards the rear edges of the site.Below the topsoil (silty sand) and course gravel bed, varying depths of shallow soft rock occur.

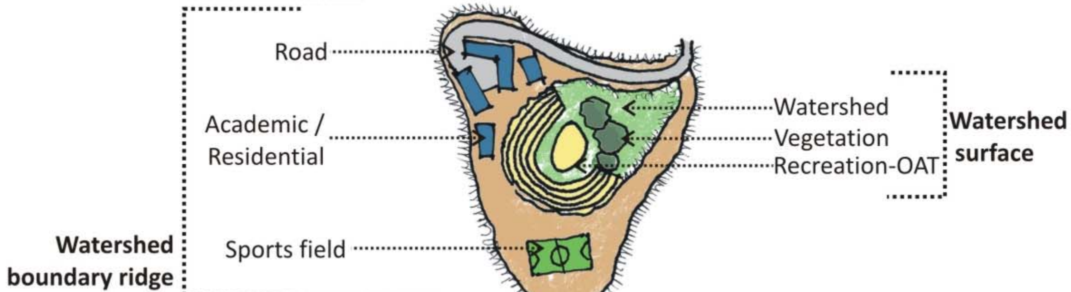


Interpretation of Waterhseds

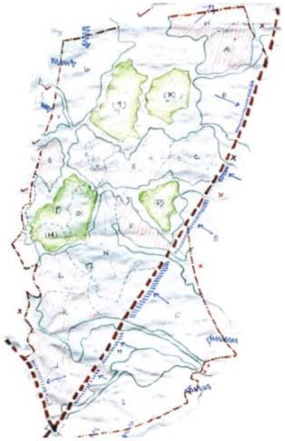
	BUILT	NATURAL
Watershed edges: A network of interconnected ridge lines, from which incident water run-off is maximum. Hence most impervious surfaces and permanent structures that need drainage can be situated on this area.	Roads & Infrastructure  Institutional Residential 	Sports field  Parks 
Watershed plains: These are flat or slightly sloping surfaces which are bound by raised edges. There is maximum infiltration of incident water on these surfaces, which hence must be left pervious.	Recreation  Commercial Industrial	Agriculture  Woodlands Agro-Forestry Water bodies 

Strategies fo Watershed Usage



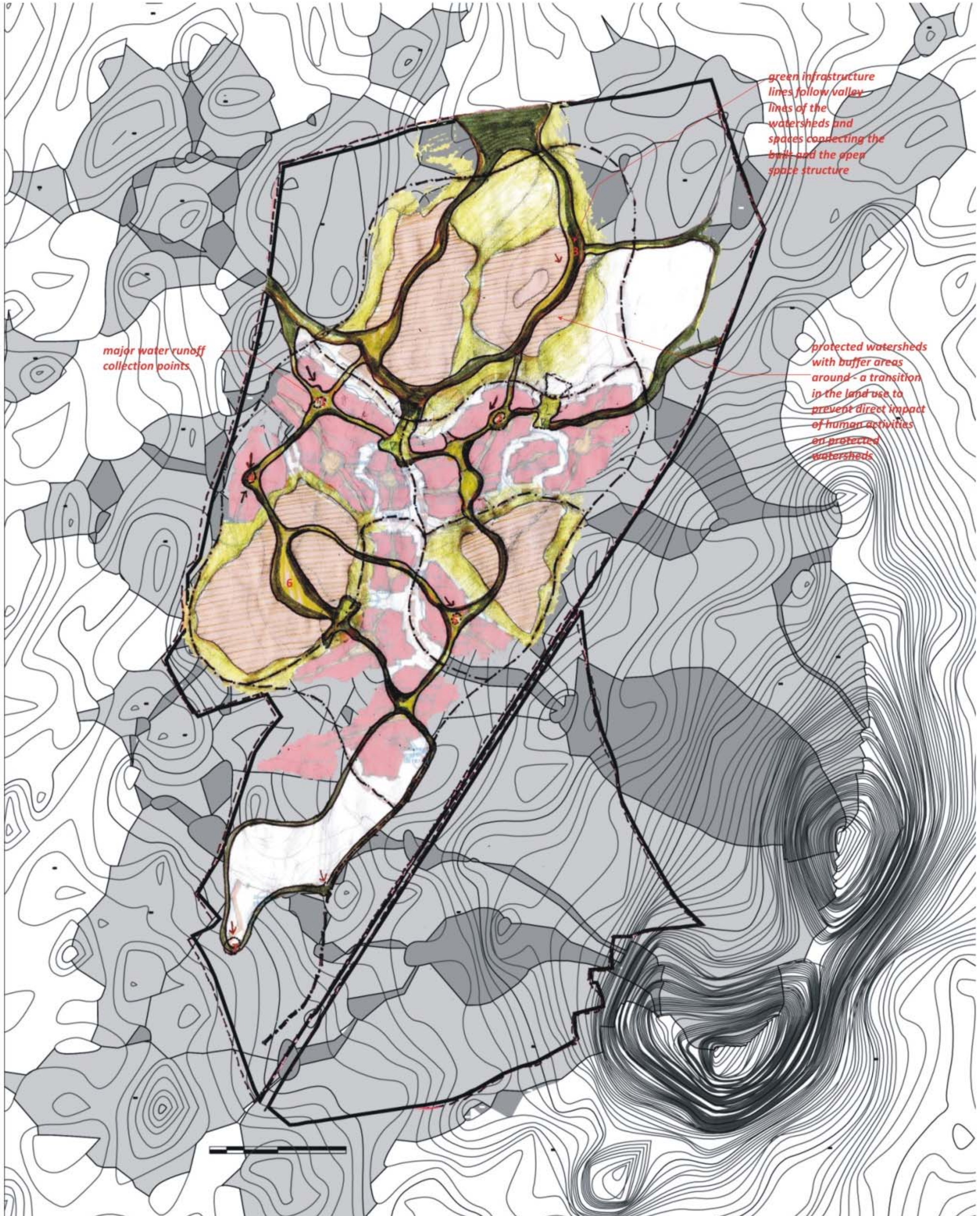


1.Ridges of the watersheds on site



2.Watersheds - water flow directions

3.Protected watersheds



ESTABLISHING GREEN INFRASTRUCTURE

In a broader sense, green infrastructure consists of the inherent natural green resources as well as the built infrastructure comprising of storm water drains, waste water utilization set ups etc. which can be merged with the surrounding landscapes.

NATURAL

Ecological corridors:

wildlife corridors

bio-diversity hub

Special vegetation reserves:

For threatened species

For medically important species

Buffer plantations:

Shelterbelts and wind breaks

Woodlands '*orans*'

Orchards

Energy plantation

Horticulture

Agriculture

BUILT

Storm water collection:

Surface run-off (paved surfaces)

Roof top run-off

Reed beds

Water harvesting structures

Waste water and sludge treatment and re-utilization (DEWAT)

Settling tanks

Underground chambers

Gravel filter (constructed wetlands)

Polishing pond (constructed wetlands)

Vermicomposting pits

Biogas chambers

Circulation:

Pedestrian

Cycle

Vehicular

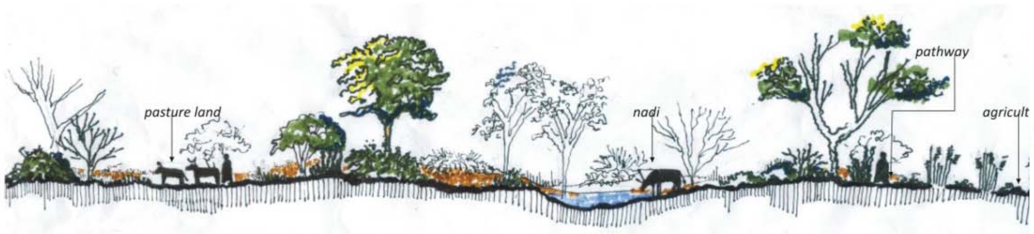
Other Services

LEGEND

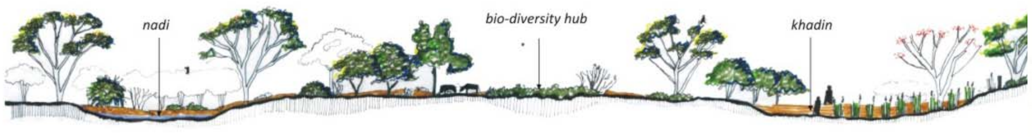
Green infrastructure

Built infrastructure

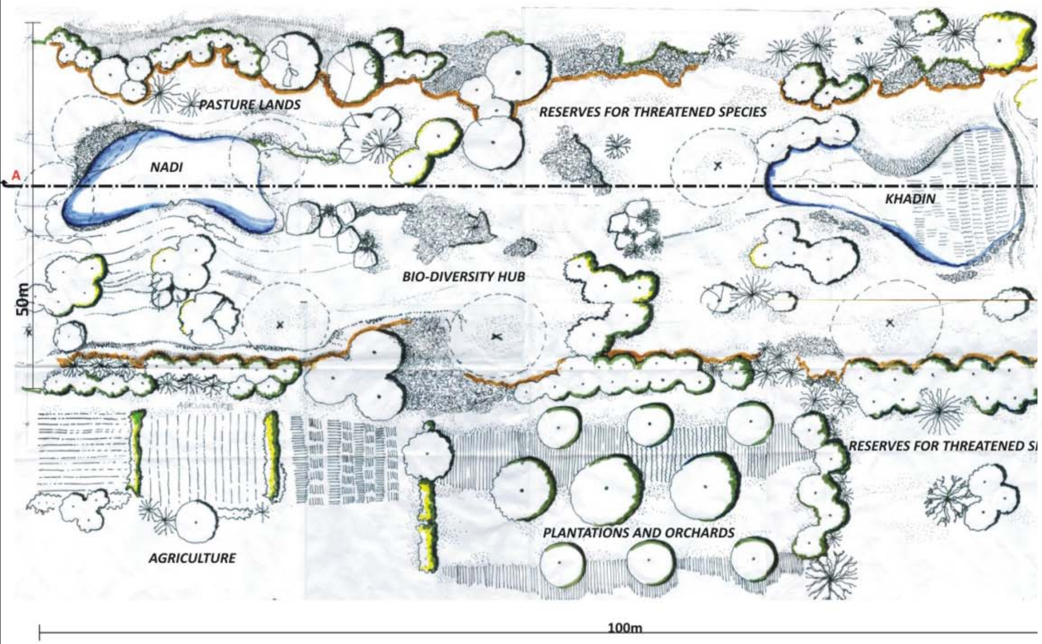
Buffer area around protected watersheds



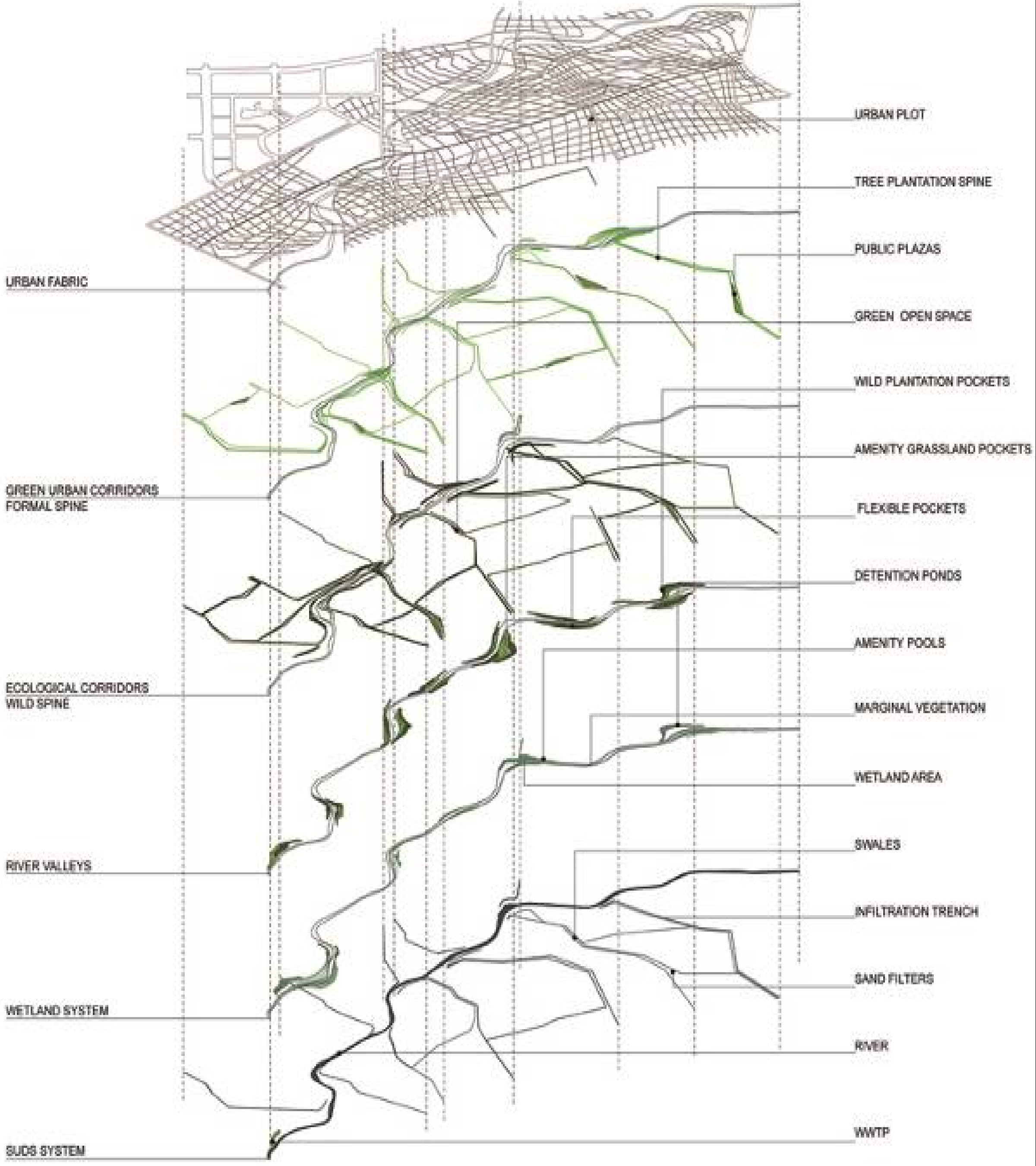
Section through pasture land, *nadi* and agricultural field



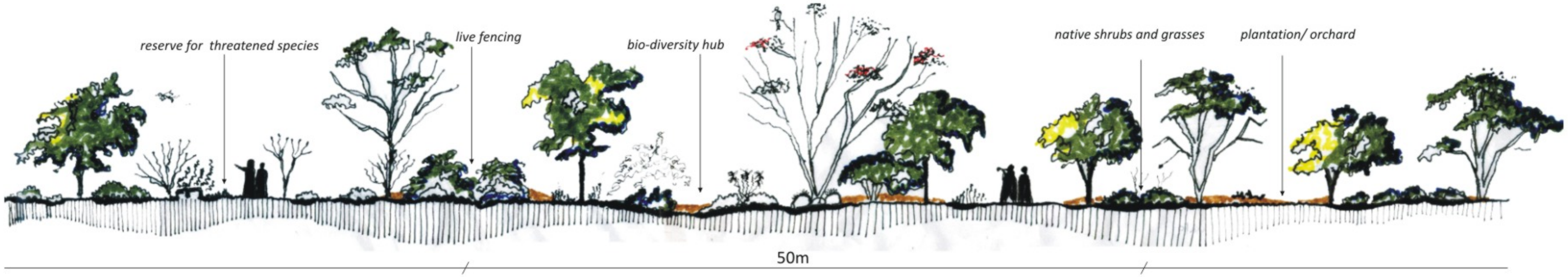
Section AA through *nadi*, bio-diversity hub and *khadin*



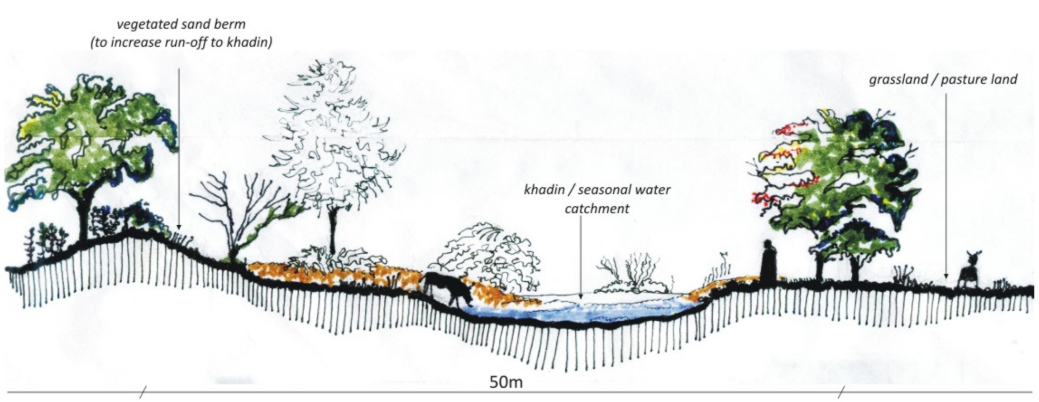
Water harvesting in and around bio-diversity hub (plan)



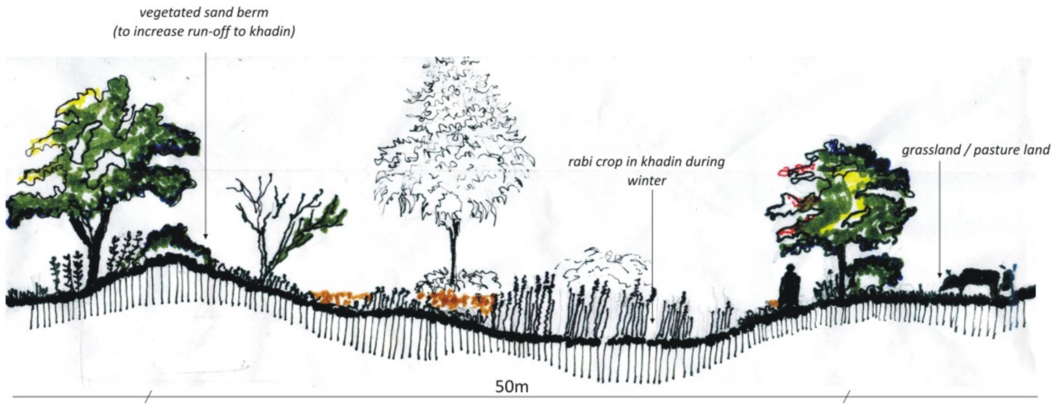
LANDSCAPE NETWORK STRATEGY



Section through vegetation reserves, bio-diversity hub and plantations/orchards



Section through *khadin* during monsoons



Section through *khadin* during winters

WILDLIFE CORRIDOR AND BIO-DIVERSITY HUB

Shrubs

Capparis decidua Ker
Leptadenia pyrotechnica Khimp
Balanites aegyptiaca Hingota
Acacia jacquemontii Bhu -bavali
Zizyphus nummularia Bordi
Acasia nilotica Babool
Grewia tenax Gangeti
Echinops echinatus Untkantara
Flueggia leucopyrus Ghatbor
Sarcostemma acidum kheer kheemp (outcrop)
Euphorbia caducifolia Thhor
Commiphora wightii Gugul
Calligonum polygonoides - phog
Suaeda fruticosa –potassium content good
Euphorbia nerifolia
Calotropis procera Aak

Herbs

Tephrosia purpuria Buena
Solanum surattense Bhuringni (Chhoti Kateli)
Crotolaria burhia Sinia
Fagonia arabica Dhamasa
Indigofera cordifolia Bekria
Aerva javanica Bui
Cassia angustifolia Sonamukhi
Corchorus depressus Cham ghas

Grasses

Cenchrus biflorus Bhurat
Desmostachya bipinnata Dab
Cenchrus ciliaris Dhaman
Lasiurus sindicus Sewan
Panicum antidotale Gramma
Aristida adscensionis Lapla

Trees

Prosopis cineraria -khejri
Tecomella undulata - rohida
Salvadora oleoides - Meetha jaal
Acacia senegal Kumath
Maytenus emarginata Kankera
Balanites roxburghii Hingoto
Salvadora persica peelu
Cordia gharaf Goondi
Moringa concanensis Sargooro
Acasia leucophloea – safed kikar
Anogeissus rotundifolia
Tamarix articulata - farash
Azadirachta indica Neem
Zizyphus rotundifolia Ber

Climbers and creepers

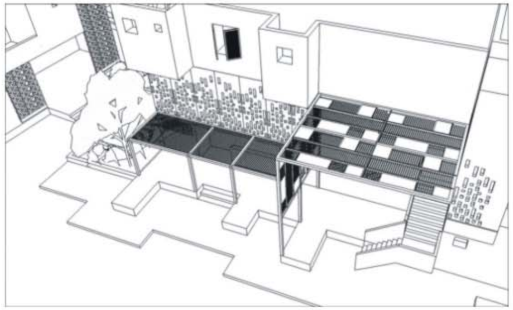
Cocculus pendulus Pilan
Citrullus colocynthis Tumba vel
Clerodendrum phlomidis Arni

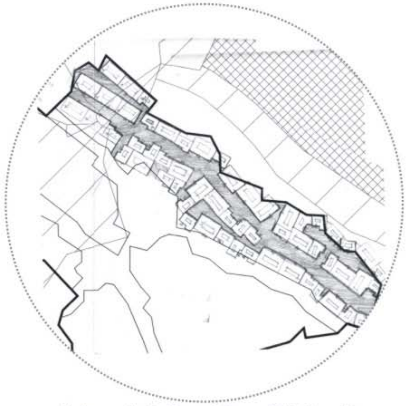
ECOLOGICAL LANDSCAPES BIO-DIVERSITY HUB

Bio-diversity hub deals with development and management of indigenous species of plants to regenerate natural landscape of the region. Best left undisturbed by heavy human interference, trails through this hub can be used for study purposes.

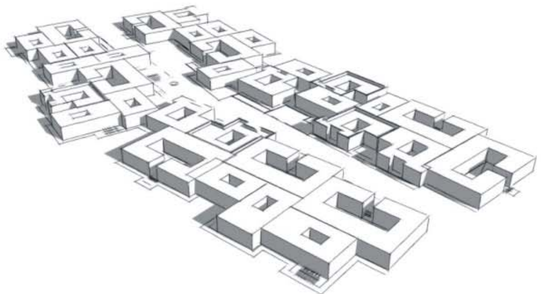
ECOLOGICAL RESTORATION OF NON-ARABLE LANDS

Starting with pioneering species of vegetation that occupy a piece of uninhabited land first, the regeneration process would continue with other native plant species of the region. As a buffer/transition from habitated spaces for such areas, vegetation reserves for threatened species or medically important species, energy plantations or orchards, agriculture or horticulture, or grasslands/pasturelands can be proposed.

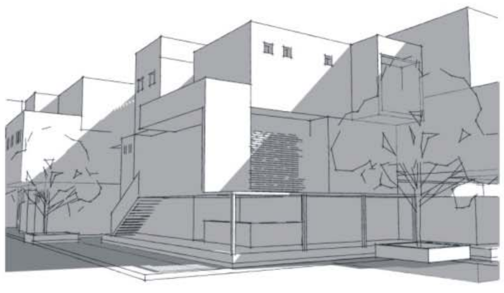




Schematic Built and Open Relationship



Built organization with central space as a pedestrian core.

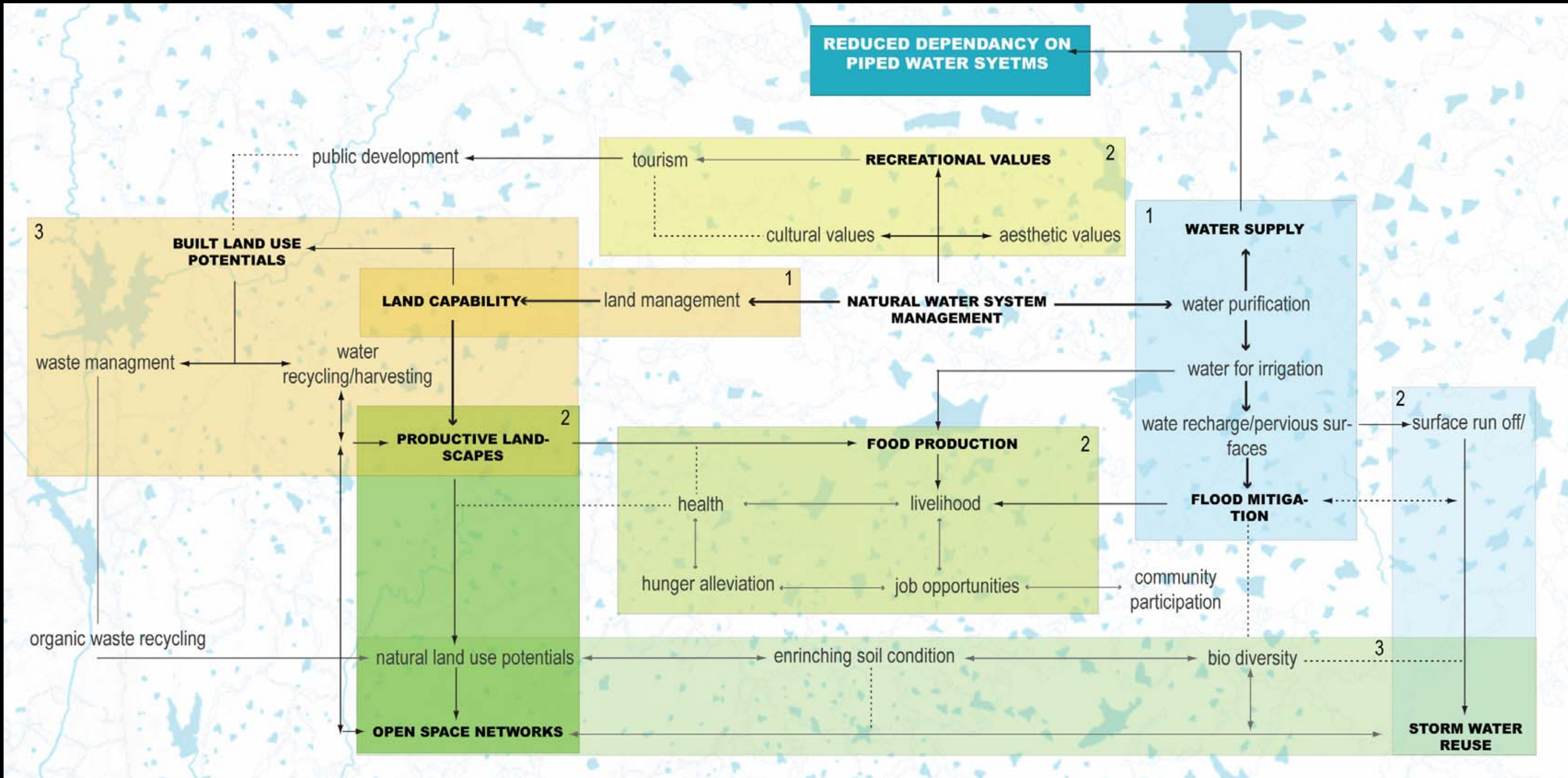


Master Plan Structure Plan

The diagram above represents the basic structure plan of the master plan, indicating the distribution of built form within the campus, the hierarchies and intensity of open spaces in the campus and the circulation plan of the campus. The plan also reflects the spatial organization of the conserved spaces in the master plan, that perform as a parallel entity as spaces of productive and ecological benefit not only for the campus but also toward regional bioreserve contnuity

View of the transect between the Building and Conservation Zone

View of the Conserved Watershed Zone - Productive Landscape



LANDSCAPE AS A ECOSYSTEM SERVICE FEEDBACK AGENT

High Fragmentation due to individual/small plots
Loss of Traditional Livelihoods
Unutilized spaces in Setbacks
Fragmented Open Space structure
Increased social stratification
Shifting Livelihood Patterns
Loss of Arable Lands
Decontextualized Traditional Settlements
Incompatible Land Use increases alienation
Decreased Food Security
Increased Ecological footprint of Food
Externalized resource Management
High Emissions
Zero sequestration
Exclusively Consumptive ecosystems
Reduced Biodiversity
Increased Radiation
Increased Urban Heat Island
Reduced green cover
Car Prioritized circulation needs
Vehicular access to individual plots
Increased Flooding
Reduced water storage capacity
Ground water depletion
Increased Run-off
Reduced Percolation
Increased Dust
Increased Soil Erosion
Increased Siltation
Contiguous Open Space structure
Internalized Resource Management
Retention of Traditional Livelihoods
Land Use in tandem with Traditional Settlements
Undivided plots
Retention of Traditional Livelihoods
Increased Canopy Cover
Increased Food Security
Open Spaces as Productive Landscapes
Increased Potential sequestration
Green Infrastructure for passive drainage
Permeable surfaces
Watershed as Determinant
Closed Water Loop
Natural valleys as Greenways
Contiguous Green Networks
Programmed open spaces for Productive uses
Density as a derivative of Topography
Watershed as planning parameter
Minimal Road networks
Increased tree canopy cover
Integrate Wetlands in the Green Networks
Climate responsive Built Form