URBAN DESIGN GUIDELINES FOR BIOPHILIC NEIGHBORHOODS IN A HILL TOWN

A DISSERTATION

Submitted in partial fulfillment of the requirements for the award of the degree of

MASTER OF ARCHITECTURE

By

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CANDIDATE'S DECLARATION

I hereby certify that this report entitled **"URBAN DESIGN GUIDELINES FOR BIOPHILIC NEIGHBORHOODS IN A HILL TOWN"** which has been submitted in partial fulfilment of the requirement for the award of the degree of **Master of Architecture**, submitted in the Department of Architecture and Planning, Indian Institute of Technology- Roorkee, is an authentic record of my own work carried out during the period from July 2011 to June 2012, under the supervision and guidance of **Dr. Pushplata ,** Department of Architecture and Planning, Indian Institute of Technology, Roorkee, India.

The matter embodied in this dissertation has not been submitted by me for the award of any other degree of this or any other institute.

Date: 15th June 2012

Place: Roorkee

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This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

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Executive Summary

Forever mankind has co-evolved with nature, relying on each other, hand in hand, an innate relationship where not only does he receives but also gives and forms a part of a loop that results in civilization. Unfortunately, most of the urban centers today tend to forget those values of the past. The essential relationship developed over centuries has started losing its importance.

Connectedness to nature is essential for stress free healthy living. Nature is where we get fresh air, water, food and protection from. So it is not an option but a compulsion, an essential to everyday living. Then why are the cities, urban centers missing out on the joy of nature.

Need of the study

Nature, which has always inspired architecture and urban spaces, is moving out from the current day context. We see problems of recessed green cover, artificial unearthly elements taking the place of nature. We need to understand that in order to live a healthy life one needs to stay in proximity to nature and also make sure we preserve it well for our future generations to come.

Why at the neighborhood level?

Clarence Perry's Neighborhood Concept has been one of the most important ideas in the history of planning. The experience of living is most vital at a neighborhood level where the scale is not too big and comprise of the most basic and important building type i.e. house. If things are not right at the neighborhood level, it is not possible to maintain a good quality of life in a city or town. So a well-planned and sustainable neighborhood can give way to a well-planned and sustainable region and across other larger scales.

A biophilic neighborhood is one where nature is close at-hand, where there are trees, gardens, streams and other growing life just outside one's door, which are in turn connected to larger, more expansive networks of green spaces and wildness, that may be

easily reached. There should be sufficient gathering areas for children to play in nature rather than more conventional playgrounds. Pedestrian connections, bicycle facilities and infrastructure, and urban neighborhoods that allow adults and children to walk out the front door and move from smaller to progressively larger and more expansive natural areas encouraging physical exercise.

Aim of the study

The aim of this research is to find various means to incorporate nature into urban public spaces of a neighborhood in hill towns.

Objectives of the study

1. To develop an understanding on how urban cities and neighborhood can be made 'Biophilic'.
2. To check the relevance of biophilic concepts and ideas applicable in an urban hill town.
3. Formulate guidelines and suggest various interventions to bring nature into the urban public spaces of an urban neighborhood in a hill town.

Biophilia

The term 'biophilia' was popularized about two decades ago by Harvard conservationist E.O. Wilson to refer to the need of connection with nature and other forms of life which was inherently ingrained into humans. Wilson described it as: "Biophilia is the innately emotional affiliation of human beings to other living organisms. Innate means hereditary and hence part of ultimate human nature." [biophiliccities.org]

Biophilic cities

At the outset it is important to understand what a biophilic city is; its features and qualities. In lay man's terms, the meaning is evident from the word 'biophilic' itself. 'Bio' refers to nature and 'philic' means to have affinity. 'Biophilic city', therefore, in its crudest form means a city with an affinity to nature. This meaning may be extrapolated keeping in mind the many values inculcated by humans through daily interactions with nature. A biophilic city can, thereby, be defined as a city which puts the highest priority upon nature in its design, planning as well as functioning.

Biophilic urban design

Biophilia provides for various urban design elements across different scales –

Building - Green rooftops, Sky gardens and green atria, Rooftop garden, Green walls, Daylit interior spaces.

Block - Green courtyards, Clustered housing around green areas, native species yards and spaces.

Street - Green streets, Sidewalk gardens, urban trees, Low-impact development, Vegetated swales and skinny streets, edible landscaping, High degree of permeability

Neighborhood - Stream day lighting, stream restoration, Urban forests, Ecology parks, Community gardens, Neighborhood parks and pocket parks, Greening gray fields and brownfields

Community - Urban creeks and riparian areas, Urban ecological networks, green schools, city tree canopy, community forest and community orchards, greening utility corridors.

Region - River systems and floodplains, regional green space systems, greening major transport corridors.

Relevant-studies

Soma Master-plan, Bengaluru - Architect Ken Yeang

Davse village, Lavasa - The Bio-mimicry Guild

Guideline study - District 6, City of Madison, Wisconsin, United States

Several other hill town and neighborhood guidelines have been studied and analyzed through the lens of biophilia in order to understand their feasibility in hill areas.

Clustered-Compact-Dense development in hills

Height - Population is ever increasing, which means the load on the available land is increasing. Therefore to rationalize the height of buildings should be allowed to increase up to the level it does not harm the natural settings of the place.

Density - Low-rise high-density development is a favorable condition, but for areas with higher density, mid-rise high-density should also be considered which does not harm the natural setting of the place.

Compactness - allows for walkability. It also reduces the building footprint allowing greater green and open spaces. If we have to maintain height restrictions on buildings it

should be compact in planning so as to accommodate the maximum density without destroying the open green areas.

Cluster - Compact-Clustered Development should be encouraged with High-Density and essentially Low / Mid-Rise structures which do not harm the natural surroundings of the place and encourage interaction with nature.

Low Impact Development - Water percolation into the earth's surface is not preferred in steep hill areas as it leads to landslides and soil erosion. Rain water harvesting is essential as water is scarce. Green rooftops provides immense advantages but at a high cost. Large roofs and clustere of large number of small roofs must be made into green roofs instead of individual small ones.

Conclusion - Hill towns provide the perfect setting for biophilic neighborhoods because of it natural terrain, topography, climate and unique and beautiful wildlife species. Existing urban neighborhoods can be retrofitted into biophilic neighborhoods. New areas should essentially be biophilic in order to live a nature and wilderness filled life.

Acknowledgement

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Chapter 1 Introduction

1.1 Overview

Forever mankind has co-evolved with nature, relying on each other, hand in hand, an innate relationship where not only does he receives but also gives and forms a part of a loop that results in civilization. Unfortunately, most of the urban centers today tend to forget those values of the past. The essential relationship developed over centuries has started losing its importance.

Connectedness to nature is essential for stress free healthy living. Nature is where we get fresh air, water, food and protection from. So it is not an option but a compulsion, an essential to everyday living. Then why are the cities, urban centers missing out on the joy of nature.

Today the cities are becoming urban heat islands and concrete jungles with very less traces of nature or greenery or wilderness in it. In fact, we have become so alien to nature, that today's younger generation is not even aware of which natural species of plants and animals are available locally nor can they identify by looking at them. But, surely they know the names of the latest gizmos and PlayStations and computer games. Children prefer staying inside watching their favorite TV channel whereas they should be playing out in the green.

Who is responsible for this unhealthy change in the attitude of these children?

Well my study looks into this sphere of urban design where efforts are being made to rejuvenate the dead, machine based cities and neighborhoods with nature and wilderness.

1.2 Need of the study

In order to understand the nature of human civilization, a question, which frequently occurred to me, was why do we find certain places pleasing and attractive? Why to others we are indifferent? Is there something common between places of different tow cultures?

The making of the place is based on the relationship of human beings to their natural environment. These notions are constant and guide the making of the built environment at all levels irrespective of location and culture. The abstract physical space is made unique and precise through its local cultural manifestation, thus every situation is local as well as general.

Nature, which has always inspired architecture and urban spaces, is moving out from the current day context. We see problems of recessed green cover, artificial unearthly elements taking the place of nature. We need to understand that in order to live a healthy life one needs to stay in proximity to nature and also make sure we preserve it well for our future generations to come.

1.3 Why at the neighborhood level?

Clarence Perry's Neighborhood Concept has been one of the most important ideas in the history of planning. The experience of living is most vital at a neighborhood level where the scale is not too big and comprise of the most basic and important building type i.e. house. If things are not right at the neighborhood level, it is not possible to maintain a good quality of life in a city or town. So a well-planned and sustainable neighborhood can give way to a well-planned and sustainable region and across other larger scales.

Perry's idea of defining a neighborhood by a school, mixing of uses and activities, the pedestrian scale, the attempt to slow down automobiles, etc. makes immense sense and are being successfully implemented all over the world. By incorporating the sense of the place, its natural surroundings along with a more pedestrian and walking oriented life will result in a better neighborhood.

"Biophilia," is a concept popularized by E.O.Wilson. He defines Biophilia as "the innately emotional affiliation of human beings to other living organisms," something essential for healthy living and an essential quality for urban life. "Nature, we increasingly understand, is not something optional, but absolutely essential to modern daily life, and not something to be relegated to the occasional visit to some mostly remote place we think of as "nature" – something "over there"). We should modify the Neighborhood Concept to incorporate our growing appreciation to reconnecting with nature. [Beatley, 2011]

A biophilic neighborhood is one where nature is close at-hand, where there are trees, gardens, streams and other growing life just outside one's door, which are in turn connected to larger, more expansive networks of green spaces and wildness, that may be easily reached. There should be sufficient gathering areas for children to play in nature rather than more conventional playgrounds. Pedestrian connections, bicycle facilities and infrastructure, and urban neighborhoods that allow adults and children to walk out the front door and move from smaller to progressively larger and more expansive natural areas encouraging physical exercise.

Biophilic neighborhoods and places will make us more resilient as a society, helping to steady us in times of crisis, taking us to places that inspire, restore and uplift us. It can redefine the ways in which we understand community wealth. We are apt to think of our community assets in the usual, narrow way (property values, built infrastructure, etc.). An expanded understanding of community wealth includes many other things: friendships and social patterns, the abundance of time in community, history and stories, the presence of elders and the young together in the same urban spaces, food heritage, etc. Nature in our cities is sometimes mapped, and the economic value of the services it provides is even sometimes calculated, but it is largely overlooked as the asset it is: something that will make us happy, help deepen our commitments to place and community, and deliver an element of wonder and amazement that will make every day a joy to live and experience.

Humans need to find creative ways to coexist with other animals. They add much to the wonder of the places we live, offering wildness that ought to be appreciated and celebrated.

Biophilic neighborhoods can overcome intergenerational divides and to bring together young and old residents to enjoy and celebrate together the nature around them. One of the most effective ways that local natural history, and a love of nature, is conveyed to young people is through time spent with grandparents. Elders will need to play an increasingly important role in becoming nature coaches, adding a valuable measure of meaning and pleasure to their lives while rising to the challenge of imparting an ecological consciousness to the next generation.

Although it is very practical and realistic to live close to nature, but there are many dangers of outdoor urban play and exploration too. There is a different way in how the home is perceived today—a shift from thinking about enhancing the resale of the house to a sense of what might make the house more livable, enjoyable and meaningful. Implementing biophilic neighborhood ideas will be both easier today because of these trends, and, over time, help further strengthen these concepts. It does suggest the potential for a greater caring about, and interest in, the urban natural world, and that is a promising development indeed.

1.4 Aim of the study

The aim of this research is to find various means to incorporate nature into urban public spaces of a neighborhood in hill towns.

1.5 Objectives of the study

1. To develop an understanding on how urban cities and neighborhood can be made 'Biophilic'.
2. To check the relevance of biophilic concepts and ideas applicable in an urban hill town.
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1.6 Methodology

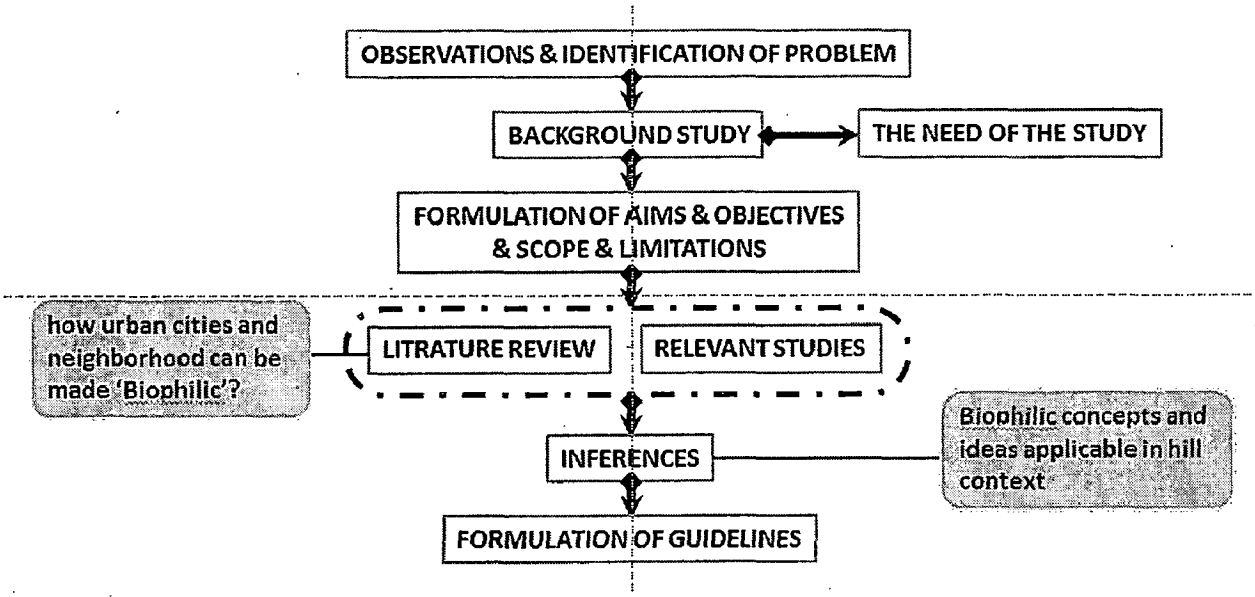


Figure 1 Research Methodology

1.7 Scope and Limitations

The scope of the thesis encompasses the urban design elements such as parks, open spaces, streetscapes, buildings (façade and roof tops), etc. at the building level, block level, street level and neighborhood level. It does not deal with the elements at community or regional level.

Chapter 2 Literature review

2.1 Learning from Nature

Nature has a sound reason behind every shape and form of its parts and elements. These shapes and forms are in direct relevance with the purpose of existence of the elements and the role it plays in the world.

For instance, the slope and shape of a mountain is corresponding to the amount of matter that gravity allows it to hold. At any other angle or shape, the mountain would become unstable and materials would fall off. The shape and form of the mountain is, therefore, a derivation of the gravitational pull exerted on matter and the frictional forces which hold them together.

Similarly, the neatly spherical shape of the falling water droplet is the outcome of its surface tension which pulls it into a shape which has the minimum surface area for its volume, i.e. the sphere. Any deformation that the shape undergoes is a result of the forces of wind, friction, gravity and elasticity.

2.1.1 Characteristics of Nature

Levels of scale In any system where there is a good functional order, it is necessary that there be functional coherence at different levels. The jump between two adjacent systems cannot be too big, since a big jump will tend to destroy adequate communication between the levels.
Centers Many natural processes have centers of action: the action radiates outward from some system of centers.
Alternating Repetition In nature, almost every repetition which occurs is an alternating repetition, rather than a simple repetition. Example – waves in the ocean repeat, mountains in a mountain range repeat, the trees in a forest, and the leaves in a tree they all repeat.
Boundaries The need for boundaries comes about as a result of need for functional separation and transition between different systems.

Positive Space Every whole has another whole next to it, so that the wholes and the spaces between wholes form an unbroken continuum. The positive nature of the spaces is necessary to preserve the wholeness of the system. The outward pressure on the soap bubbles comes from every bubble as a result the equilibrium creates a condition where the bubble walls flatten out, and become positive.
Good Shape Many natural systems have a tendency to form closed gestalts. Leaves often have natural and beautiful shape. A good shape is a major center, intensified by various minor centers.
Deep interlock and Ambiguity Deep interlock in natural systems comes about because next door systems interact most easily along extended surfaces.
Local Symmetries Local symmetry is pervasive throughout nature... the sun is symmetrical (roughly), a volcano is symmetrical about its center, trees are symmetrical bout their trunk, etc.
Graded Variation Gradients occur throughout nature. Any time that a quantity varies systematically, through space, a gradient is established. Example – we climb a mountain the climate gets colder and the air gets thinner.
Contrast Contrast corresponds to the fact that all natural systems get their fundamental energy from the interaction of opposites like negative and positive.
Roughness Roughness appears in the world, constantly, as a result of the interplay between complex wholeness, and the constraints of 3-dimensional space.
The Inner Calm The inner calm is essential to any natural system – the fact that each configuration that occurs in nature is always the simplest one consistent with the conditions.
Not Separateness There is no perfect isolation of any system, and each part of every system is always part of the larger system in the world around it and connected to them deeply in behavior.

Table 1 – Characteristics of Nature

[Christopher, A.; The Nature of Order and the Art of building; Book-1]

2.2 Biophilia

The term 'biophilia' was popularized about two decades ago by Harvard conservationist E.O. Wilson to refer to the need of connection with nature and other forms of life which was inherently ingrained into humans. Wilson described it as: "Biophilia is the innately emotional affiliation of human beings to other living organisms. Innate means hereditary and hence part of ultimate human nature." [biophiliccities.org]

2.3 Biophilic Cities

At the outset it is important to understand what a biophilic city is; its features and qualities. In lay man's terms, the meaning is evident from the word 'biophilic' itself. 'Bio' refers to nature and 'philic' means to have affinity. 'Biophilic city', therefore, in its crudest form means a city with an affinity to nature. This meaning may be extrapolated keeping in mind the many values inculcated by humans through daily interactions with nature. A biophilic city can, thereby, be defined as a city which puts the highest priority upon nature in its design, planning as well as functioning.

In a biophilic city, the prime motive is to ensure that the inhabitants, in the course of their normal day-to-day living, is exposed to nature - plants, trees, animals, birds- and they are able to see, feel and interact with it in its richness. Nature, in itself, is all encompassing- starting from microorganisms to invertebrates to larger animals and trees. These elements, in dealing with the man-made, forms an ecosystem which drives the character and feel of the city. In this modern world, urban living has been stripped of nature with human surroundings comprising mostly of buildings and other structures. The concept of biophilic cities looks to salvage whatever nature is left in the existing cities, and introduce new forms of nature in every new structure that is built. It perpetuates the idea that nature, in new and innovative forms, shapes and images, can be integrated with the built environment.

Biophilic urban design and urban planning both symbolize the establishment of connection with and designing for integration with nature in cities- one particular but critical element of green urbanism. By campaigning for the inherent need to connect with nature, the biophilic city concept relates the arguments for green cities and green urbanism directly to well-being of humans rather than tying it to energy or environmental concerns.

In placing their emphasis on things like investments in transportation, energy efficiency, and production of renewable energy, and, by neglecting the 'human-nature' relation, the vision of green

cities is not especially green; even though these aspects are all important for sustainable urban living in the twenty-first century. Biophilic cities bring the focus back on the human – nature connection by stressing upon the actual green features, life-forms, and processes with which humans, as a species, have coevolved.

Although, for the most part, the concepts of biophilic cities and green urbanism overlap complementing each other, there are certain points of divergence. A biophilic city extends far beyond a simple bio-diverse city. A biophilic city integrates with nature in every essence- learning from it, emulating its systems, and incorporating its shapes, forms, and images into its fabric. Biophilia clearly distinguishes itself from the concept of green cities by celebrating an urban structure whose form evolves from an inspiration in nature, encouraging ornamentations and textures embedded in geology and natural history of the place. Biophilic cities extend beyond green urbanism by valuing love and care for nature, encompassing in itself the steps, programs and actions that help protect and safe guard nature. Biophilia entails a mix of innovative greening of urban environment with a commitment to outdoor life. It gives importance to the ability of the inhabitants to reach on foot, by bicycle, or by transit to a park or point of wild nature. For instance, some cities, like New York, have proposed provision of parks within a ten-minute walk of every resident, and now, encourage family camping in parks. In many cities, parks have become extended classrooms for schools. At the same time, the biophilic elements, serves many other important functions of the city like retaining storm-water, sequestering carbon, cooling the urban environment, and moderating the impacts of air pollution.

At this juncture, lists of some of the prominent qualities that are to be found in a biophilic city are enlisted in the following pages. While there does not exist a single or definitive definition or a universal meaning of biophilic design, the enlisted qualities give an idea of what a biophilic city is and may look like.

2.3.1 Indicators of a Biophilic City

2.3.1.1 Biophilic Conditions and Infrastructure

1. Percentage of population within 100 meters of a park or greenspace *Example:* PlaNYC's target of a park or greenspace for all residents within a 10-minute walk by 2030. Evidence suggests that parks and greenspaces within 100 meters are more commonly visited; perhaps a sensible target is to provide at least one park or greenspace within 100 meters for all residents.
2. Existence of a connected, integrated ecological network; green urbanism from rooftop to region *Example:* Helsinki, Finland's regional, connected greenspace network; Keskupuesto Park provides an unbroken green wedge from old-growth forest at edge of town to very center of the city.
3. Percentage of city land area in wild or semi-wild nature *Example:* Cities must provide more than formal parks, grass median strips, and exotic landscaping; there must be areas where residents can see and experience native wild or semi-wild nature—forests, wetlands, meadows, and native vegetation. In the city of Perth, Australia, the two largest parks—Bold Park and King's Park—are largely left in native bushland. Nagoya, Japan has set aside 10 percent of its land for nature preserves. A target of 10 percent seems a reasonable and minimal target and goal.
4. Percentage forest cover in the city (in some regions this will be less appropriate) *Example:* American Forests recommends a target of 40 percent forest canopy cover over an entire metropolitan area; higher in outer areas, lower in city center locations. São Paulo, Brazil, which struggles to protect Atlantic forests, has approximately 20 per cent of its jurisdiction in dense forest.

5. Extent and number of green urban features (e.g., green rooftops, green walls, trees) *Example:* One green rooftop or other urban green feature per 1,000 inhabitants, or minimum one per urban block. Chicago, for example, now has more than 500 green rooftops.
6. Miles per capita of walking trails *Example:* Anchorage, Alaska has a whopping 250 miles of trails, and with a population of about 280,000, that converts to about 1 mile of trail per 1,000 population, a relatively high level; these trails are multiseasonal and offer considerable wildness within the city's borders.
7. Number of community gardens and garden plots (absolute and per capita); access to community garden area *Example:* Seattle's P-Patch community program has established the goal of at least one community garden per 2,500 city residents.

Table 2 - Biophilic Conditions and Infrastructure

[Beatley, T; Biophilic Cities; 2011]

2.3.1.2 Biophilic activities in a city

Percentage of population that is active in nature or outdoor clubs or organizations; number of such organizations active in the city *Example:* Many urban residents are active members in nature clubs, bird-watching or gardening clubs, and other organizations that encourage connections with nature and outdoor activities. One potential and reasonable target would be for at least one quarter of a city's population to be active members and involved in one or more of such organizations.
Percentage of population engaged in nature restoration and volunteer efforts (e.g., such as Urban Bushcare), as well as absolute number *Example:* Brisbane, Australia has 124 active bushcare groups (known as Habitat Brisbane) and some 2,500 active volunteers; out of a city population of approximately 1 million, this represents only a .0025 participation rate. A minimum target might be to see 1–5 percent of a city's population actively participating in bushcare efforts.
Percentage of time residents spend outside (may vary depending on climate) *Example:* Currently most Americans spend only about 5 percent of the day outdoors. An initial target of 15–20 percent would seem reasonable, and even ambitious, depending on the climate and time of year.
Percentage of residents who actively garden (including balcony, rooftop, and community gardens) *Example:* Recent surveys indicate that an impressive 44 percent of the residents of Vancouver, British Columbia grow at least some of their own food.
Extent of recess and outdoor playtime in schools *Example:* Finland's school system provides outdoor play opportunity between each teaching segment during the school day (essentially every 45 minutes).

Table 3 - Biophilic activities in a city

[Beatley, T; Biophilic Cities; 2011]

2.3.1.3 Biophilic attitudes and knowledge

Percentage of population that can recognize common species of native flora and fauna *Example:* At least one-third of a city's residents should be able to correctly identify a common native bird species, say, a cardinal in Richmond, Virginia.
Extent to which residents are curious about the natural world around them (as measured by a proxy such as a survey question or community experiment). *Example:* Residents of a city should spend, on average, a minimum of thirty minutes a day watching, exploring, or learning about the nature around them. A number of local and state governments have administered nature or wildlife awareness surveys that collect information about the amount of time spent looking at or experiencing nature, as well as the extent of knowledge about local species of flora and fauna.

Table 4 – Biophilic attitudes and knowledge

[Beatley, T; Biophilic Cities; 2011]

2.3.1.4 Biophilic institutes and governance

Adoption of a local biodiversity action plan or strategy *Example:* Many cities around the world have prepared biodiversity action plans, for instance, Dublin, Ireland and Capetown, South Africa.
Extent of local biophilic support organizations, for example, existence of an active natural history museum or botanical garden *Example:* U.S. cities such as Cleveland, Ohio have both an active local botanical garden and a natural history museum. A reasonable target is to ensure that cities have municipal organizations and capabilities equivalent to these two forms of biophilic engagement and education.
Priority given to environmental education *Example:* Many urban schools have outdoor classrooms and educational efforts that tie learning in traditional areas (science and math) to hands-on activities that involve learning about nature. One reasonable target is that at least half of a city's public schools operate such initiatives.

Percent of local budget devoted to nature conservation, recreation, education, and related activities *Example:* While there are few comparative studies, a reasonable target is that a minimum of 5 percent of a city's budget should be devoted to nature conservation, education, and restoration.
Adoption of green building and planning codes, grant programs, density bonuses, greenspace initiatives, and dark-sky lighting standards *Example:* Many American cities, such as Seattle and Portland, have municipal code provisions that either mandate or encourage green features and biophilic design. A city's planning code should include a combination of incentives (e.g., density bonuses) and requirements (e.g., greenspace factor) to encourage green urban features.
Number of city-supported biophilic pilot projects and initiatives *Example:* Many cities, such as Chicago, have seen great value in piloting new green design ideas and concepts and providing technical and financial support. A city should have under way at least five biophilic pilot projects or initiatives.

Table 5 – Biophilic Institutes and Governance

[Beatley, T; Biophilic Cities; 2011]

2.3.1.1 Biophilic Cities as easily accessible places of abundant nature

Biophilic cities are concerned about their connection with nature at large and the feasibility of its residents to move from a neighborhood park to a larger green space. It pays importance to the development of an ecological network and maintaining its integrity, thereby, providing its residents with easy access to nature. The biodiversity that a city harbors enables (or has the potential to enable) to allow urbanites to enjoy wilderness. The concept of biophilic city views nature as an entitlement of all individuals, and as considers it essential for a meaningful and happy life. Therefore, biophilic cities seek to make it possible for all its residents to access and enjoy nature equally.

2.3.1.2 Biophilic Cities are places that appeal to multiple human senses

Nature has elements that appeal to all human senses- vision, hearing, smell, touch and taste. Similarly, biophilic cities aim to appeal to multiple human senses and make urban living rich sensory experience. Textures, shapes, colors of structures, touch of grass and foliage, sounds of flora, fauna and manmade objects are all sources of sensory experience in biophilic cities.

Urban planning and design today often undervalue the dimension of sound, especially those associated with nature. The emphasis is mostly on visual appeal. Biophilic cities seek to counterbalance this bias by highlighting the importance of sounds as a means of connecting with nature. According to the concept of biophilic cities, waking up to the chirping of birds, moving around in the choir of mechanical sounds during the day, and, going back to bed in a cacophony of crickets and screech owls, etc. are all essential auditory experiences essential for therapeutic and pleasurable urban living.

2.3.1.3 Biophilic Cities Are Inspired by and Mimic Nature

Biomimicry Strategies for Cities
1. Use waste as a resource.
2. Diversify and cooperate to fully use the habitat.
3. Gather and use energy efficiently.
4. Optimize rather than maximize.
5. Use materials sparingly.
6. Don't foul their nests.
7. Don't draw down resources.
8. Remain in balance with the biosphere.
9. Run on information.
10. Shop locally

Table 6 – Biomimicry Strategies for Cities

[Benyus, 2002]

2.3.1.4 Biophilic Cities favors forms and shapes of nature

One of the prominent ways of connecting to nature is through visual references to the natural world- its symbols, pictures, shapes, and forms. Biophilic cities seek to bring these references into the built environment of our cities and neighborhoods. These images, shapes and forms could be incorporated in the building façades, on street signs (and street names), or on sidewalks and pedestrian spaces and in the architecture of the buildings and structures throughout the city. Biophilia maintains that these visual references form an important dimension as natural shapes and forms are beautiful, reassuring, and valuable touch points of our deep evolutionary bonds with nature.

2.3.1.5 Biophilic Cities cherishes biodiversity and uniqueness in nature

Biophilic cities not only emphasize the existence of nature within the urban fabric, but also deal with its role in the lives of its populace and operation of the city's leaders.

Although subjective and hard to quantify, biophilic cities lay importance on the awareness of the importance of nature amongst its residents and officials. This spirit or sensibility of biophilia fits in both as an activity as well as an approach to governance of the cities.

2.3.1.6 Active involvement of the residents with nature

Present day urban living is disconnected with our surroundings and the environment that sustains us. Biophilic cities aim to change these conditions by providing opportunities for its residents to reconnect with their surroundings and the nature around them. In doing this, it seeks to shift the priorities of its inhabitants such that they recognize the significance of nature and care about it.

This connection can be instigated in many different ways. Some of them could be providing environmental education, teaching natural history in schools, and offering outdoor education programs for adults that include not only classes but outings and field study opportunities.

2.3.1.7 Biophilic Cities re-establish the connection to climate

Present day urban living has shut out the outdoor elements from our lives, restricting our experience of these elements mostly to the time when we move from a car to a building and back again. Biophilic cities propose to enhance our interaction with the outdoor elements by providing facilities conducive to such interactions.

2.3.1.8 The global dimension of Biophilic Cities

Cities often determine and affect biodiversity in a wider extent than just to itself through their consumption patterns and material flows. Biophilic cities aim to moderate and reduce these impacts, thereby, influencing the biodiversity at a much global level.

Concern for the global biodiversity may be expressed in different ways. Adoption of bird-friendly design standards to minimize loss of bird life, both migratory and local species, from tall buildings in the city is one example. Another example could be the development of wildlife underpasses and overpasses within a city to reduce its impact on the local biodiversity.

2.4 Biophilia & Urban Design

Biophilia advocates that natural and biophilic elements be the priority of all design and building projects- like medical facilities, schools, communities, blocks, network of streets and urban levels.

Biophilic Cities campaigns for the development of natural spaces in different scales and in a nested manner. The overall effort should be to form a network of spaces connecting different scales resulting in a unified effort and not just a piece by piece sum total. For instance, the lowest level could be the front lawn of a residence which is nested within the larger community green which, in turn, could be nested in the neighborhood green plan, and so on and so forth.

2.4.1 Biophilic Urban Design Elements across Scales

Scale	Biophilic Design Elements
Building	Green rooftops Sky gardens and green atria Rooftop garden, Green walls Day lit interior spaces
Block	Green courtyards Clustered housing around green areas Native species yards and spaces
Street	Green streets, Sidewalk gardens, urban trees Low-impact development Vegetated swales and skinny streets Edible landscaping High degree of permeability

Neighborhood	Stream day lighting, stream restoration Urban forests, Ecology parks Community gardens Neighborhood parks and pocket parks Greening gray fields and brownfields
Community	Urban creeks and riparian areas Urban ecological networks Green schools, City tree canopy Community forest and community orchards Greening utility corridors
Region	River systems and floodplains, Regional green space systems, Greening major transport corridors

Table 7 - Biophilic Urban Design Elements across Scales

[Beatley, T; Biophilic Cities; 2011]

Chapter 3 Relevant Studies

3.1 SOMA Master-plan, Bengaluru, India.

This is a master-plan proposal for a middle class suburb at the outskirts of Bengaluru by architect Ken Yeang. The proposal exemplifies how Green aesthetics and Green Eco-infrastructure can become the main driving factor in master planning.

The site is set around green hinterlands, giving it a perfect setup for creating ecological connections/ corridors throughout the master-plan to the green areas beyond. It exemplifies how natural and artificial areas can be linked to maintain an ecological connect in an urban master-plan. These corridors help in getting the local flora and fauna near to the urban settlements thus reducing the disconnect with nature, which this thesis aims to achieve.

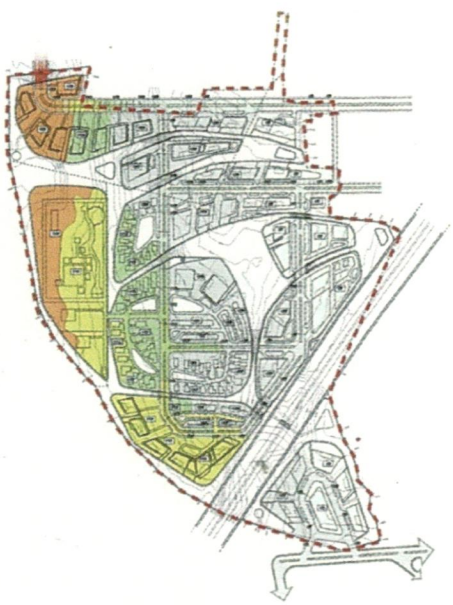
The site, covering nearly 87 acres, abuts an existent forest reserve. Yeang began by setting out a long green corridor along the forest edge which is then drawn across the master-plan to establish a framework of green Eco-infrastructure. [Hart, S. (2011)]

Figure 2 – Soma Masterplan conceptual clustering

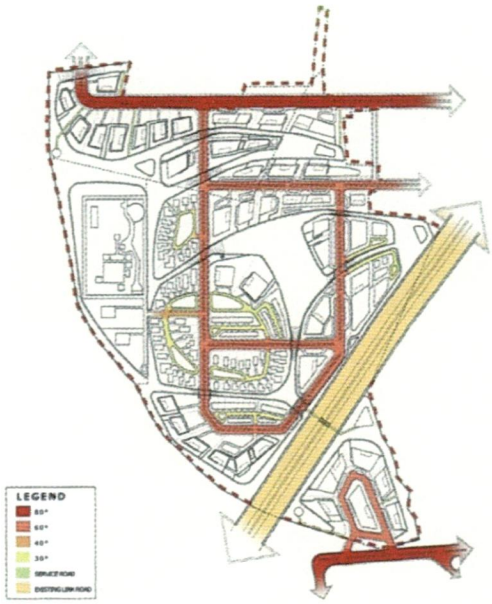
According to Ken Yeang, Eco-master-planning incorporates four sets of strategies or driving forces which he refers to by different color names.

- **Green strategies**–natural utilities (photosynthesis, food chains, etc.)
- **Grey strategies** - man-made infrastructure
- **Blue strategies** - water management and sustainable drainage
- **Red strategies** - human systems (culture, diet, rules and regulations)

Although all four needs to be incorporated but it is important to find out which colour is going to provide the best starting strategy which catalyzeswiththe rest of the colours. In this project it is the green strategies that initiate the master-plan.



Zoning



Grey EcoInfrastructure: Traffic & Road Hierarchy

Green EcoInfrastructure

Figure 3 – Conceptual zoning of Soma Masterplan on the basis of Green, Blue, Red and Grey infrastructure

Figure 4 – Soma Masterplan site-plan

Figure 5 – Ecological and vegetation concept – Soma Masterplan

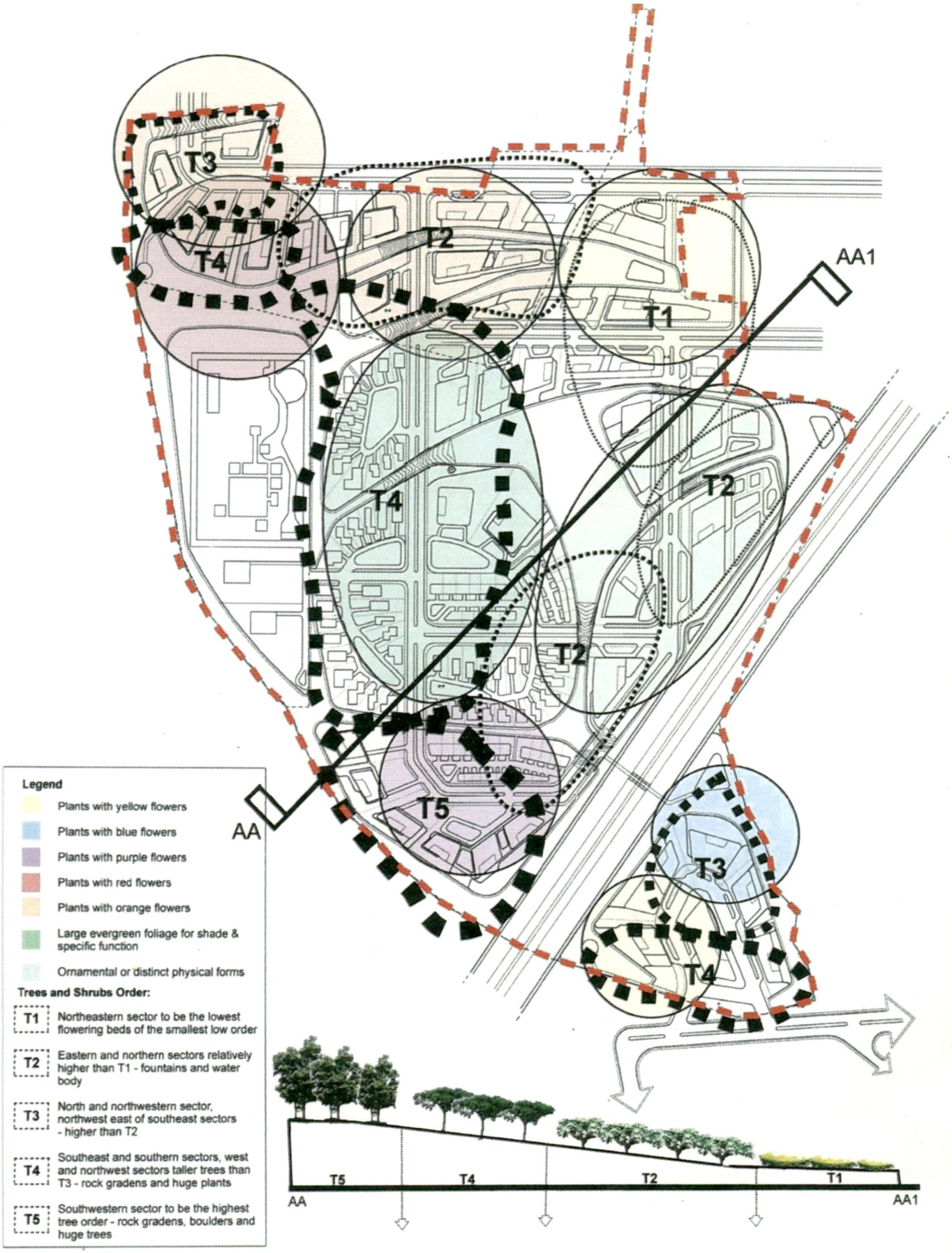


Figure 6 Landscape zoning – Soma Masterplan

The landscape plan is divided into four major segments. First are the primary green areas which include central parks and other green areas highly accessible by the public and are centrally located in the site. Second comes the secondary green spaces which are more in number and is more evenly distributed throughout the site along the buildings. Such areas include specially cater to private residential areas. Third are the tertiary spaces which include green roof tops and bridges connecting buildings etc. last is the ecological corridor which gives a green connect throughout the master-plan.

Different zones in the master-plan have different colour of flowering trees and planters. The colour of trees and plants helps in distinguishing one zone from the other.

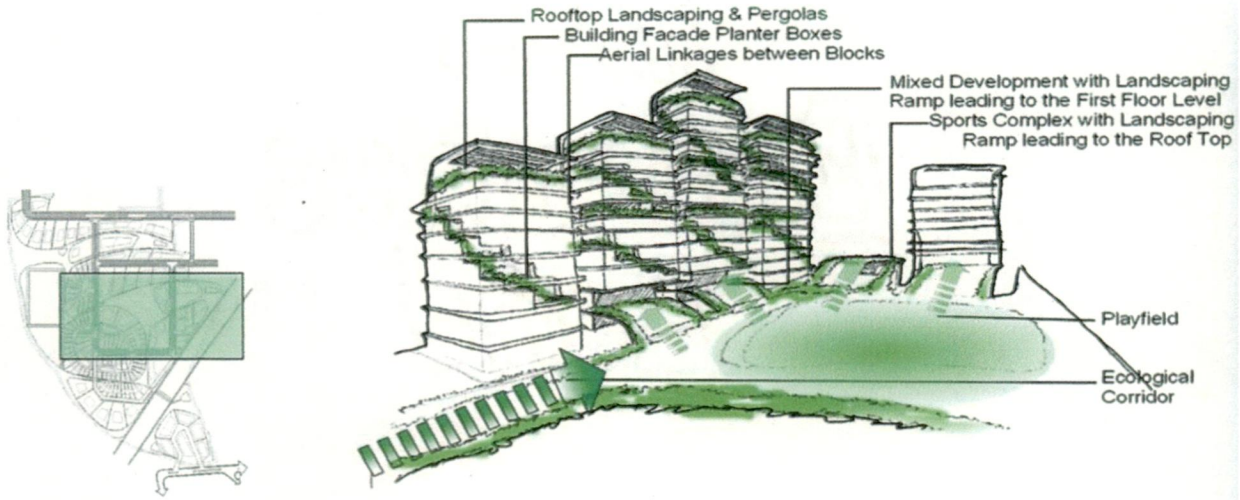


Figure 7 – neighborhood clusture and buildings – Soma Masterplan

Eighteen percent of the master-plan is dedicated to green areas. These green areas are well mingled with built forms creating a platform for local vegetation and habitat to pierce into the urban fabric.

Water sensitive master-planning is an essential feature of the project. Retention ponds and bio-swales are incorporated in the green areas which help percolate water into the sur-surface.

The master-plan specifies the use of sustainable and recycled materials for building construction, and maximum opening for light and natural ventilation. [Hart, S. (2011)]

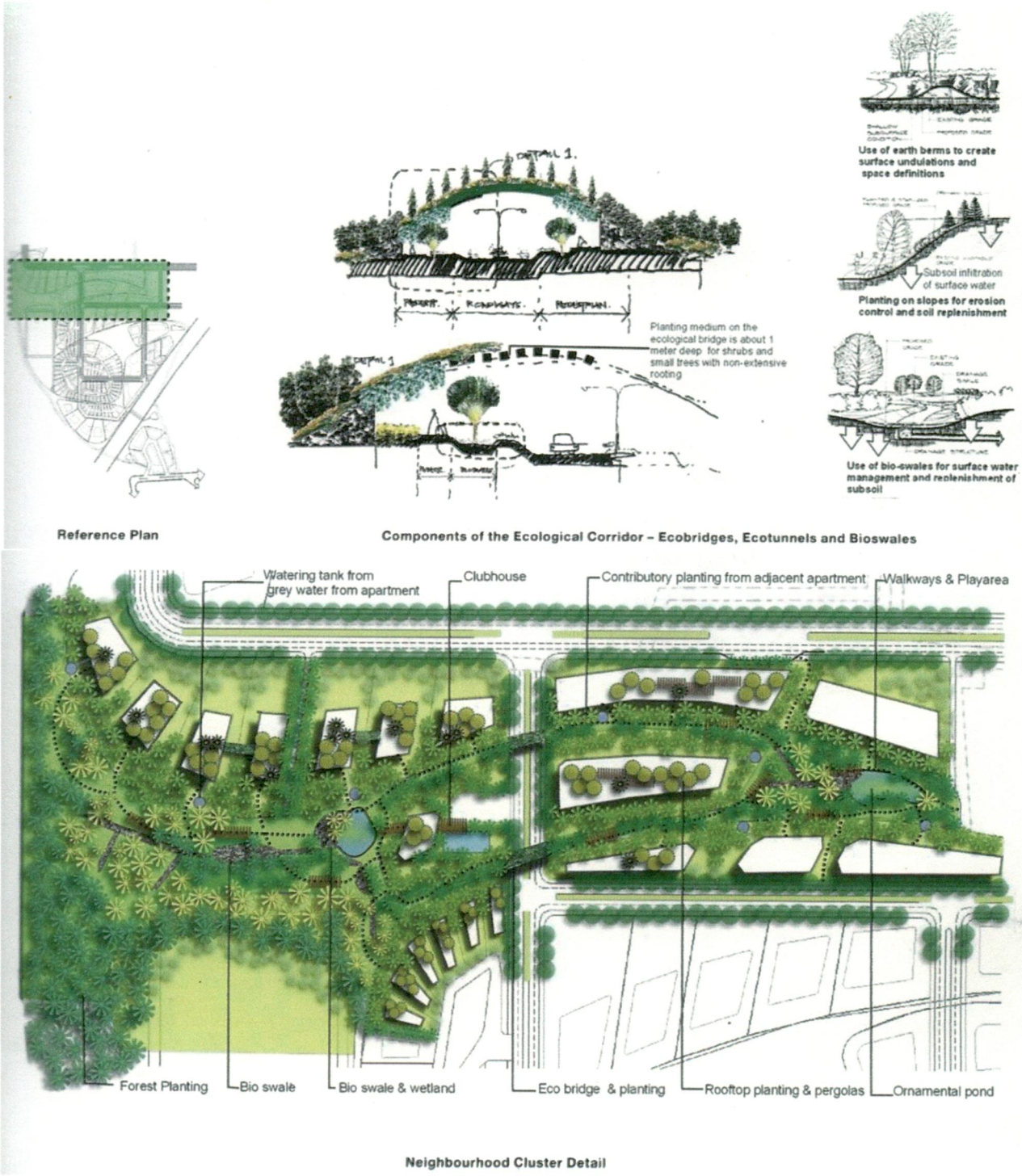


Figure 8 – Eco-bridges, Eco-tunnels and Bioswales – Soma Masterplan

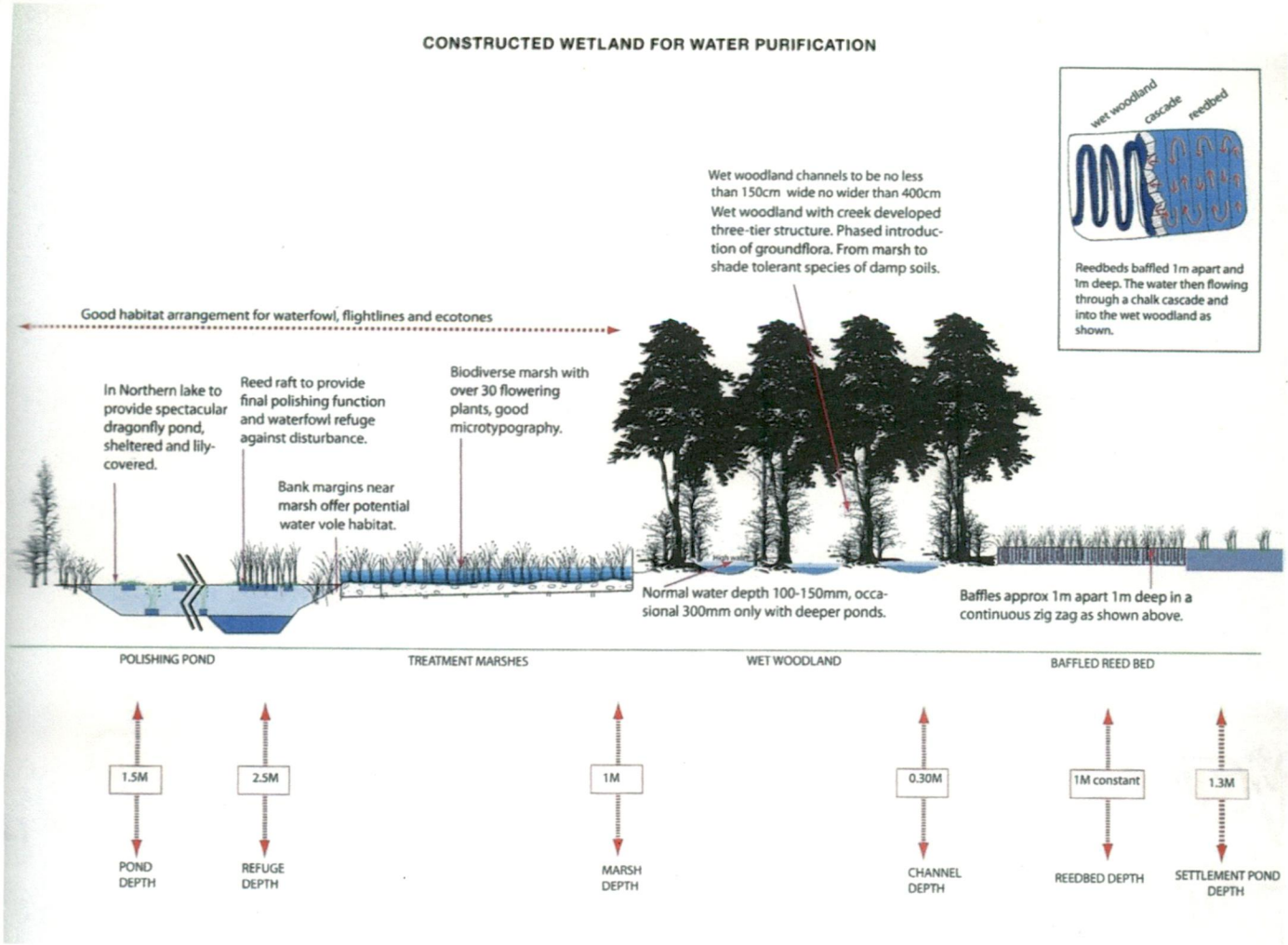
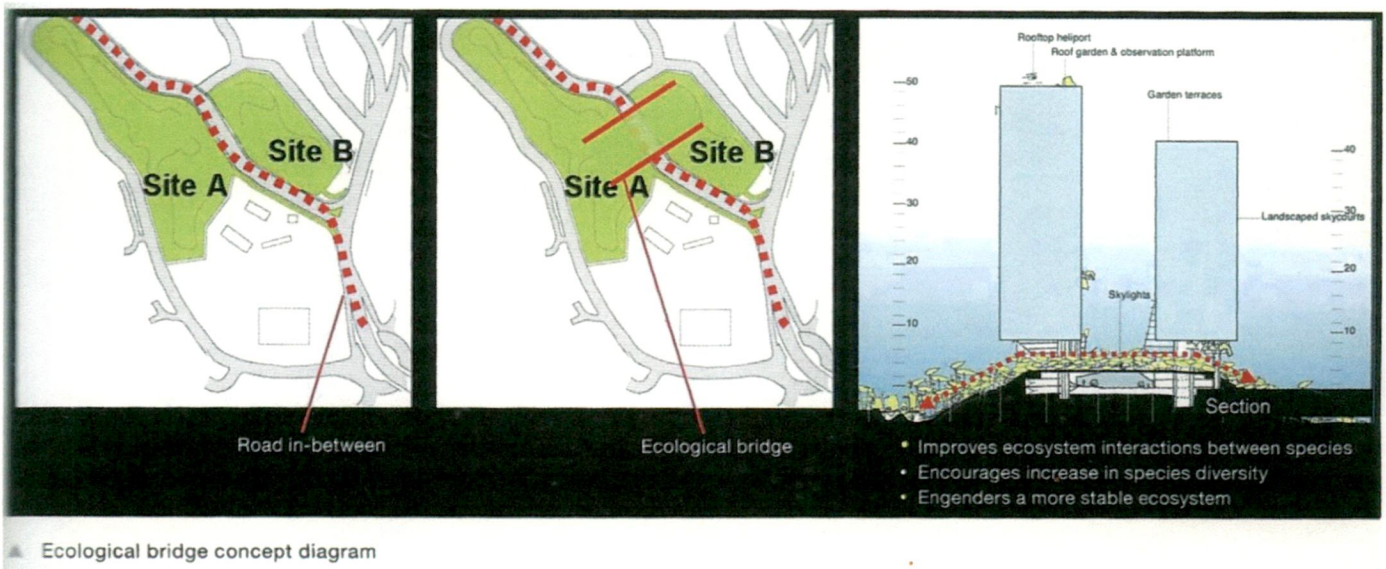


Figure 9 – Wet land for water purification – Soma Masterplan



Ecological bridge concept diagram

Figure 10 – Ecological bridges concept diagram – Soma Masterplan

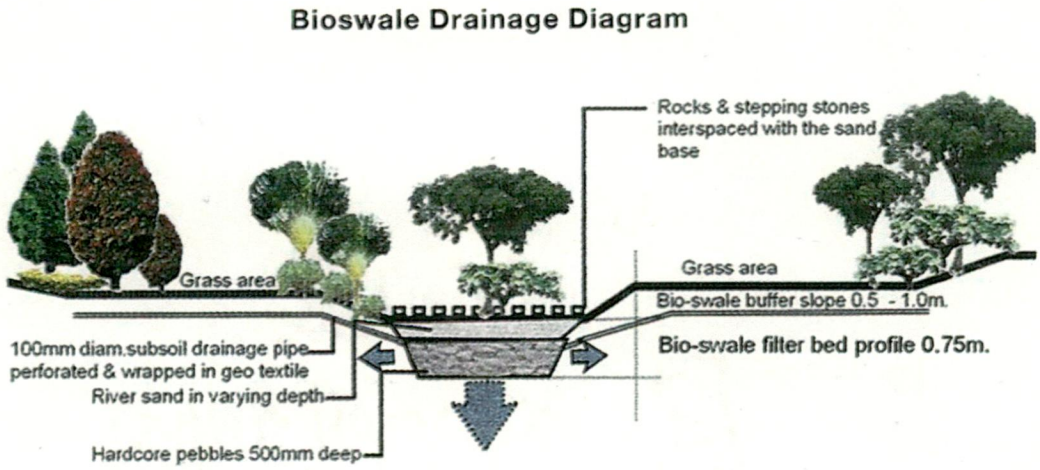


Figure 11 – Bioswale Drainage Daigram – Soma Masterplan

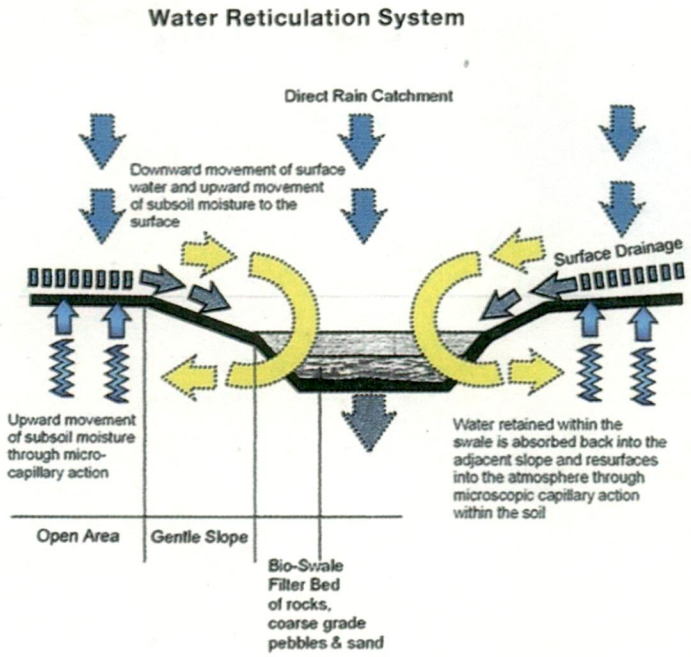


Figure 12 – Water Reticulation System – Soma Masterplan

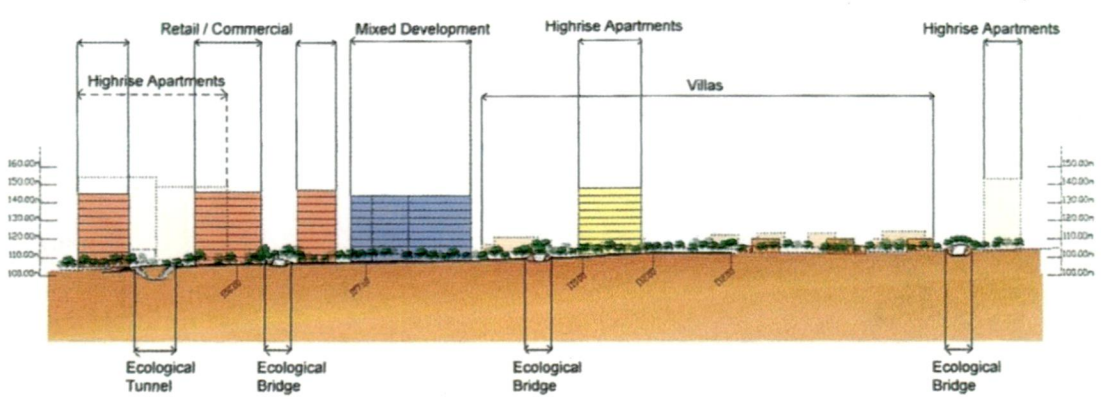


Figure 13 – Section showing Ecological Bridges and Tunnels – Soma Masterplan

3.1.1 Inferences from the study

- Green aesthetics should be used as the key driving strategy for a biophilic neighborhood.
- Natural eco-system should be brought inside the urban fabric.
- Ecological corridors, tunnels, bridges etc. should be adopted to create linkages between natural and artificial ecosystem.
- Landscape trees, flowering plants, wild bushes should be used to create identity to different neighborhoods or districts.
- Landscape zoning as per colour of foliage should be done.
- Clustering of buildings around green areas creates a biophilic environment.
- Water sensitive master planning is essential.
- Green roofs, facades and courtyards should be incorporated at building level.

3.2 Lavasa, India

Figure 14 – Conceptual regional view of Dasva, Lavasa

The development is spread over 15,000 acres set amidst the beautiful Mose Valley (located on the edge of the Western Ghats and the Sahyadri mountain range). Situated 2-3,000 feet above sea level, the project will offer a comfortable climate, modern city living amenities and reliable infrastructure. [Source hok.com]

3.2.1 Key features of the Masterplan –

- Protecting the ecology of the site.
- Protecting the existing land
- Low impact development
- Compact hill station development.
- Maintain the natural wetlands of the area like nallas, channels.
- Local vernacular architecture along with locally available and sustainable building material helps in creating a more climate responsive architecture at the building level.
- Careful study of the forest systems and local trees helped in understanding how surface water runoff can be controlled.

- All open surfaces are made of permeable materials which help in water percolation into the earth's crust.

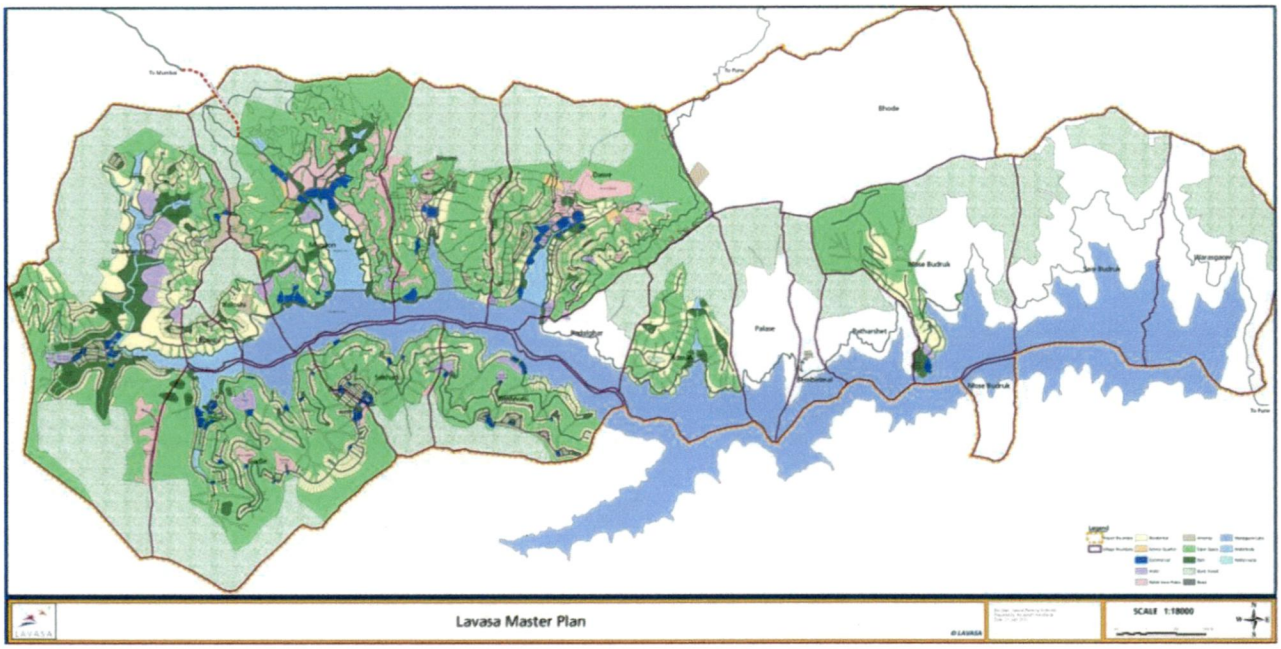


Figure 15 Masterplan of Dasve, Lavasa.

- Preservation of sensitive natural open space areas ensures that the hill station does not become overcrowded over time.
- Reforestation and replanting most of the areas helps in re-establishment of the local ecosystems and the character.
- Use of bioswales in the storm water system, cisterns to capture and reuse rainwater as well as grey water irrigation practices have been incorporated into the masterplan.

[Source hok.com]

3.2.2 Role of forest ecosystems

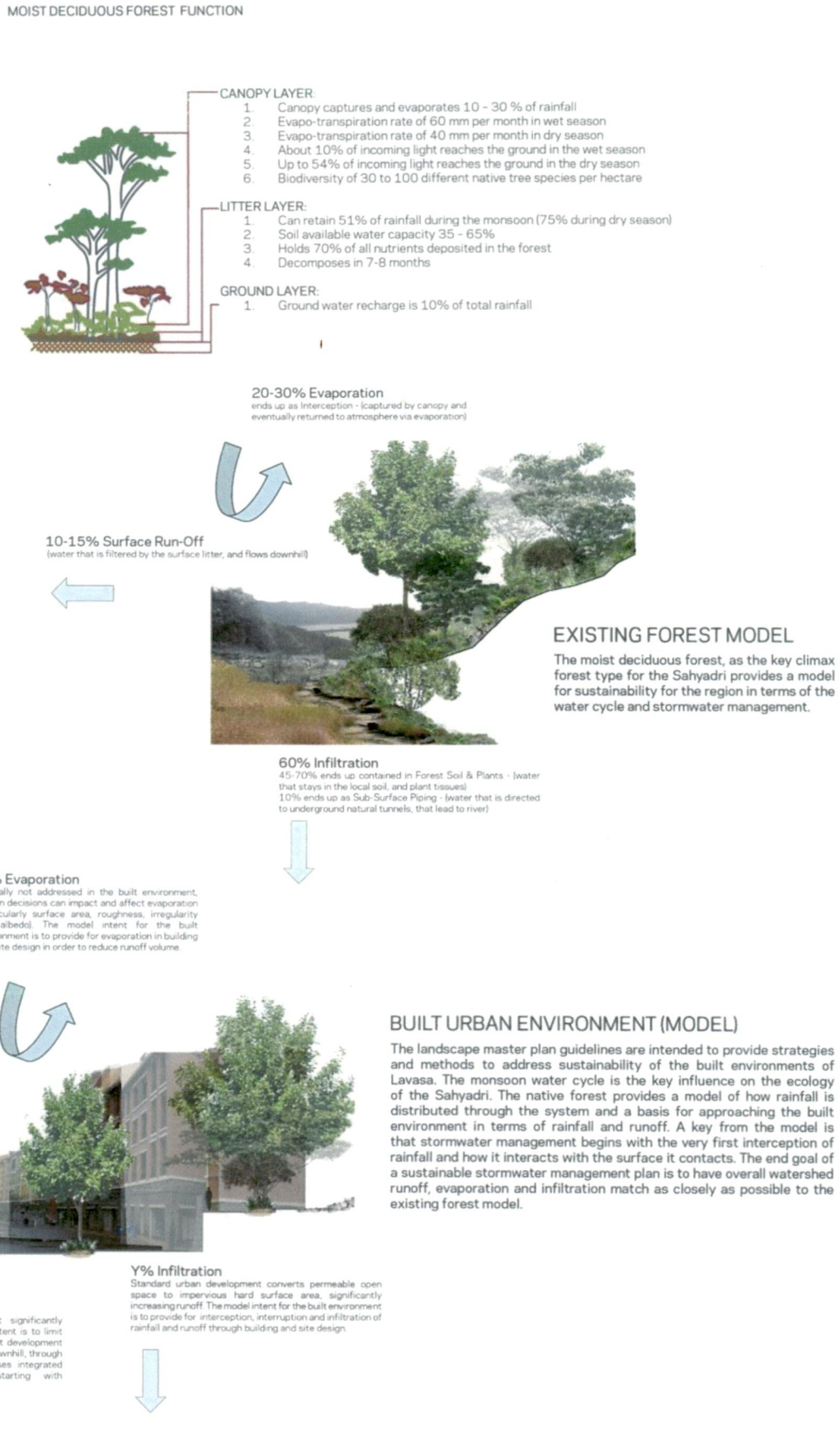


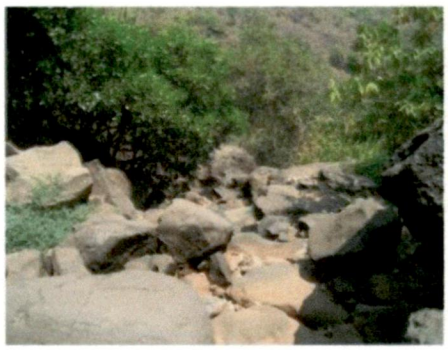
Figure 16 – Role of forest ecosystem in Dasve, Lavasa

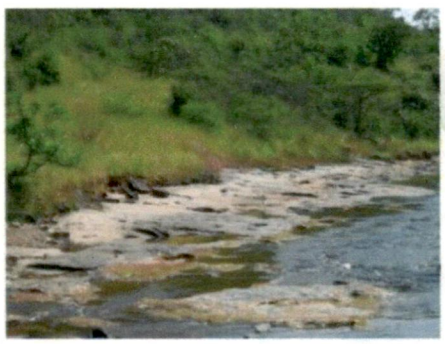
NALLAH CHANNELIZATION

Where it is necessary to enlarge and reinforce a nallah to accommodate anticipated flow volumes, utilize natural nallah principles to inform design and performance. Allow the nallah to change, provide for natural stream meander, varied sizing of rock in channel and the inclusion of vegetation along banks and channel. Avoid straightening the channel and lining it with consistent grading of rock and removal of vegetation as these qualities speed the flow of the stream. The intent is not to merely match the visual character of the natural nallah, but to mimic its performance by modeling the natural nallah.

Nallah gabion channelization at Dasve.

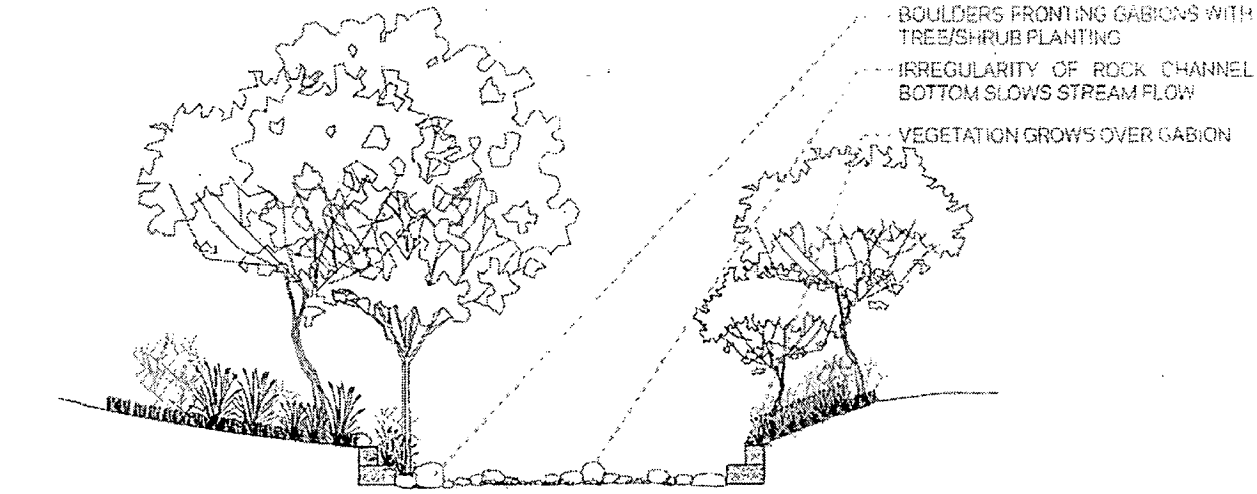
Nallah retaining wall channelization at Dasve.



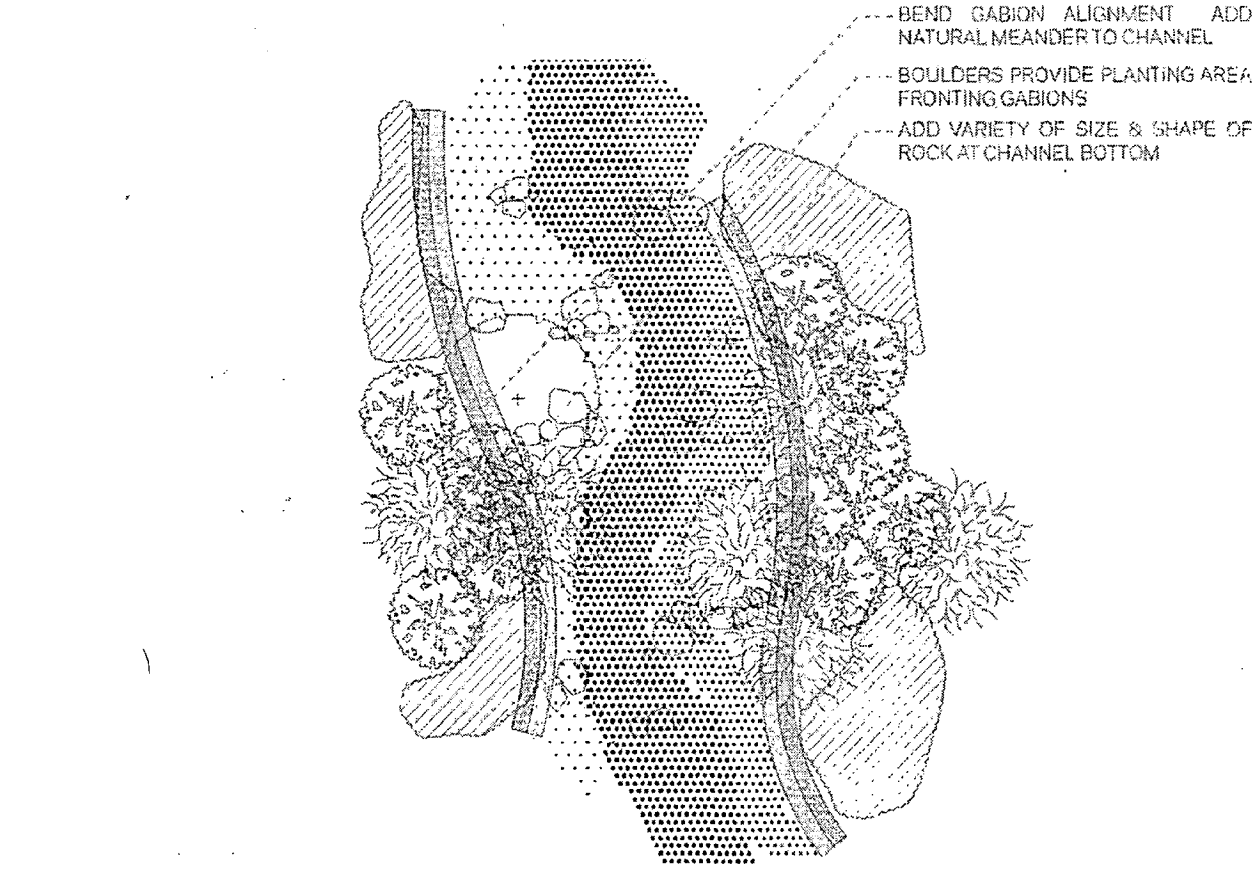


Natural principles in nallah channelization.

Figure 17 – Nallah Channelization at Lavasa



SECTION: NATURAL PRINCIPLES IN GABION NALLAH CHANNELIZATION



PLAN: NATURAL PRINCIPLES IN GABION NALLAH CHANNELIZATION

Figure 18 – Detail of nallah channelization

3.2.3 Concept of new urbanism in Lavasa

Principles of New Urbanism	Translated into the Master Plan
Commuting	
Walkability with everything within a 10 minute radius from work or home.	Lavasa encompasses a well-connected system of roads and pathways to make most facilities within walking distance.
Connectivity	
A network of streets, boulevards and alleys to easily disperse traffic.	An interconnected combination of roads, streets and walkways to ensure unhindered movement of traffic and vehicles.
Mixed Use and Diversity	
A mix of commercial and residential premises within neighbourhoods and blocks.	The Master Plan places the Town Hall at the centre of the town with residential apartments and commercial complexes dispersing in varied zones from the centre.
Mixed Housing	
A range of living spaces based on a variety of factors, size, proximity to the town centre, pricing, etc.	To develop as a city for people across the socio-economic spectrum, Lavasa has studio apartments, 1/2/3 BHK apartments and villas in varying sizes.
Quality Architecture and Urban Design	
Detailed attention to aesthetics and human comfort.	We believe that planners, designers and architects of Lavasa have created a town plan that will have a timeless appeal to generations, but contemporary design and architectural themes.
Traditional Neighbourhood Structuring	
A discernible city centre and more open public spaces that encompass a range of uses and densities.	Planned to promote people-friendly spaces, pedestrian walkways and meeting places, Lavasa's towns will comprise galleries, arcades, courtyards, street-side cafes and a variety of gardens and semi-covered spaces.
Planned Increased Density	
Transect Planning so that population density decreases progressively as it moves away from the town centre.	Lavasa's residential apartments are densest around the centre of town and decrease at a pre-determined pace farther from the centre. The hillside villas are laid out in planned neighbourhoods.
Smarter Transportation	
An advanced commuting network for enhanced efficiency.	An integrated and balanced transport system with varied modes of transport, walkways, bus lanes and automobile channels.
Sustainability	
Minimal impact on the environment.	Preservation through optimal utilization and minimal exploitation of available natural resources, thus ensuring continued access to future generations. Initiatives like Continuous Contour Trenching to prevent topsoil erosion and extensive Hydroseeding to enhance green cover.
Quality of Life	
A better life and soulspace.	An exhaustive range of organizations, services and information implies a host of opportunities for education, recreation, employment and business. Inspired by the idea of maximum living, Lavasa will thus also act as a catalyst for self-discovery and a better quality of life.

Table 8 – Concepts of New Urbanism in Lavasa

3.2.4 Inferences from Lavasa

The concept of New Urbanism at Lavasa helps in achieving perfect setting for a biophilic urban neighborhood in a hill town.

- Nature in urban spaces is not just aesthetics but essentially an outcome of a functional process with a greater cause.
- A neighborhood should have impressions of the natural forest or wildlife area neighboring it.
- A biophilic neighborhood is essentially a pedestrianized zone with minimum vehicles, so as to people can enjoy the nature around them.
- Investigating into the natural settings around an area helps in finding ideal solutions to problems native to the place.

3.2.4.1 Biomimicry Strategies at Lavasa

- Habitat should be fully used and incorporated in masterplanning.
- Provide for resource efficiency.
- Maintain balance with biosphere.

Study of Hill Town Guidelines

Following are the studies of some hill town guidelines through the lens of Biophilia in order to understand the applicability of the concepts at an urban hill town level.

3.3 District 6, City of Madison, Wisconsin, United States.

Following are the various guidelines and recommendations which were relevant to the concept of Biophilia :

3.3.1 Compact Building Design

Vital urban communities are places where residents live within close proximity to the amenities that satisfy their daily needs. Compact building patterns can contribute to a distinct community identity by shaping meaningful public open space, supporting a diverse mixture of uses, and supporting efficient transit systems and a vibrant, pedestrian-friendly public realm.

3.3.2 Sustainability

According to the Environmental Protection Agency, buildings account for a significant portion of society's environmental footprint.

Recommendations

"Green" building practices include: procuring building and site materials from regional sources, maximizing material recycling and reuse, and utilizing daylighting and passive heating/cooling to the fullest extent possible

- "Green" site design includes: minimizing parking demand through pedestrian-oriented, mixed-use design and on-site stormwater retention and infiltration

- Allow building density bonuses (e.g., additional building height) in exchange for amenities that are in the public interest, such as outdoor plazas, courtyards, and other open spaces, and connecting community multi-use trails and greenways.

3.3.3 Pedestrian Circulation Systems

Goal is to create a safe, walkable, attractive planned pedestrian environment.

Figure 19 Example of a sidewalk with pedestrian benches

Recommendations

- Establish uninterrupted patterns of pedestrian flow through the use of sidewalks, signage, and buffering devices.
- Utilize building setback requirements to locate pedestrian amenities such as seating and landscaping.
- Incorporate landscaped buffer between street and sidewalk.
- Outdoor seating located in building setback for restaurants and cafes is encouraged.

3.3.4 Parking and Service Areas

Parking often creates significant visual and physical barriers to active pedestrian streetscapes. Pedestrian— automobile conflicts are often a result of poor parking placement and design and steps

should be taken to maximize safety. Further, the impervious cover of parking areas is a primary source for the adverse impacts of stormwater runoff.

Recommendations

- Parking should be sited to the rear or non-street side of the main building with access from side streets when possible.
- When possible, buildings should share curb cuts; parking areas should cause minimal disturbance to pedestrian pathways.
- Parking areas shall include uninterrupted designated pedestrian circulation pathways.
- Parking shall incorporate stormwater management best practice strategies.
- To the maximum extent practicable, the overall total of impervious surface shall be reduced in parking lots by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, and using pervious materials in overflow parking areas.

3.3.5 Building Façade

Façade materials reflect building character, use, and quality.

Recommendations

- Exterior facades should be consistent with surrounding buildings, façade articulation that mimic windows, and utilize landscaping best practices.

3.3.6 Stormwater Management

Stormwater management is compulsory as it delivers benefits such as water quality improvement, groundwater recharge, wildlife habitat and natural scenery. Studies from around the world have explicitly concluded that proactive site planning and design is the most cost-effective approach for mitigating the adverse impacts of stormwater runoff. Due to the limited space in the corridor, stormwater management needs to be robust and innovative.

Goal: Effective, innovative and attractive on-site design and management practices that reduces the volume, velocity and contamination of stormwater runoff to the maximum extent practicable.

Figure 20 bioretention median in a parking lot

Recommendations

- A "treatment train" approach should be required to integrate multiple stormwater best management practices, such as bioretention swales, vegetated channels, rain gardens, permeable paving materials, cisterns, and green roof systems.

- Impervious surfaces should be disconnected to the maximum extent practicable to optimize infiltration.

- Landscaped areas and traffic islands should include areas to infiltrate stormwater.

- Rooftop runoff shall be directed to pervious areas so it is not directly routed to the roadway or storm sewer system.

- Permeable construction materials are strongly encouraged for use in low automobile traffic areas, such as driveways, sidewalks, plazas, overflow parking areas and other pedestrian walkways.

3.3.7 Open Space

By creating an expanded network of high-quality open space, we can improve the health of our natural environment, revitalize local economies, and provide important social gathering places for our citizens. ~Center for Resilient Cities

Open spaces can be a key community amenity, not just for those who live there but also for those who use the area on a daily basis. Pedestrian plazas, mini-parks, or "vest pocket" parks are not intended to replace public parks; they are oriented toward smaller areas and less-intense uses. This can provide opportunities for eating areas, work break-time spaces, rest areas for pedestrians and cyclists, and socialization.

Goal: Enhance the quality of the built environment throughout the District through the creation of meaningful, usable open space.

Recommendations

- Require large sites to provide landscaped and well-connected public areas on site
- Pedestrian plazas or other on-site open space shall provide:
    - A degree of privacy from traffic while maintaining inviting entrances from the street
    - Gathering places for site users throughout the day
    - Connections to other open spaces, such as greenways, public parks, and bike paths
- On-site open spaces should avoid long stretches of paved areas without landscaping features
- A rich assemblage (i.e. various ages and species) of trees and shrubs species are strongly encouraged for landscaping areas.
- Tree and shrub species should be planted in strategic locations to maximize summer shade and to reduce winter shade.
- When planting trees, shrubs and grasses, group similar species to minimize maintenance requirements and provide ample space for root growth.

Goal: Create a well-connected network of open spaces

Future development should protect existing green and open spaces and enhance the system with new connecting greenways and pedestrian paths. A network of parks and open spaces can offer many benefits to the surrounding communities:

- Improving the aesthetic quality of the area and the safety of open spaces. This includes adding lighting and signage in existing green spaces as well as on the routes that connect them.

- Creating a well-connected open space network will offer additional recreational opportunities for residents.

Goal: Identify space for future community gardens

[Urban Design District #6. Corridor Plan and Design Guidelines. Madison, Wisconsin. 12 May 2008]

3.3.8 Lessons drawn from the study

1) Compact and high densities are essential for urban hill town neighborhoods.

2) Create a safe, walkable, attractive street level, including usable open space such as parks, side yard gardens, etc.

3) Provide for innovative storm water management.

4) Create a well-connected network of open spaces to protect existing green and open space, and enhance this system by strategically adding connecting greenways and pedestrian paths.

5) Future community garden spaces should be pre assumed while planning.

Chapter 4 Analysis of guidelines

In this chapter I have done a comparative analysis of the different cases discussed in Chapter-3 on the basis of the biophilic urban design goals (Chapter-2) in order to understand the feasibility of the general biophilic principles on a hill town.

Following are the eight cases analyzed in this chapter -

1. SOMA Masterplan, Bengaluru, India.
2. District 6, City of Madison, Wisconsin, United States.
3. La Mesa, California, United States.
4. City of Pittsburgh, Pennsylvania, United States.
5. City of Kelowna, British Columbia, Canada.
6. City of San Clemente, California, United States.
7. VanDusen Botanical Garden, Vancouver, British Columbia, Canada.
8. Shimal, Himachal Pradesh, India.

The cases are compared on the basis of the following heads as interpreted from Chapter 2 –

At Neighborhood level –

Development; Open green areas; Connectivity; Edible landscape; Wet lands; Trees; Natural habitat.

At Street level –

Character and Connectivity; Landscape; Low Impact Development; Preserve nature.

At Block level –

Development; Open green areas; Landscaping; Natural habitat.

At Building level –

Materials, Colour and Lighting; Indoor environment; Rainwater harvesting; Form and Orientation; Roof; Landscaping; Services.

4.1 At Neighborhood level

	PROJECTS	SOMA MASTERPLAN, BENGALURU	CITY OF MADISON'S URBAN DESIGN DISTRICT 6	CITY OF LAMESA, CALIFORNIA	CITY OF PITTSBURG, CALIFORNIA	CITY OF KELOWNA, CALIFORNIA	SAN CLEMENTE, CALIFORNIA	VANDUSEN BOTANICAL GARDEN,	SHIMLA CITY DEVELOPMENT PLAN (JNNURM)
DEVELOP-MENT	CLUSTERED DEVELOPMENT	O	O	O	O	O	O		O
	COMPACT AND DENSE	O	O	O		O			O
OPEN GREEN AREAS	NATURAL LANDSCAPE CLOSE TO DENSE POPULATION	O	O	O		O	O		
	PUBLIC AMENITIES - PLAYSCAPES AND COMMUNITY GARDENS	O	O	O					
	PERIMETER PLANTING TO DEFINE EDGES	O			O	O		O	
	WILD AND NATURAL PARKS			O	O			O	O
CONNECT-IVITY	HIGH PERMEABILITY (PEDESTRAIN)	O	O	O	O	O			O
	ACCESS TO LARGE ECOLOGICAL NETWORK (WALKING TRAIL)	O					O	O	
EDIBLE LANDSCAPE	EDIBLE SPECIES - FOOD RESILIENCE					O		O	
	PLANTING FRUIT TREES							O	
	CONVERT TURF GRASS LAWN	O		O				O	

Table 9 Neighborhood level analysis (part-1)

		PROJECTS	SOMA MASTERPLAN, BENGALURU	CITY OF MADISON`S URBAN DESIGN DISTRICT 6	CITY OF LAMESA, CALIFORNIA	CITY OF PITTSBURG, CALIFORNIA	CITY OF KELOWNA, CALIFORNIA	SAN CLEMENTE, CALIFORNIA	VANDUSEN BOTANICAL GARDEN,	SHIMLA CITY DEVELOPMENT PLAN (JNNURM)
WET LANDS	CONSERVE WETLANDS		O		O	O	O	O	O	
	STORM WATER MANAGEMENT		O		O	O	O		O	O
TREES	PROTECT OLD TREES		O	O	O		O		O	O
	TREES AS SPACE DEFINING ELEMENT		O		O	O	O	O	O	
	INCREASED TREE CANOPY		O	O	O			O		
	INDIGENOUS AND ENDEMIC TREE TO BE PLANTED		O	O				O		
NATURAL HABITAT	TREE HOUSE									
	BUTTERFLIES AND INSECT FLOWERING PLANTS		O						O	
	INCLUDE NATURAL HABITAT (LOCALLY FOUND)		O	O	O	O	O			

Table 10 Neighborhood level analysis (part – 2)

4.2 At Street level

	PROJECTS	SOMA MASTERPLAN, BENGALURU	CITY OF MADISON'S URBAN DESIGN DISTRICT 6	CITY OF LAMESA, CALIFORNIA	CITY OF PITTSBURG, CALIFORNIA	CITY OF KELOWNA, CALIFORNIA	SAN CLEMENTE, CALIFORNIA	VANDUSEN BOTANICAL GARDEN,	SHIMLA CITY DEVELOPMENT PLAN (JNNURM)
CHARACTER AND CONNECTIVITY									
STREETS REFLECT CHARACTER OF HILL SIDE			O	O	O	O			O
LIVELIER MORE ACTIVE MIXED USE STREET		O	O	O		O			O
WELL CONNECTED BY PUBLIC TRANSIT			O	O	O	O	O		
CONNECTED STREETS AND PATHWAYS THROUGHOUT		O	O	O	O	O			
GROUND FLOOR AT HUMAN SCALE		O	O	O		O			
PEDESTRAIN CONNECTION TO RIPARIAN AREAS		O		O	O		O		
LANDSCAPING									
PLANTING STRIPS ALONG DRAINS					O	O	O		O
SIDE-WALK GARDEN		O	O	O		O			
FENCES SHOULD NOT BLOCK VIEW FROM STREET		O	O	O	O	O	O		
LARGE SINGLE LEVEL PLATFORMS TO BE AVOIDED									
NARROW, WAVY, VEGETATION FILLED GREEN STREET		O	O		O	O			
LOW IMPACT DEVELOPMENT									
BIO-SWALES AND RAIN GARDENS ALONG STREETS AND SIDEWALKS		O	O	O				O	
CURB EXTENSIONS COLLECT/RETAIN STORM WATER		O	O	O	O	O			
ECO-BOULEVARDS - WATER TREATMENT		O		O			O	O	
PERMEABLE PAVING		O	O	O	O	O		O	O
PRESERVE NATURE									
RETAIN TREES AND NATURAL FEATURES FALLING IN THE RIGHT OF WAY		O		O	O	O	O		O
CONSIDER MATURE TREES AND HEAVILY LANDSCAPE BOULEVARD		O	O	O				O	
PRESERVE AND CREATE NATURE TRAILS		O	O						

Table 11 Street level analysis

4.3 At Block level

		PROJECTS	SOMA MASTERPLAN, BENGALURU	CITY OF MADISON'S URBAN DESIGN DISTRICT 6	CITY OF LAMESA, CALIFORNIA	CITY OF PITTSBURG, CALIFORNIA	CITY OF KELOWNA, CALIFORNIA	SAN CLEMENTE, CALIFORNIA	VANDUSEN BOTANICAL GARDEN,	SHIMLA CITY DEVELOPMENT PLAN (JNNURM)
DEVELOPMENT	HIGH DENSITY CLUSTERED HOUSING		O	O	O					O
	STAGGERED SETBACK		O		O	O	O	O		
	SPLITING PLOTS BETWEEN ADJACENT PROPERTIES			O			O			
	RECONFIGURE ABANDONED PLOTS			O	O					O
OPEN GREEN AREAS	POCKET PARKS		O		O			O		
	GREEN COURTYARDS		O				O			
	FENCES SHOULD NOT BLOCK VEIW		O	O		O	O			
	NATIVE BUSHES AND SHRUBS AS FENCING		O	O		O	O			
LANDSCAPING	INFORMAL CLUSTERING OF PLANTS		O				O	O		
	IRRIGATED LANDSCAPING		O	O	O					
	MINIMIZE IMPERVIOUS SURFACE		O	O	O	O	O			O
NATURAL HABITAT	PROTECTING NATURAL FEATURES		O	O	O	O	O	O		O
	MINIMIZE GRADING AND RETAINING WALLS				O		O			O
	SCREENED SERVICES AND UTILITIES			O			O			

Table 12 Block level analysis

4.4 At Building level

		PROJECTS	SOMA MASTERPLAN, BENGALURU	VANDUSEN BOTANICAL GARDEN, COLUMBIA	CITY OF MADISON'S URBAN DESIGN DISTRICT 6	CITY OF LAMESA, CALIFORNIA	CITY OF PITTSBURG, CALIFORNIA	CITY OF KELOWNA, CALIFORNIA	SAN CLEMENTE, CALIFORNIA	SHIMLA CITY DEVELOPMENT PLAN (JNNURM)
MATERIALS, COLOUR AND LIGHTING	LOCAL BUILDING MATERIALS			O	O	O		O		
	USE OF RECYCLED BUILDING MATERIAL			O	O	O				
	NO CONTRASTING COLOURS		O				O		O	
	LOW VOC PAINTS				O			O		
	BUILDING LIGHTING NOT DOMINANT		O							O
INDOOR ENVIRONMENT	LOCAL CLIMATE RESPONSIVE ARCHITECTURE		O	O	O	O	O	O		
	NATURAL DAYLIGHTING		O	O	O			O		
	INTERIOR OPEN AIR COURTYARD		O		O					
	COURTYARD AND GARDEN PLANTS		O							
	WATER FEATURE			O				O		
	HIGH PERFORMANCE WINDOWS				O	O				
	GREEN PERMEABLE FEATURE		O	O	O	O	O	O		
RAINWATER HARVESTING	WASTE WATER HARVESTING SYSTEM		O	O	O	O	O			O
	RAIN WATER COLLECTION AND REUSE		O	O	O	O		O		O
	ROOFTOP GARDEN		O	O			O			O

Table 13 Building level analysis (part-1)

		PROJECTS	SOMA MASTERPLAN, BENGALURU	VANDUSEN BOTANICAL GARDEN,	CITY OF MADISON'S URBAN DESIGN DISTRICT 6	CITY OF LAMESA, CALIFORNIA	CITY OF PITTSBURG, CALIFORNIA	CITY OF KELOWNA, CALIFORNIA	SAN CLEMENTE, CALIFORNIA	SHIMLA CITY DEVELOPMENT PLAN (JNNURM)
FORM AND ORIENTATION	FORM AND SCALE APPROPRIATE TO NATURAL CONTEXT		O		O	O	O	O	O	
	FORM FOLLOWS CONTOURS				O		O	O		O
	ORIENTATION TO MAXIMIZE VIEWING CORRIDORS		O				O	O		
ROOF	ROOF SLOPE SAME DIRECTION OF MOUNTAINS						O			O
	ROOFLINE SHOULD NOT BREAK THE NATURAL BACKDROP						O	O		
	ROOFLINE SHOULD MIMIC THE NATURAL LINES OF HILLSIDE						O			
LANSCAPING	LANDSCAPE FOR PROTECTING VIEWS FROM THE SITE		O			O	O	O	O	
	LANDSCAPING FOR HIDING VIEWS OF IMPOSING FAÇADE		O		O	O		O		
	HIGH WATER EFFICIENCY AND INCREASED BIO-DIVERSITY		O	O		O		O		
	USE OF NATIVE , WATER-CONSERVING SPECIES		O		O	O		O		
	USE OF PLAZAS, GARDENS, COVERED WALKWAYS, ROOF TOP TERRACES, ETC		O	O		O	O	O		
SERVICES	SOLAR WATER HEATING		O	O		O	O			
	TELECOMUNICATION FACILITIES WITH MINIMUM VISUAL INTERFERENCE		O		O					O

Table 14 Building level analysis (part-2)

4.5 Clustered-Compact-Dense development in hills

4.5.1 Height

- In hill architecture the human scale should be maintained, buildings should be less heighted.
- Scale and permeability with development of the past should be retained.
- The height of a building should not break the ridgeline beyond in order to maintain the natural setting of the place.
- By regulating height restrictions, the magnitude of the development should be maintained.
- The environmental control cost of a building with more number of floors is very high. In low rise buildings the technology involved can be less sophisticated and inexpensive.
- Less height means more interaction with neighbors.
- Low or mid-rise development does not create a sense of vertigo.

Discussion – All the above stated points suggests less height of buildings in hills. But at the same time population is ever increasing, which means the load on the available land is increasing. Therefore to rationalize the height of buildings should be allowed to increase up to the level it does not harm the natural settings of the place.

4.5.2 Density

- High density high-rise development blocks major viewing corridors. High density low or medium-rise development should be planned along with site planning emphasizing views.
- Stepped development helps in increasing the density of a hill town. In fact with increase in slope the density can also increase. The stepping of built forms also gives connect between interior and open spaces allowing children to move out in the nature and play.

Discussion – In urban towns in hills low-rise buildings are preferred as they don't break the natural setting. But density of population is ever increasing. Low-rise high-density development is a favorable condition, but for areas with higher density, mid-rise high-density should also be considered which does not harm the natural setting of the place.

4.5.3 Compact

- Access and circulation in a hill town depends upon the density it needs to cater to. So in case of an urban area with high density loads, it is important to keep compactness in planning so as to create a walk-able experience.
- In hills building are prone to high velocity wind. This can result in undesirable conditions inside the building. This can be avoided by compact clustering of buildings.

Discussion – Compactness allows for walkability. It also reduces the building footprint allowing greater green and open spaces. If we have to maintain height restrictions on buildings it should be compact in planning so as to accommodate the maximum density without destroying the open green areas.

So till now it is low-rise / mid-rise, high-density, compact development that is essential for hill development.

4.5.4 Clustered

- Cluster development allows integration of natural terrain and features such as trees, natural water drains, etc. at a site planning level.
- Increases green open spaces for recreational purposes.
- Clustering provides for views to all residences of important natural networks and features.
- Impervious surface is reduced.
- Environmentally sensitive zones of a plot are protected.
- The cost of services and other facilities such as roads, electricity and gas lines etc., are reduced considerably due to common use.
- The open spaces created provides platform for edible landscaping.
- Cluster development helps in creating pedestrian pathways both along and perpendicular to contours thus reducing the distance to be travelled.

- Clustered development increases proximity thus encouraging pedestrainazation and use of public transport and reduces vehicular roads.
- There are three types of clusters – standard, formal and organic. Organic clusters should be used as it diversifies in form, location and climate. Organic hill-side architecture is greatly influenced by local culture and climate.

Discussion – the above stated advantages are essential for biophilia and cannot be ignored in a biophilic environment. Thus compact-clustered development should be encouraged with high-density and essentially low / mid-rise structures which do not harm the natural surroundings of the place and encourage interaction with nature.

4.6 Low Impact Development (LID) in hills

Low Impact Development refers to the development which safeguards and restore the hydrology of a site or neighborhood. Following are the common elements of LID-

- Permeable pavement – reduces run-off.
- Cisterns and rain barrels – stores rain water collected form roof collection.
- Green roofs – reduces the ecological footprint by adding green cover on the roof top.
- Bio-swales – helps in purification and increasing the quality of surface run-off water.
- Bio retention / rain-gardens – helps in ground water recharge using rain water from other impervious surfaces.
- Maintaining and creating wetlands

Looking in the hill context and constrains, steep hills does not allow for percolation of water in the ground surface. High water-table in hills gives rise to problem of landslide and soil erosion as the rocks are loosely packed. Thus ground water recharge in steep (app above 10%) hill areas is not recommended.

Since hilly areas are mostly water scarce (cannot store water naturally over periods) it is highly recommended that all rain water collected from roofs and other impervious surfaces should be stored

in cisterns or barrels for later domestic use after a little filtration. This can be done in lots with small sizes.

Green roofs are feasible on large roofs. It has immense advantages including growing edible landscape, incorporation of local habitat like butterflies etc. but in hilly areas where the clustered form does not allow for long roof surfaces it is not very feasible. The cost of installing green roofs are very high and doing it on a small scale does not make any sense. The structural load of a building also enormously increases with the installation of green roofs which is not very favorable in hills.

Although it is not favorable to do in small units, large roof tops and clusters of roof tops can be implemented with green roofs in order to achieve economic feasibility and also reduce the overall impact in the surroundings.

4.7 Mixed-use streets in hills

Compact and clustered development gives rise to short distances and a more walk-able environment. One of the main concepts of biophilia deals with bringing people outside of their workspaces and homes and inducing interaction with nature. For more time to be spent outside it is important to have social interaction and a more enjoyable walking experience.

The building frontages and ground floor level should be made very interactive and in a human scale. The terrain in mountains does not allow cars to access all roads which is also one of the desired conditions for a healthy city. So it becomes very important to adopt mixed-use in residential neighborhoods with facilities and amenities which caters locally and fulfills the need of independent neighborhoods.

Chapter 5 Proposed Urban Design Guidelines

5.1 Introduction

In this chapter the biophilic urban design intentions and ideas for an urban hill neighborhood are translated into guidelines so that the resulted urban environment fits the vision of a biophilic neighborhood.

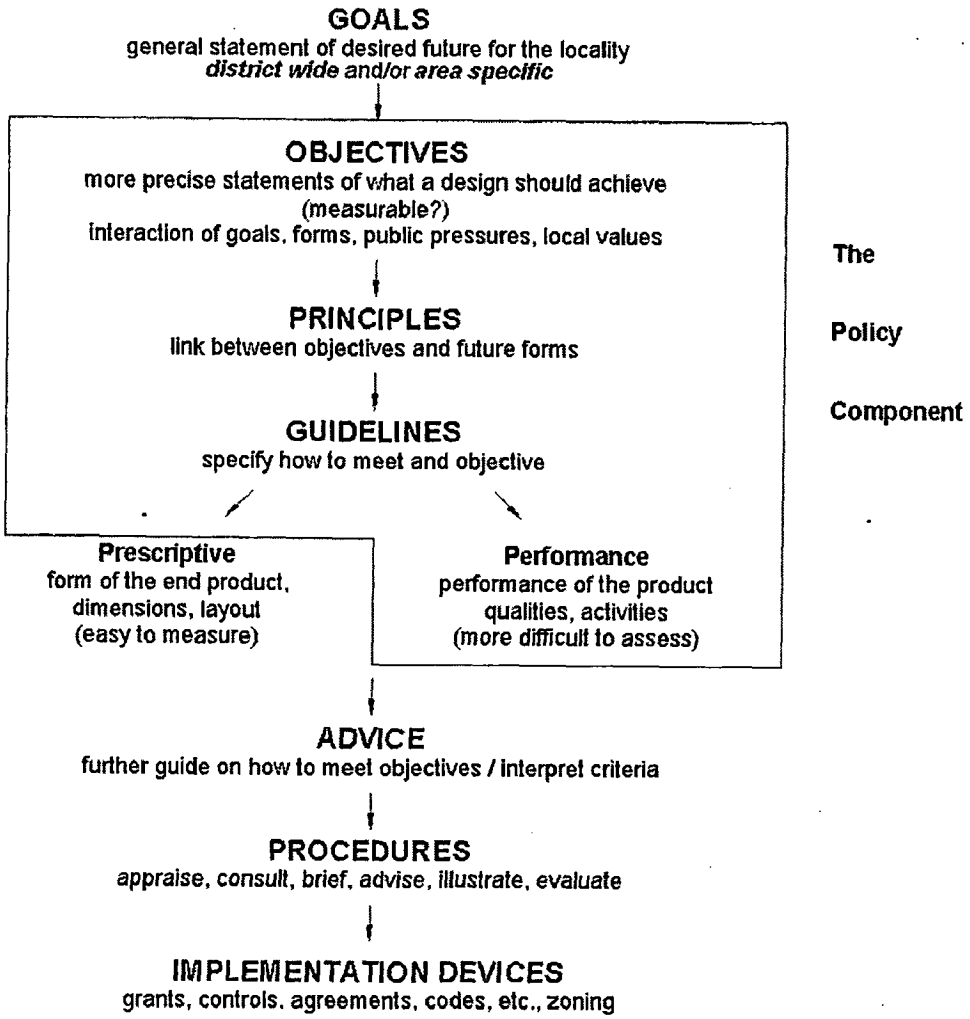


Figure 21 Key components of design policy. [Source – Punter & Carmona (1997)]

A study and analysis of hill side development guidelines of hill towns reviewed in Chapter-4 through the lens of biophilia (Chapter-2) led to the proposed guidelines and has been discussed in this chapter.

5.2 Urban Design guidelines for Biophilic neighborhood in a hill town

5.2.1 Neighborhood level

5.2.1.1 Development

Compact-clustered development should be encouraged with high-density and essentially low / mid-rise structures which do not harm the natural surroundings of the place and encourage interaction with nature.

1. Clustered form of development should be promoted to conserve nature. Viewing corridors, wildlife habitat areas, natural water courses, important trees and riparian networks should all be preserved.
2. Development should be compact and dense, fitted around green areas.
3. New areas should fit around protected natural areas such as streams, woodlands and other rich in biodiversity areas.

5.2.1.2 Open green areas

1. Greenness and density should be combined to create a more outdoor oriented life.
2. Open space within the precinct should be universally accessible by the general public, and provide points of interest and public amenity such as play-scapes and community gardens.
3. Green spaces of a neighborhood should be reclaimed and restored.
4. Wild and natural parks (even very small ones) should be preserved.
5. New parks should be created.
6. Trees should be used as space defining elements. The Planting of trees must be in an organized format so as to create (useable) space.
7. Shading must be provided in these open spaces by using natural vegetation.
8. Flowering plants which attract butterflies and insects should be incorporated.

5.2.1.3 Connectivity

1. Access to larger ecological networks through nature trails should be provided.
2. Neighborhood should be highly permeable from a pedestrian point of view.
3. Pathway connecting major destinations of a neighborhood should be provided.

5.2.1.4 Edible landscape

1. Native shrubs and edible landscape should be grown.
2. Fruit trees should be planted.

5.2.1.5 Wet lands

1. A remnant creek or stream or water body should be in close proximity to a neighborhood where possible.
2. Restore and create wetlands (make sure the land stability and erosion patterns are not negatively affected)

5.2.1.6 Urban trees

1. Native species of trees should be planted.
2. Increase tree canopy area in a neighborhood.
3. Avenues of trees must be implemented in the public realm.
4. Indigenous and where possible endemic trees must be planted in the public realm.
5. Heritage trees must be preserved.

5.2.1.7 Conserve nature

1. Nature and farmland should be conserved.
2. Protect biodiversity.
3. Natural habitat (found locally) should be incorporated.

5.2.2 *Street level*

5.2.2.1 Character and connectivity

1. Type, scale, nature, context and character should be reflected in street design.
2. Consider mature street trees and heavily landscaped boulevards on all roads, including local streets.
3. A livelier, more active mixed-use street is desired.
4. Streets and pathways should be connected throughout the neighborhood.
5. Pedestrians should be able to move from the building door step to larger expanses of nature.
6. Ground floor plane throughout the neighborhood should be of a human scale, and ensure high quality pedestrian experience.
7. Automobiles should be reduced inside a neighborhood. Dedicated pathways for pedestrians should be provided linking all major and minor public spaces, altogether creating an outdoor oriented healthy lifestyle for its inhabitants.
8. Visual and pedestrian connection to restored riparian wetlands should be provided.

5.2.2.2 Landscaping

1. Side-walk gardens should be provided.
2. Planting strips should be provided along drainage lines.
3. Large single level building platforms should be avoided. Lot grades should mimic the natural slope, and slopes should be promptly re-vegetated.
4. Narrow, wavy, vegetation-filled green streets, with sidewalks should be provided.
5. Views from the street should not be blocked with solid fences.
6. Bollards, light poles and other street furniture should complement the natural surroundings.

5.2.2.3 Low impact development

1. In steel hills water should not be allowed to enter the subsoil as it hampers the land stability. Pervious surfaces should be reduced.
2. Rain water collected from roofs and other impervious surfaces should be stored in cisterns or barrels for later domestic use after a little filtration. This can be done in lots with small sizes.
3. Large roof tops and clusters of roof tops can be implemented with green roofs in order to achieve economic feasibility and also reduce the overall impact in the surroundings.

5.2.2.4 Conserve nature

1. Retain substantive trees and natural features within the road right-of-way, to the extent possible – consider alternate road design.
2. Preserve the major systems of existing 'open space trails' and corridors and establish links to existing and planned trails in and around the area.

5.2.3 Block level

5.2.3.1 Development

1. Setbacks of buildings should be staggered.
2. Reconfigure abandoned plots (grey and brown fields.)

5.2.3.2 Open green areas

1. Pockets parks should be created/restored.
2. Abundant nature throughout: Sidewalk gardens, yard farms, backyard woodlots should be provided.
3. Green courtyards in between clusters should be given.
4. Establishing butterfly courtyards.
5. Views from the street should not be blocked with solid fences.
6. Native bushes and shrubs should be used as fencing material.

5.2.3.3 Landscaping

1. Trees and shrubs should be planted in irregular manner and not in grids or lines. It should mimic the natural surroundings.
2. Landscaping should occur in clusters to mimic the natural environment
3. Houses or plots should be sited in order to preserve the existing vegetation and not harm the natural setting of the place.

5.2.3.4 Edible landscaping

1. Side yards and back yards should be used for edible landscaping.
2. In-between left over space should be used for food production.

5.2.3.5 Conserve nature

1. Natural features such as existing trees, drains of water or small water falls, native vegetation should not be altered.
2. Grading and retaining walls should be minimized. If required retaining walls should be made out of local stones giving a natural texture.

5.2.4 Building level

5.2.4.1 Material colour and lighting

1. Subdued colour range complimenting shades of colours in natural surroundings should be used on building facades.
2. Locally available building materials should be used.
3. Recycled material should be used.
4. Lighting inside and outside the building should not be loud or dominant.

5.2.4.2 Form and orientation

1. Placement and orientation of buildings should be regulated to maximize view of natural features.
2. Form and Scale of development to be appropriate to natural context.
3. Form to follow contours.
4. Development must incorporate local climatic responsive architecture.
5. Select high performance windows to reflect or transmit heat and orient windows properly relative to the sun.

5.2.4.3 Indoor environment

1. Water features should be provided which enhance the human comfort of indoor space.
2. The building should receive sufficient day-lighting.
3. Local climate responsive architecture should be incorporated in building design.
4. Plants should be provided in the interiors, as they provide fresh air inside the building.
5. Provide for views wherever possible.

5.2.4.4 Roof

1. In order to reduce environmental impact, water run-off and visual impact at street level, green roofs should be promoted only on large roofs or set of small roofs together.
2. The roof of a house should always slope in the same direction as that of the mountain face it's on.
3. Roofline shall not visually disturb the existing ridgeline prevalent in the region.
4. If a house breaks the natural horizon of the ridge line, then it should complement the natural ridge line in its form, colour and texture.

5.2.4.5 Landscaping

1. Intrude landscape features and elements into the following areas - plazas, gardens, covered walkways, courtyards, rooftop terraces, verandas, patios and other spaces.
2. Landscaping should be used for hiding views of imposing building facades, reflective glass, retaining walls, roadways and utility corridors, while protecting views from the site.
3. Rooftop, Building façade, Balconies, Window openings, Terraces, Fire escapes, etc. should be made green using native species and local edible landscape.
4. Landscape areas (including vegetated roof and facades) should be designed for high water efficiency and increased biodiversity through the use of native 'water-wise' plants.

5. Clinging plants and vines shall be installed on the walls and fences

5.2.4.6 Services

1. Ensure that telecommunications facilities are designed to integrate into existing structures and/or landscapes with minimal visual intrusion.
2. Solar water heating and other passive techniques should be incorporated in the building design.

Chapter 6 CONCLUSION

Abundance of nature is found in and around hills to exploit the effects of biophilia. The terrain and topography of hills provide for perfect setting for a biophilic town or neighborhood. Along with creating environmentally sustainable development emphasis should be given to fostering relationship with nature.

We talked about incorporating wilderness into our urban lives. The extent to which it is incorporated depends upon the density of the town or settlement. The outer areas with low density provides for higher degree of wilderness whereas the cores have less. But it is essential for developing relation with nature.

Nature should be preserved and restored. Clusters help in protecting natural and sensitive areas. Compactness and density gives room for more green open spaces. Trees are the most important natural element which needs to be saved and increased.

Climate plays an important role in design for human comfort. Solar passive techniques reduce the stress on artificial techniques. Buildings should be oriented as per the sun and prevailing winds to reach that desired quality of human comfort.

High density results in Low-carbon life reduced urban heat-island effect and sense of community living. It promotes out-door oriented lifestyle with more interaction with nature and also allows for car free zones.

Low-Impact development is essential but not at the cost of changing terrains. Water percolation should be avoided as it affects land stability leading to landslides and soil erosion. Green roofs are a feasible option and it also drastically reduces the visual load of a setting when used at a block or cluster level.

It is possible to retrofit existing neighborhoods in biophilic ones, its only that sensitivity to nature that is required. The areas which has been damaged or hampered by human over time should be reconfigured to regain its original charm. New areas should essentially be biophilic in order to live a nature and wilderness filled life.

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