PRELIMINARY DRAFT

NATIONAL BUILDING CODE OF INDIA

PART 10 LANDSCAPE DEVELOPMENT, SIGNS AND OUTDOOR DISPLAY STRUCTURES

Section 1 Landscape Planning, Design and Development

BUREAU OF INDIAN STANDARDS

C O N T E N T S

National Building Code Sectional Committee, CED 46

FOREWORD

This Code (Part 10/Section 1) covers provisions relating to landscape planning, design and development with the aim of improving quality of outdoor built environment and protection of the land and its resources.

This Part of the Code was first published in 1970 and subsequently revised in 1983 and 2005. This Part earlier covered provisions relating to only signs and outdoor display structures. With growing urban development and environmental degradation, it had become imperative to determine landscape design parameters, and also provide rules, regulations, controls and procedures for the protection, preservation and modification of surrounding environment. In the last revision of 2005, this Part was, therefore, sub-divided into two sections as follows, by including a new section relating to landscaping:

Section 1 Landscape planning and design
Section 2 Signs and outdoor display structures

The components of landscape design and external development were earlier covered in the Code in its various Parts/Sections but a comprehensive treatment was given in this new Section in the last revision only. A brief clause on street furniture was also introduced in this Section in this revision.

In the 2016 revision of the Landscape Chapter of the National Building Code, several significant updates were introduced to address contemporary needs and technological advancements. Key terminologies were included or modified to align with the new provisions and technological developments in landscape design. A new clause detailing landscape site planning requirements was added, emphasizing ecological, cultural, and contextual considerations. Comprehensive guidelines for the general development of landscapes were incorporated to promote sustainability, accessibility, and ease of maintenance. A clause on roof landscapes was introduced to guide the integration of green roofs, addressing both environmental benefits and urban design enhancements. Provisions related to earth slopes and grading were reorganized under statutory approvals, ensuring logical placement. Additionally, a materials and finishes plan became a mandatory part of the landscape development documentation, detailing specifications such as type, color, and treatment. Paved surface guidelines were relocated under general landscape development for better sequencing, and updated lists of plant species for various applications were included to reflect ecological and functional diversity. These updates collectively aimed to enhance the quality, sustainability, and practicality of landscape planning and design.

In this revision, the Section is now called, Section 1 Landscape planning, design and development, and accordingly various provisions have been detailed to cover

relevant aspects relating to overall landscape planning, design and development. In this revision, the following modifications have been incorporated:

a) Comprehensive guidelines for the planning and design of green roofs, including considerations for intensive and extensive green roofs, have been added to promote environmental benefits and urban heat island mitigation.

b) A new requirement to include a materials and finishes plan as part of the landscape development documentation, detailing specifications such as type, color, thickness, and surface treatment.

c) Revised and expanded lists of plant species categorized by their applications, ensuring relevance to diverse environmental and aesthetic needs.

d) A new clause providing detailed recommendations on sustainable practices, accessibility, resilience, and maintenance ease for landscape spaces.

e) Provisions on earth slopes and grading are now included under the statutory approvals clause for logical organization.

f) Specific provisions for paved surfaces in external areas have been moved to the section on general landscape development for consistency.

g) Inclusion of detailed landscape site planning requirements, with emphasis on ecological, cultural, and contextual considerations for sustainable development.

~~All standards cross-referred to in the main text of this Section, are subject to revision.~~ The parties to agreement based on this Section are encouraged to investigate the possibility of applying the most recent editions of the standards.

For the purpose of deciding whether a particular requirement of this Section is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this Section.

Members are requested to share their inputs/comments on the draft particularly w.r.t the changes listed above in the foreword; and especially on those text highlighted in yellow in this draft.

Important Explanatory Note for Users of the Code

In any Part/Section of this Code, where reference is made to **'good practice'** in relation to design, constructional procedures or other related information, and where reference is made to **"accepted standard"** in relation to material specification, testing, or other related information, the Indian Standards listed at the end of the Part/Section shall be used as a guide to the interpretation.

At the time of publication, the editions indicated in the standards were valid. All standards are subject to revision and parties to agreements based on any Part/ Section are encouraged to investigate the possibility of applying the most recent editions of the standards.

In the list of standards given at the end of a Part/Section, the number appearing within parentheses in the first column indicates the number of the reference of the standard in the Part/Section.

NATIONAL BUILDING CODE OF INDIA

PART 10 LANDSCAPE DEVELOPMENT, SIGNS AND OUTDOOR DISPLAY STRUCTURES

Section 1 Landscape Planning, Design and Development

1 SCOPE

This Code (Part 10/Section 1) covers requirements of landscape planning, design and development with the view to promoting quality of outdoor built and natural environments and the protection of land and its resources.

2 TERMINOLOGY

For the purpose of this Section, the following definitions shall apply.

2.1 Avenue – A wide road or pathway lined with trees on either side.

2.2 Buffer – The use of landscape elements to reduce or curtail view, sound or dust with plants or earth berms, wall etc.

2.3 Canopy/Tree canopy – The average horizontal spread of the tree, taken from dripline to dripline.

2.4 Climber – A woody or herbaceous plant which either clings to a wall, trellis or other structures or can be supported or trained as it grows.

NOTE – It is sometimes also called creeper or vine.

2.5 Columnar – A slender, upright plant form.

2.6 Contour – The form of the land, existing or proposed; a part of the topography, indicated by map lines at intervals, to understand the landform clearly. The contour line is imaginary and indicates continuous elevation above mean sea level or an assumed datum line.

2.7 Contour Interval – The difference in elevation or the vertical distance measured between consecutive contour lines.

2.8 Drainage – Drainage is the natural or artificial removal of surface and subsurface water from an area through use of vegetated/open channel, pipes, drain boards, chambers, etc.

2.9 Egress – A way out, or exit.

2.10 Elevation – A contour line or notation of relative altitude with respect to a benchmark, useful in plotting existing or proposed feature.

2.11 Erosion – Wearing away of soils, rocks, sediments, etc, by gradual action of natural processes (such as water, wind and glacier).

2.12 Exotic – A plant that is not native to the area in which it is planted.

2.13 Fence – A barrier of plant or construction material used to define the boundary of an area and to restrict visual and/or physical access.

2.14 Foliage – The collective leaves of a plant or plants.

2.15 Geogrid – A deformed or non-deformed netlike polymeric material used with foundation, soil, rock, earth, or any other geotechnical engineering-related material as an integral part of the human made project structure or system.

2.16 Geo-Textile – Any permeable textile or fabric (natural or synthetic) used to retain or protect soil and filter and drain water as an integral part of project, structure or system such as terrace garden, etc.

2.17 Girth of Tree – Girth is a measurement of the circumference of the trunk of a tree, measured perpendicular to the axis of the trunk. It is measured at breast height (1.4 m above ground level).

2.18 Grade – The slope or lay of the land as indicated by a related series of elevations.

2.18.1 *Natural Grade* – Grade consisting of contours of unmodified natural landform.

2.18.2 *Finished Grade* – Grade accomplished after landscape features are installed and completed as shown on plan as proposed contours or spot levels.

2.19 Gradient – The degree of slope of a pipe invert or road or land surface. The gradient is a measure of the slope height as related to the length. The slope is expressed in terms of percentage or ratio.

2.20 Grading – The cutting and/or filling of earth to establish finished contours.

NOTE – Grading facilitates good drainage and shapes land to suit the intent.

2.21 Grasses – Plants that characteristically have joint stems, sheaths and narrow blades (leaves).

2.22 Grass Paver – Grass paver is a permeable structural grid cellular system (concrete, HDPE or any other polymer) for containing and stabilizing gravel or turf.

2.23 Green Roof – A roof surface of a building that is partially or completely covered with a growing medium and vegetation. Green roofs can be deep (intensive) or shallow (extensive).

NOTE – Intensive green roofs are elevated greens which can sustain shrubs, trees, walkways and benches with their complex structural support, irrigation, drainage and root protection layers. Extensive green roofs are shallow, relatively light and are solely used for their environmental benefits. They support native ground cover that requires little maintenance.

2.24 Green Walls – A supporting structure completely or partially covered with vegetation which is grown with soil or growing medium. It can be either free standing or part of a structure. They include climbing plants such as vines that grow directly on the wall, or walls that comprise of modular panels, containers and an integrated irrigation system.

2.25 Ground Cover – The planting material that forms a carpet of low height.

2.26 Hard Landscape – Civil work component of landscape development such as pavements, walkways, roads, retaining walls, sculptures, street amenities, fountains and other elements of the built environment.

2.27 Hardy Plant – Plants that can withstand harsh temperature variations, harsh wind, pollution, dust, extreme soil conditions, and can tolerate either drought or flooding.

2.28 Heat Island Effect – A phenomenon in which air and surface temperature of an area are higher than nearby areas due to the replacement of natural land cover with pavement, building, and other infrastructure.

2.29 Hedge – Shrubs or trees (usually of the same species) planted closely together in a linear configuration. A hedge may be pruned to shape or allowed to grow to assume its natural shape.

2.30 Herb – A plant with a non-woody or fleshy structure. Certain herbs are highly useful for cooking or of high medicinal value.

2.31 Ingress – A way in, or entrance.

2.32 Invert – The lowest inside point of a pipe, culvert, or channel.

2.33 Irrigation – The artificial application of water, to assist in growing and maintenance of plants.

2.34 Kerb – A concrete or stone or similar hard edging along a pathway, or along a road, often constructed with a channel to guide the flow of stormwater.

2.35 Microclimate – A local atmospheric zone where the climate (temperature, humidity, wind, etc) differs from the surrounding areas. The term may refer to areas as small as a few square metres or as large as many square kilometres.

2.36 Mound – A small hill or bank of earth, developed as a characteristic feature in landscape.

2.37 Mulching – A practice of using a protective covering, usually of organic matter such as leaves, straw, placed around plants to retain moisture, improve soil conditions and prevent the growth of weeds.

2.38 Permeable Paving – Paving surfaces that reduce runoff by allowing rainwater to soak through the surface into the underlying sub-base where the water is stored temporarily before allowing it to seep into the ground or flow to the drains.

2.39 Plants – The living beings consisting of trees, shrubs, herbs, grasses, ferns, mosses, etc, typically growing in a permanent site, absorbing water and inorganic substances through their roots, and synthesizing nutrients in their leaves through the process of photosynthesis.

2.39.1 *Endemic Plant* – The plant which is found only in one geographic location on earth.

2.39.2 *Invasive Plant* – The species of plant which is not native to a specific location (an introduced species) and has a tendency to spread to a degree believed to cause damage to the environment.

2.39.3 *Native Plant* – A plant indigenous to a particular locale.

2.39.4 *Naturalised Plant* – A plant that is established as a part of the flora of a locale other than its place of origin.

2.40 Screen – A vegetative or constructed hedge or fence used to block wind, undesirable views, noise, glare and the like, as part of in landscape design; also known as ‘screen planting’ and ‘buffer plantation’ (*see also* **2.2**).

2.41 Sediment – The product of erosion processes; the solid material, both mineral and organic, that is in suspension, is being transported or has been moved from its site of origin by air, water, gravity or ice.

2.42 Shelterbelt – Shelterbelt is usually made up of one or more rows of trees or shrubs planted in such a manner so as to provide shelter from wind, and protect soil.

2.43 Shrub – A woody plant of low to medium height, deciduous or evergreen, generally having many stems.

2.44 Soft Landscape – The natural elements in landscape design, such as plant materials and the soil itself.

2.45 Spot Elevation – In surveying and contour layout, an existing or proposed elevation of a specific point noted as a dot on the plan.

2.46 Street/Outdoor Furniture – Items of furnishing in outdoor landscape such as benches, trash receptacle signage, play equipment.

2.47 Swale – A linear wide and shallow depression used to temporarily store, route or filter runoff. A swale may be grassed or lined.

2.48 Topsoil – The uppermost layer of the soil.

2.49 Transplanting – Technique of moving a plant from the place where it is growing and replanting at another location.

2.50 Tree – A woody plant, generally taller than 2.00 m, with a well-distinguished trunk or trunks below the leaf crown.

2.50.1 *Deciduous Tree* – Tree that sheds all its leaves during a part of the year.

2.50.2 *Evergreen Tree* – Tree that remains green for most part of the year and sheds leave slowly throughout the year.

2.51 Tree Drip Line – The branch spread of a tree defined by the outermost circumference of a tree canopy where water drips onto the ground.

2.52 Tree Grate – A grille, installed at the base of a tree otherwise surrounded by pavement that allows the free passage of air, water, and nutrients to the tree root, but does not interfere with the foot traffic.

2.53 Tree/Plant Guard – The protection around a tree or plant to help prevent damage.

2.54 Xeriscape – A landscape that requires little or no irrigation or other maintenance.

3 STATUTORY APPROVALS

3.1 Requirements for Registration and Competence of Professionals

The qualification and competence for carrying out the landscape planning, design and development work shall be as given in Part 2 ‘Administration’ of the Code.

3.2 Application for Statutory Approvals and Required Drawings

For any development project for which a permit or license or statutory approval is required, an application shall be made to the Authority on the prescribed form containing such particulars as the Authority may require. The form shall be signed by the owner and shall include the information given in **3.3**. For various aspects of obtaining the permit, etc, reference shall be made to Part 2 ‘Administration’ of the Code.

3.3 Landscape Development Documents Required for Statutory Approvals

3.3.1 *Landscape Master Plan*

The site plan to be submitted with the application for permit shall be drawn to a scale of not less than 1 in 200 for a site up to one hectare and not less than 1 in 500 for site up to 10 hectare and not less than 1 in 1 000 for site more than 10 hectare. The following information shall be provided in addition to requirements for site plan as stated in Part 2 'Administration' of the Code:

a) Existing and proposed topographic contours at intervals not exceeding 500 mm and/or spot elevations as pertinent and bench mark of site with reference to the city datum relative to the mean sea level.
b) Limits of the 100 year flood plain and water surface elevation, where applicable.
c) Location of existing major physical features, such as railway track, drainage ways.
d) Location of service utilities adjacent to the project with relevant top and invert levels clearly indicated.
e) Point of egress and ingress including locations and width of road.
f) Fully dimensioned loading spaces and manouvering areas.
g) Parking including, location, parking spaces, size and number, and typical parking space details for both persons with disabilities and for standard spaces.
h) Circulation for vehicles, bicycle and pedestrian, including for persons with disabilities clearly identified.
j) Detail for parking areas including type of lighting, material for paving, and security rooms, rest rooms; and type of directional signage, etc.
k) Drainage system, proposed finished ground elevations and finished grades.
m) Location of proposed fire hydrant points.
n) Location of fire lanes.
p) Proposed lighting layout.
q) Landscape irrigation points and source of irrigation water.
r) Vegetation for screening by type, material, height, location, and spacing or fences, walls.
s) Location of proposed street furniture, landscape structure.
t) Refuse container location, size, and access.
u) Landscape paving materials with location.
w) Location, type, size, and height of existing and proposed signage.
y) List of existing trees with botanical and common names and height, girth, canopy of the tree and existing grade levels (*see* **11.1.2** for plant material schedule).
z) Prior approvals, where applicable.

3.3.2 *Grading Plan and Stormwater Management Plan*

The grading plan shall be drawn to a scale of not less than 1 in 200 for a site up to one hectare and not less than 1 in 500 for a site up to 10 hectare and not less than 1 in 1 000 for site more than 10 hectare. The grading plan should include measures for soil and sedimentation control and also measures during construction to prevent soil erosion, and also water harvesting practices (*see also* **11** and **12**).

3.3.2.1 *Grading design*

Design for changes in elevation in the outdoor environment is a primary component of landscape development. Grading of proposed external development areas should relate

to the existing topography of the site and it should direct surface water runoff to the designated drainage and water harvesting area. Grading design parameters are as follows:

a) Proposed grading design should respond to the function and purpose of the activities to be accommodated within the site.
b) New development and structures to be integrated with existing landform within the site and in its immediate surroundings.
c) Stormwater to be directed away from buildings.
d) Steep slopes to be modified to minimize or eliminate erosion.
e) Legally, grades cannot be changed beyond the property line of the site.
f) Rate of stormwater runoff leaving the site after construction not to exceed the pre-construction rate.
g) Grading design should optimize cut and fill.

3.3.2.2 *Grading plan*

3.3.2.2.1 The submitted grading plan should include the following:

a) All existing and proposed features of the site, including all building with plinth level;
b) Structures such as walls, walks, steps, roads;
c) Utilities such as water lines, sewer and stormwater drainage, electrical lines; and
d) Utility structures like manholes, junction boxes, sewage treatment plant, septic tank, soak pit, water tanks, water treatment plant, transformers and all underground structures indicated appropriately.

Proposed features shall be indicated in firm lines and existing features in dash.

3.3.2.2.2 The grading plan should represent:

a) General landform concept graphically represented with appropriate symbols and abbreviations (*see* **3.3.2.4**).
b) Proposed contour lines should be integrated with existing and proposed elevations within the project site.
c) Location of swales and surface water flow, surface and subsurface soil drainage system or water harvesting systems.
d) Location of drainage catchments, areas of retention/detention or disposal/outfall point as the case may be.
e) Spot grades on road, walks, and swales including top level and relevant invert levels of all utilities and utilities structures as mentioned above; critical spot elevation to be established (*see* **3.3.2.3**).
f) Spot elevation of building floor finish level, steps, walls, terraces and other such structures.
g) Changes in direction or rate of slope.

3.3.2.2.3 *Spot elevations*

Spot elevations shall be used to supplement contours in the following situations:

a) To indicate variations from the normal slope or gradient between contour lines.
b) To indicate elevations of intersecting planes and lines, like corners of buildings,

walls, steps and kerbs.

c) To indicate elevations at top and bottom of vertical elements like walls, steps and kerbs.
d) To indicate floor and entrance elevations.
e) To indicate elevations of high and low points.
f) To indicate top elevations of utilities and utilities structure.

3.3.2.3 *Slope calculation*

Slopes are expressed as follows:

a) Percentage (of slope) = $\frac{\text{Vertical rise} \times 100}{\text{Horizontal distance}}$, for example $\frac{1 \times 100}{50}$ = 2 percent

b) Proportion (of slope) = $\frac{\text{Vertical rise (1.0 m)}}{\text{Horizontal distance}}$, for example 1 m in 50 m or 1:50

c) Degree of slope, expressed as angle, for example, 10°, 15°, etc.

3.3.2.4 *Typical grading symbols and abbreviations*

Symbol	*Description*
- -(100)- -	Existing contour
- 100 -	Proposed contour
(100.5)	Existing spot elevation
100.5 (Bold)	Proposed spot elevation
CB	Catch basin
FFL	Finished floor level
FGL	Finished ground level
TW/BW	Top of wall/Bottom of wall
TK/BK	Top of kerb/Bottom of kerb
HP/LP	High point/Low point
IL	Invert level

3.3.3 *Planting Plan*

The planting plan shall be drawn to a scale of not less than 1 in 200 for a site up to one hectare and not less than 1 in 500 for a site up to 10 hectare and not less than 1 in 1 000 for site more than 10 hectare with part plans at 1 in 200 of two of the design areas. Planting plan should include plant material schedule as shown in Table 1. The planting plan and landscape plan shall show identical information to avoid conflict between both plans. The planting plan shall include the layouts as per the following requirements, drawn to the scale:

a) Location of proposed trees, shrubs, ground covers including grass area indicated clearly with appropriate symbols and legend shall be indicated.
b) The shape, size, diameter of canopy of plants with their possible growth in coming 3 years shall be indicated.
c) Functional attributes and growth pattern tabulation shall be attached as given in Table 2, as an annex.

d) All existing vegetation shall be marked on the landscape plan and areas designated for preservation of existing vegetation on site shall be demarcated clearly (*see also* **11.1.2**).

e) A concept plan of scale not less than 1 in 1 000 indicating the intent of the design with respect to the functions for various parts of the scheme shall be included with a short narrative, where applicable.

Table 1 Plant Material Schedule
(*Clause* 3.3.3)

Sl No.	Tree No.	Code	Botanical Name	Common Name	Quantity
(1)	(2)	(3)	(4)	(5)	(6)

Table 2 Plant Material Schedule Showing Functional Attributes and Growth Pattern of Each Plant
[*Clause* 3.3.3 (c)]

Sl No.	Relevant Features	Description Plant –1
(1)	(2)	(3)
i)	Botanical name	
ii)	Common name	
iii)	Plant code	
iv)	Type (Evergreen/Deciduous)	
v)	Height	
vi)	Spread/Canopy	
vii)	Form of tree	
viii)	Flower colour	
ix)	Seasonal duration	
x)	Zone (Functional attributes)	
xi)	Characteristics	
xii)	Function	
xiii)	Remarks (including with regard to poisonous character and health ground)	

3.3.4 *Materials and Finishes Plan*

The materials and finishing plan shall be drawn to a scale of not less than 1 in 500 for a site up to 10 hectare and not less than 1 in 1 000 for site more than 10 hectare. The plan shall include materials specifications such as type, colour, size, thickness, and surface treatment.

3.3.5 *Basic Design and Construction Details*

Construction details, specifications and methods used for the following landscape elements are to be included, where applicable:

a) All paved areas for pedestrian and vehicular use, including edges, kerbs, bumper stops, steps, ramps, planters, railings or other protective devices; tree protection with tree grating, tree guard, etc; provision for wheel chair access and movement, and other accessibility details in accordance with **13** of Part 3 'Development Control Rules and General Building Requirements' of the Code.
b) Boundary wall, fence, retaining wall, etc.
c) Structures in landscape such as gatehouses, kiosks, toilets, pergolas, space frame, pools, ponds, water bodies, any other special features.
d) Site utilities such as stormwater drains, manholes, catch basins, outdoor lighting fixtures, electric feeder pillars, junction box, fire hydrant, garbage collection points, litter bins.
e) Outdoor signage and street furniture.
f) Play equipment and tot lots, where appropriate.
g) Any other relevant detail or information.

3.3.6 *Irrigation Plan*

The irrigation plan shall be drawn to a scale of not less than 1 in 500 for a site up to one hectare and not less than 1 in 1 000 for site more than one hectare. The plan shall include the following information:

a) The source of irrigation water.
b) Type of water conserving irrigation systems proposed, if any.
c) Extent of supplementary irrigation provided by water harvesting measures, if any.
d) Layout of the irrigation system proposed (including arrangement of hydrants or sprinklers indicating location and type with typical details and specifications, etc as applicable to the irrigation system).

4 LANDSCAPE SITE PLANNING REQUIREMENTS

Formulation of site plan requires collection of relevant information, investigations into existing conditions, identification of appropriate program elements and consideration of required strategies to enhance, protect, adapt, develop and/or mitigate fundamental criteria relevant to the site and context specific landscape and their assessment. The steps required are-

4.1 Analysis and Investigations

Data collection and site investigations, along with assessment of their historic natural, cultural and social context, potential development alternatives, anticipation of conflicts and challenges, development opportunities, and prioritization of site-specific factors are required for comprehensive site planning. This includes documentation and analysis of following:

4.1.1 *Location and Context*

Landscape development brief shall include appropriate approaches for regional and bio-climatic variations considering following aspects:

a) Surrounding land uses, context and buildings: Spatial organization of neighborhood, scale and ownership of adjacent properties, their usage and existing off-site nuisances.

b) *Circulation and Linkages* – Access and connectivity for pedestrians, cyclists and vehicles, to and from road, and/ or local transit corridors and nodal points, landmarks, strategic links, emergency routes, parking, with all entrance and egress points. Carrying capacity of adjacent transport infrastructure and neighborhood or local area network.

c) *Service and Utility Connections* – Potable water, sanitation, sewage, gas, electricity, stormwater drainage, AV service lines, locations and capacity.

d) Historic buildings, landmarks or Precincts: Historical context and chronological study, if relevant.

e) Ecology and Natural History of the area

4.1.2 *Site*

Whether designing to avoid impacts to a significant landscape area or to restore an ecological community, a detailed analysis may be conducted to understand the dominant site processes, based on topographic survey and other data sources.

a) Topography, Landform and Natural Features: Topographic survey to map landform, contours, levels, significant natural features, existing vegetation, built structures, services, utilities, edge conditions and boundary conditions.

b) *Solar Aspect and Orientation* – Slope aspect and orientation analysis depicting exposure to sun, light and heat, requirement for shade and protection from the elements as per the local climate to determine orientation of buildings, shade structures, wind and weathering conditions.

c) *Hydrology and Drainage* – Slope analysis to map topographic contour intervals, slopes and watershed for surface and sub-surface water flows and collection. Demarcate rivers, streams, perennial and seasonal water bodies and wetlands, floodplains. Highlight areas of instability. Identify buildable slopes, steep slopes and potential slope stabilization strategies. Water testing to identify water table levels and quality of potable water.

d) *Geology/ Soils* – Soil classification of types and uses, texture, condition, fertility, water holding capacity and absorption capacity, soil stability to determine development, structural requirements and compensatory requirements to deal with soil, water and slope conditions.

e) *Existing Vegetation and Wildlife* – Inventory of trees, shrubs and other planting, identifying native, introduced, exotic and invasive species, highlighting significant value plantation and specimen trees. Conservation measures and protection plan for mature trees and incorporation of healthy trees of ecological, cultural or aesthetic value in design. Identification of wildlife species, critical biodiversity and

impact of changes to the landscape.

f) Existing Site Character, Infrastructure and Built Mass: Site typology, scale, proportions, open space hierarchy and typology. Siting of existing buildings, structures and utilities, height, entrances, aesthetic treatment, materials and location of existing services, entries.

4.1.3 *Climate Consideration*

Study of weather conditions including temperature variations, seasons, precipitation, winds and diurnal impacts. Peak storm conditions and recent climate change extremes. Favorable conditions will determine siting of structures, planting, buffers with protection, mitigation measures to address adverse impacts.

4.1.4 *Visual and Aesthetic Aspect*

Landscape development to enhance visual linkages and reinforce sight lines. Views to and from the site may need to be preserved or screened, avoid adverse impacts on adjacent properties and capture solar access. Important considerations are visibility, appearance, mitigation, effects and impacts, local context and character.

a) *Views* – Partial or full views, prospects or field of vision as seen from a place whether pleasant or unattractive, distinctive or nondescript, that may include background, mid ground and/or foreground elements or features determine scenic preferences. These include views dominated by, or with a high proportion of attractive features, such as water, mountains and hills or significant natural features, skyline features and key focal points. Discordant or unsightly views to or from the site identified.

b) *Viewsheds* – Panoramic views with distinctive elements, diversity, scenic compositions, heritage, consistency and coherence of built form are valued and worthy of protection.

c) *Viewpoints* – Primary views in one direction to an attractive or distinctive feature, with secondary views in other directions. Desirability of views, viewing distance, proportion and orientation of viewpoints impact landscape character. Priority should be given to scenery and sightlines from accessible public spaces.

4.2 Framing the Landscape Programme or Brief

The landscape brief to be conceptualized to maximize site potential while the site constraints, prevailing guidelines and user needs should also be taken into consideration.

4.2.1 *Review of Existing Master Plans, Guidelines and Standards*

Existing master plans, regulations, byelaws, standards that delineate uses, connections, materials or conventions, shall be reviewed for ensuring compliance. The landscape development brief shall be in consonance with the statutory/development requirements.

4.2.2 *Users and Socio- Cultural Factors*

Landscape development briefs should be framed for specific uses and activities understanding the social, economic and safety related aspects, and ensuring universal

access, inclusion and legibility as well as significant heritage and cultural values.

4.2.3 *Assessing 'Fit'*

Through framing design objectives, articulating site specific design requirements and potential impacts on the site and their treatment, the appropriate landscape interventions may be programmed.

Design Objectives - Development priorities, critical landscape considerations and design principles will determine the spatial organization and hierarchy, visual composition, verticality, buffers, safety, access and circulation, needs of users, ecology, planting, aesthetic enhancement, as well as protection, mitigation and adaptation strategies.

Design Requirements - Landscape treatment, vertical scale, entry and exits, circulation routes,pedestrian areas, emergency and disaster preparedness, grading and drainage, integration of utilities and site amenities, active and passive recreation spaces, high visitor volume facilities, surface treatments and landscape components including security, lighting, irrigation, material selection and installation of landscape furniture, shade structures, signage and urban art.

Design Impacts - Assessment of landscape development impact on context and neighborhood aesthetics, landscape performance, site character, topography and level change and protection of environmentally sensitive areas.

4.2.4 Mitigation of Adverse Factors

Adverse factors include safety hazards, visual elements, auditory or olfactory nuisances. To avoid, remedy and/ or reduce impacts of adverse conditions that could be a result of context or land use, design, ongoing management, views, future maintenance or development, requires:

a) Identification of existing and potential impacts that can influence the design or use of the project
b) Outline measures to avoid or reduce the impact as far as practical during construction and operation.

4.2.5 Landscape Development for Special Conditions

The landscape development brief shall recognize special conditions, such as reclamation and/or rehabilitation of land, mitigation of other special existing conditions and conservation of existing value, prior to formulating a landscape master plan.

5 GENERAL LANDSCAPE DEVELOPMENT GUIDELINES

5.1 General

5.1.1 The general landscape development guidelines should be applied at two levels:

a) *Masterplan level* – This consists of those projects where the level of intervention is restricted to large scale landscape site planning; and

b) *Detailed landscape design level* – This consists of those projects where detailed landscape design is involved.

Open spaces are often further defined based upon access and ownership as public, semi-public and private. Planning and design of open spaces should consider the following aspects:

1) *Sustainability* – Environmental sustainability and green principles may be incorporated to ensure that landscape development does not hamper the existing ecology of the site and its surroundings (*see also* Part 11 'Approach to Sustainability' of the Code). Land, vegetation and water sensitive design options may be explored during the design stage by incorporating a clear grading, drainage and planting strategy while developing the landscape concept. Cut and fill of the land may be minimized while locating the built blocks and circulation spaces. Gentler slopes with adequate green cover aids in erosion control thereby retaining the humus rich top soil. Stormwater runoff within the site may be filtered and either stored or allowed to recharge the groundwater table depending on the site conditions. As far as possible, it is desirable to use native and naturalized non-invasive species.

2) *Accessibility* – The planning and design of open spaces may be accessible for a wide range of users, including pedestrians, cyclist, transit riders and those using private modes of transport (*see also* **13** of Part 3 'Development Control Rules and General Building Requirements' of the Code). An ideal public space may be well connected to a surrounding bus/metro/mass rapid transit system facility or a neighbourhood street or a regional route.

3) *Resilience* – Resilience is the ability of a landscape to adapt to change and regain its original state when subject to shock, such as flooding, drought and pest attack. Natural landscapes have an inherent ability to exhibit resilience, while human altered landscapes should be designed to incorporate resilience as a core principle of design.

4) *Ease of maintenance* – Ease of maintenance may be regarded as an important consideration in a well-designed landscape. This may also aid in ensuring savings in energy and resources.

5.1.2 The various guidelines for landscape spaces may be grouped as follows, which are given in **5.2** and **5.3**, respectively:

a) *Guidelines for general open spaces* – These pertain to open spaces framed for specific uses and user groups, and include understanding of social, economic and safety related aspects.

b) *Guidelines for special conditions* – These pertain to open spaces which are either ecologically or culturally significant, and may require special considerations, such as reclamation, rehabilitation, restoration and/or redevelopment.

5.2 Design Guidelines for General Types of Landscape Open Spaces

5.2.1 The design for the general type of open spaces should consider the following parameters:

a) *Hierarchy of open spaces* – Open spaces may be studied with respect to its relative size to better understand the complexities of the issues related to them, with respect to functional, visual and ecological concerns.

b) *Usage of open spaces* – Design of open spaces should have a certain character based on its usage. It is desirable that the design of these open spaces take into consideration the existing and proposed use of the open space, as well as the specific needs of the users. The design of these spaces may also be reviewed in terms of whether they are public, semi-public or exclusively private spaces. Open spaces may be planned for a variety of functional uses by different users or diverse user groups, so that they are able to provide for a variety of recreational opportunities and spatial experiences.

c) *Location of spaces* – The design guidelines may be interpreted so as to suit the bio-geoclimatic setting of these landscapes. The approach to planning and design of these open spaces would vary greatly depending on the climatic conditions and layout of the site. The specificities of the requirements for landscape should be studied in detail before commencing the planning and design process.

The following types of generic open spaces may be identified:

a) Regional parks/city parks,
b) Roads,
c) Public plazas and urban squares,
d) Multipurpose open spaces/mela grounds,
e) Urban riverfronts and waterfronts,
f) District parks/neighbourhood parks,
g) Theme parks/waterparks,
h) Sports facilities/playgrounds/stadium complexes/sports centre,
j) Golf courses/equestrian grounds,
k) Plant nurseries,
m) Pocket parks, and
n) Open spaces associated with largescale developments.

5.2.2 *Design to Take into Consideration the Site Context*

a) The site and context study are important tools for assessing the suitability of land use and nature of design intervention. The design for any particular site may be developed as an outcome of the site analysis.

b) The design may be conceptualized so as to maximize the site potentials while the site constraints should also be taken into consideration.

5.2.3 *Design for Maximizing Usable Space*

a) Landscape elements, such as outdoor furniture, lighting and other required facilities, may be placed sensitively along the proposed circulation path with consideration of usage patterns.

b) Adequate shading may be provided for areas where the community congregates in warmer climatic locations, while areas designed for public gathering in cold regions may be shielded from wind.

c) The extent of the paved areas may be restricted to a minimum, keeping in mind the pedestrian routes, density of usage, spaces for congregation, etc. Paved areas may be planned so that they do not restrict any natural surface flow of water and nor do they get waterlogged during the rainy months.

d) Landscape design may be used to improve the environmental quality of the open spaces. Sufficient landscape may be provided at both horizontal and vertical planes to reduce the ambience temperature and glare. This may be in the form of conventional planting or devices like vertical greenwalls, green roofs, etc. Large unshaded paved plazas may contribute to urban heat island effect. *See* **7.1.2.2** and **7.4.7** of Part 11 'Approach to Sustainability' of the Code.

5.2.4 *Provision for Various User Activities Spanning Different Age Groups*

a) A variety of recreational options for different ages and interests may be provided.
b) Different cultural recreation preferences may be considered while designing open spaces by using community feedback to determine their needs and requirements.
c) A variety of amenities that encourage extended use, such as water fountains, and picnic tables, may be provided.
d) Plants for hiding and materials for making shelters may be considered. Opportunities to create appreciation for nature and the pleasure of discovering scientific phenomenon may be provided.
e) Spaces should be designed for use by people of all abilities, including those using mobility aids (for example, wheelchairs). *See* **13** of Part 3 'Development Control Rules and General Building Requirements' of the Code.

5.2.5 *Provision for Free and Imaginative Play Opportunities in Children's Play Areas*

a) Opportunities for children to explore imaginative play through interaction with natural elements of their environment may be provided.
b) Raised beds or planting areas, play shelters, niches, sand areas, etc, may be provided.
c) Ways of functioning of natural systems within the site may be explored. For example, hydrology and water flows that attract butterflies, birds, and frogs may be considered.
d) Science play opportunities that stimulate curiosity about science may be provided. Suggested elements may include centrifugal force, sound waves, sunlight refractors, weather stations and windmills.
e) Signage that gives cues to parents about things to show or teach their children, using equipment or other elements of the playground, may be provided.
f) All possible efforts should be made to extend opportunities to children of all

abilities and age, by providing access to a variety of play features and using features that appeal to all of the senses. *See* **13** of Part 3 'Development Control Rules and General Building Requirements' of the Code.

5.2.6 *Design for Safety and Security*

a) Hard landscape materials and their details may be worked out so that sharp corners, injurious edges and easily breakable materials are avoided in the public landscape.
b) Plant materials may be selected taking into consideration the possible issues of allergic reactions or toxicity.
c) Level differences in the open spaces may be treated with adequate care so as to avoid potential fall/injury. Level differences of a single step may be avoided in landscaped areas since they may aggravate the chances of tripping and injury.
d) Durable, easy to repair equipment and safety surfacing may be considered for play areas. International Safety Standards, such as fall zones, safety surface, fall height, and entrapment concerns may be considered for play equipment and surfaces. The flooring material of these spaces may be impact absorbing and injury proof.
e) In areas for smaller children, the number of exits and their placement may be limited so that they are easily monitored by parents and guardians.
f) Creation of hidden areas in the landscape should be avoided. The density of vegetation and height of the understory planting may be decided so as to keep the view-lines clear.
g) Lighting may be done so as to ensure that all usable areas of the landscape are well lit and there are no dark spots in the landscape.

5.2.7 *Review of Existing Master Plans, Regulations and Initiatives*

Existing master plans, regulations, byelaws, etc, that may have defined uses, connections, materials or conventions, shall be reviewed for ensuring compliance. Design of public open spaces may address the concerns of the neighborhood and express the identities of the neighborhoods they pass through.

5.2.8 *Design for Continuity between Multiple Public Open Spaces and Parks*

a) Linear parks may be used to provide continuous paths for bicycles and pedestrians.
b) Greenway plans may be researched and opportunities to connect greenway paths be explored so as to establish connections between adjacent neighborhoods. Pedestrian movement corridors may be given precedence over vehicular corridors.
c) Commuting or high speed bike lanes may be separated from the pedestrian paths.
d) Signage style and vocabulary along multiple open spaces and parks to guide users may be kept consistent for ease of understanding. *See* Part 10 'Landscape Development, Signs and Outdoor Display Structures, Section 2 Signs and Outdoors Display Structures' of the Code.

5.2.9 *Pathways and Pedestrian Movement Corridors*

a) Pedestrian circulation path consists of sidewalks, wheelchair ramp, and landings. Footpaths of minimum width 1.80 m may be provided along the length of road for any public or private building where pedestrian traffic is expected. *See* **4.3.2.1** of Part 3 'Development Control Rules and General Building Requirements' of the Code for computation of capacity of footpaths with respect to their widths.
b) Natural materials such as stone, or manmade materials such as tiles or cast *in-situ* concrete, of appropriate thickness may be used as paving finish in external areas. Adequate slope and drainage facility may be considered for all external paved surface integrating it with the pavement design.
c) Surface treatment of the finishes may be such that it remains anti-skid throughout the seasons. Smooth finish is not recommended for external areas except to convey any design concept.
d) Change in levels and steps may be depicted in different texture or colour as a visual clue.
e) The cross slope of sidewalk may be designed so as not to exceed two percent (1 in 50). The longitudinal slope of path may not exceed 1 in 20, unless the longitudinal slope of the road exceeds this maximum, in which case the norms applicable to a ramp should be applied. Kerb ramps may be provided at pedestrian crossings. *See also* **13** of Part 3 'Development Control Rules and General Building Requirements' of the Code.
f) All ramps should have minimum width of 1.20 m, excluding edge protection. The cross slope of ramp should not exceed 1 in 50 and the longitudinal slope of ramp may not exceed 1 in 12. All ramps may have an unobstructed level landing both at top and bottom of the ramp. The landing may have the minimum width as that of the ramp. The landing may be minimum 1.50 m in length. Any ramp beside the road may be located in such a way so that vehicles cannot park blocking the access. The ramps shall also comply with the requirements of **13** of Part 3 'Development Control Rules and General Building Requirements' of the Code.
g) Handrails may be provided for any ramp with a vertical height greater than 150 mm, to prevent pedestrians and wheelchair users slipping from the ramp. The height of the top handrail may be 900 mm from the top surface of the ramp. The ramp surface may be rough finished. All ramp and landing may be designed so that water does not collect on the surface of the ramp or landing.
h) Requirements of **7.4.3** of Part 11 'Approach to Sustainability' of the Code should also be taken in to consideration.

5.2.10 *Provision for Adequate Parking Requirements*

a) Parking spaces may be provided off-street or as dedicated parking pockets with ample turning radii for manoeuverability of vehicles.
b) The parking lots need to be shaded during the day while being well lit during the night and should be easily accessible.
c) Pedestrian connections to and fro the parking lots may be denoted with easily recognizable signage elements.
d) The parking spaces shall be provided in accordance with **10** of Part 3 'Development Control Rules and General Building Requirements' of the Code.
e) Parking bays for persons with disabilities shall be provided as per **13** of Part 3

'Development Control Rules and General Building Requirements' of the Code.

5.2.11 *Adopting Rational Approach to Grading*

a) Grading may be used to minimize creation of steep slopes and retaining walls in the landscaped areas by assessing the existing contours and locating the functional landscape spaces, taking into consideration the existing layout of the land.
b) Site grading may generally be limited to areas adjacent to the building, under access roads and driveways, or in areas where cut and fill are inevitable such as those sites which are prone to landslides.
c) Buildings and roads may be planned so as to generally follow the existing contours. On sloping sites, buildings may have multiple levels to maximize the potential of contoured sites.
d) Wherever possible, measures like naturally stabilizing slopes and bio-engineering measures may be explored in order to avoid construction of retaining walls.
e) Where grading occurs, new slopes may be configured to retain the natural character of the site. New contour lines may be carved to mimic the natural contours.

5.2.12 *Designing for Road Landscapes*

a) Kerbs may be provided on the edges of the driveways to adequately control drainage within the road, prevent moisture from entering the sub-grade, separate the road from the pedestrian area, and provide adequate lateral support for the pavement structure.
b) The roads should provide clear access to fire fighting vehicles, ambulance, sanitation vehicles, etc, and also allow for safe movement for vehicles, pedestrians and wheelchair users. The road widths, alignments and service lanes, etc, may be such that they are adequate as per the relevant Indian Road Congress Standards.
c) Lane markings, kerb edges, central median, etc, may be provided for smooth movement of the traffic and also to guide the vehicles to stay within the designated driveways.
d) Driveways may preferably be shaded by trees. The choice and appropriateness of selection of plants along the road should be in accordance with **7**.
e) Pedestrian crossings (on grade/subways/foot overbridges) may be provided along the pedestrian sidewalks at vehicular intersections to allow for continuous uninterrupted pedestrian movement.
f) Pathways along vehicular roads may be physically separated by means of kerbs, graded separation, barrier, railing, or other means to prevent ingress of vehicles.
g) Roads may be designed with provision for appropriate street furniture (*see* **13** and other urban adjuncts for the convenience of the users). Benches, shelters, poles, signs, bus stops, etc, may be located on edge of the sidewalk with clear minimum width of 1.20 m to enable unhindered pedestrian circulation.

5.3 Open Spaces Design Guidelines for Ecologically Sensitive Zones and Historic Precincts

5.3.1 *Site Processes and Climatic Considerations*

Whether designing to avoid impacts to a significant landscape area or to restore an ecological community, a detailed analysis may be conducted to understand the dominant site processes. The following processes may be considered:

a) Topography;
b) Hydrology;
c) Biotic aspects (plants and animals);
d) Biogeochemical processes; and
e) Climatic considerations.

Stormwater adjacent to restoration areas may be managed to prevent any additional stormwater runoff to these areas. For water conservation practices, *see* Part 11 'Approach to Sustainability' of the Code, in addition to the following:

a) The surface water runoff may be directed towards designed bio-retention systems (for example, swales, rain gardens, or vegetated filters).
b) Wherever possible, stormwater may be used as a resource and the offsite impervious area water runoff may be captured so that this stormwater can be used where it is needed. Watershed impacts in landscape patches may be taken into cognizance during the design stages. Areas where upstream development may cause increased runoff may be designed with higher peak flows.
c) Planting areas may be incorporated so that they may capture and help in filtration and percolation of stormwater for ground water recharge.

5.3.2 *Design as a Response to the Existing Environment*

a) Preservation of existing elements of value, such as mature trees, rocky outcrops, etc, may be considered.
b) The historic precedents in the vicinity may be taken into consideration. Opportunities for passive recreation as well as active recreation may be considered so that it minimizes the impact on the natural condition of the open spaces especially in regional parks and city level parks encompassing large areas.
c) The processes of site inventory, and site assessment and analysis may be done to confirm the value of the site which needs to be retained or preserved.
d) The proposed usage of the site may be verified against the historical, cultural and ecological values of the site to ascertain the validity of the proposal.

5.3.3 *Designing and Locating Landscape Lighting*

a) Haphazard placement of landscape light fixtures shall be avoided. The landscape light fixtures may be chosen from a pre-determined palette or designed so as to enhance and complement the character of the site.
b) Light fixtures and fittings may be located in a sensitive manner so as to minimize the glare as well as prevent night sky pollution. *See* **7.5** of Part 11 'Approach to Sustainability' of the Code.

c) The height of light fixtures should be decided based on their spacing to prevent wastage of energy or creation of dark patches.
d) Sturdy and durable light fixtures may be chosen to prevent vandalism.

5.3.4 *Protection and Conservation of Significant Landscape Areas*

a) Barriers should be placed to prevent dumping and to restrict vehicle access, wherever necessary.
b) Hard surfaces, including bike trails and boardwalks may be developed and strategically placed so as to avoid dissecting, diminishing, or disturbing preservation areas.
c) Opportunities for ecological and conservation research may be identified.

5.3.5 *Identification of Ecological Communities and their Connectivity*

a) The type of vegetation community present, whether forest, shrub land, meadow, stream, tidal marsh or wetland, can guide the design for adjacent sites and the design and construction practices required to protect the community. Designers may familiarize themselves with the extent and history of the site. Imported soils, the elimination of a surface water source, or nutrient inputs may drastically change the structure and function of the site flora or fauna, and these changes may or may not be reversible.
b) Surrounding areas for vegetation/wildlife movement opportunities or concerns to be explored. Linked parks may provide connectivity for plant species to spread seed and for smaller animals and birds to move. However, this may be both problematic and beneficial, as both desirable and undesirable species may spread.
c) Native species may be encouraged to migrate to new areas by mimicking the conditions of successfully established habitat nearby. Barriers for the spread of invasive species may be created. Site disturbance adjacent to areas which harbour endemic species, may be minimized.

5.3.6 *Enhancement of Habitat Opportunities*

a) Habitat areas may be established in those areas where human usage is compatible or acceptably low.
b) Contiguous and dedicated open spaces may be established. The adjacent patches of species' habitat may be connected whenever possible, prioritizing areas adjacent to existing habitat for expansion.
c) For river corridors, conditions that encourage fish migration may be enhanced. If there are upstream migration blockages, they may have to be removed.
d) Planting areas that can capture stormwater may be included in the landscape. Native vegetation that is consistent with the site that provides wildlife food may be planted. Vegetation along water edges for fish protection from predators may be provided.

5.3.7 *Compliance with State Level, National Level and International River Revitalization Treaties, Coastal Management Program Policies, River Cleaning Missions, etc*

a) Underutilized areas may be restored.

b) Water dependent and recreational uses may be minimized.
c) Damage from flooding and erosion may be minimized using non-structural technologies.
d) The consumption of natural resources may be minimized through efficient planning and design.
e) Water quality standards should be adhered to and discharge of hazardous substances into coastal waters avoided.
f) Compatible land uses with surrounding properties may be promoted.
g) Impacts to navigable waters may be avoided.

5.3.8 *Preservation of the Character of Existing Landscapes of Ecological and Culturally Significant Landscape Areas*

a) The history of a site, including original designs, past reconstructions, master plans and other development plans are important and shall be referred to understand and preserve important cultural landscapes.
b) A cultural landscape report may be prepared if the landscape is historically important.
c) Archeological investigation may be conducted, if found necessary.
d) Sites with potential buried resources should be granted protection.
e) For cultural landscapes, existing viewsheds may be preserved and enhanced through tree preservation, removal and replanting.

5.3.9 *Design for Resilience and Ease of Maintenance*

a) Detailed as-built drawings that show locations of all hidden utilities of the external areas may be provided. The documents containing waterproofing and protection layer details should be provided to the maintenance team.
b) Hose tapping points no more than 20 m from all planting areas may be provided to minimize hose-runs.
c) The amount of funds for maintenance and manpower requirement for the external development zone may be assessed before initiating the design, and the design should be commensurate with the maintenance budget.
d) Manuals for equipment operation and maintenance, for tools, and for replacement parts may be provided, to be kept in a locked cabinet on site.
e) Adequate training should be provided to all the operations personnel and gardeners.
f) Preparation of a post-occupancy maintenance plan may be done in accordance with **7.1.2.3** of Part 11 ‘Approach to Sustainability’ of the Code.

6 SIGNAGE

Signage shall be in accordance with Part 10 ‘Landscape Development, Signs and Outdoor Display Structures, Section 2 Signs and Outdoors Display Structures’ of the Code.

7 PLANTING DESIGN

7.1 Plant material is a very important component of landscape development, and planting design is integral to any landscape plan. Designing with plants requires awareness and knowledge of a broad range of aspects including ecology, botany, horticulture, aesthetic value, growth and survival, and use of plants to address environmental and ecological concerns.

7.2 Plant Material

The major sets of factors that influence the choice of plant material are related to the characteristics, both botanical and physical of plant material and the context in which the plant material is to be used. The inter-relationship of these sets of factors is the basis for developing a sound approach to the process of designing with plants.

7.2.1 *Physical and Botanical Characteristics of Plant Material*

The information on plant material should be available in a systematic format to include definition, significance and design implications of the following aspects:

a) Nomenclature (botanical and trade name);
b) Origin, family and natural habitat;
c) Growth characteristic and form as a function of habit;
d) Physical characteristics, for example, bark texture, foliage, etc;
e) Propagation and maintenance; and
f) Use in landscape design.

7.2.2 *Vegetation Types (Evergreen and Deciduous)*

Some examples of the functional implications of using evergreen and deciduous plant material for specific situations are:

a) *Evergreen trees*

1) For places requiring shade throughout the year,
2) For strong visual screening,
3) As part of windbreak or shelter planting, and
4) For areas where leaf litter is to be discouraged.

b) *Deciduous trees*

1) For greater visual variety,
2) As partial visual barrier ,
3) For areas where under-planting is to be encouraged (for example, grass),
4) For emphasis on branching and flowering pattern, and
5) For areas where shade is not required throughout the year.

7.2.3 *Growth Rate and Age of the Vegetation*

Growth rate is directly related to the life-span of a tree and slower growing trees have a

life-span extending to hundreds of years. The fast growing trees to the exclusion of slower growing varieties is not recommended. Landscapes are developed to sustain future generations; slow growing long lived native trees shall be emphatically included in all major planting schemes, specially those related to institutional campuses and large urban development. However, fast growing species have a limited role, and are appropriate in situations, where,

a) quick effects are required, for example, in shelterbelts;
b) immediate results with regards to stabilization of soil, etc are necessary, for example, in soil conservation schemes; and
c) used as 'nurse plants' to protect slower growing sensitive species, when necessary.

The slower growing species would generally be appropriate in situations where sustained environmental benefits are required such as roadside planting, campuses, townships, industrial areas, and other public landscapes.

7.2.4 *Growth Habits of Various Kinds of Vegetation and their Form*

The overall physical form of a plant is usually the result of the foliage density and branching pattern. It may also be expressed as the proportionate relations between height and canopy spread. The latter is direct expression of growth habit.

A number of classifications of tree by their overall form exist, but it is almost impossible to have a variety according to regional conditions. The following classification into basic types may be useful:

a) *Trees of fastigiated or columnar habit* – Examples of trees of this type are:

1) *Casuarina equisitifolia* (Beet-wood)
2) *Grevillea robusta* (Silver oak)
3) *Polyathia longifolia* (Ashok)
4) *Populus species* (Poplar)

Though the branching pattern of each is different, the overall shape is similar.

b) *Tall trees with broad canopy* – Examples of trees of this type are:

1) *Dalbergia sissoo* (Sheesham)
2) *Tamarindus indica* (Imli)
3) *Terminalia arjuna* (Arjun)

The canopy shape does not fit into any specific geometrical category.

c) *Trees of spreading habit* – Examples of trees of this type are:

1) *Delonix regia* (Gulmohar)
2) *Lagerstromia flosreginae* (Pride of India)
3) *Pithecolobium saman* (Rain Tree)

Though these trees vary greatly in size, their basic form is similar.

d) *Trees of weeping habit* – Examples of trees of this type are:

1) *Callistemon lanceolatus* (Bottle brush)
2) *Salix babylonica* (Weeping willow)

The above classification is helpful in choosing various combinations of the above types to achieve desired function and visual objectives.

7.2.5 *Foliage Characteristics of Plant Material*

Visual effects imparted by vegetation, for example the perceived visual textures of plant forms depend on:

a) *Leaf size and shape* – Examples of plants with large leaves and bold foliage texture are:

1) Neolamarckia cadamba (Kadam)
2) Ficus lyrata (Fig)
3) *Plumeria acutifolia* (Temple tree)
4) *Pterospermum acerifolium* (Kanak champa)

Leaf shape can also determine the appearance of the foliage of the plant, as for example:

1) *Callistemon lanceolatus* (Bottle brush) – Narrow leaves giving a feathery appearance
2) *Polyalthia longifolia* (Ashok) – Long narrow leaves
3) S*alix babylonica* (Weeping willow) – Narrow leaves giving a feathery appearance

b) *Leaf texture* – The textural appearance of a plant is the result of the play of light and shade on the foliage. Plants with larger leaves generally appear bolder in texture than smaller leaves plants as the areas of light and shade are larger and therefore more clearly differentiated.

c) *Leaf and foliage colour* – Most trees in India have foliage in varying shades of green with variations in colour at the time of leaf fall and at the period when the tree is newly in leaf, when the leaves are fresh and much lighter in colour. Examples are:

1) *Lagerstroemia speciosa* (Jarul) – Leaves acquire reddish tinge before falling

2) *Polyalthia longifolia* (Ashok)*, Delonix regia* (Gulmohar)*, Erythrina indica* (India coral tree), etc – Leaves turn yellow before falling

3) *Ficus infectoria* (Pilkhan), *Mangifera indica* (Mango) *etc.* – Young leaves

have reddish tinge

d) *Foliage density and distribution* – An important consideration is the way in which particular kinds of vegetation are perceived. Tree masses are usually seen from greater distance than shrub areas; foliage texture of different distinctive kinds of trees growing together has to be markedly distinctive for individual species to be recognizably apparent. In shrub areas subtle differences in foliage texture may suffice for creating the required visual effect.

7.2.6 *Flowering Characteristics of Plant Material*

7.2.6.1 Important considerations while identifying plant material according to flowering characteristics are as follows:

a) Season,
b) Density and distribution of flowers on the plant,
c) Botanical characteristics of flowers (for example, single/cluster, etc),
d) Colour, and
e) Presence or absence of foliage during flowering period.

7.2.6.2 For the purpose of understanding the visual effect of flowers, tree species may be divided into two types:

a) Trees on which flowers appear in profusion and therefore have a very strong visual impact, for example, *Delonix regia*, *Cassia fistula*, *Lagerstroemia flosreginae.*

b) Those on which flowers are less profuse, or perhaps last for a shorter period and visual impact is more subtle, for example, *Thespesia* spp.*,* etc.

c) *Aromatic/Non aromatic* – for example, *Plumeria* spp.

An additional consideration when choosing shrubs for their flowering quality is the visual appearance of the flowers themselves, as shrubs are usually seen from quite close. Distinctive flowers are those of,

a) *Beleperone guttata* (Shrimp plant)
b) *Hibiscus rosa-sinensis* (Clinex hibiscus)
c) *Jasminum sambac* (Chameli)
d) *Tabernaemontana coronaria* (Cape jasmine)
e) *Thevetia peruviana* (Yellow oleander)

7.2.6.3 The olfactory characteristics, that is, odour, of flowers may be an added benefit of flowering plants. Flowers with distinctive scent include those of *Nyctanthes arbor-tristis* (Har-singar), *Jasminum pubescens* (Chameli), *Cestrum nocturnum* (Raat ki Rani), etc.

7.2.6.4 Flowering characteristics of plant material may be classified as per the following format:

Botanical Name	*Characteristics of Flower*	*Seasonal Duration*	*Visual Impact*

7.2.7 *Native-adaptive species*

Incorporating native-adaptive species into landscaping and planting designs is an essential strategy for sustainable development. Native plants are naturally suited to the local climate, soil, and environmental conditions, making them more resilient to pests, diseases, and extreme weather events.

7.2.7 *Growth Requirement of Plant Material*

Information about growth requirements of plant material applicable in landscape design pertains to the ability of particular plants to survive in specific environmental situations. These environmental conditions may arise from a number of aspects as given in **7.2.7.1** to **7.2.7.4**. Capacity of plants to grow in cultivated situations is related to the environmental conditions obtaining in their natural habitat.

7.2.7.1 *Soil conditions*

Physical as well as chemical properties of the available soil are important. These may or may not be amenable to change, they would therefore affect the choice of plant material considerably. Physical properties include consideration of light (for example, sandy) and heavy (for example, clayey) soils, and their structure. Chemical properties pertain to the presence or absence of nutrients and salts; soil, alkalinity or acidity. A preliminary soil analysis is essential for implementing effective planting schemes.

7.2.7.2 *Availability and quality of water*

The water requirement may be derived by data of humidity and rainfall of plants' natural habitat. The water table of the area where the plantation is to be done has a crucial bearing on the design with plants as well as a financial implication for reduced maintenance if planted appropriately.

7.2.7.3 *Availability of sunlight*

The growth rate of plants is directly related to sunlight requirement and availability; such as plants that require: (a) full sunlight; (b) partial sunlight; (c) predominantly shade; and (d) complete shade.

7.2.7.4 *Quality of air*

Growth may be affected by chemical pollutants, such as sulphur dioxide or physical pollution such as dust. Certain plants have the ability to withstand pollution, such plants are imperative for industrial areas, roads, highways, etc.

7.2.8 *Maintenance*

The success of a designed landscape depends upon the growth of vegetation over an extended period of time; therefore maintenance of landscape is also a design component. Maintenance needs and practices in any given situation arise out of the inter-relationship between the growth requirements of plant material chosen and the environmental conditions existing on site.

The likely degree of maintenance should be assessed based on the following:

a) Scale of the design project,
b) Financial and manpower resource,
c) Availability of manures,
d) Future intensity of site, and
e) Environmental conditions.

In small scale projects, such as gardens and small parks, the natural environmental conditions can be changed and maintained by management practices such as irrigation and application of fertilizers. The choice of plant species is therefore not very strictly limited by the existing environmental conditions. On larger scale schemes, such as very large parks, campuses and townships, this kind of intensive maintenance may not be possible. The process of choosing plants shall therefore respond to the existing environmental conditions, and also in such cases the choice of plant material is restricted by these conditions and suitable species become limited. The type of treatment adopted, as given below, may also serve as a guide to the degree of maintenance required:

a)	Low maintenance	The lowest degree of maintenance is usually possible in areas treated with native species of trees only. A slightly higher degree is necessary where native shrubs are also used, as these may require pruning.
b)	Medium	Areas treated with a mixture of native and exotic trees. Exotic shrubs and trees.
c)	High	Exotic shrubs and ground covers. Lawns and maintained grass areas. Annual flowers and special schemes.

7.3 Functional Aspects of Design with Plants

Plant materials in landscape design may be used to,

a) improve existing environmental conditions with respect to soil, drainage, microclimate, air pollution;
b) create a designed physical environment through the organization of open space; and
c) interpret and express the contemporary understanding of the man-nature relationship, that is, design with plants on an ecological rather than horticultural basis.

7.3.1 *Choosing of Plant Material*

Two sets of factors influence the choice of plant material in landscape design. One relates to information about plant material itself that determines the suitability of plant material from the point of view of growth requirements of plant material, and physical characteristics of the plant material. The second relates to the situation for which a planting proposal has to be made that pertains to the context in which the plant materials have to be used. Considerations of scale (that is, regional, local or very small scale situations), the existing environmental conditions, and functions which the plant material has to fulfill are important. Also the level of maintenance which is likely to be kept up, has to be considered which is especially important on very large sites. The biological history and ecological need of exotic plant should be studied prior to introduction in the landscape schemes to avoid the hazard of the species that may become invasive.

The factors determining choice of plant materials may be thus summarized as follows:

a) *Environmental conditions existing on site* – These include climatic, soil characteristics, water table, etc.

b) *Functions which plant material has to fulfill in specific situations on a given site* – These may be either environmental functions (pertaining to improvement of soil conditions, modification or microclimate, etc) or design functions (relating to creating spaces enclosure, framing views, providing visual relief, etc).

c) *Physical characteristics and growth requirements of plant material* – The former include foliage density, foliage texture, leaf size and shape, flower colour, rooting characteristics, etc. The latter include moisture requirements, whether the plant grows in sunny or shaded conditions, etc.

7.3.2 *Methodology of Design with Plants*

The process for designing with plants on a given site condition may be as per the format given below:

Zone	*Characteristics*	*Functions*	*Form*	*Species chosen*	*Remarks*

Plant material used in landscape design may be broadly classified as follows:

Plant Material	*Classification*
Tree	Large Medium Small
Shrub	Tall Low
Ground cover	Very low shrubs less than 300 mm high

7.3.3 *Functions of Plant Material*

7.3.3.1 *Trees*

Trees perform the following functions:

a) Improvement in air quality,
b) Increase in oxygen levels,
c) Protection of soil,
d) Modification in microclimate,
e) Providing shade,
f) Providing habitat for fauna,
g) Providing enclosure,

h) Providing direction and framing views,
j) Screening,
k) Providing visual relief,
m) Reduction in noise levels,
n) Acting as windbreaks and shelterbelts, and
p) Providing fruits, seeds, etc, for consumption and therapeutic value.

NOTE – For functions of plants/shrubs to reduce noise, **3.6** of Part 8 'Building Services, Section 4 Acoustics, Sound Insulation and Noise Control' of the Code may be referred.

7.3.3.2 *Shrubs*

The functions are similar to those of trees. Shrubs may be used together with trees to reinforce the functions, for example, noise barrier, shelterbelts, enclosures, etc.

Other forms in which shrubs may be used are as follows:

a) *Hedges* – These require regular maintenance.
b) *Shrubbery* – Here plants are allowed to retain their natural shape; they therefore require little maintenance.

Shrubs provide barriers, which may either be visual or physical (hedges). Barriers may be required in a range of situations, for example they may be only for defining space, or they may be required for security and have to be, therefore, necessarily impenetrable.

7.3.3.3 *Ground cover*

Ground cover plants are those which naturally grow to a very low height. Some of the uses for which they may be used are:

a) Stabilizing soil on steep slopes such as embankments.
b) As a low maintenance substitute for grass (where the surface is not to be used).
c) For providing variety in surface treatment.
d) Contrast with paving materials, for example to soften rigid lines of paving.
e) As a subtle means of demarcating space, as for example, in places where tall plants would be visually intrusive.
f) In combination with other plants to provide contrast or harmony in form.

7.3.3.4 *Climbers*

Certain climbers because of their spreading habits may also be used as ground cover (for example, *Asparagus* spp.). Also, climbers can increase the green cover without taking a lot of ground space. Climbers are useful for shading exposed walls from direct sunlight. They may also be used for stabilizing soil on embankments (for example, *Ficus stipulata, Ipomea biloba*). On sites where a high degree of security makes fencing necessary, climbers and spreading plants like *Bougainvillea* species, may be

trained on boundary wall.

7.4 Planting for Shelter and Soil Conservation

The use of vegetation for controlling wind is widely recognized as an effective way of conserving soil and reducing erosion by wind. Vegetation may therefore be used for modifying the microclimate, by obstructing, guiding, deflecting or filtering wind current.

Vegetation areas designed to fulfill these general functions are usually classified as windbreaks and shelterbelts. Windbreak is grown protective planting around gardens and orchards. Windbreaks generally consist of single or double row of trees. Shelterbelt provides an extensive barrier of trees with several rows of trees. Plant species are chosen with particular regard to their physical and growth characteristics, and their effectiveness in achieving the desired results. Both windbreaks and shelterbelts have considerable visual impact in the landscape in which they are situated, they therefore need to be designed so that they make a positive visual and aesthetic contribution to their environment.

7.4.1 *Function*

Windbreaks and shelterbelts fulfill essential micro-climatic functions in rural and urban environments. Benefits accruing from plantation of shelter planting may be as follows:

a) Reduction in wind velocity resulting in the arrest of movements of sand and soil particles.
b) Prevention of soil erosion.
c) Modification of micro-climate; moderation of change in air temperature.
d) Protection of crops from being blown by high winds.
e) Protection of livestock.
f) Reduction in loss of soil moisture by evaporation.
g) Increase in soil moisture due to greater dewfall in sheltered areas has been found to be 200 percent higher than on exposed ground; heaviest dew fall is over a distance of 2 to 3 times the height of the shelterbelt.
h) Beneficial effect on growth of plants that are affected by high winds.
j) Extensive shelterbelts may also be used to augment the supply of fuel in rural areas.
k) The zone of influence of shelterbelt on crop yield extends to a distance of 20 times the height of the belt, with the maximum effect being observed 10 times the height of the tree belt, on the leeward side.

7.4.2 *Wind Erosion*

Some of the basic functions of windbreaks and shelterbelts in arid and semi-arid areas are to conserve soil and reduce erosion by wind. The latter is a natural phenomenon in lands having very little rainfall (125 mm to 250 mm) and in areas adjoining a river, lake or sea. Wind erosion is a serious problem in areas where the ground is virtually bare and devoid of vegetation.

Factors which influence the degree and kind of wind erosion are as follows:

a) *Features of wind* – Speed, direction, temperature, humility, burden carried, etc.
b) *Character of surface* – Rough or smooth plant cover, obstruction, temperature, etc.
c) *Topography* – Flat, undulating broken, etc.
d) *Character of soil* – Texture, organic matter, moisture content, etc.

7.4.2.1 *Techniques for control of wind erosion*

The principal method of reducing surface velocity of wind, upon which depends the abrasive and transportation capacity of wind, is by vegetation measures. Vegetation methods are found to be most effective in the form of windbreaks and shelterbelts. In aerodynamic terms, these provide protection as follows:

a) Sheltered zone on the leeward side extends to approximately 15-30 times the height of the belt.
b) A dense belt provides greater shelter immediately to leeward side but the sheltered area is not as extensive as when a more permeable zone of vegetation is provided.
c) Porosity is important in the effectiveness of shelterbelt and proper selection of tree species is necessary. Porosity near ground level is desirable.
d) Effectiveness of shelter planting depends more on height and permeability than on width. The width influences the general microclimate but above a certain minimum width, it does not affect greater reduction in wind velocity.

Protection obtained varies in relation to height (*H*) of shelterbelts, as given below:

Distance	*Wind Reduced by* in percent
H	90
2*H*	75
5*H*	50
10*H*	20

This indicates that it is better to have several windbreaks 5*H* to 6*H* apart rather than large forest stands with wide open spaces in between.

7.4.3 *Profiles*

A belt which rises and falls abruptly on windward and leeward sides is said to be more effective. Smaller trees and shrubs should occupy the inter-spaces between tall trees.

NOTE – Some authorities maintain that triangular section of shelterbelt planting can be more effective.

The depth of the shelterbelt should be approximately ten times its height. This is, however, only a thumb rule. Much lesser widths of 20 m to 30 m have also been found to be useful in particular situations; 15 m should be considered as minimum width.

Apart from factors such as climate, soil, fast rate of growth, one of the more significant considerations in choosing species for shelter planting is the possibility of a particular species serving the dual role of wood-production (for fuel, fodder) as well as shelter.

7.4.3.1 *Spacing of plants in windbreaks and shelterbelts*

Windbreaks usually consist of a single or multiple rows of trees planted closely according to species. Normally, one year old trees are used. As the roots of tree extend for some distance beyond the rows in which they are planted, the same should be taken into account while planting windbreaks. The most common layout where shelter planting is part of an extensive planned programme, is that of tree belts arranged in a chessboard pattern, each field being protected from every side. This pattern gives full protection to all the fields, provided that the right distance between the fields has been chosen. Efficient protection is achieved if belts are separated by a distance of not more than 20 times the height of the trees. A considerable mixture of species is recommended so as to compensate for different rates of growth and also to achieve variety in the form of crowns.

7.4.3.2 Within shelterbelts, close spacing of trees is the general practice. The recommended spacing for shrubs is 1 m and for tree such as *Casuarina* spp. and *Grevellia robusta* (Silver Oak*)* 2.5 m. Spacing between rows should be 2.0 m to 4.0 m to enable mechanized cultivation. Five rows of tree and shrubs are considered necessary for proper protection.

7.4.4 *Management*

Shelterbelts should be regarded as living groups of trees to be managed in perpetuity and the following shall be taken into consideration for management thereof:

a) Thinnings are limited to a strict minimum.
b) Cutting is done individually by single tree selection method.
c) Continuous cultivation may be required in areas with scanty rainfall.
d) If individual trees do not survive, they should be replaced immediately to avoid gaps in the vegetation belt .The shelterbelt should be protected from cattle, either by fencing or by other means, especially in the early stages.

The location of shelterbelt may be related to local features such as public and private road networks, buildings, irrigation and water conservation works and methods of soil management practice (contour bunding, contour cultivation, etc). Careful choice of site will provide maximum protection to adjacent land and give shelter and shade.

The application of the concept of shelterbelts to landscape planning and design may be effective in the creation of landscape structure of very large developments at the regional scale, or townships or campuses. Shelterbelts can also be established in association with, or instead of road side planting. This itself creates a distinctive landscape pattern. The advantages of using native species in shelter planting are:

a) New development is merged into the existing landscape. The original

character of the landscape is therefore not obtruded upon.

b) The shelterbelt is a component of land management (previous waste or barren land is conserved).
c) Additional habitat for wildlife are brought into existence.

7.4.5 Species suitable for windbreaks are:

a) *For dry and arid regions*

1) *Ailanthus excelsa* (Maharukh)
2) *Albilzia lebbeck* (Siris)
3) *Azadiracta indica* (Neem)
4) *Casuarina equisetifolia* (Beef-wood)
5) *Dalbergia sissoo* (Sisham)
6) *Eugenia jambolana* (Jamun)
7) *Grevillea robusta* (Silver oak)
8) *Peltophorum ferrugineum* (Cooper pod)
9) *Tamarindus indica* (Imli)
10) *Pongamia glabra* (Indian beech)
11) *Tamarix articulata* (Tamarisk)

b) *For coastal areas*

1) *Anacardium occidentale* (Cashew)
2) *Ailanthus triphysa* (Halmaadi)
3) *Casuarina equisetifolia* (Beef-wood)
4) *Pongamia glabra* (Indian beech)
5) *Sesbania aculeata* (Sesban)
6) *Thevetia peruviana* (Yellow oleander)
7) *Thespesia populnea* (Indian tulip)
8) *Vitex negundo* (Sephali)

7.5 Air Pollution Control by Plants

Air pollution may be caused by areas or point sources such as cities, burning of wastes, industrial emissions, factories, construction activities or by linear sources such as highways. Vegetation buffers can minimize the build-up of pollution levels in urban areas, by acting as pollution sinks.

Studies have established that air pollution, smoke and sulphur dioxide leads to an exacerbation of chronic respiratory diseases and they are linked to increased risks of lung cancer, pneumonia, tuberculosis, chest disease in children, stomach cancer and cardiovascular diseases. Lead from vehicle exhausts may have an adverse effect on mental health of children, asbestos from disintegrating clutch and brake linings has been considered as a causal factor in lung cancer.

7.5.1 *Effect of Plants*

Plant leaves function as efficient gas exchange systems. Their internal structure allows rapid diffusion of water-soluble gases. These characteristics allow the plant to respire and photosynthesize, and they can also remove pollutant from the air. Some of the beneficial results of plantations may be:

a) They are good absorbers of sulphur dioxide.
b) Parks with trees have sulphur dioxide level lower than city streets.
c) Roadside planting can reduce traffic generated air borne lead, on leeward side.
d) Heavy roadside planting in the form of shelterbelts can result in a reduction in airborne lead.
e) Complete dust interception can be achieved by a 30 m belt of trees. Even a single row of trees may bring about 25 percent reduction in airborne particulate.

7.5.2 *Choosing Plants*

The three main criteria for selection of plants may be:

a) Trees, shrubs should have a dense foliage with a large surface area, because leaves reduce pollutants.
b) Evergreen trees are found to be more effective.
c) The species chosen should be resistant to pollutants, particularly in the early stages of their growth.

The following species may be examined for their likely potential for pollution control:

1) *Acacia arabica* (Babul),
2) *Citrus* spp.,
3) *Diospyros* spp.,
4) *Ficus bengalensis* (Banyan),
5) *Ficus religiosa* (Peepal),
6) *Lilium* spp. (Lily),
7) *Polyalthia longifolia* (Ashok),
8) *Tamarindus indica* (Imli),
9) *Thuja occidentalis* (Cedar),
10) *Prosopis juliflora* (Mesquite), and
11) *Zizyphus jujuba* (Jujuba), etc.

Filtering of pollutants is most effective when plants are close to the source of pollution. The design of shelterbelts against pollution is similar to those for protection from wind. They should be permeable to encourage air turbulence and mixing within the belt. There should be no large gaps. The profile should be rough and irregular and should present a tall vertical leading edge to the wing. Spaces should be left within the shelterbelt to allow gravity settlement of particles.

7.5.3 *Applications*

Air pollution shelterbelts maybe used to protect sensitive land uses from air pollution. For instance school playgrounds, children play area and residential estates close to major roads may be so protected. Shelterbelt protection may also be provided for hospitals, institutions, etc, where the vegetation may also be a visual screen and a partial noise barrier. Vegetation may also be used where the existing means of pollution control have proved inadequate.

8 SPECIFICATIONS FOR PLANTING WORKS

The requirements relating to plant materials and other materials; execution of work of tree planting, shrub planting and grassing; maintenance; etc, shall be as given in **8.1** to **8.6**. The contractor shall furnish all materials, labour and related items necessary to complete the work indicated on drawing and specified herein and shall carry out maintenance of the premises for 12 months after completion of the work or as specified by the landscape architect.

8.1 Materials

8.1.1 *Plant Materials*

Plant materials shall be well formed and shaped true to type, and free from disease, insects and defects such as knots, windburn, injuries, abrasion or disfigurement. All plant materials shall be healthy, sound, vigorous, free from disease, insect pests, or their eggs, and shall have healthy, well-developed root systems. All plants shall be hardy under climatic conditions similar to those in the locality of the project. Plants supplied shall conform to the names listed on both the plan and the plant list. No plant material shall be accepted if branches are damaged or broken. All material shall be protected from sun and adverse weather until planted. Nursery stock shall be inspected and approved by the landscape architect and the horticulturist/botanist shall do the botanical authenticity of the selected species.

All plants shall conform to the requirements specified in the plant list, except those plants larger than specified may be used if approved, but use of such plants shall not increase the contract price. If the use of the larger plant is approved, the spread of roots or ball of earth shall be increased in proportion to the size of the plant. Plants shall be delivered with legible identification labels.

The minimum acceptable size of all trees after pruning, with branches in normal positions, shall conform to the measurement specified in the bill of quantities unless stated otherwise. Caliper measurement shall be taken at a point on the trunk 1.0 m above natural ground. All trees supplied shall have terminal shoots. All specimen trees shall have a minimum crown spread of not less than half the size of the overall height.

8.1.2 *Topsoil (Good Earth) with p*H *Range between 6.5 and 7.5*

Topsoil or good earth shall be a friable loam; typical of cultivated top soils of the locality contains at least 2 percent of decayed organic matter (humus). It shall be taken from

a well-drained arable site. It shall be free of subsoil, stones, earth clods, sticks, roots or other objectionable extraneous matter or debris. It shall contain no toxic material. No topsoil shall be delivered in a muddy condition.

Top soil in the project area shall be stripped, stacked, stored and used for filling on completion of construction.

8.1.3 *Fertilizer*

Dry farm yard manure shall be used. It shall be free from extraneous matter, harmful bacteria, insects or chemicals.

8.1.4 *Root System*

The root system shall be conducive to successful transplantation. Where necessary, the root-ball shall be preserved by support with hessian or other suitable material. On soils where retention of a good ball is not possible, the roots should be suitably protected in some other way which should not cause any damage to roots.

8.1.5 *Condition*

Trees and shrubs shall be substantially free from pests and diseases, and shall be materially undamaged. Torn or lacerated roots shall be pruned before dispatch. No roots shall be subjected to adverse conditions, such as prolonged exposure to drying winds or subjection to water logging, between lifting and delivery.

8.1.6 *Marking*

Each specimen of tree and shrub, or each bundle, shall be legibly labelled with the following:

a) Its name;
b) Name of the supplier, unless otherwise agreed; and
c) Date of dispatch from the nursery.

8.2 Execution

8.2.1 *Fine Grading*

Grades should be smooth and even on a uniform plane without abrupt changes or pockets and slope away from the buildings. The nominated landscape contractor should verify the surface drainage of planting areas and notify the landscape architect of any discrepancies, obstructions or other conditions considered detrimental to proper execution of the work and plant growth.

8.2.2 Landscape work should be tied to the existing condition such as existing trees, landscape features, utility lines, pavement kerbs. Finished grade should bear proper relationship to such control. The nominated landscape contractor shall adjust all works as necessary to meet the conditions and fulfill the intention of the drawings. After initial settlement the finish grade should be as follows:

a) Turf : 20 mm lower than adjacent walks/kerbs.

b) Shrubs and ground covers : 40 mm lower than adjacent walks/kerbs.

Prior to planting operation, the contractor should ensure all planting areas free of weeds, debris, rocks over 25 mm in diameter and clumps of earth that do not break up.

8.3 Tree Planting

8.3.1 Trees should be supplied with adequate protection as approved. After delivery, if planting is not to be carried out immediately, balled plants should be placed cheek to cheek and the ball covered with sand to prevent drying out. Bare rooted plants can be heeled in by placing the roots in a prepared trench and covering them with earth which should be watered in to avoid air pockets round the roots.

8.3.2 *Digging of Pits*

Tree pits shall be dug a minimum of three weeks prior to backfilling. The pits shall be 1 200 mm in diameter and 1 200 mm deep. While digging the pits, the topsoil up to a depth of 300 mm may be kept aside, if found good (depending upon site conditions), and mixed with the rest of the soil. If the soil is bad below, it shall be replaced with the soil mixture as specified further herein. If the soil is normal it shall be mixed with manure; river sand shall be added to the soil if it is heavy.

8.3.3 *Flooding of Pits to Reduce Air Pockets*

The soil backfilled, watered through and gently pressed down, a day previous to planting, to make sure that it may not further settle down after planting. The soil shall be pressed down firmly by treading it down, leaving a shallow depression all round for watering.

8.3.4 *Planting*

No tree pits shall be dug until final tree positions have been pegged out for approval. Care shall be taken that the plant sapling when planted is not buried deeper than in the nursery, or in the pot. Planting should not be carried out in water logged soil. Trees should be planted up to the original soil depth; the soil marks on the stem is an indication of this and it should be maintained on the finished level, allowing for setting of the soil after planting. All plastic and other imperishable containers should be removed before planting. Any broken or damaged roots should be cut back to sound growth.

The bottom of the planting pit should be covered with 50 mm to 75 mm of soil. Bare roots should be spread evenly in the planting pit; and small mound in the centre of the pits on which the roots are placed will aid an even spread. Soil should be placed around the roots, gently shaking the trees to allow soil particles to shift into the root system to ensure close contact with all roots and to prevent air pockets. Back fill soil

should be firm as filling proceeds, layer by layer, care being taken to avoid damaging the roots.

8.3.5 *Staking*

Newly planted trees shall be held firmly although not rigidly by staking to prevent a pocket forming around the stem and newly formed fibrous roots being broken by mechanical pulling as the tree rocks.

The main methods of staking shall be:

a) A single vertical stake, 900 mm longer than the clear stem of the tree, driven 600 mm to 900 mm into the soil.
b) Two stakes as above driven firmly on either side of the tree with cross-bar to which the stem is attached (suitable for small bare-rooted or balled material).
c) A single stake driven in at an angle 45º and leaning towards the prevailing wind, the stem just below the lowest branch being attached to the stake (suitable for small bare-rooted or balled material).
d) For plant material 3 m to 4.5 m high with a single stem, a three-wire adjustable guy system may be used in exposed situations.

The end of stake should be pointed and the lower 1.0 m to 1.2 m should be coated with non-injurious wood preservative allowing at least 150 mm above ground level.

8.3.6 *Tying*

Each tree should be firmly secured to the stake so as to prevent excessive movement. Abrasion shall be avoided by using a buffer, rubber or hessian, between the tree and stake. The tree should be secured at a point just below its lowest branch, and also just above ground level; normally two ties should be used for tree. These should be adjusted or replaced to allow for growth.

8.3.7 *Watering*

The contractor should allow for the adequate watering in all newly planted trees and shrubs immediately after planting and shall, during the following growing season, keep the plant material well-watered.

8.4 Shrub Planting in Planters and Beds

All areas to be planted with shrubs shall be excavated, trenched to a depth of 750 mm, refilling the excavated earth after breaking clods and mixing with manure in the ratio 8:1 (8 parts of stacked volume of earth after reduction by 20 percent; 1 part of stacked volume of manure after reduction by 8 percent).

Tall shrubs may need staking, which shall be provided if approved by the landscape architect depending upon the conditions of individual plant specimen.

For planting shrubs and ground cover shrubs in planters, good earth shall be mixed with manure in proportion as above and filled in planters.

Positions of shrubs to be planted should be marked out in accordance with the planting plan. When shrubs are set out, precautions should be taken to prevent root drying. Planting holes 400 mm in diameter and 400 mm deep should be excavated for longer shrubs. Polythene and other non-perishable containers should be removed and any badly damaged roots carefully pruned. The shrubs should then be set in holes so that the soil level, after settlement, will be at the original soil mark on the stem of the shrub. The hole should be back-filled to half its depth and firmed by treading. The remainder of the soil may then be returned and again firmed by treading.

8.5 Grassing

8.5.1 *Preparation*

During the period prior to planting, the ground shall be maintained free from weeds. Grading and final levelling of the lawn shall be completed at least three weeks prior to the actual sowing. Regular watering shall be continued until sowing by dividing the lawn area into portions of approximately 5 m^2 by constructing small bunds to retain water. These bunds shall be levelled just prior to sowing of grass plants. At the time of actual planting of grass, it shall be ensured that the soil has completely settled.

8.5.2 *Soil*

The soil itself shall be ensured to the satisfaction of the landscape architect to be a good fibrous loam, rich in humus.

8.5.3 *Sowing the Grass Roots*

Grass roots shall be obtained from a grass patch, seen and approved beforehand. The grass roots stock received at site shall be manually cleared of all weeds and water sprayed over the same after keeping the stock in a place protected from sun and dry winds. Grass stock received at site may be stored for a maximum of three days. In case grassing for some areas is scheduled for a later date fresh stock of grass roots shall be ordered and obtained. Small roots shall be dibbled about 75 mm apart into the prepared grounds. Grass areas will only be accepted as reaching practical completion when germination has proved satisfactory and all weeds have been removed.

8.5.4 *Maintenance of Grassing*

As soon as the grass is approximately 30 mm high, it shall be rolled with a light wooden roller in fine, dry weather. When it has grown to 50 mm to 80 mm above ground, weeds shall be removed and regular cutting with a scythe and rolling shall be then begun. A top-dressing of farm yard manure, bone meal at the rate of 50g/m^2 and NPK (Nitrogen, phosphorus and potassium fertilizer) at the rate of 10 g/m^2 shall be applied when the grass is sufficiently secure in the ground to bear the mowing machine, the blades shall be raised 25 mm above the normal level for the first two or three cuttings. That is to say, the grass should be cut so that it is from 40 mm to 50 mm in length,

instead of the 30 mm necessary for mature grass.

In the absence of rain, during monsoon, the lawn shall be watered with sprinklers, every three days, soaking the soil to a depth of at least 200 mm. Damage, failure or dying back of grass due to neglect of watering specially for seeding out of normal season shall be the responsibility of the contractor.

Any shrinkage below the specified levels during the contract or defects liability period shall be rectified at the contractor's expense. The contractor shall exercise care in the use of rotary cultivator and mowing machines to reduce to a minimum the hazards of flying stones and brickbats. All rotary mowing machines are to be fitted with safety guards.

8.5.5 *Rolling*

Lawn mower with roller shall be used periodically, taking care that the lawn is not too wet and sodden.

8.5.6 *Edgings*

These shall be kept neat and shall be cut regularly with the edging shears.

8.5.7 *Watering*

Water shall be applied at least once in three days during dry weather. Whenever watering is done, it should be thorough and should wet the soil at least up to a depth of 200 mm.

8.5.8 *Weeding*

Prior to regular mowing, the contractor shall carefully remove rank and unsightly weeds.

8.6 Maintenance

8.6.1 The landscape contractor shall maintain all planted areas within the landscape contract boundaries for one year until the area is handed over in whole or in phases. Maintenance shall include replacement of dead plants, watering, weeding, cultivating, control of insects, fungus and other diseases by means of spraying with an approved insecticide or fungicide, pruning, and other horticulture operations necessary for the proper growth of the plants and for keeping the landscape contract area neat in appearance.

8.6.2 *Pruning and Repairs*

Upon completion of planting work under the contract, all trees should be pruned and all injuries repaired, where necessary. The amount of pruning shall be limited to the minimum necessary to remove dead or injured twigs and branches, and to

compensate for the loss of roots and result of transplanting operations.

Pruning and removal of any part of plant materials should be done with clean sharp tools. Tools used to carry out the pruning work shall be appropriate for the task. The surface of tools and equipment shall be sterilized after use on the plant materials that are suspected or known to be diseased. Cuts on plant materials shall be made into the living tissues to induce callousing. Cut surface shall be flat, sharp and without jagged or torn edges.

Pruning shall be done in such a manner as not to change the natural habitat or special shape of the trees. Pruning operation shall consider carefully the natural growth pattern of branches on the tree, palm or shrub. Tree branches shall be pruned back to the collar at the base of the branch.

8.6.3 *Tree Guards*

Where tree guards are necessary, care should be taken to ensure that they do not impede natural movement or restrict growth.

8.6.4 *Nursery Stock*

Planting should be carried out as soon as possible after reaching the site. Where planting needs to be delayed, care should be taken to protect the plants from pilfering or damage from people or animals. Plants with bare roots should be heeled-in as soon as received or otherwise protected from drying out, and others set closely together and protected from the wind. If planting needs to be delayed for more than a week, packed plants should be unpacked, the bundles opened up and each group of plants heeled-in separately and clearly labelled. If for any reason the surface of the roots becomes dry, the roots should be thoroughly soaked before planting.

8.6.5 *Protective Fencing*

According to local environment, shrubs shall be protected adequately from vandalism, until established.

8.6.6 *Routine Maintenance Work Schedule*

Sl No.	*Operation*	*Frequency*
(1)	(2)	(3)
i)	Watering	Checking all planting areas and pits and water as often as necessary to ensure that planting material does not dry out
ii)	Weeding	Monthly

iii)	Edging	Monthly
iv)	Fertilizing:	
	a) Trees/palms	Once every three months
	b) Shrubs/ground covers	Monthly
	c) Grass	Once every three months
v)	Loosening of soil	Monthly
vi)	Control of pest by applying appropriate insecticides	Fortnightly
vii)	Control of disease by applying appropriate fungicides	Monthly, increasing the frequency to fortnightly during rainy season
viii)	Grass cutting	Fortnightly
ix)	Pruning and shaping trees/palms	Once every six month for small and low sagging branches
x)	Staking	As and when required
xi)	Trimming shrubs/ground covers	Monthly or as when required

8.6.7 *Clean-Up Works*

There shall be areas designated by landscape architect for the contractor to carry out clean-up works. These shall include the following:

a) Removal of dead and/or overhanging branches of existing trees, palms, shrubs and ground covers.
b) Removal of any garbage and unsightly foreign materials.
c) Removal of dead vines and plant materials.

The contractor shall prevent damages to the existing plant materials, identified to be conserved. The plant materials that are to be conserved if damaged beyond use during the clean-up operations, the contractor shall be liable to replace the plant materials at his expense.

8.6.8 *Restoration*

The contractor is responsible for the use of all materials, labour and equipment and any injury to the plant material, labour and equipment shall be repaired or the same replaced by the contractor at his own expense.

8.6.9 *Completion*

On completion, the ground shall be formed over and left tidy.

9 SERVICE/UTILITIES IN LANDSCAPE DEVELOPMENT

9.1 Designed integration of structures and elements related to external services (underground and over ground utilities) with landscape is most essential for any outdoor space. This may, therefore, be taken care of in conjunction with the provisions under Part 4 'Fire and Life Safety', Part 8 'Building Services', Part 9 'Plumbing Services' and Part 11 'Approach to Sustainability' of the Code.

The following services, generally, are the subject of design coordination work for external areas:

a) *Stormwater drainage*

1) Stormwater network;
2) Open drain and swale;
3) Subsurface drainage system;
4) Catch basin and manholes;
5) Culvert and bridge;
6) Percolation pits;
7) Water harvesting units;
8) Retention walls and tanks;
9) Connection of all service lines up to out-fall; and
10) Other related structures.

b) *Sewage disposal system*

1) Sewerage network;
2) Manholes, inspection chambers and grease trap;
3) Septic tank, soak-pits, sewage treatment plant and root zone unit;
4) Solid waste management units;
5) Connection of all service lines up to out-fall; and
6) Other related structures.

c) *Water supply (including irrigation)*

1) Water supply network;
2) Inspection chamber and valve chamber;
3) Water tank and treatment plant;
4) Tube well, bore well and associated pump houses, etc;
5) Service lines, elements associated with water features and pools; and
6) Irrigation lines and allied requirements.

d) *Fire lines*

1) Yard hydrant lines;
2) Yard or fire hydrants and hose reel box;
3) Fire water tank and pumps; and

4) Inspection chamber and valve chamber.

e) *Electrical works*

1) Electrical network;
2) Light fixtures for road, pedestrian paths, special landscape features and building façade;
3) Inspection chambers, junction boxes and feeder pillars;
4) Electric poles, high voltage lines and towers;
5) Transformer, substation and distribution box; and
6) Other related structures.

f) *Telephone and underground cable network*

1) Telephone network;
2) Inspection chambers;
3) Telephone poles, transmission towers; and
4) Other related structures.

g) *Fuel and gas line*

1) Supply network;
2) Inspection chamber and valve chamber;
3) Fuel tank and gas tank; and
4) Other related structures.

h) *HVAC*

1) Ventilation shafts for basement ventilation; and
2) Chiller and cooling towers.

9.1.1 The following guidelines shall be applied for the designed integration of external services networks and elements in the landscape proposal:

a) The manholes and inspection chamber covers for all external services should be adequately designed for the imposed load (pedestrian or vehicular) and the top finish level has to be in alignment or flushed with the pavement or finished ground level. The alignment of these structures should be such that it is in geometric perpendicular or parallel with adjacent building or landscape lines. This would facilitate easy and unobstructed movement for pedestrians and increase the accessibility for wheelchair users in public place and also aid the landscape geometry to be maintained.

b) Fire hydrants should be prominently located and integrated with the landscape. Aesthetically designed fire hose cabinet with clear access as per statutory norms for fire safety, to be located in geometric relation with adjacent building or landscape lines. These structures should not be a

hindrance to vehicular or pedestrian movement.

c) Irrigation hydrants should be unobtrusively located and generally at the edge of shrub planting and additionally in close proximity to a drainage chamber or catch basin to avoid waterlog. Hydrants should not be located inside the chamber to minimize waterlog from leaking pipes causing various health related hazards. Hydrants should be located 200 mm above the ground level.

d) Landscape lighting is a specialized activity and illumination consultant or designer should develop the landscape lighting plan taking into consideration energy saving measures, safety aspects, lighting pollution and illumination level. Light fixtures are an important part of street furniture and it is advisable to use pole mounted light fixtures for public landscape than bollards that are prone to vandalism and damage.

e) Water body and fountains in public spaces should have filtration facility to avoid health hazards related to stagnant water. The piping should be concealed and the pump room, balancing tank and all other service structures to be designed as an integral part of landscape.

f) Storage facilities for inflammable liquid fuel and gas should be designed as an integral part of the landscape and should be housed in designed enclosures taking into consideration all statutory norms these structures are subjected to.

g) All underground service lines have to be well coordinated and stacked appropriately in the design stage to avoid overlaps and marked with indicators above the ground for ease in maintenance and servicing. Underground service stacks should be generally aligned in soft areas with no tree plantation, this would facilitate easy maintenance without disrupting the hard surface.

h) Designed façade for service structures that are above the ground in external areas is advisable so as to assist in developing aesthetically pleasing exterior environment. Such structures should be designed in a modular way so that it would be part of the street furniture.

10 ENGINEERED LANDSCAPES (INCLUDING VERTICAL GREENERY AND PODIUM LANDSCAPES)

10.1 Podium Landscape

10.1.1 *Green Roofs*

10.1.1.1 Green Roofs also known as ‘Vegetated roof’ or ‘Living Roof’ can be differentiated further as Extensive Green Roofs. With limited accessibility, these are largely planned as part of Sustainable development strategies. Tend to be simpler, with hardy plants that require little maintenance once established. Enhanced rainwater harvesting, thermal comfort thru insulation, reduction in reflective glare and potential to become habitats for small fauna are some of the benefits of Green Roofs.

Effort should be made to consolidated areas of planting instead of fragmented ones.

10.1.1.2 Design layouts of such areas need to be well coordinated with the various service structures that are located on the terraces including the routing of various pipes and conduits. Maintenance paths should be clearly defined so that planting is not unduly disturbed. Structural design of the supporting slab should take the load of planting medium into account. MEP services should provide for the sub-surface drainage and irrigation of the planting areas as well as overall surface drainage of the roof extent.

10.1.1.3 Since the planting palette is limited to small shrubs and ground cover, depth of soil is not more than 300mm. Alternate planting medium such as patented rock wool in 50-75mm thickness can also be considered which are engineered to retain moisture for extended durations of time. Appropriate & robust water proofing system that incorporates the expansion joint in the slab (if any) & proper junction detail is critical to the development of Green Roofs.

10.1.1.4 Sequence of construction should be:

a) preparation of concrete surface for application of waterproofing layer/membrane as per vendor's specification;
b) Application of the same should be as per the product specification; testing of waterproofing layer;
c) Laying of lean concrete / equivalent material to protect the waterproofing followed by the suitable drainage layer/ materials / system selected for sub-surface drainage; Installation of main irrigation line;
d) Filling of soil/planting media as per section;
e) Laying of drip irrigation lines;
f) Planting of Shrubs & ground covers should be done after all the associated civil & MEP work activities are completed.

10.1.1.5 Regular cleaning of drainage system should be done as per maintenance schedule. Weeding, pruning and periodic thinning of roots to prevent overgrowth of plants besides regular application of organic/inorganic fertilizers & pesticides should be done to conform to the best practices of sustainable planting.

10.1.2 *Podium Landscape - Terrace Gardens*

10.1.2.1 Terrace Gardens are landscaped spaces within the building envelop either at the top floor or intermediate floors, maybe totally open to sky or part of covered balcony. Main purpose is to provide usable open spaces for the residents for seating, gatherings and play etc. depending on the scale and relation to the architectural intent of the terrace. Since climatic factors become intensified at upper terrace levels, creation of comfortable microclimate is important considering the wind & sun direction as well as the placement of surrounding buildings,

10.1.2.2 Close & timely integration with architectural design is must to effectively work out circulation & usage pattern. Design layouts need to be well coordinated with the various service structures that are located on the terraces including the routing of various pipes and conduits. Structural design of the supporting slab should take the load of planting medium into account. MEP services should provide for the sub-surface

drainage and irrigation of the planting areas as well as overall surface drainage of the roof extent.

10.1.2.3 Planting soil fill requirement may range from 450mm – 900mm suitable for small/medium sized shrubs and medium size trees. Light weight soil mix may be considered to optimize the structural load. Pedestal paving (flooring slabs on adjustable jacks/pedestal) along with sustainable drainage roofing system with drain cells is also recommended for ease of construction & long-term maintenance. Use of self-contained planters in fibre glass or powder coated galvanized steel is recommended for small terraces with limited civil-work provision. Balustrade height should not be compromised due to the placement of planters next to it. While designing for individual residence terraces post occupancy, check that the items can fit into lifts/stairs for ease of installation.

10.1.2.4 It is recommended that all civil work such as in-situ planters, feature wall, water feature, pedestal for lights/play equipment/trellis/gazebo etc. are constructed in RCC for which dowels are left at the time of casting of terrace slab. This will result in a seamless water proofing which is done after all the concrete work is complete. In case of deferred timeline, repeat of water proofing is recommended for all the surfaces as per the sequence mentioned in 10.1.1.d. 10.1.2.e. Same as 10.1.1.e.

10.1.3 *Podium Landscape - Landscape Over Parking / Basement Slab*

10.1.3.1 These are Open spaces situated over concrete slab that are designed and developed for active community use in a project. They are large (usually more than 4000 sq.m. in area) with car parking beneath the slab. They could be located either on the ground level or first floor level of the site, extending out from the building extent/footprint. It is important that all the landscape structures located over the concrete slab are identified during the site planning process. Podium landscapes over parking garages offer significant opportunities to improve landscape amenities and contribute greatly to the open space provision of a site. By considering landscapes over structure early in the design process, adequate soil depth, surface / sub-surface drainage and appropriate water proofing can be accommodated. This goes a long way in ensuring that the podium landscapes are as verdant and lush as if they are developed on natural ground. Vehicular movement, parking and fire tender path are often part of the design, and their load also need to be considered in structure design. Since, these spaces are typically surrounded by tall buildings, shadow analysis across various seasons and daylight hours should be done to ascertain areas suitable for various activities and planting intent. Similarly, narrow spaces are also prone to wind tunnel effect impacting the general comfort levels in landscape. Design and detailing of swimming pool and water feature requires additional considerations of structural provision and water proofing etc.

10.1.3.2 Collaborating with the architect and engineers during the site planning phase to ensure appropriate soil depths, widths and volumes are incorporated in locations that are beneficial to landscape spaces. Integration with architectural design of corresponding level should be done so as to achieve/enhance the continuity/flow of spaces and circulation pattern between the indoors and outdoors. As is applicable in the landscape design of any large site, EC/EIA guidelines (pertaining to the provision of green areas and number of trees) should be referred to for podium landscapes as well. Well In time and proper coordination with structural consultant regarding planting

soil, swimming pool and vehicular load is critical.

Coordination with MEP consultant regarding comprehensively designed surface and sub- surface drainage system for the landscape should be undertaken at design development stage. It is important that this system is designed to adequately deal with the predicted rainwater for its geographical location. Additional consideration should be made for drainage from upper areas such as façade run off etc. Surface water from upper roofs must not be discharged into lower podium deck levels. Site services layouts and location of service structures also need to be overlapped with the landscape design and coordinated accordingly. Basement ventilation systems are a functional requirement for underground car parks. Vents, louvres, fire escape staircase or any other systems should be integrated within the façade of the building or coordinated with the landscape design so as to maintain it's aesthetics and functionality. Structural provisions such as expansion joints alignment in the non-tower area should take the landscape design into consideration. These should be located such that they are easily identifiable and accessible for future maintenance.

Expansion joints should be preferably located in the paved area. If occurring the planting area, it should not be buried in the soil, but extruded upto 50-100mm higher than soil level by means of concrete walls on either side. Fully automated irrigation system should be provided using recycled water to make the landscape sustainable.

a) **10.1.3.3** Minimum 600mm filling depth should be considered for shrub planting in projects with smaller drainage basins (less than 200 sq.m.) Minimum 900mm filling depth for shrub planting in projects with large drainage basins (200-300 sq.m.) should be taken to account for the additional thickness of lean concrete/ screed required for constructing drainage slopes in addition to the planting soil. (*see* Fig. 1).

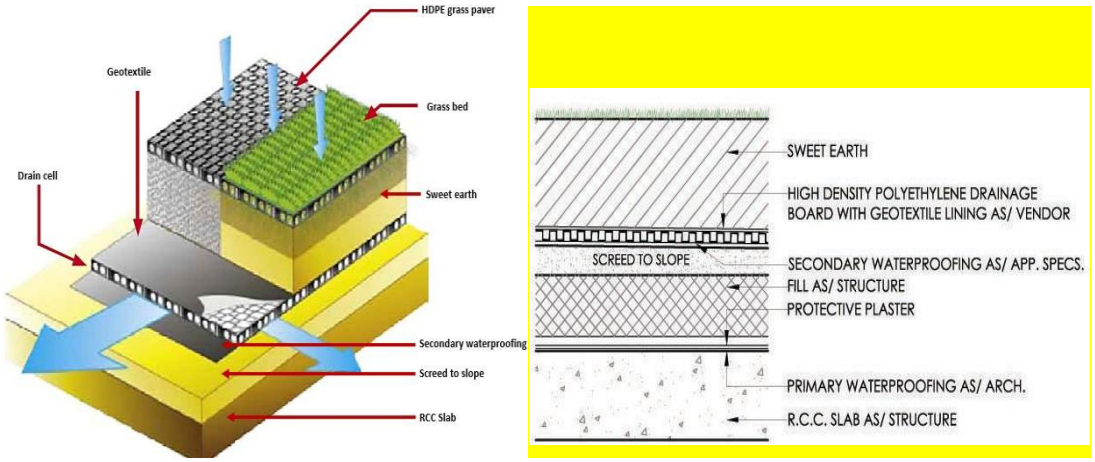

FIG. 1

b) 1200-1500 mm fill should be considered for large trees in planter of not less than 2000 mm x 2000 mm. Having specified this, it is equally important that use of raised planters is limited where possible to minimize visual and physical clutter

within landscape. Planters can instead be made purposeful by setting them at 450mm height to function as informal seating. (*see* Fig. 2).

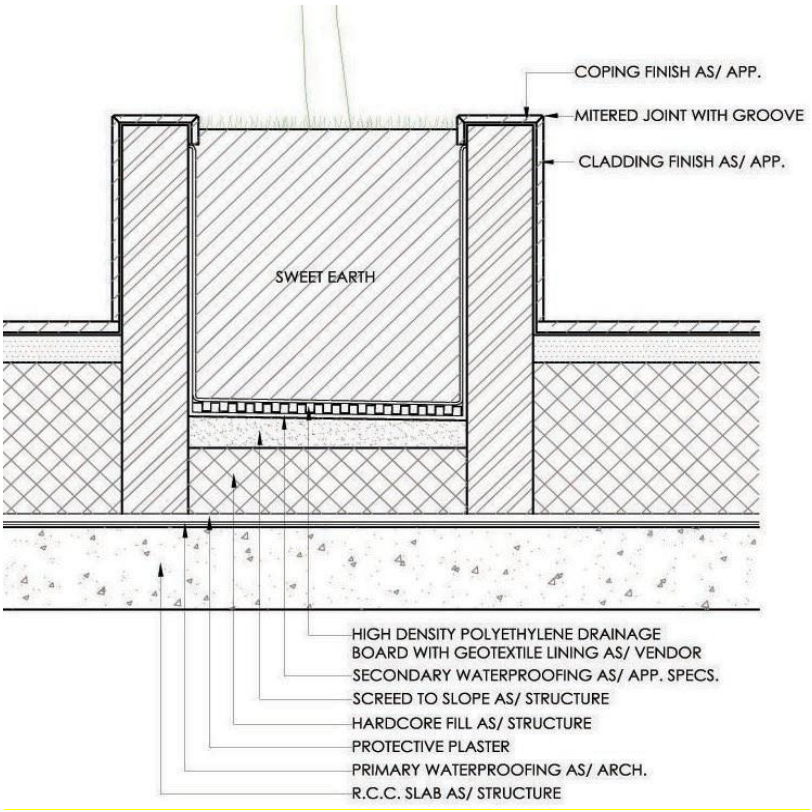

FIG. 2

c) Consider providing raised platforms or mounding to achieve required soil depth. (*see* Fig. 3).

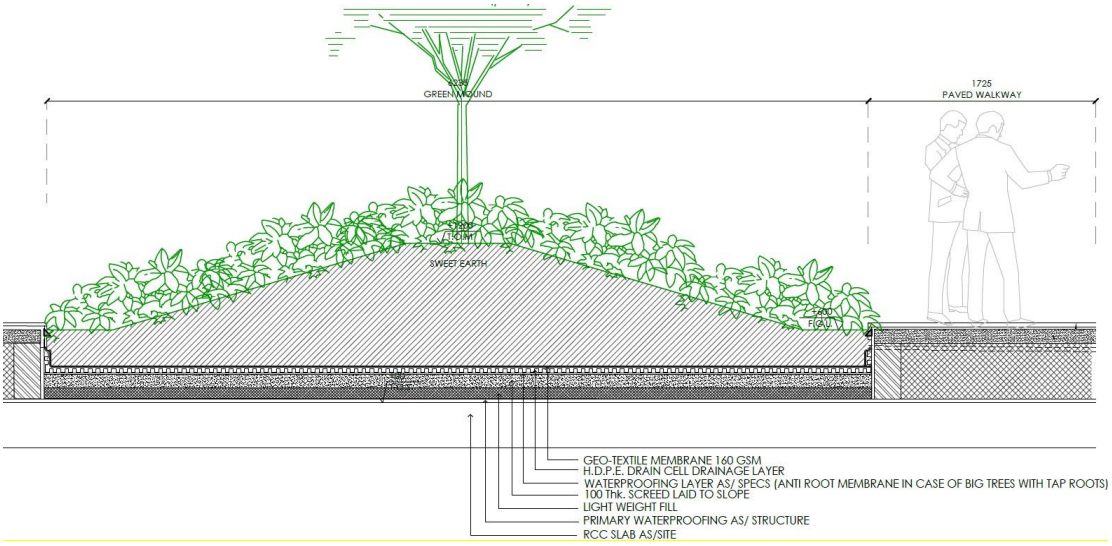

FIG. 3

In areas of dense plantation particularly consisting of large trees, a high-density polyethylene (HDPE) root barrier membrane should be fixed along vertical and/ or horizontal surfaces to contain the growth of roots that might damage the structure of the podium. It is recommended that it is installed between the protection layer of waterproofing, and the drainage layers.

10.1.3.4 It is recommended that all civil work such as in-situ planters, feature wall, water feature, pedestal for lights/play equipment/trellis/gazebo etc. are constructed in RCC for which dowels are left at the time of casting of terrace slab. This will result in a seamless water proofing which is done after all the concrete work is complete. In case of deferred timeline, repeat of water proofing is recommended for all the surfaces as per the sequence mentioned in 10.1.1.d. Proper treatment of expansion joints should be done as per vendor specifications of the selected product before the finishing work is carried out.

d) **10.1.3.5** All drainage, irrigation as well as waterproofing provisions should be inspected and maintained regularly. Weeding and Pruning of plants besides regular application of organic/inorganic fertilizers & pesticides should be done to conform to the best practices of sustainable planting. (*see* Fig. 4).

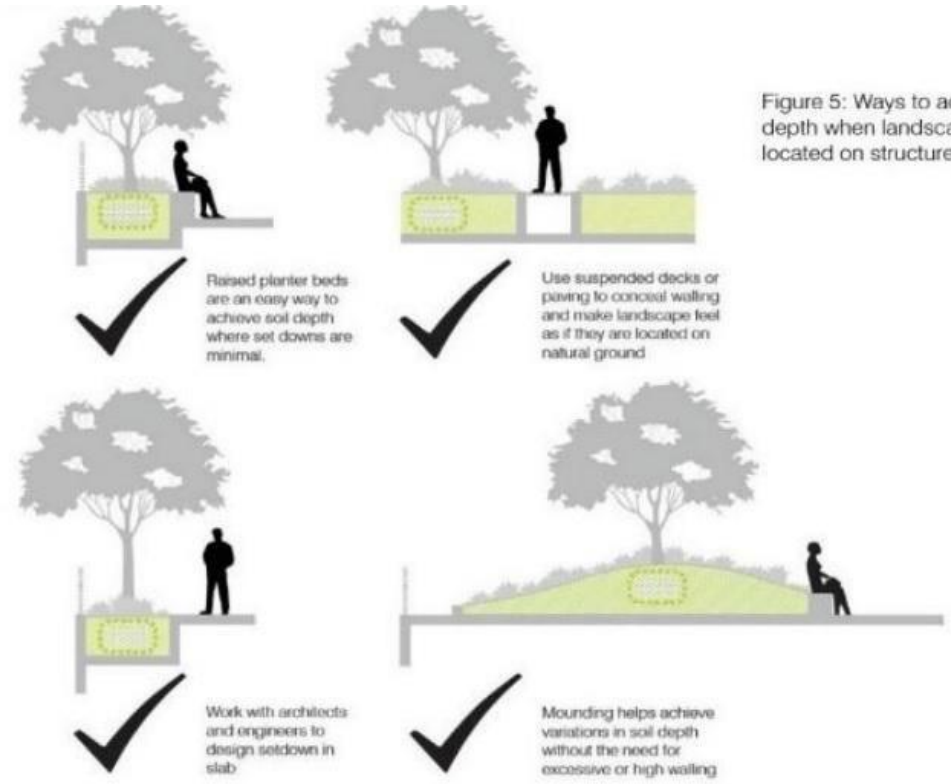

Figure 5: Ways to achieve soil depth when landscapes are located on structure

FIG. 4

10.2 VERTICAL GREENERY

Vertical greenery, also known as living walls or green facades, is an innovative design element that integrates vegetation into building exteriors or interiors. These systems improve air quality, provide thermal insulation, and contribute to energy efficiency by reducing heat gain. Vertical greenery enhances aesthetic appeal, supports urban biodiversity, and mitigates the urban heat island effect. It also promotes occupant well-being by fostering a connection to nature. It includes following categories:

10.2.1 *Prefabricated Green Wall*

A Green Wall is a vertical structure built to be covered with vegetation. Green walls include a vertically applied growth medium as well an integrated hydration and fertigation delivery system. These can be set up indoors or outdoors, as free-standing installations or attached to existing or proposed host walls. Also termed as Living Walls, they could function as urban agriculture, urban gardening or provide aesthetic enhancement as art installations.

10.2.1.1 Since the Green walls take the support of host walls, it is important to coordinate their location with respect to the surrounding architectural functionality and aesthetics. Structural provisions required for the stability and anchoring for these walls need to be considered early in the planning stage. MEP provisions regarding irrigation and drainage is also critical. In case of installation at greater heights on the buildings, provisions for accessibility for maintenance should be given. In case of indoor locations, it is important that the plants in green walls have best conditions for growth including sun light and humidity levels.

e) **10.2.1.2** Since the Green walls take the support of host walls, it is important to coordinate their location with respect to the surrounding architectural functionality and aesthetics. Structural provisions required for the stability and anchoring for these walls need to be considered early in the planning stage. MEP provisions regarding irrigation and drainage is also critical. In case of installation at greater heights on the buildings, provisions for accessibility for maintenance should be given. In case of indoor locations, it is important that the plants in green walls have best conditions for growth including sun light and humidity levels. (*see* Fig. 5).

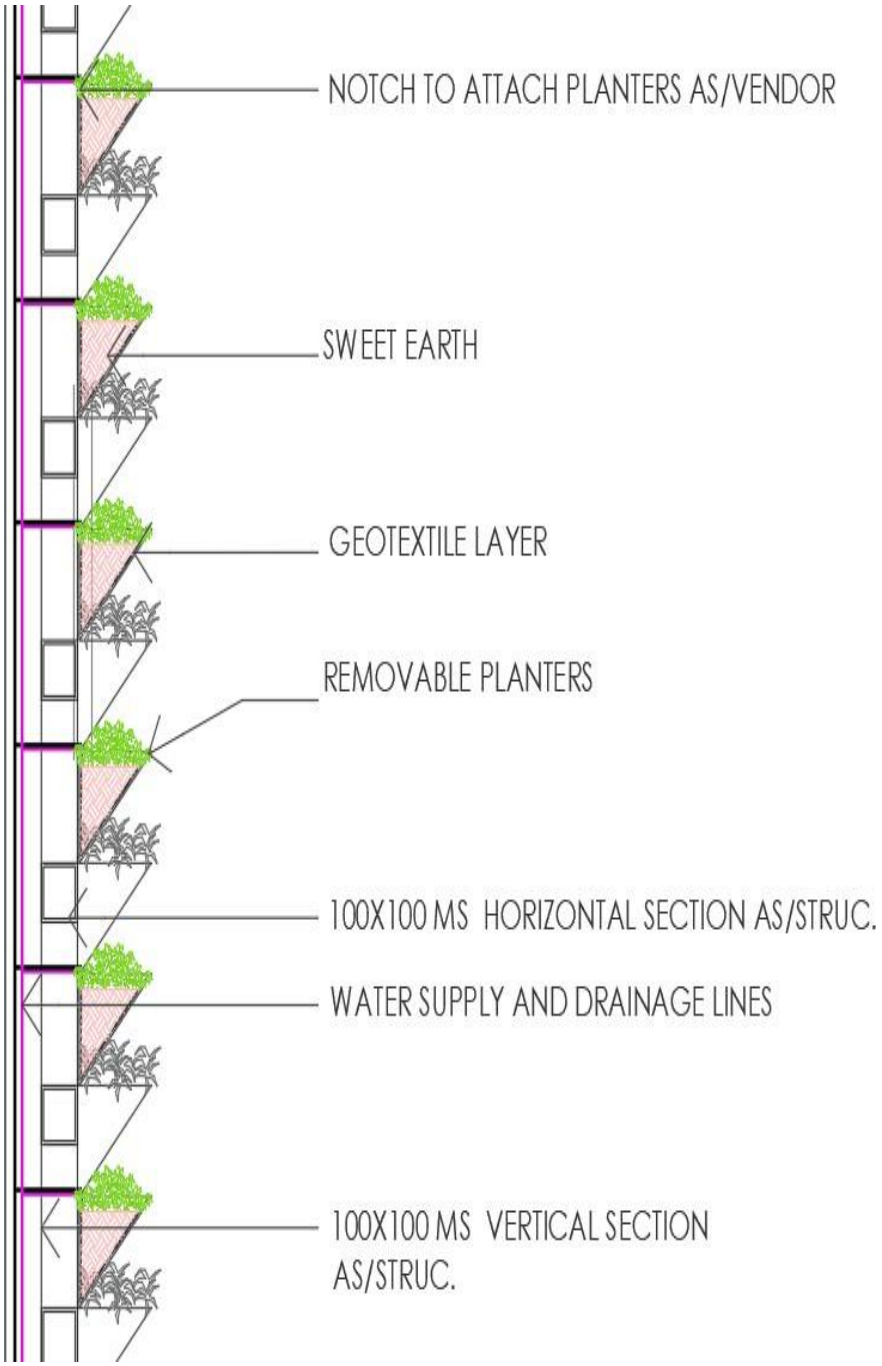

FIG. 5

10.2.1.3 Green walls are completely artificial systems using continuous or modular, planted- in units. Continuous living wall system can be made of felt- layers or be a block of concrete. Modular panels use modules of sphagnum, substrate filled metal cage, gabions, preformed plastic modules or rock wool units. Plants are rooted directly in the structure (in case of felt layers or sphagnum units) or in growth medium before being added to the earlier mentioned modules. The growing media can be organic materials such as coconut coir, peat, tree bark, or inorganic materials such as

expended clay pallets, gravel, perlite, mineral soil, mineral wool, sand, vermiculite ; although different components are often mixed together depending upon various factors, like loading / construction constraints, types of plants used, local availability and climatic conditions. The system is usually Hydroponic (the mineral nutrients are applied to the plants as inorganic ions in water) It is very important to select plants that can thrive in the engineered system of planting.

10.2.1.4 Appropriate waterproofing should be done on the host surface before the start of installation process. Sequence of plantation usually depends on the type of modular system selected and should be carefully factored in during the process of construction.

10.2.1.5 Regular maintenance of the irrigation and drainage system are particularly necessary for the survival of vegetation.

10.2.2 *Greenery Trained On Wires (Screens or Green Façade)*

f) This type of Vertical Greenery utilizes climbing or drooping plants either growing up or falling directly on the walls or on a support system (e.g. trellis or wire cable) typically planted at the ground level. Green facades have growth medium only at the base (either in a container or as a ground level planting bed) Selection of plants should consider the micro-climate around the building such exposure to sunlight and wind tunnel effect etc. In case of specifying plants with sucker roots (like ivy), their impact on the built surface should be understood. Specification of the wires/ support system to train the climbers should be vetted by the structure consultant with regards to the live & dead load of the plant. Since it will be next to impossible to repaint the metal members without damaging the greenery, inert metals should be used for the support system and permanent finish should be considered for the built surface. (*see* Fig. 6).

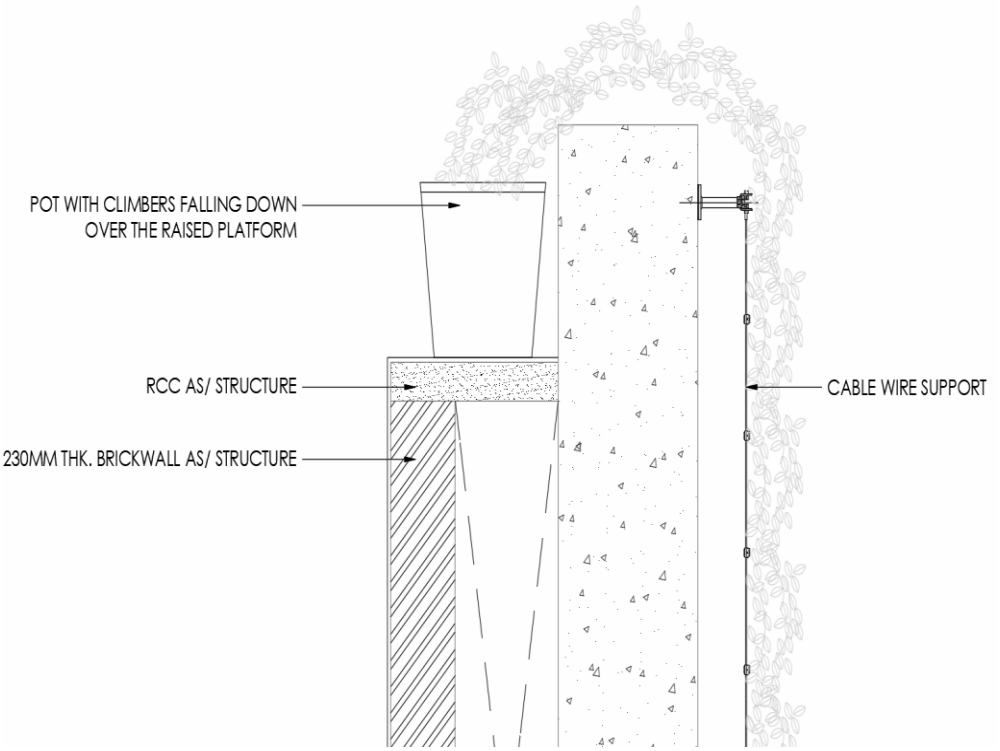

FIG. 6

10.2.3 *In-Built Planters Along The Edge of The Building or Around Internal Courtyards*

These are usually narrow, typically cantilevered, planter boxes designed as a projection to the outer wall / railing. Constructed in concrete, they need to be considered as part of building edge wall detail and be well-integrated with the engineering systems right from the planning stage. Besides factors such as selection of appropriate plants, provision of irrigation and drainage, an important aspect is the accessibility and safety of maintenance team.

10.3 BROWNFIELD LANDSCAPES

All brownfield/ derelict landscape areas should prioritize stabilization, ecological restoration, stormwater management, and public space integration. Once remediated, these areas can support native vegetation, community well-being, and long-term site stability.

Following are the general recommendations and course of action:

a) Site Preparation and Stabilization

1) *Regrading* – Proper grading is essential to ensure drainage and stability. (Civil engineers and landscape architects collaborate on this)
2) *Soil Remediation* – Soil contamination treatment is necessary for ecological restoration and suitability for vegetation.

b) Ecological Restoration and Vegetation

1) *Native Vegetation* – The use of native, drought-tolerant plants to restore biodiversity, stabilize soil, and improve ecological health.
2) *Erosion Control* – Ground covers, mulch, and other methods are to be adopted for the prevention of erosion and enhanced stability.

c) Water and Stormwater Management

1) *Stormwater Management* – Systems such as bioswales, rain gardens, and ponds should be recommended for managing runoff, improving water quality, and reducing flooding.
2) *Water Quality* – The treatment of water runoff, including the use of constructed wetlands or ponds, should be addressed.

d) Post-Reclamation Land Use

1) *Public/Open Spaces* – The potential for reclaiming areas into parks or recreational spaces, with an emphasis on integrating pathways and public access for community use.
2) *Infrastructure Integration* – The design of infrastructure such as pathways, seating, and educational features (for example, signage in the case of mines) should ensure that reclamation is functional and safe.

e) Long-Term Maintenance and Monitoring

1) *Monitoring* – Regular assessments of vegetation, soil health, and water systems to ensure the long-term success of reclamation efforts are mentioned across all sites.
2) *Maintenance Plans* – Continuous upkeep of vegetation, stormwater systems, and infrastructure is necessary to ensure sustainability and prevent deterioration

Given below are the three types of brownfield landscape:

a) Brownfield/Derelict Landscapes - Landfill Areas

1) *Landfill Capping* – Multi-layer caps are used to prevent infiltration, control emissions, and support vegetation. This is specific to landfill sites to contain waste and ensure environmental safety.
2) *Erosion Control* – Groundcovers and mulch specifically prevent erosion on landfill sites and help enhance soil stability.
3) *Infrastructure Integration* – The design of pathways and seating that integrates with stormwater management systems for landfill areas is mentioned, ensuring both functional and aesthetic aspects.
4) *Maintenance Plans* – Specific plans for the upkeep of vegetation and infrastructure to ensure sustainability of the landfill site's ecological restoration.

b) Brownfield/Derelict Landscapes - Abandoned Mines

1) *Regrading and Pit Closure* – Involves filling mine shafts and regrading for safety, specific to mining sites to avoid hazards.
2) *Safety Barriers* – Installing visual barriers to prevent access to hazardous areas is unique to mine reclamation.
3) *Revegetation* – Use of native, drought-tolerant species specifically to restore biodiversity and stabilize soil in abandoned mine sites.
4) *Water Quality* – The use of constructed wetlands or ponds for managing runoff and water quality, which is especially important in the context of mining sites to handle water contamination from mining activities.
5) *Educational Features* – The integration of signage or interpretive trails for ecological or historical education at reclaimed mine sites, providing community awareness of past activities.

c) Derelict Industrial/Infrastructure Sites

1) *Evaluation and Hazard Removal* – Assessment of contamination and removal of hazardous materials, specific to industrial sites that may contain a wide range of pollutants.
2) *Site Clearing* – Demolition of structures to prepare the site for future development, which is unique to industrial sites.
3) *Soil Remediation* – Emphasis on soil treatment to restore fertility and ecological function, tailored to industrial sites that may have had diverse industrial pollutants.
4) *Stormwater Systems* – The installation of stormwater systems like bioswales and ponds to manage water and improve quality is similar to other chapters but applied to infrastructure sites.
5) *Public Access* – The creation of pedestrian paths and integration with community infrastructure, ensuring that reclaimed industrial sites become accessible and connected to local communities.
6) *Recreational Facilities* – The addition of recreational spaces for community use while respecting the ecological restoration goals.

7) *Infrastructure Maintenance* – Special focus on the maintenance of pathways, signage, and recreational areas to ensure long-term success and public accessibility, which is specific to industrial site reclamation.

10.4 INTERIOR LANDSCAPE

Interior landscape could either be a simple exercise of situating plants in movable planters as per the interior layout or a more complex one of creating a distinct landscape area within the building .Key factors of the first typology would be selection of plants suitable to the interior space based on the it's scale and function. Material, size and shape of planter is equally important in ensuring that the overall ambience is maintained as well adequate growing media for the plants is available. Provision of artificial light (that may be required in absence of natural light) and appropriate relative humidity levels (in case of fully air-conditioned spaces) need to be considered for health of plants. Strategy of plant rotation may also be required to maintain the plants. Process of designing and developing a distinct landscape area is much more complex where guidelines of a general landscape are applicable along with following factors:

a) Aspects of spatial experience and functionality need to be well integrated with the interior design intent right at the planning level.

b) Coordination with the building engineering systems is critical to not only the development but also the working and maintenance of the landscape including water feature system, irrigation, drainage, lighting, audio and surveillance network.

c) Sustainable development strategies need to be put in place right at the concept stage, these cannot be an afterthought.

d) Selection of appropriate plants and strategizing the maintenance manual for them taking into account the constraints of site.

10.5 LAND RECLAMATION PROJECTS

Land reclamation projects involve the restoration and improvement of land that has been disturbed or degraded. The general objective is to enhance ecological stability, promote biodiversity, and prepare the site for future use, whether for agricultural, recreational, or urban purposes. The design of the reclamation process emphasizes ecological restoration, soil health, water management, and land stability. Guidelines for the project should include a focus on sustainable methods that support both the environment and future land use. Following aspects to be considered for land reclamation projects:

10.5.1 Process of Coordination with Associated Design Fields/Consultants
Successful land reclamation projects require collaboration among several specialists, including environmental consultants, hydrologists, soil experts, and landscape architects. Coordination efforts should begin with a site assessment, during which consultants evaluate factors such as soil quality, contamination risks, erosion

potential, and local biodiversity. Ongoing collaboration ensures that each aspect of the project, from ecological restoration to water management, is appropriately addressed. This may involve sharing data, aligning timelines, and regularly communicating progress and challenges to integrate expertise from each field.

10.5.2 Construction Details and Specifications

a) Site Assessment and Preparation:

1) *Evaluation* – Conduct thorough site assessments to identify contamination, erosion risks, and ecological challenges.

2) *Land Preparation* – Remove debris and invasive plant species, address contamination, and prepare the soil for planting.

3) *Erosion Control* – Use geotextiles, mulches, and other materials to prevent erosion during and after the reclamation process.

b) Ecological Restoration and Vegetation:

1) *Soil Remediation* – If contamination is present, remediate the soil to restore fertility and safety for plant life.

2) *Native Planting* – Select and plant native species to support local ecosystems and biodiversity.

3) *Habitat Creation* – Establish habitats that support local wildlife, ensuring ecological balance.

c) Hydrological and Water Management:

1) *Stormwater Management* – Develop effective drainage systems (such as swales and rain gardens) to manage runoff and improve water quality.

2) *Water Retention and Irrigation* – Install water-efficient systems like drip irrigation and rainwater harvesting to reduce water consumption and support plant growth.

d) Soil and Land Stability:

1) *Regrading and Soil Compaction* – Regrade the land to enhance drainage and prevent erosion, ensuring proper vegetation growth.

2) *Soil Fertility and Structure* – Amend soil where necessary to improve fertility and structure, supporting sustainable vegetation.

e) Post-Reclamation Land Use and Integration:

1) *Land Use Planning* – Develop plans for future land uses, balancing ecological goals with community needs (e.g., for agriculture, recreation, or urban development).

2) *Recreational Spaces* – Design accessible public spaces, integrating ecological restoration goals with community benefits.

10.5.3 Sequence of Construction

a) Site Assessment: Begin with an evaluation of the site's condition, identifying areas needing remediation and assessing ecological and hydrological factors.

b) Land Preparation: Clear debris, remove invasive species, and prepare the soil for planting.

c) Soil Remediation: Address contamination and improve soil fertility to support plant life.

d) Vegetation Planting: Implement native planting strategies to restore ecological balance and enhance biodiversity.

e) Erosion Control Measures: Install protective measures such as geotextiles and mulches to prevent soil erosion during construction.

f) Water Management Systems: Develop and implement stormwater management and irrigation systems.

g) Soil Stabilization and Regrading: Regrade land and compact soil to ensure stability for vegetation and prevent erosion.

h) Habitat Creation: Construct wildlife habitats to integrate biodiversity into the project site.

i) Final Land Use Planning: After reclamation, finalize plans for agricultural, recreational, or urban purposes, incorporating green spaces.

10.5.4 Maintenance Matrix / Parameters

a) Monitoring: Conduct regular assessments of soil quality, vegetation health, and hydrology to ensure the success of the reclamation efforts. This includes checking for signs of erosion, contamination, or species imbalances.

b) Maintenance Tasks:

1. Vegetation Care: Regularly monitor and maintain plant health, including trimming, reseeding, and controlling invasive species.

2. Soil Management: Schedule periodic soil amendments and fertility tests to maintain soil health and support plant growth.

3. Erosion Control: Reapply mulches, geotextiles, and other erosion- control measures as necessary, especially after heavy rainfall or storm events.

4. Water System Upkeep: Regularly check and maintain irrigation systems, rainwater harvesting setups, and stormwater management infrastructure.

5. Long-Term Evaluation: Establish a long-term plan for continued monitoring and maintenance to ensure the continued ecological health of the site and its

suitability for future land use.

11 PROTECTION OF LANDSCAPE DURING CONSTRUCTION

Development projects involve disturbance to the existing soil conditions, removal of existing trees and overall change in the microclimate and drainage pattern. Measures to minimize hazardous effects should be put into effect as explained below.

11.1 Pre-Construction Measures

Measures for the prevention of soil erosion, sediment control and management of stormwater shall be implemented as given in **11.1.1** to **11.1.5**.

11.1.1 *Timing of Construction*

Construction work and erosion control applications shall be scheduled and sequenced during dry weather periods when the potential for erosion is the lowest. Slope protection techniques to control erosion shall be used when construction during wet season is unavoidable. Sedimentation collection systems, drainage systems, and runoff diversion devices shall be installed before construction activity. The landscape architect/engineer-in-charge shall monitor the site conditions and progress of work and schedule appropriate timing and sequencing of construction.

11.1.2 *Preservation of Existing Vegetation*

11.1.2.1 Protection of existing vegetation (including trees, shrubs, grasses and other plants) where possible, by preventing disturbance or damage to specified areas during construction is recommended. This practice minimizes the amount of bare soil exposed to erosive forces. All existing vegetation shall be marked on a site survey plan. A tree survey in prescribed format shall be carried out as indicated in Table 3.

The landscape plan should indicate trees, which have been preserved, and also those, which had to be transplanted or removed clearly differentiating between these three categories.

Table 3 Plant Material Schedule for Tree Survey
(*Clause* 11.1.2.1)

Sl No.	Tree No.	Botanical Name	Common Name	Girth	Height	Spread	Condition
				mm	mm	mm	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

11.1.2.2 Trees retained on the project site shall be protected during the construction period by following measures:

a) Damage to roots shall be prevented during trenching, placing backfill, driving or parking heavy equipment, dumping of trash, oil, paint, and other materials detrimental to plant health by restricting these activities to outside the area of the canopy of the tree. Following points to be adhered

1) Each tree to be retained shall have a designated Tree Protection Zone identifying the area sufficiently large enough to protect it and its roots from disturbance.

2) Improvements or activities such as paving, utility and irrigation trenching including other ancillary activities shall occur outside the Tree Protection Zone, unless otherwise specified. The protection fence shall serve as the Tree Protection Zone. (*see* Fig. 7 & 8).

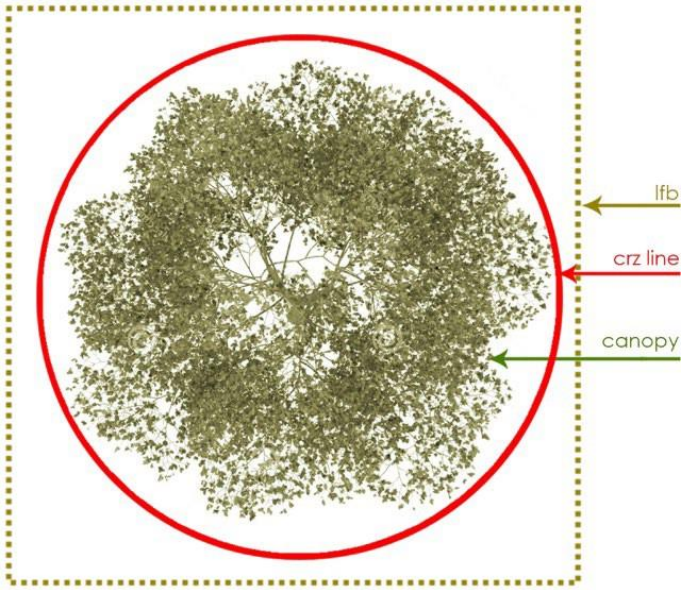

FIG. 7

lfb = line for barricading

crz = critical root zone

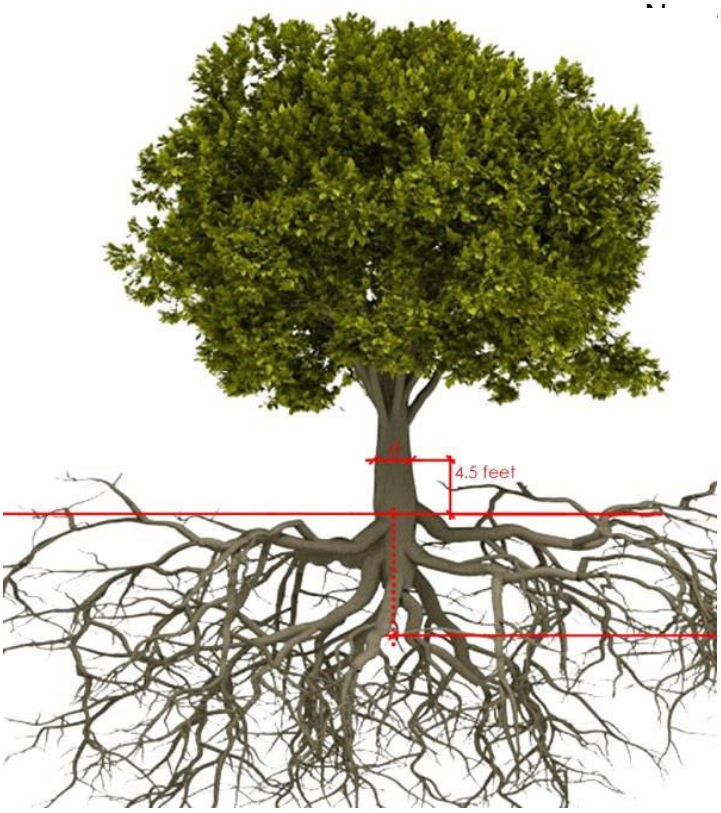

FIG. 8

Calculate dia @ breast height (bh)= d (in inches)
bh = 4.5 feet from the ground. Calculate Critical Root Zone (CRZ) R = d * 1.25
Consider numeral 'R' in the answer as R feet which is radius of CRZ.

b) Trees shall not be used for support; their trunks shall not be damaged by cutting and carving or by nailing posters, advertisements or other material.
c) Lighting of fires or carrying out heat or gas emitting construction activity within the ground, covered by canopy of the tree shall not be permitted.
d) Young trees or saplings identified for preservation (height less than 2.00 m, 0.10 m trunk girth at 1.00 m height from finish ground, 2.00 m crown diameter) within the construction site have to be protected using tree guards of approved specification.
e) Existing drainage patterns through or into any preservation area shall not be modified unless specifically directed by the landscape architect/engineer-in-charge.
f) Existing grades shall be maintained around existing vegetation and lowering or raising the levels around the vegetation is not allowed unless specifically directed by the landscape architect/engineer-in-charge.
g) Maintenance activities shall be performed as needed to ensure that the

vegetation remains healthy.

h) The preserved vegetated area shall be inspected by the landscape architect/engineer-in-charge at regular intervals so that they remain undisturbed. The date of inspection, type of maintenance or restorative action followed shall be recorded in the logbook.

j) Following guidelines need to be adopted for the transplantation of trees that need to be preserved at site under the supervision of landscape architect/ engineer-in-charge:

1) Identification of trees that can be transplanted should be done in the planning and feasibility stage and criteria for such identification should be mentioned . The criteria can be established as per the significance of trees as mentioned in the planting section 7.3.1.
2) Exclusions of certain tree species from transplantation: List of negative trees not only to be based upon the species but also other criteria to check the appropriateness of that individual tree.The number of trees allowed to be cut should be associated with the area of site. Also,the number of trees that are allowed to be cut should be backed up with some logic that has to be verified by the forest officials.
3) Procedure to be followed for tree transplantation at any project site:

i) A Site tree report should be made containing the catalogue of trees to be transplanted with their name, size, age, ecological significance recorded. Photograph of trees before and after transplantation should be recorded for monitoring the health of trees.
ii) The receptor site for transplantation should be assessed for feasibility based on the proximity to the project site, similar soil condition, water table, its availability and quality, surrounding context, microclimate. The center to center distance of the transplanted trees to be monitored and supervised.

11.1.3 *Staging Areas*

Measures shall be followed for collecting runoff from construction areas and material storage sites; diverting water flow away from such polluted areas, so that pollutants do not mix with stormwater runoff from undisturbed areas.

Temporary drainage channels, perimeter dike/swale, etc, shall be constructed to carry the pollutant-laden water directly to treatment device or facility. The plan shall indicate how the above is accomplished on site, well in advance of the commencing of the construction activity.

11.1.4 *Preservation of Topsoil*

Topsoil removal and preservation shall be mandatory for development projects larger than 1.00 hectare. Topsoil shall be stripped to a depth of 200 mm from areas proposed to be occupied by buildings, roads, paved areas and external services. Topsoil is rich in organic content and is essential to establish new vegetation. It shall be stockpiled to a height of 400 mm in designated areas and shall be reapplied to site during

plantation of the proposed vegetation. Topsoil shall be separated from subsoil debris and stones larger than 50 mm diameter. The stored topsoil may be used as finished grade for planting areas.

11.1.5 *Spill Prevention and Control*

Spill prevention and control plans shall be made, clearly stating measures to stop the source of the spill, to contain the spill, to dispose the contaminated material and hazardous wastes, and stating designation of personnel trained to prevent and control spills. Hazardous wastes include pesticides, paints, cleaners, petroleum products, fertilizers and solvents.

11.2 Measures During Construction

During construction soil becomes unconsolidated due to removal of stabilizing material such as vegetation and disturbance of stabilized existing grade resulting in loss of topsoil and also deposition in undesirable places. A soil erosion and sedimentation control plan to be prepared prior to construction. The soil erosion, sediment control and stormwater practices should be considered whilst construction is proceeding, in accordance with **11.2.1** to **11.2.4**.

11.2.1 *Sedimentation Basin*

A temporary dam or basin at the lowest point of the site has to be constructed for collecting, trapping and storing sediment produced by the construction activities, together with a flow detention facility for reducing peak runoff rates. This would allow most of the sediments to settle before the runoff is directed towards the outfall.

11.2.2 *Contour Trenching*

Contour trenching is an earth embankment or ridge-and-channel arrangement constructed parallel to the contours along the face of the slope at regular intervals on long and steep slopes (in sloping areas with slopes greater than 10 percent) (*see* Fig. 9). They are used for reducing runoff velocity, increasing the distance of overland runoff flow, and to hold moisture and minimize sediment loading of surface runoff. Vegetative cover of tree and native grasses in the channels may be planted to stabilize the slopes and reduce erosion.

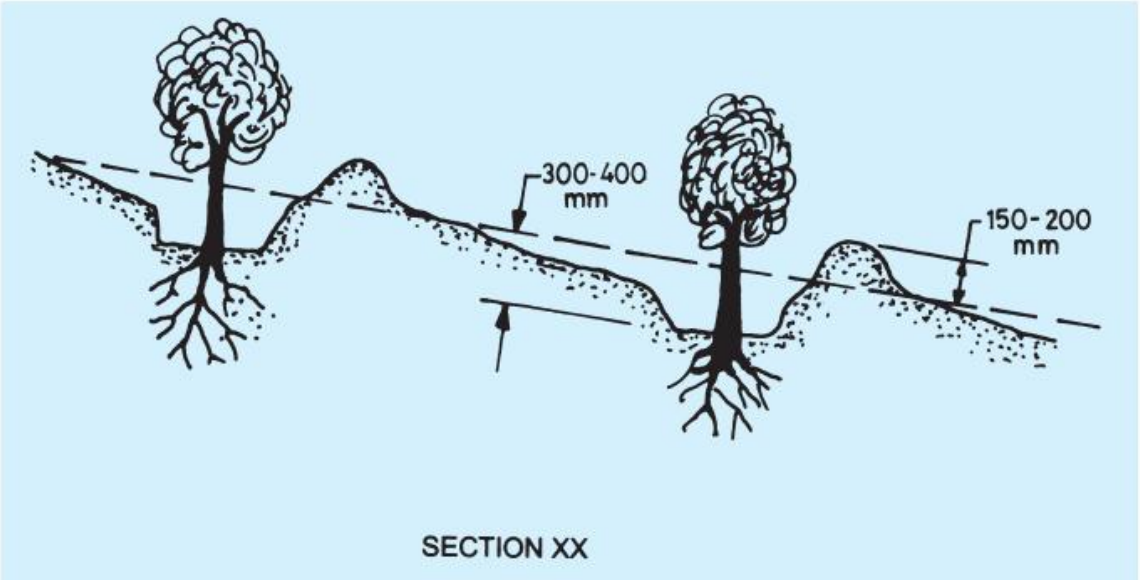

FIG. 9 TYPICAL CONTOUR TRENCHES

11.2.3 *Mulching*

Mulching shall be used with seeding and planting in steep slope areas (slopes greater than 33 percent) that are prone to heavy erosion. Netting or anchoring shall be used to hold it in place. Other surface runoff control measures like contour terracing to break up concentrated flows shall be installed prior to seeding and mulching. Materials such as straw, grass, grass hay and compost shall be placed on or incorporated into the soil surface. In addition to stabilizing soils, mulching will reduce the stormwater runoff over an area. Together with seeding or planting, mulching aids plant growth by holding the seed, fertilizers and topsoil in place. It retains moisture and insulates the soil against extreme temperatures.

11.2.4 *Geo-Grids*

A deformed or non-deformed netlike polymeric material used with foundation, soil, rock, earth or any other geo-technical engineering-related material as an integral part of the human-made project structure or system, called geo-grids may be used as control measure. On filling with lightly compacted soil or fine aggregate, a monolithic structure is created providing an effective means of confinement for unconsolidated materials within the cells and preventing their movement even on steep slopes. If required the area can then be seeded to maintain 'green' environment. The junctions have a central opening through which water can permeate ensuring that organic material receives moisture for rapid growth.

11.2.5 *Construction and demolition waste management planning*

The guidelines of any water management needed for demolition work for landscape development to be referred from the Part 11 Section 10 of NBC to protect the existing vegetation and soil in the development area.

11.3 Post Construction Measures

Post construction aspects for protection of landscapes should include the aspects of management of vegetation. The codes pertaining to the maintenance of vegetation should be referred from the guidelines as mentioned in **8** .

12 SOIL WATER CONSERVATION AND REDUCTION

The soil conservation, sediment control and stormwater management practices as given under **12.1** to **12.3** shall be followed after construction is completed.

12.1 Vegetative Measures

The vegetative measures shall include the following.

12.1.1 *Topsoil Laying*

This includes the placement of topsoil or other suitable plant material over disturbed lands to provide suitable soil medium for vegetative growth. Topsoil laying shall involve replacing fertile topsoil that were stripped and stockpiled during earlier site development activities; the laid soil shall be stabilized before the next monsoon by planting grass, shrubs and trees.

The following guidelines shall apply to the placement of topsoil:

a) The existing or established grade of subsoil should be maintained.
b) A *p*H of 6.0 to 7.5 and organic content of not less than 1.5 percent by mass is recommended for topsoil. Where *p*H is less than 6.0, lime shall be applied to adjust *p*H to 6.5 or higher up to 7.5. Any soils having soluble salt content greater than 500 parts per million shall not be used.
g) Prior to spreading the topsoil, the sub-grade shall be loosened to a depth of 50 mm to permit bonding. Topsoil shall be spread uniformly at a minimum compacted depth of on grade of 1:3 or steeper slopes; a minimum depth of 100 mm on shallower slopes is essential. A depth of 300 mm is preferred on relatively flatter land. (*see* Fig. 10).

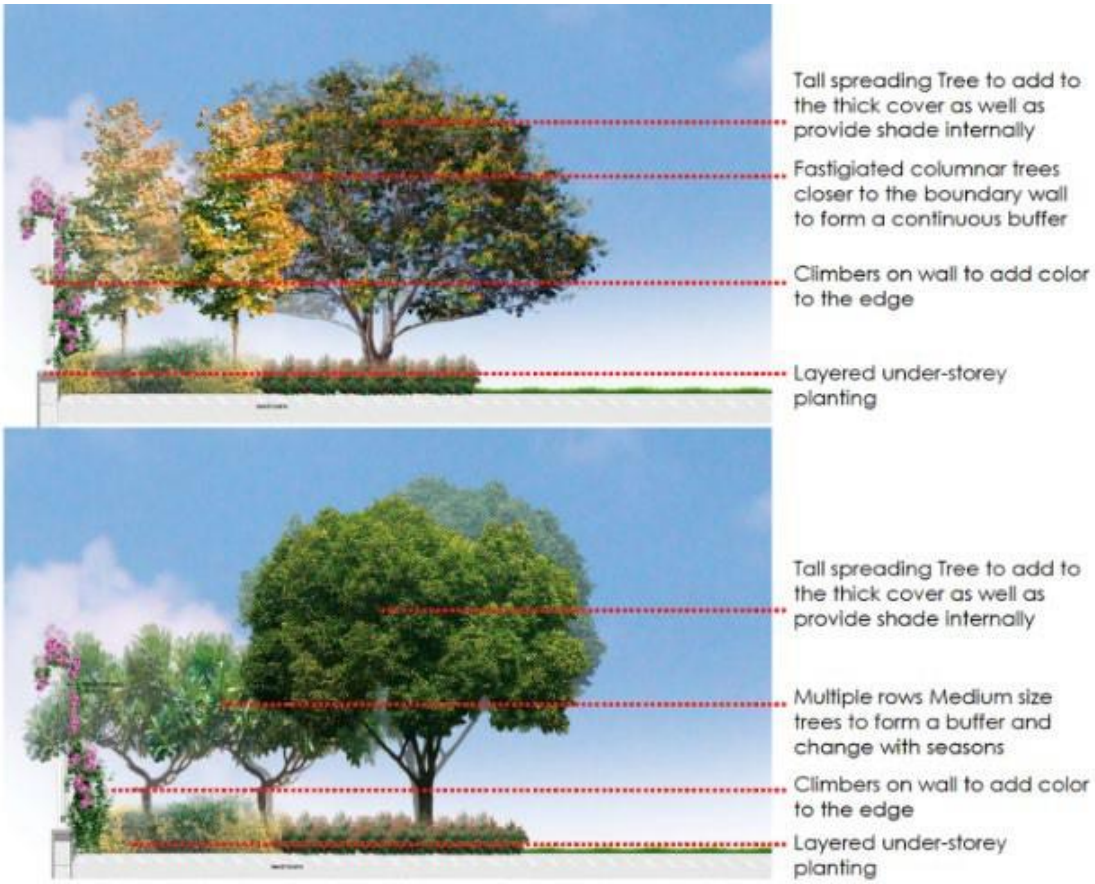

FIG. 10

The sites should be planted with buffer trees in a tiered manner along the movement corridors for pollution reduction. Trees can act as efficient biological filters, removing significant amount of particulate pollution from the atmosphere up to some extend, the given list of the trees can control particulate pollution there is potential for improved air quality and substantial cost saving.

12.1.2 *Planting/Vegetation Cover*

The most effective way to prevent soil erosion, sedimentation and to stabilize disturbed and undisturbed land is through the provision of vegetative cover by effective planting practices. The foliage and roots of plants provide dust control and a reduction in erosion potential by increasing the infiltration, trapping sediment, stabilizing soil, and dissipating the energy of hard rain. Temporary seeding shall be used in areas disturbed after rough grading to provide soil protection until final cover is established. Permanent seeding/planting is used in buffer areas, vegetated swales and steep slopes. The vegetative cover also increases the percolation of rainwater thereby increasing the ground water recharge.

12.2 Stormwater Management and Filtration Techniques

The surface water flow is increased in urban areas due to predominance of hard

surfaces. Stormwater management techniques assure conservation of water thereby increasing the ground water recharge. Filters facilitate draining pollutants out from surface water runoff through straining before discharge into the drainage way. Rainwater harvesting and sullage recycle systems need to be implemented on all new constructions over 1 000 m^2 in urban areas. *See also* Part 9 'Plumbing Services, Section 2 Drainage and Sanitation' and **7.2** of Part 11 'Approach to Sustainability' of the Code.

12.2.1 *Rainwater Harvesting Structures in Urban Environment*

12.2.1.1 Water harvesting refers to the collection and storage of rainwater and also harvesting surface and ground water, prevention of loss through evaporation and seepage, and other hydrological and engineering interventions aimed at conserving water.

12.2.1.2 The advantages of using rainwater harvesting structures in urban areas are as follows:

a) Water harvesting recharges ground water and is an ideal solution to water problems in areas with inadequate water resources.
b) Increase in ground water aquifer level due to methods enhancing infiltration.
c) Mitigation of the effect of drought.
d) Reduction of stormwater runoff into the public drainage system.
e) Reduction of flooding of the roads during monsoons.
f) Removal of pollutants and soil from the stormwater runoff.
g) Reduction of soil erosion.

12.2.1.3 Methods of ground water recharge may be as follows:

a) Recharge pits
b) Recharge trenches
c) Reuse of abandoned dug wells
d) Reuse of abandoned hand pumps.
e) Recharge shafts
f) Lateral shafts with bore wells
g) Spreading techniques like percolation ponds, check dams or gabion structures.

12.2.2 *Structures for Rainwater Harvesting and Soil and Water Conservation*

These may be as given in **12.2.2.1** and **12.2.2.2**.

12.2.2.1 *Infiltration techniques*

h) *Infiltration trenches* – An infiltration trench is a rock filled trench that receives stormwater runoff. Stormwater passes through a combination of pre-treatment measures, a grass swale and into the trench to be stored in void spaces and then infiltrates into the soil matrix.

i) *Bio-filtration swale/grass swale* – Bio-filtration swales are vegetated channels with a slope similar to that of standard storm drain channels (less than 0.6 percent), but wider and shallower to maximize flow residence time and promote pollutant removal by filtration through the use of properly selected vegetation. It has to be designed to trap particulate pollutants (suspended solids and trace metals), promote infiltration and reduce the flow velocity of the stormwater runoff. It shall be integrated with stormwater system (*see* Fig. 11).

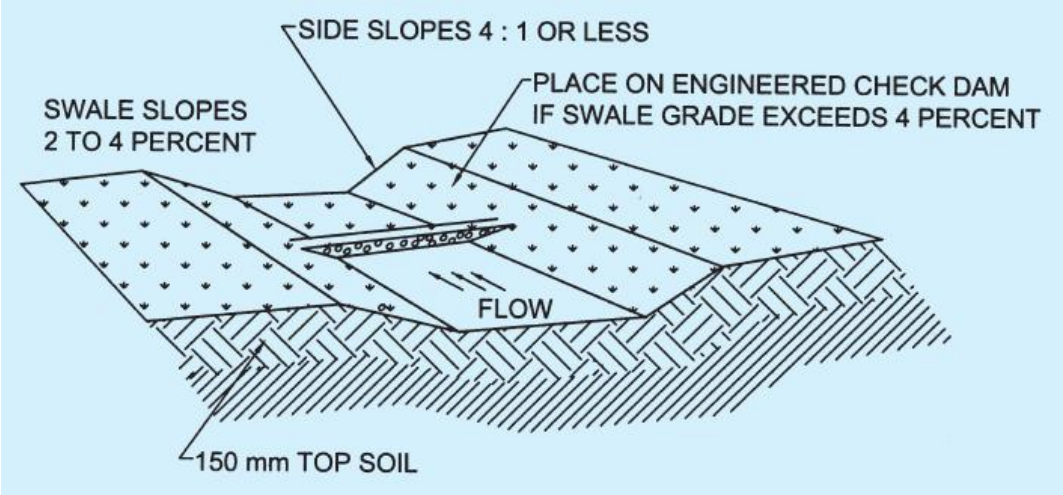

FIG. 11 GRASS SWALE

j) *Sand filter* – Sand filters are devices that filter stormwater runoff through a sand layer into an underground drain system which conveys the water to a detention facility. They are effective in removing total suspended solids. The effectiveness of sand filtration is improved if it is preceded by a grass swale with infiltration trench.

12.2.2.2 *Detention facilities*

a) *Wet ponds* – Wet ponds are constructed basins that have a permanent pool of water throughout the year (or at least throughout the wet season). Wet ponds retain the stormwater runoff in a permanent pool and facilitate pollution removal through settling and biological update.

b) *Stormwater wet lands* – Stormwater wet lands are structures similar to wet ponds that incorporate wetland plants into the design. They have to be designed for treating stormwater runoff, and typically have less biodiversity than natural wetland systems. A distinction should be made between using a constructed wet land for stormwater management and diverting stormwater into natural wetland. The latter is not recommended because it would degrade the resource.

c) *Wet vaults and storage tanks* – Wet vaults and tanks are underground facilities used for the storage of surface water, and typically constructed from reinforced cement concrete (vaults) or corrugated pipes (tanks). The water that is captured in these vaults and tanks may be used later for irrigation.

12.3 Conservation and Reuse of Water for Irrigation

The following measures shall be followed for design of irrigation systems for landscape works:

a) Water conserving irrigation systems should differentiate between systems for different water use zones on the site. Supplementary irrigation sources should be used by means of appropriate water harvesting measures.
b) The irrigation system should be designed considering the prevailing wind direction, slope and proposed grade, type of soil, soil percolation, and the type of vegetation to be watered.
c) Spray irrigation to be designed to provide total head to head cover to avoid dry spots and spray on to paved areas and unplanted surfaces.
d) Spray irrigation is to be avoided in areas of width less than 3.00 m.
e) Sullage recycle systems are ideal for large housing complexes and residential colonies. Sullage (or water from kitchens and bathrooms) is treated and recycled for gardening and toilet flushing reducing fresh water requirement by 60 percent. Irrigation system should be designed keeping sullage recycle in view.
f) For requirements regarding, the volume of water for different kinds of landscapes, Part 9 ‘Plumbing Services, Section 1 Water Supply’ of the Code may be referred.

12.4 Noise reduction measures

The landscape design and development should ensure adoption of elements that reduce noise and mitigate negative distractions.

These are the recommended measures:

a) During site planning and design, meet with stakeholders and potential site users to identify needs and techniques appropriate to the site type and user groups. Work with designers to design the project so that buildings can optimize views and deflect surrounding noise.

b) Design the outdoor mental restoration spaces away from distractions, such as noise from mechanical systems, building and facility operations, and traffic. To minimize noise, incorporate multiple solutions such as quieter pavement or road surfacing, dense foliage, earth berms, and barriers or screens. Schedule maintenance activities when site users are not present.

c) Design a variety of smaller, mentally restorative spaces conveniently located throughout a site rather than one large space. If possible, consider integrating these outdoor spaces with interior public spaces to enhance the connection to nature throughout a site.

13 STREET FURNITURE

The design elements for outdoor spaces may be classified under the following categories:

a) *Pavement and other pedestrian movement spaces, covering*

1) footpath with heavy pedestrian traffic,
2) footpath with light pedestrian traffic,
3) plaza and public assembly spaces,
4) kerb to footpath, and
5) steps and ramps.

b) *Parking and vehicular movement corridor, covering*

1) parking unit,
2) median and road divider,
3) road marking, and
4) speed breaker.

c) *Traffic management units, covering*

1) Bollards,
2) Barriers,
3) Crash guard,
4) Gate/Access control,
5) Vehicular height restrictors, and
6) Traffic separators.

d) *Outdoor public conveniences, covering*

1) Seating,
2) Drinking fountains, and
3) Toilet/Wash rooms.

e) *Shelter and kiosks, covering*

1) Bus shelters,
2) Police booth,
3) Telephone booth,
4) Milk booth/Food stall,
5) Florist,
6) Information desk, and
7) Snack and coffee stall.

f) *Outdoor illumination, covering*

1) Street light,
2) Façade light, and
3) Ambient light.

g) *Tree protection units, covering*

1) Tree guard,

2) Tree grate, and
3) Planter.

h) *Garbage collection units, covering*

1) Litter bin, and
2) Spittoons.

j) *Service utilities, relating to*

1) Water supply network,
2) Stormwater network,
3) Sewerage network,
4) Electrical network,
5) Telephone lines,
6) Cable e-net,
7) Gas, and
8) Irrigation network.

k) *Display and signage* – Location of the street furniture shall be coordinated with the traffic flow pattern of vehicles and pedestrians and external services.

14 Cultural Heritage landscapes and Natural feature areas (To be detailed)

14.1 Natural Landscapes

This chapter covers the special considerations required for developmental works in 'natural landscapes'.A landscape ecology approach needs to be adopted to guide the implementation of intervention processes, focusing on the functions and structures of the natural landscape systems.

Objective of regulation guidelines is:

a) To conserve and protect the natural landscape;
b) To ensure livelihood security to the local community;
c) To promote development in a sustainable manner based on scientific principles, taking into account natural hazards and climate change.

It may involve the contribution of experts such as ecologists, landscape designer, environmental designer, geographer and planner to relate the manmade systems such as urban, tourism development with natural systems such as ecosystems and habitats.

The guidelines that provide specific recommendations for managing different types of natural landscapes, categorized by landform, vegetation, and water bodies.

a) Land: Different terrain types, such as mountains, plateaus, and deserts, require tailored strategies. For deserts, specific measures include afforestation, eco- restoration, and the use of appropriate technologies to combat desertification.These efforts should be integrated with community development and governmental initiatives to ensure their success.
b) Vegetation: Forest management, including the protection of natural, reserved, and protected forests, is essential for preserving biodiversity. Grasslands, which play a crucial role in carbon sequestration and ecosystem health, also require specific conservation efforts.
c) Water Bodies: Wetlands, lakes, rivers, and coastal water bodies are vital to maintaining biodiversity and water quality. The guidelines provide detailed strategies for the protection of both inland and coastal water systems, from freshwater marshes to coral reefs. Managing these areas requires careful attention to their hydrological regimes and the protection of sensitive ecosystems.

14.1.2 *Principles Guiding development in Natural Environments*

14.1.2.1 *Sustainability*

The focus here is on creating landscapes that are viable in the long term, considering both ecological health and human needs. Sustainable landscapes balance natural systems with human activities.

14.1.2.2 *Resilience*

Resilience is crucial for landscapes to recover from disturbances such as climate change, natural disasters, or human intervention. Resilient landscapes can withstand and adapt to these changes without significant degradation.

14.1.2.3 *Regeneration*

These landscapes go beyond sustainability and resilience. Regenerative practices aim to restore and improve ecological health, enhancing biodiversity, soil fertility, and water retention, among other factors.

14.1.2.4 *Water-Sensitivity*

Water plays a critical role in the health of natural landscapes. Water-sensitive landscapes prioritize water management that conserves, protects, and utilizes water in a sustainable way, addressing both quality and quantity.

14.1.2.5 *Climate Change Adaptation*

This principle involves preparing natural landscapes to adapt to the impacts of climate change. Measures focus on increasing the landscape's capacity to deal with shifting weather patterns, sea-level rise, and other climate-related challenges.

14.1.3 *Checklist of Components of Natural Landscapes*

14.1.3.1 *Topography and slope*

Study of terrain and slope characteristics, which influence water drainage, soil stability, and vegetation types.

14.1.3.2 *Hydrological regime*

Analysis of water flow patterns and water availability, key to understanding ecosystem function.

14.1.3.3 *Ecology and biodiversity*

The diversity of plant and animal species within a landscape, essential for maintaining ecosystem services and resilience.

14.1.3.4 *Climate and microclimate*

Consideration of local weather patterns and microclimates, which impact vegetation growth and water availability.

14.1.3.5 *Study of the Region by Scale*

Guidelines for evaluating landscapes at various scales, from regional to site level:

a) Regional Level
b) Urban Level
c) Inland parcels within urban limits
d) Inland parcels beyond urban limits
e) Site Level

14.1.4 *Threats to Natural Landscapes*

Identification of potential threats, including climate change, deforestation, pollution, and urbanization.

14.1.5 *List of Permissible Activities*

Establishment of activities that are allowed within natural landscapes, ensuring they align with conservation goals.

14.1.6 *Monitoring and Evaluation*

Key performance indicators and bio-indicators for assessing the health of natural landscapes. Regular assessments ensure ongoing protection and improvement.

14.1.7 Conservation and Protection of Natural and Ecological Landscapes Strategies for identifying sensitive areas and protecting them from development, encroachment, and degradation.

14.1.8 *Special Provisions for Eco-Sensitive Zones*

Designating areas that require special attention due to their high ecological or cultural value, and implementing additional protection measures.

14.1.9 *Impact of Cultural Activities on Natural Landscapes*

Analysis of how cultural activities, such as agriculture and tourism, affect natural landscapes and strategies for minimizing negative impacts.

14.1.10 *Mitigation Strategies*

Recommendations for mitigating the impacts of human activities on natural landscapes, including sustainable land use, restoration efforts, and community engagement.

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