



Guidelines for Greening of Industrial Areas in Uttarakhand

Sustainable and Environment-friendly Industrial Production Project, Phase II



Development of Guidelines for Greening of Industrial Areas in Uttarakhand under SEIP Project

Guidelines for Plantation in the Industrial Parks of Uttarakhand

Submitted By

*Engineering Services
&
RBased Services Pvt. Ltd.*

August, 2020

ABOUT

*The present report is based on the project “**Development of Guidelines for Greening of Industrial Areas in Uttarakhand under SEIP Project**”. Allotted to **Engineering Services by German Development Cooperation (GIZ)**.*

***RBased Sevices Pvt. Ltd.** is the partner agency of Engineering Services which provides the Geospatial Consultancy in the present collaboration for the above mentioned project.*

The project have the objective to develop guidelines for developing green belt in the selected five industrial parks of Uttrakhand, namely IIR Pantnagar, IIE Sitarganj, IIE Haridwar, IIE Kotdwar and IT Park Dehradun. The complete study is divided into three sections first benign the report on the existing green area in the industrial park, secondly the report on the potential green space were plantation can be done in order to satisfy the greenery norms or increase the green cover in the industrial parks, thirdly the report on the guidelines to be followed in the green areas of the industrial parks.

The present report is on the guidelines for developing green space in the industrial parks. The guidelines are provided for section of trees, selection of location and amount of trees that may be procured by the individual industrial parks in order to fulfil the greenery norms.

ACKNOWLEDGEMENT

We hereby thank German Development Cooperation (GIZ) for contributing in India's development by working jointly with partners in India for sustainable economic, ecological, and social development from last sixty years. GIZ have help improve the overall scenario of the way in which these development activities have been carried out in India. A major part of which is improving the technological contribution in such studies. One of the major development in the technology has been inclusion and proper use of Geospatial technology such as remote sensing and GIS in these fields.

We are deeply grateful to Mr. Nitesh Patel for managing this project. We thank SIIDCUL and UEPPCB for advising various aspects of the project, and also for providing industrial datasets for data analysis, interpretation and presentation. We thank Mrs. Yashoda Rawat for handling the financial procedure and documentation while the project.

Finally, we thank all of the team members of Engineering Services and Rbased Services Pvt. Ltd. who contributed in the completion of this project.

Table of Contents

1. Introduction.....	1
2. Uttarakhand: A Brief Profile.....	2
3. Checklist for pre- planting, during planting and post planting phases	2
3.1 Pre-planting:.....	2
3.2 During planting:	3
3.3 Post Planting:	4
4. Identification of areas for plantation.....	5
4.1 Street plantation	5
4.2 Common open spaces and amenity areas.....	5
4.3 Unit (individual industry) level plantation.....	5
4.4 Plantation in and around water bodies	5
5. Guidelines for plantation in the identified areas.	6
5.1 Street plantation	6
5.1.1 Guidelines: Avenue plantation-general concerns	6
5.1.2 Criteria for selection of plant material for roads/avenue planting	6
5.1.3 Note on clearance for planting trees	7
5.2 Open spaces plantation	7
5.2.1 Guidelines: Open spaces plantation -general concerns.....	7
5.2.2 Criteria for selection of plant material for open space planting.....	8
5.3 Unit (individual industry) level plantation.....	10
5.3.1 Guidelines: Unit plantation -general concerns.....	10
5.3.2 Selection criteria unit/industry boundary	10
5.3.3 At entry and exits-guidelines	10
5.4 Water body plantation.....	11
5.4.1 Guidelines: Water body -general concerns	11
5.4.2 Criteria for selection of plant material for water body planting	11
6. List of trees for the different identified areas.....	12
7. Selection of suitable tree species based on criteria as soil, water requirement, aesthetics, etc	15

8.	Selection of tree species for environmental (pollution resistance) aspects.....	19
9.	Planting and climate change adaptation: Reducing urban heat island effects	20
10.	Integration of storm water management with plantation	21
11.	Indoor Plantation.....	22
11.1	What are indoor plants?	22
11.2	What makes a good office plant?.....	22
11.3	Benefits of office plants:.....	24
11.3.1	Improve office air quality	24
11.3.2	Plants improve office productivity and creativity	24
11.3.3	Plants improve office spaces?.....	25
11.3.4	Do plants reduce absenteeism?	25
11.3.5	Which plants offer the best health benefits?.....	25
12.	Tree Procurement.....	26
12.1	Overview.....	26
12.1.1	Road Side and Road-Divide/Road-Median	26
12.1.2	Industrial premises between 1 to 6 Ha.....	26
12.1.3	Open Spaces.....	27
12.1.4	Industrial premises greater than 6 Ha	27
12.2	Industries wise tree procurement recommendation:	28
12.2.1	IIE Pantnagar:	28
12.2.2	IIE Sitarganj:.....	29
12.2.3	IIE Kotdwar:	30
12.2.4	IIE Haridwar:	30
12.2.5	IT Park Dehradun:.....	31
	Appendix A: Plantation Guide.....	32

List of Figures

Figure 1: Circular weeding	3
H k i w t g " 4.≤...!..õ...ö...!..m.p.q.v.....	3
Figure 3: Cutting coppice growth	4
Figure 4: Weeding around stem.....	4
Figure 5: Pruning	5
Figure 6: Physical form of the tree	7
Figure 7: Planting near boundary walls	7
Figure 8:Planting near electrical poles (Source: SaskPower).....	7
Figure 9: Example of block and boundary planting in open space.....	9
Figure 10 Formation of heat island.....	20
Figure 11 Heat island mitigation.....	20
Figure 12 Urban heat island.....	21
Figure 13 Trees plantation for mitigation of heat island.....	21
Figure 14 Importance of green cover in storm water management	21
Figure 15 Design of storm water channels below plantation.....	22
Figure 16 Road side plantation	26
Figure 17 Road divide plantation.....	26
Figure 18 Proposed tree plantation in industrial premises between 1 to 6 Ha.....	27
Figure 19 Proposed tree plantation in open space	27
Figure 20 Proposed tree plantation in industrial premises greater than 6 Ha	28

List of Tables

Table 1: List of trees for different identified areas.	12
Table 2: Matrix for selection of trees.....	15
Table 3: Pollution resisting trees.....	19
Table 4 Procurement statistics of IIE Pantnagar.....	29
Table 5 Procurement statistics of IIE Sitarganj	29
Table 6 Procurement statistics of IIE Kotdwar.....	30
Table 7 Procurement statistics of IIE Haridwar.....	31
Table 8 Procurement statistics of IT Park Dehradun.....	31

1. Introduction

Trees are one of the most prominent constituents of our ecosystem because of their conspicuous size and shape. Trees are important to the humanity not only economically, environmentally, industrially but also spiritually, historically and aesthetically as they sustain human life by providing a large number of goods such as food, fodder, fuel and services like soil and water conservation, pollution control, climate regulation, recreation aesthetic functions etc. Trees improve the quality of the air we breathe and play a vital role in maintaining the oxygen cycle, which is essential for the survival of all living being. When properly grown, they act as barriers against sun, wind, dust, noise and other pollutants. Even individual tree, if strategically planted adjacent to a house, can provide relief from dust, noise and annoying lights at night. Trees thus reduce stress on human beings. They also help to reduce the temperature by providing shade and by intercepting, absorbing and reflecting solar radiation, especially in warmer places, where there are year-round warmth and sunshine. Trees also function as natural air conditioners by evaporating water from their leaves through the process of evapotranspiration.

Large scale urbanization and industrialization in the Himalayan region have led to the development of severely eroded, barren and denuded areas in many parts of the state. That have many severe impacts on our environment and ecosystem. Large urban areas with low green cover such as dense cities and industrial areas act as heat islands. According to the United States Environmental Protection Agency (EPA, 2020) such areas e c p " c h h g e v " c " e q o environment and quality of life in multiple ways such as:

- < Increased Energy Consumption
- < Elevated Emissions of Air Pollutants and Greenhouse Gases
- < Compromised Human Health and Comfort
- < Impaired Water Quality

It becomes a responsibility of industrial areas to take remedial action to reduce and recover from the impact as mentioned above. One such action can be afforestation. There is an immense scope of undertaking plantation works on community and panchayat lands, van panchayat areas, civil and industrial areas, a roadside plantation along national and state highways and other village roads. Afforestation has immense potential to maintain greenery to the industrial area and thereby reducing there environmental ill-effects. Afforestation also helps to restore the ecological balance.

In history, there are very few records of green belts. One of the important examples is of Queen Elizabeth I of England. She had banned new buildings in a three-mile wide belt around the City of London in 1580 [Reference: Halliday, Stephen (2004). Underground to Everywhere. Sutton Publishing Limited. p. 118]. In very recent time, the green belt policy was pioneered in the

United Kingdom in the 1930s. Campaign to Protect Rural England (CPRE) and various other organizations have helped to spread awareness about Green belts in the United Kingdom.

The objective of Green belt varies from country to country and region to region. The common objectives are to protect natural environments such as biodiversity, etc, to improve air quality of the region, pollution control, to maintain micro climate of the region, etc. Green Belt Development is an important tool that aims at overall improvement in the environmental conditions of the region.

2. Uttarakhand: A Brief Profile

The Uttarakhand is comparatively a new state, which came into existence on 9th Nov, 2000 as the 27th state of the Republic of India. It was carved out from the larger state Uttar Pradesh by taking hill districts of Almora, Bageshwar, Chamoli, Champawat, Dehradun, Nainital, Pauri Garhwal, Pithoragarh, Rudrapur, Tehri Garhwal, and Uttarkashi with the districts of Udham Singh Nagar in the Terai and Hardwar in the foothills. It lies between 28°53'24" and 31°27'50"N latitudes and between 77°03'27" and 81°02'22" longitudes. The state is strategically located and forms part of the northern boundary of the country sharing its border with China and Nepal. Himachal Pradesh and Haryana lie to its West and Uttar Pradesh to its South. Blessed with the enchanting beauty of nature and for historical and mythological regions, the state has its own uniqueness. About 64.7 % of the area is covered by forests and is rich with numerous species of plants, animals and birds. About 93 % area is hilly and the remaining 7 % is covered by plains. The elevation extends approximately from 300 m to over 7,000 m amsl.

3. Checklist for pre- planting, during planting and post planting phases

3.1 Pre-planting:

- < Survey of site and Identification of locations for planting.
- < Location- wise selection of suitable plants, also considering other criteria such as soil, height and crown, etc. refer Table No 2
- < Identification of water source, in the surrounding area and planning for post planting irrigation system for the plants.
- < Clearing of site of unwanted material, and wild / jungle growth.
- < F g o c t e c v k q p " q h " r n c p v k p i " c t g c.X1ampXf rh.)ftk i i k p i ensure aeration of the soil and space for healthy growth of roots to allow sufficient aerated and porous soil area for the plant to settle down in the new place easily without much shock. . However, in rocky areas pits have to be bigger. Trees are planted 5 to 15

m apart depending upon the space they are expected to occupy when mature. The pits have to be dug 2 to 3 weeks earlier to planting, preferable before the rainy season.

- < Transport and stacking of red soil, manure and pesticides.
- < The excavated soil should be kept near the pit in two heaps, one containing the top soil up to 50 cm depth and another from the lower part of the pit. Both pit and the excavated soil should remain exposed to weathering effects for 2 to 3 weeks. All unwanted growth of algae, fungi gets eliminated, and heat generated from the maure gets settled.)
- < Peg mark the pit and leave the pit for 15 days (Fallow period).

3.2 During planting:

- < Circular weeding up to two feet radius from the stem of the plant. (Refer to Fig.1)
- < Internal distribution of plants on site and planting. Soil working up to 2 feet radius -6 inches deep using crow bars around the plant.
- < Application of pest control items.
- < Refill mix:
 - Ø 2:1:1:1 Ratio of dug out soil, red soil, farm yard manure, sand.
 - Ø Application of vermi compost or fertilisers-2kg/pit
 - Ø 20 grams/pit. FOLIDOL chemical for controlling white ants.
- < Identification of areas requiring tree guards, getting them made and fixing tree guard.
- < U v c m k p i " q t " h k z k p i " v j g " u w r r2q t v " u v k e m u " y k v j



Figure 1: Circular weeding

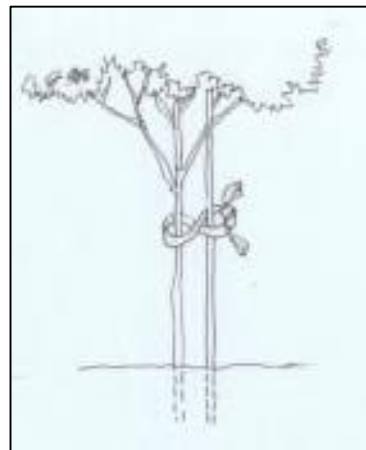


Figure 2: "8" knot

- < After a few showers the soil of the pit settles down making a cavity. This cavity should be filled up with more soil and planting be done in the center of the pit. Only that much part of the sapling will go down which was under the soil in the nursery.
- < All side shoots should be removed from the seedling at the time of planting.
- < Watering the plant

3.3 Post Planting:

- ⟨ Watering the plant as required.
- ⟨ Protection of sapling from stray cattle is important in tree plantations so maintenance of the tree guards is important.
- ⟨ Removal and re-fixing of tree guards to facilitate soil working whenever required depending upon the soil type where the planting is done.
- ⟨ Circular weeding regularly for many times - to a radius of 2 feet around the plant. (Refer to Fig.3)
- ⟨ Application of chemicals, fertilizers/neem cake etc. regularly.
- ⟨ Cutting back of coppice growth and removal of weeds in the plantation area. (Refer to Fig.4)
- ⟨ Given proper attention, the sapling will reach a height of nearly 2-3 m in the first year itself depending on tree species and thus its crown will rise beyond the reach of the cattle. The fence, however, should not be dismantled. It should be allowed to remain for three years or more till the stem is thick enough to stand any damage.
- ⟨ To make a plant tall and stately, proper pruning of branches should be done from early stage of growth. Pruning of branches lower than 6 feet 6 inches. (Refer to Fig.5)
- ⟨ Other such shoots that would develop afterwards from the elongated stem should be cut away for several years till the contemplated height of the stem is reached. Pruning of unwanted growth will help in utilization of nutrients (micro and macro) and water for better growth of remaining parts, thereby making them strong and healthy.
- ⟨ Sometime the main stem bifurcates before reaching the required height. In such case the weaker branch should be removed; if both are of equal vigour, the one towards the sun should be retained.
- ⟨ While cutting a branch no stump should be left. The cut surface must be painted with coal tar or a fungicide to avoid attack of diseases.

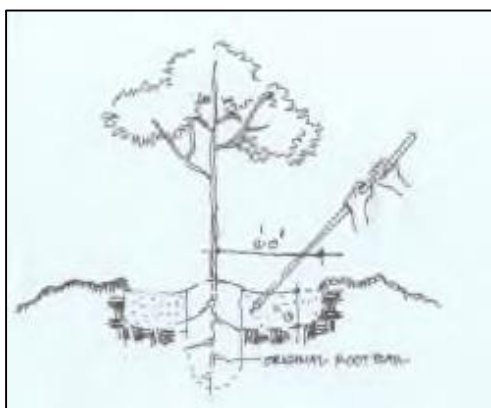


Figure 4: Weeding around stem

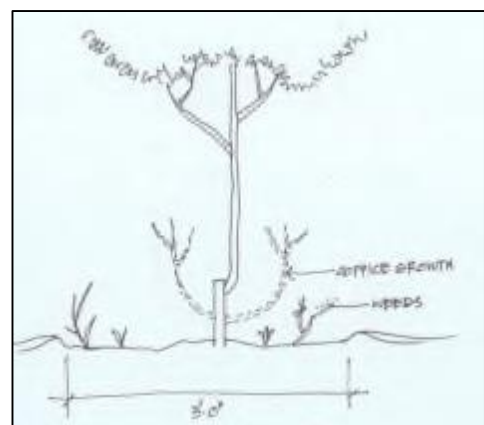


Figure 3: Cutting coppice growth

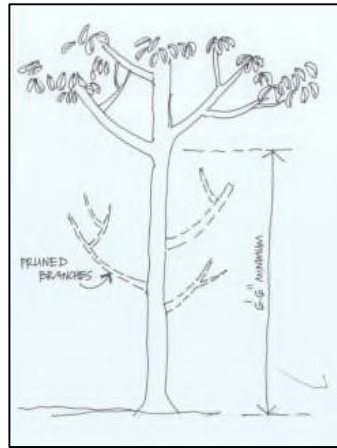


Figure 5: Pruning

- < Nitrogen at the rate of 20 g per plant in the form of ammonium sulphate urea or other nitrogenous fertilizer should be applied during the first irrigation inside the basin.
- < The tree should be kept free from weeds for at least two years to avoid competition and promote growth.
- < When the plant attains a height of 4 to 5 m, not much care except pruning is needed.

4. Identification of areas for plantation

Major areas for plantation in industrial areas are as follows:

4.1 Street plantation

- 3 36 m. and more wide roads.
- 3 24 m. wide roads
- 3 18 m. wide roads
- 3 12 m. wide and less roads
- 3 Central median

4.2 Common open spaces and amenity areas

- 3 Block plantation
- 3 Boundary plantation

4.3 Unit (individual industry) level plantation

- 3 Plantation at entry and exit
- 3 Boundary plantation
- 3 Incidental open spaces

4.4 Plantation in and around water bodies

5. Guidelines for plantation in the identified areas.

5.1 Street plantation

5.1.1 Guidelines: Avenue plantation-general concerns

- ³ Clash between avenue trees and an overhead electric line is an omnipresent problem. To allow proper growth of trees, and to avoid periodic pruning, either the electric supply lines should go underground or overhead electric lines should be insulated. (eg: Bauhinia species, Lagerstroemia species)
- ³ Street lighting:
 - ◁ Effectiveness of street lighting is reduced because of the position and height of the street light in relation to that of the trees.
 - ◁ Trees and street light positions should be staggered. On the other hand, street lighting affects the night life of trees and ultimately affects its life cycle. In order to restore night life to trees, preferably in residential areas, lighting can be at low level.
- ³ Underground services cable, drainage and storm water systems: care should be taken in plant species selection and planting distances from underground lines so that the root system of plant do not clog drains and do not damage the underground infrastructure and service lines.
- ³ Most of the avenue planting happens between the property line and road edge. There is hardly any soil area left over for aeration resulting in poor development of root zone. Trees fall down for the whirl winds effect and sudden outburst of rain and disrupt urban life pattern
- ³ Possibility of providing appropriate soil area around tree shall be considered.
- ³ Using trees for commercial purposes like nailing of name plates, advertisement boards etc. shall be avoided.
- ³ Where road side development is still to come, plan for multiple rows of trees on either side to protect it from uprooting by sudden gush of winds and outburst of rains.
- ³ Except in situations where specific function is expected, trees should be planted at a distance where only 10% of the crown is generally overlapped. (crown width should be considered at the trees mature stage)

5.1.2 Criteria for selection of plant material for roads/avenue planting

- ³ Type (ever green or deciduous)
- ³ Growth rate and age of vegetation.
- ³ Physical character of the tree like form, (fastigate form, broad canopy, spreading canopy, etc.)

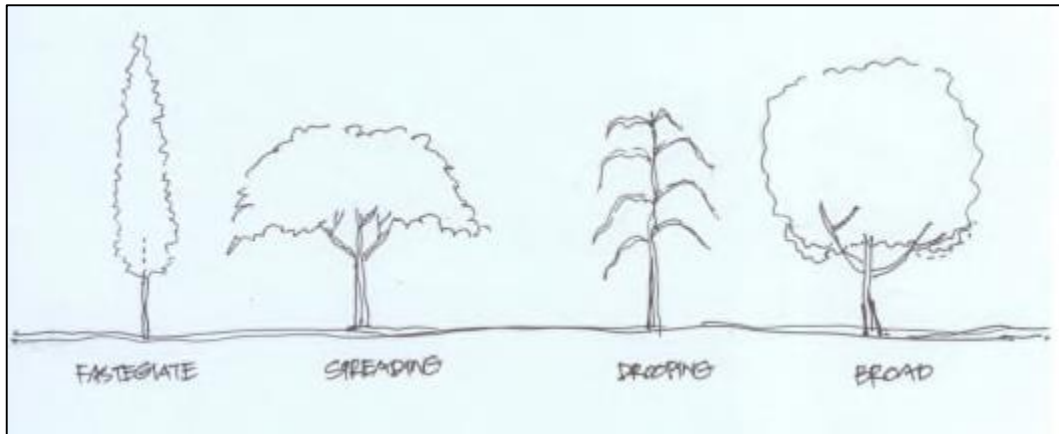


Figure 6: Physical form of the tree

- 3 Ultimate height and spread of tree,
- 3 Crown clearance from ground, etc
- 3 Flowering season, color, flower density.
- 3 Leaf size, leaf texture, leaf, and foliage color, foliage density and distribution.

5.1.3 Note on clearance for planting trees

For tree planting, the clearances required may be noted as::

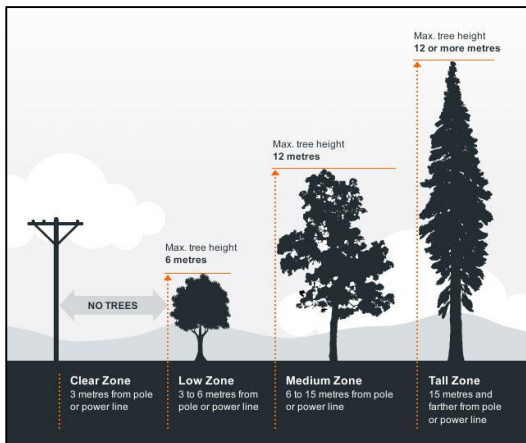


Figure 8: Planting near electrical poles (Source: SaskPower)

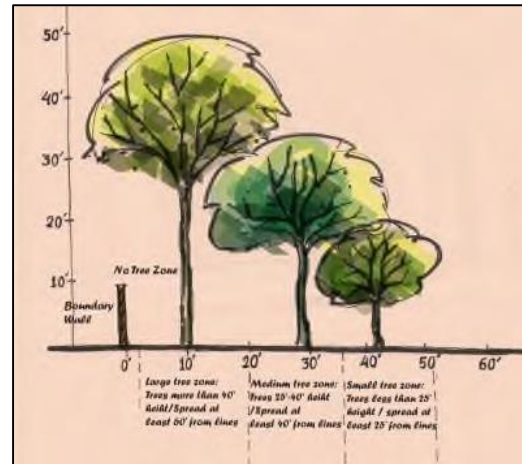


Figure 7: Planting near boundary walls

5.2 Open spaces plantation

5.2.1 Guidelines: Open spaces plantation -general concerns

Open space planting can happen in two categories.

- 3 Open space boundary planting
- 3 Open space block planting.

General concerns.

- 3 Plantation in unprotected open spaces requires fencing or tree guards.

- 3 Boundary can have a minimum of 3 rows where possible, with height hierarchy, to withstand strong winds.
- 3 Species variation can be maintained to avoid monoculture and improve resilience and diversity.

5.2.2 Criteria for selection of plant material for open space planting

- 3 Preference for local and adopted species,
- 3 Species that have thorns like *Prosopis* species
- 3 Species that attract birds and insects, like *Acacia nilotica*
- 3 Species that have fruiting like *Mangifera indica*
- 3 Species with better sustainability can have preference.
- 3 Species with low visual appeal, insignificant flowering lanky form and lactation can also be preferred for open space block planting.



Figure 9: Example of block and boundary planting in open space

5.3 Unit (individual industry) level plantation

5.3.1 Guidelines: Unit plantation -general concerns

- 3 Unit boundary plantation should have similar character to that of the front boundary and inside plantations to establish homogeneity in the total unit area.
- 3 Plantations should be at a distance of minimum of 3m. From boundary wall and buildings so that the roots do not damage the structures.
- 3 Trees that display a stark contrast to the avenue and opposite side unit planting can be avoided.
- 3 On the front side of the unit boundary, trees with similar Form, growth rate, habit and foliage density can be preferred.

5.3.2 Selection criteria unit/industry boundary

For three sides of the industrial plot excepting the front side:

- 3 Plants that are sturdy and having defined form to delineate the edge as a green edge.
- 3 That easily associate with other species of plants. like *Peltophorum pterocarpum* and *Cassia siamia*.
- 3 That can survive in the pollution caused by the industry.
- 3 Plants that can sustain medium drought conditions and medium soil nutrient availability (usually local species and adapted ónaturalized species.)
- 3 That adds to the homogeneity of green cover continuity of the industry and the total area in totality.

5.3.3 At entry and exits-guidelines

Plants that:

- 3 Have very less leaf fall, *Alstonia scholaris*.
- 3 Have very strong visual effect with vibrant flowering in terms of color and flower density,
- 3 Provide shade throughout the year,
- 3 Reduce visuals glare.
- 3 Provide aesthetic quality to space and intellectual stimulation that elevates human spirits.
- 3 Complements the architectural forms
- 3 Establishes visual comfort areas.
- 3 Forms overhead and ground space definition.
- 3 Induce scale.
- 3 Forms a framing element, gives foreground and backdrop effect.
- 3 Reduce visual pollution.
- 3 Introduces ornamental effect.

5.4 Water body plantation

5.4.1 Guidelines: Water body -general concerns

- 3 Trees having character to frame views and enhance visual quality.
- 3 Entire shore area need not be planted considering the scenic value of the place.
- 3 Plant height hierarchy can be maintained keeping the smallest height plant nearer to the shore.
- 3 Planting in feeder nalas and monsoon time intermittent nalas can be avoided.

5.4.2 Criteria for selection of plant material for water body planting

Following types of species can be considered for water body shore planting

- 3 U r g e k g u " v j c v " u w t x k x g " r c t v k c n " u w d o g t i g p e g "
- 3 Trees that can provide habitat for avi fauna population.
- 3 Trees with drooping character like weeping willow, that visually associate with water.
- 3 Trees with less leaf fall
- 3 Trees that sustain high moisture levels.
- 3 Trees that have characteristics of mangrove species.

6. List of trees for the different identified areas

The following table 1 lists the recommended trees / plants suitable for planting in the different areas identified within the industrial parks.

Table 1: List of trees for different identified areas.

S.No.	Scientific Name	Common Name	36 m. road	24 m. road	18 m. road	12 m. road	Foot path	Service roads	Central median	Open space - boundary	Open space - block	Unit - boundary	Unit - entry exit	Unit - incidental spaces	Water body boundary
1	Acacia auriculiformis	Acacia auriculiformis													
2	Acacia nilotica	Babul,Nalla Tumma													
3	Acacia suma	Tellachandra													
4	Achras sapota	Sapota, chikku													
5	Adina cordifolia	Bandaru, Haldi													
6	Aegle marmelos	Maredu													
7	Aglaia elaeagnoides	Yerra Adugu													
8	Ailanthus excelsa	Pedda Manu													
9	Albizia amara	Nalla regi, Narlingi													
10	Albizia chinensis	Bandi Chinduga													
11	Albizia lebeck	Dirisinal, sirisamu													
12	Albizia odoratissima	Chinduga, Ganara													
13	Alstonia scholaris	Eddakla Pala													
14	Albizia procera	Tellachin duga													
15	Anacardium occidentale	Cashew nut													
16	Anogeissus latifolia	Tiruman													
17	Artocarpus heterophyllus	panasa													
18	Avicennia officinalis	Nalla mada													
19	Azadirachta Indica	Neem,vepa													
20	Bauhinia malabarica	Bauhinia malabarica													
21	Bauhinia racemosa	Bahuinia racemosa													
22	Bauhinia purpurea														
23	Bauhinia variegata	Aare													
24	Barringtonia Acutangula	Kadimi, Kurpa													
25	Bixa orellana														
26	Bombax ceiba	Buruga,Semal													
27	Boswellia serrata	Gandru-chettu													
28	Butea monosperma	Flame of the forest													
29	Callistemon viminalis	Bottle Brush													
30	Capparis grandis	Reguti													
31	Careya arborea	Budadharimi													
32	Carica papaya	Boppai,Paringi,Papaya													
33	Cassia auriculata														
34	Cassia fistula	Rela,Golden-shower													
35	Cassia nodosa	Cassia nodosa													
36	Cassine glauca	Cassine glauca/Neridi													
37	Cassia siamea	Seema tangedu													
38	Ceiba pentandra	Buruga													
39	Chloroxylon swietenia	Billudu													
40	Chikrasia tabularis	Konda Vepa													

S.No.	Scientific Name	Common Name	36 m. road	24 m. road	18 m. road	12 m. road	Foot path	Service roads	Central median	Open space - boundary	Open space - block	Unit - boundary	Unit - entry exit	Unit - incidental spaces	Water body boundary
41	Cochlospermum religiosum	Konda Gogu													
42	Commiphora berryi														
43	Dalbergia latifolia	Rose-Wood, Jitregi													
44	Dalbergia paniculata	Pachari, Porla-pachari													
45	Dalbergia sissoo	Sissoo													
46	Dalbergia spinosa	Chillangi Limonia elephantum													
47	Dendrocalamus strictus	Bamboo, Gatti veduru													
48	Delonix elata	White gulmohar													
49	Delonix regia	gulmohar													
50	Derris indica	Derris indica													
51	Dillenia pentagyna	Revada, Dog Teak													
52	Dillenia bracteata	Kalli Teak													
53	Diospyros chloroxylon	Kalli Teak													
54	Diospyros ferrea	Chinna ulinja													
55	Dodonaea viscosa	Bandam, pulivavilli													
56	Dolichandrone falcata	oddi													
57	Eeretia acuminata .														
58	Ehretia laevis	Tella pisini													
59	Erythrina indica	Badida													
60	Erythrina suberosa	Muni mudugu													
61	Ficus amottiana	Kalla ravi													
62	Ficus hispida	Bommudu, kaki medi													
63	Ficus mollis	Marri, banyan tree													
64	Ficus mysorensis	Goni chettu													
65	Ficus religiosa	Ashvatham, Bodhy													
66	Ficus racemosa														
67	Feronia limonia	velega													
68	Gmelina arborea	Gummadi-teku													
69	Grevillea robusta	Silver oak, Parana													
70	Hydnocarpus alpina	Yeru tunki													
71	Hardwickia binata	Nara yepi, Anjan													
72	Jacaranda mimosaefolia	Jacaranda													
73	Lagerstroemia parviflora	Chennangi, Nandi													
74	Lagerstroemia speciosa														
75	Limonia elephantum	Velga, wood apple													
76	Lumintzera racemosa	Thanduga													
77	Madhuca Indica	Ippa, Gul-Mohwa													
78	Madhuca longifolia	Madhuca longifolia													
79	Mangifera indica	Mamidi, Mango													
80	Millingtonia hortensis	Akasa malli													
81	Mimusops elengi	Pogada													
82	Melia azedarach	Turka Vepa													
83	Murraya koenigii	Karivepaku, Curry leaf													
84	Parkia biglandulosa	Badminton Ball													
85	Peltophorum pterocarpum	Pacha sunkesula													
86	Phyllanthus distichous	Racha usiri													
87	Phyllanthus emblica	Usiri													

S.No.	Scientific Name	Common Name	36 m. road	24 m. road	18 m. road	12 m. road	Foot path	Service roads	Central median	Open space - boundary	Open space - block	Unit - boundary	Unit - entry exit	Unit - incidental spaces	Water body boundary
88	<i>Pithecolobium dulce</i>	Sima chinta													
89	<i>Polyalthia longifolia</i>	Ashoka, Naramamidi													
90	<i>Pongamia pinnata</i>	Kanuga													
91	<i>Putranjiva roxburghii</i>	Yenki, Venki, Danthi													
92	<i>Sapindus emarginatus</i>	Kunkudu, Soap nut													
93	<i>Saraca asoka</i>	Asokamu													
94	<i>Samanea saman</i>	Rain tree, Nidra													
95	<i>Simarouba glauca</i>	Simarouba													
96	<i>Syzygium alternifolium</i>	Jinna													
97	<i>Syzygium cumini</i>	Neredu, Jamun, Black													
98	<i>Syzygium jambos</i>	Alla Neredu													
99	<i>Spathodea companulata</i>	Spathodea													
100	<i>Swietenia mahogany</i>	Mohogany													
101	<i>Tabebuia heterophylla</i>	Pink Trumpet tree													
102	<i>Tabernaemontana divaricata</i>	Nandivardanam													
103	<i>Tamarindus Indica</i>	Chinta, Imli													
104	<i>Tecoma stans</i>	Suvarna ganneru													
105	<i>Tectona grandis</i>	Teak, Sagwan													
106	<i>Terminalia alata</i>	Dudamaddi													
107	<i>Terminalia arjuna</i>	Arjuna, Enamaddi													
108	<i>Terminalia bellerica</i>	Tani, Thandra, Behere													
109	<i>Terminalia catappa</i>	Adavibadam													
110	<i>Thespesia populnea</i>	Umbrella Tree													
111	<i>Wrightia tomentosa</i>	Tella Pala													

7. Selection of suitable tree species based on criteria as soil, water requirement, aesthetics, etc

Table 2: Matrix for selection of trees

S.No.	Scientific Name	Common Name	Type	Growth rate	Height	Spread	Water .RQ	Drought Tolerance	Soil Moisture	Function	Attract birds	Attract insects	Shedding of leaves	Red loamy soil	Red sandy soil	Stoney morrum soil	Shallow water edge	Sandy soil	Mixed soil (red and black)	Black cotton soil	Salane
1	Acacia auriculiformis	Acacia auriculiformis	E	F	15	7	L	H	WD	S,FL,A											
2	Acacia nilotica	Babul,Nalla Tumma	D	S	10		H	L	WD	FL		Y									
3	Acacia suma	Tellachandra	D	F	15	8	L	H	ATS	FL	Y										
4	Achras sapota	Sapota, chikku	E	S	15	12	L	H	WD	F/FL		Y									
5	Adina cordifolia	Bandaru, Haldi	D	F	15	7	L	H	WD	FL	Y	N	M								
6	Aegle marmelos	Maredu	D	S	12	6	H	L	W	S,FL		Y									
7	Aglaia elaeagnoides	Yerra Adugu	E	M	10	6	M	M	MD	S,FL											
8	Ailanthus excelsa	Pedda Manu	D	F	18	10	M	M	MD	S											
9	Albizia amara	Nalla regi, Narlingi	D	M	6m	6	L	H	WD	A,FL	Y	N	M								
10	Albizia chinensis	Bandi Chinduga	D	F	20	15	L	H	WD	S,A			M								
11	Albizia lebbek	Dirisinal, sirisamu	D	F	20	20	H	H	W	S,FL		Y									
12	Albizia odoratissima	Chinduga, Ganara	D	F	20	15	M	M	M	A,FL			M								
13	Alstonia scholaris	Eddakla Pala	E	F	20	7	M	M	WD	A,FL											
14	Albizia procera	Tellachin duga	sD	F	10	8	L		WD	A											
15	Anacardium occidentale	Cashew nut	E	S	12		L	H	WD	F/FL											
16	Anogeissus latifolia	Tiruman	D	S	7	4	M	M	MD	FL											
17	Artocarpus heterophyllus	panasa	E	F	12	8	L	M	W	F/FL											
18	Avicennia officinalis	Nalla mada	E	F	8	6	M	M		F/FL											
19	Azadirachta Indica	Neem,vepa	D	S	16	12	L	H	WD	S,F	Y	Y									
20	Bauhinia purpurea	peda aare	D	F	5	4	M	M	wd	FL/A											
21	Bauhinia malabarica	Bauhinia malabarica	D	M	15	8	L	H	WD	F/FL											
22	Bauhinia racemosa	Bauhinia racemosa	D	S	5	4	M	M	WD												
23	Bauhinia variegata	Aare	D	M	8	6	M	M		A/FL											
24	Barringtonia Acutangula	Kadimi, Kurpa	E	S	8	6	L	M	M	A,FL											
25	Bixa orellana	Large shrub	E	F	6	4	M	L	WD	FL											
26	Bombax ceiba	Buruga,Semal	D	F	30	8	M	M	WD	FL											
27	Boswellia serrata	Gandru-chettu	D		20			H	WD	F/FL											

S.No.	Scientific Name	Common Name	Type	Growth rate	Height	Spread	Water .RQ	Drought Tolerance	Soil Moisture	Function	Attract birds	Attract insects	Shedding of leaves	Red loamy soil	Red sandy soil	Stoney morrum soil	Shallow water edge	Sandy soil	Mixed soil (red and black)	Black cotton soil	Salane
84	Parkia biglandulosa	Badminton Ball	E	F	20	12		M	MD	FL											
85	Peltophorum pterocarpum	Pacha sunkesula	D	F	20	15	M	M	MD	S,A,FL											
86	Phyllanthus distichous	Racha usiri	D	F	9	4	L	H	WD	FL											
87	Phyllanthus emblica	Usiri	D	F	10	7	L	H	WD	FL		Y									
88	Pithocolobium dulci	Sima chinta	E	M	15	10	M	H	WD	F			M								
89	Polyalthia longifolia	Ashoka,Naramamidi	E	F	10	2.5	L	H	WD	A,FL											
90	Pongamia pinnata	Kanuga	E	S	12	8	L	H	WD	FL											
91	Putranjiva roxburghii	Yenki,Venki,Danthi	E	S	15	7	M	M	MD	FL											
92	Sapindus emarginatus	Kunkudu, Soap nut	D	S	10	6	L	H	WD	F											
93	Saraca asoka	Asokamu	E	M	8	5	L	H	WD	A,FL											
94	Samanea saman	Rain tree, Nidra	D	F	25	20	L	H	WD	FL											
95	Simarouba glauca	Simarouba	E	F	15	9	M	M	WD												
96	Syzygium alternifolium	Jinna	E	S	10	7	M	M	WD	F											
97	Syzygium cumini	Neredu, Jamun,Black	E	S	20	12	M	M	WD	F											
98	Syzygium jambos	Alla Neredu	E	S	15	10	M	M	WD	F	Y	Y									
99	Spathodea companulata	Spathodea	E	F	20	10	L	H	WD	A											
100	Swietenia mahogani	Mohogany	D	S	25	12	L	H	WD	FL											
101	Tabebuia heterophylla	Pink Trumpet tree	D	M	8	5	M	M	WD												
102	Tabernaemontana divaricata	Nandivardanam	S E	F	3	3	M	M	WD	FL											
103	Tamarindus Indica	Chinta, Imli	D	S	25	20	L	H	WD	FRT											
104	Tecoma stans	Suvarna ganneru	E	F	5	4	M	M	WD	FL											
105	Tectona grandis	Teak, Sagwan	D	F	25	6	M	M	WD	FL											
106	Terminalia alata	Dudamaddi	D	S	20	12	M	M													
107	Terminalia arjuna	Arjuna,Enamaddi	D	S	20	10	L	H	WD	FL											
108	Terminalia bellerica	Tani, Thandra,Behere	D	M	20	10	M	M	MD	FL											
109	Terminalia catappa	Adavibadam	D	F	12	8	M	M	WD	FL											
110	Thespesia populnea	Umbrella Tree	E	M	10	8	L	H	WD	S,FL											
111	Wrightia tomentosa	Tella Pala	D	S	10	8	L	H	WD	FL											

8. Selection of tree species for environmental (pollution resistance) aspects

Table 3: Pollution resisting trees

POLLUTION RESISTING TREES			POLLUTION					
S.No	Scientific name	Local name	SPM	SO ₂	NO _x	CO	Noise	Salinity resistance
1	Albizia lebbek	Dirisinal, sirisamu, lebbek tree						
2	Alstonia scholaris	Eddakla Pala						
3	Ailanthus excelsa	Pedda Manu, Ailanthus excelsa						
4	Azadirachta Indica	Neem, vepa						
5	Bauhinia variegata	Bauhinia variegata						
6	Butea monosperma	Moduga chettu, Palas						
7	Callistemon citrinus	Bottlebrush						
8	Cassia siamea	Seema tangedu, Niala tangedu						
9	Cassia fistula	Rela, Golden-shower, Indian						
10	Dalbergia sissoo	Sissoo						
11	Delonix regia	Gulmohar, Turayi, Erraturai						
12	Diospyros melonoxylon							
13	Erythrina variegata	Erythrina variegata, Baridapu						
14	Eucalyptus citriodora	Lemon scented Eucalyptus citriodora						
15	Ficus benghalensis	Marri, pedda marri, banyan tree						
16	Ficus benjamina							
17	Ficus infectoria							
18	Ficus religiosa	Ravi, Ashvatham, Bodhy						
19	Lagerstroemia flos reginae	Lagerstroemia flos reginae						
20	Madhuca Indica	Ippa, Mahwa, Mowa, Gul-Mohwa						
21	Mangifera indica	Mamidi, Mango						
22	Millingtonia hortensis	Akasa malli, punnaga malli						
23	Peltophorum pterocarpum	Pacha sunkesula, Konda chinta						
24	Polyalthia longifolia	Ashoka, Naramamidi, Devadaru						
25	Pterospermum acerifolium							
26	Parkia biglandulosa	Badminton Ball						
27	Pongamia glabra	Kanuga						
28	Swietenia mahogani	Mahogany						
29	Samanea saman	Rain tree, Nidra						
30	Syzygium cumini	Neredu, Jamun, Jinna						
31	Spathodea companulata	Spathodea						
32	Tamarindus Indica	Chinta, Imlı, tamarind tree						
33	Tecoma alata	Tecoma spp						
34	Tecoma argentina	Tecoma spp						
35	Tabubia avlandia	Tabubia Spp						
36	Tectona grandis	Teak, Sagwan						

Note: The boxes marked green indicate tolerance to the specific pollutant. In case of noise they reduce noise pollution.

9. Planting and climate change adaptation: Reducing urban heat island effects

Areas in and around cities are generally warmer than comparable rural areas. Urban development reduces vegetative cover and adds heat absorbing surfaces such as rooftops, buildings, and paving. Heat is also added from other sources in cities such as fuel combustion and air conditioning units. This result is an urban heat island.

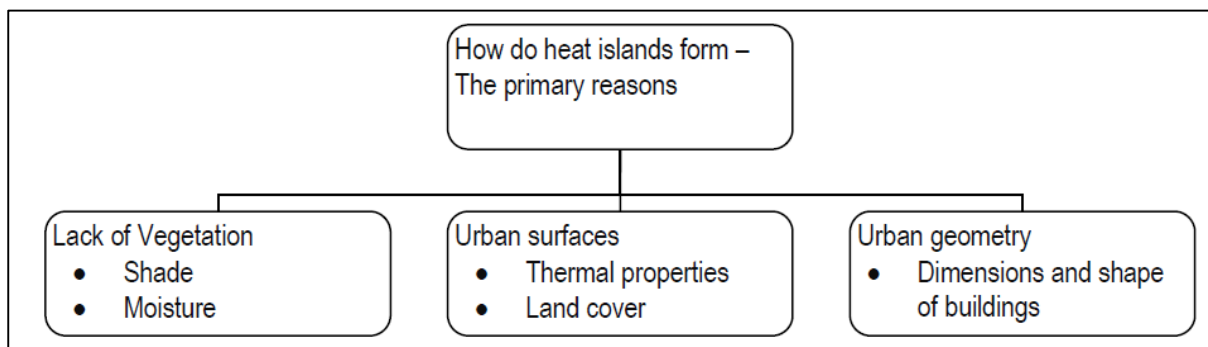


Figure 10 Formation of heat island

One of the most fundamental methods of reducing urban heat islands effects is to increase the tree cover. This shades the ground, pavements, roads and building surfaces, which otherwise usually absorb the solar radiation and result in increased surface temperatures and re-radiation of long wave heat at the pedestrian level.

The other benefit of increasing the tree cover is increased evaporative cooling. Vegetation intercepts radiation and produces shade that also contributes to reduce urban heat trapping. Trees and vegetation provide shade which helps lower surface temperatures. They also release water to the air (evapotranspiration), which helps cool the area.

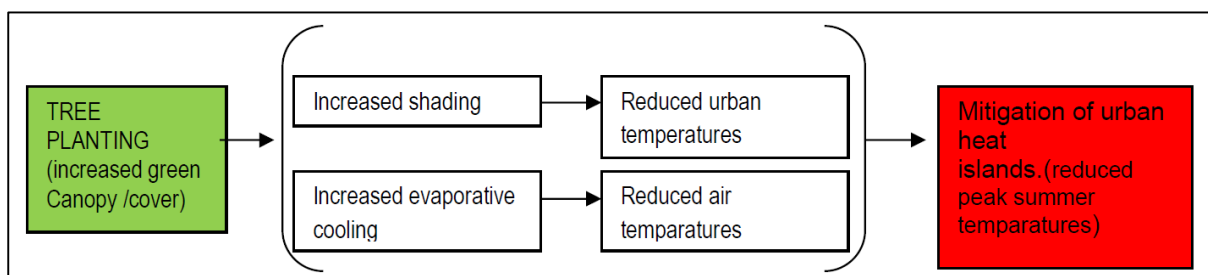


Figure 11 Heat island mitigation

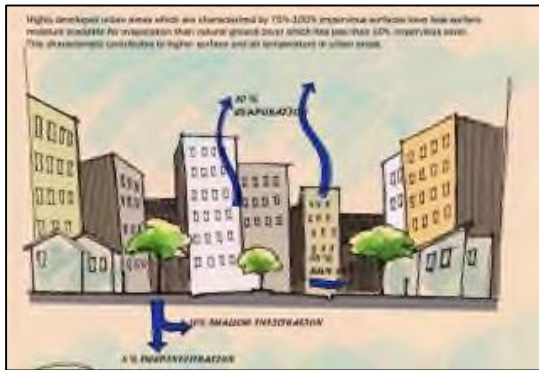


Figure 12 Urban heat island

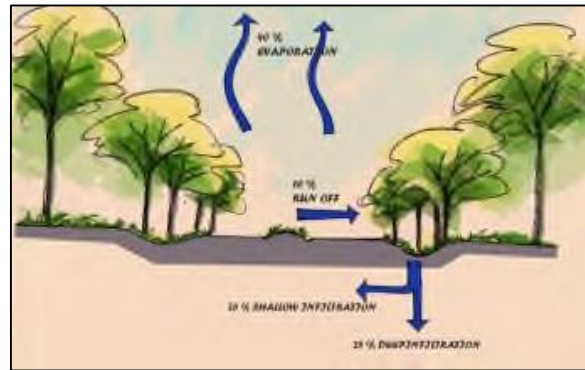


Figure 13 Trees plantation for mitigation of heat island

10. Integration of storm water management with plantation

- a. Stormwater runoff is rainfall that flows over the ground surface. It is created when rain falls on roads, driveways, parking lots, rooftops and other paved surfaces that do not allow water to soak into the ground. Stormwater runoff also picks up and carries with it many different pollutants. Managing the quantity and quality of stormwater is termed, "Stormwater Management."
- b. Preserving undisturbed vegetative cover during land development is a much more cost-effective approach than destroying these features and having to construct new stormwater management practices to replace the functions they originally provided. Trees and forests reduce stormwater runoff by capturing and storing rainfall in the canopy and releasing water into the atmosphere through evapotranspiration.
- c.

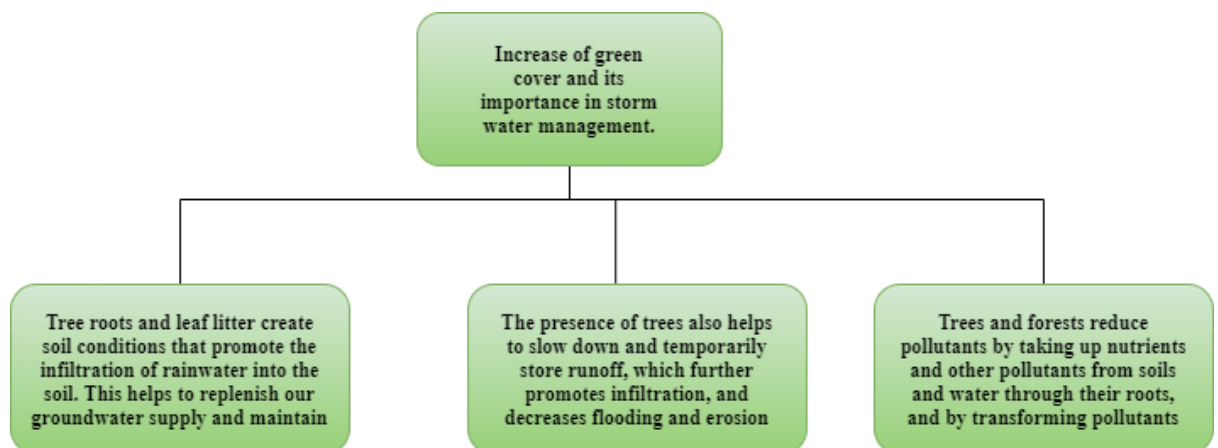


Figure 14 Importance of green cover in storm water management

- d. In addition to this the other methods of storm water management includes:

- 3 Maximize permeability introduction of permeable hard surfaces wherever possible
- 3 Minimize offsite discharge by introducing routing to local depressions, rain water harvesting pits and areas.
- 3 Use storm water channels as design elements and increase infiltration by making bio swales.

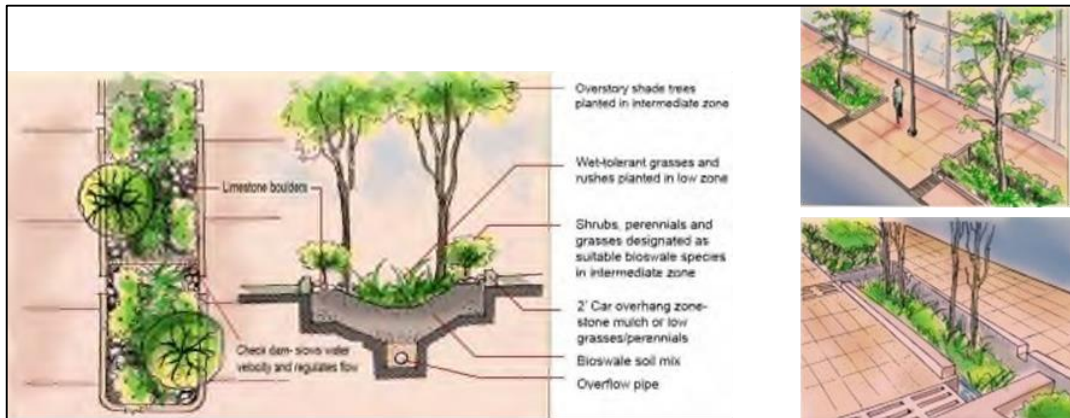


Figure 15 Design of storm water channels below plantation

11. Indoor Plantation

11.1 What are indoor plants?

An indoor plant is one that is adapted to living in low light, usually with less water and lower maintenance needs, and that can thrive indoors. In general, most plants that work well in an office environment are native to tropical or subtropical parts of the world. These are places where the climate is warm, hot or mild, the kind of climate that most of us prefer in our offices.

11.2 What makes a good office plant?

Generally speaking, plants that are low maintenance make good office plants and that includes plants that require relatively low amounts of water. Finally, take appearance into account. Although one wants plants that are easy to take care of, one also wants office plants that look nice and enhance the office space rather than distract or detract from it. Blooming plants, although they look great, usually require more sunlight and more watering and typically only bloom for a short period of time when indoors.

Here are many different types of plants that make good indoor and office plants. However, there are some that work better than others.

Some of the best and most common are in the Araceae family, such as spathiphyllum (e.g., Peace Lily, Snake Lily). They are also sometimes referred to as aroids.

Philodendrons óthese make great indoor/office plants because there are so many different kinds. There are some who suggest there are more than 900 species. Philodendrons have large and even imposing oval or spear-shaped leaves. There are two major groups of Philodendrons óclimbing (vining) and non-climbing (solitary, non-vining).

Pothos óplants that have large green leaves. They are flowering plants and cover a wide variety that are used indoors. Pothos are extremely successful indoors ó k v ø u " c n o q u v " n k m g " to grow within the confines of the built environment.

Aglaonema (Aglos) ólarge green leaves with lighter marks on them differentiate Aglaonema from some of the other plants in this list. There are many different varieties of Aglos, including newer varieties with pink and red colors in the stems and leaves. In some cultures, they are known for bringing good luck.

Nephtythis óa plant with white and green leaves that are usually arrow-shaped. These need to be kept away from any pets or other animals, because they can be toxic.

Anthuriums óa popular indoor and office plant because of the colorful blooms that come with them.

Dracaena óthere are about 40 species within this genus and are closely related to another plant on this list, the Sansevieria. Some species are large and tree-like, but some are shrub-sized and make great office plants. Cane Dracaenas are great if you are looking for a plant with substantial height.

Palms óvarious types of palms such as the Rhapsis palm and the Kentia palm are very good for office plants if you are looking for something a little taller. They do well in medium to low light, but they are not really low maintenance, so be aware of that.

Ficus trees óif you are really looking to add something taller to your indoor space then consider one of several types of Ficus. Most Ficus trees require medium to high light.

Sansevieria óa genus of flowering plants that are native to Africa. They tend to have long, tall, green leaves around a central growing point. They usually produce flowers of varying colors from greenish-white, lilac-red or brown. Sansevieria tolerates some of the lowest light conditions.

Succulents óplants with thick, fleshy, leaves that allow them to retain a lot of water. They tend to need plenty of light, so be wary of that, but these plants are famous for being drought-resistant. Avoid over-watering succulents.

Ferns óa type of plant that you are probably very familiar with. They do well indoors in low light, but they do require consistent moisture and humidity levels in order to thrive.

ZZ Plants óa green flowering plant originally from Africa that has now been cultivated for indoor and decorative use. It gets its common name from the scientific name: *Zamioculcas*

zamiifolia. ZZ Plant is a relatively newer ornamental plant and will likely increase in popularity over time.

For plants that are relatively low maintenance, you would do well to consider plants in the aroid family such as:

- < Sansevieria
- < Aglaonema
- < Pothos
- < Dracaena
- < Philodendrons
- < Zamioculcas zamiifolia (or more commonly, ZZ Plants)

Plants good for windows in office are:

- < Spathiphyllum (such as Peace Lilies)
- < Pothos
- < Philodendrons
- < Sansevieria
- < Aglaonema
- < ZZ Plant

There are many plants that can be used outdoors and repel pests like mosquitoes such as:

- < Lemongrass
- < Eucalyptus
- < Catnip
- < Citronella grass

11.3 Benefits of office plants:

11.3.1 Improve office air quality

Studies have shown that indoor plants can clean the air, which is especially advantageous in an office environment where people spend a great deal of time. Carpets and paint and other things that we use indoors do carry chemicals and plants can absorb them and produce fresh, clean, oxygen. The issue is that the more you have, the better the air. If you put one plant in the middle q h " { q w t " q h h k e g . " f q p ø v " g z r g e v " v j g " Dracaena, w c n k v { palms, ficus, ferns, etc., all help raise humidity levels and help with air quality standards

11.3.2. Plants improve people's moods

There is a growing field of interior design, biophilia that involves bringing nature into indoor u r c e g u " u q " v j c v " r g q r n g ø u " o q q f u . " e t g c v k x k v { " c about biophilia here. The amount of plants in an office or enclosed space matters. One plant

alone is likely not enough to improve moods, but a lot of them can have an effect. Plants make buildings look less drab or dreary and more sophisticated plant displays can look a lot like artwork, which has a definite elevating impact on mood.

11.3.3 Plants improve productivity and creativity

Yes, office plants have been known to improve productivity. Studies have been done that show that employees with access to indoor plants perform better and are more productive. One way to look at how moods and productivity are improved with a scenic view is to consider how hotels charge for rooms. If you book a room in Manhattan, you are likely to pay a lot more for a room with a view of Central Park than one with a view of an alley. People feel better, work better and perform better when they can see greenery, nature, get natural light and have access to plants.

11.3.4 Plants improve office spaces?

Although there are studies that show access to outdoor views and views of nature improve moods, productivity, creativity and overall health, the fact is that offices cannot provide a window view for every employee. Fortunately, these same studies show that access to plants in an office has much of the same effect.

There are other benefits, too. These days very few people have individual offices. Instead, they have cubicles, which reduces the amount of privacy that employees have and increases the noise level. Plants can reduce noise and help provide a bit more privacy, all while improving the overall appearance and look of cubicles and offices. They add color and pizzazz to otherwise dry, plain spaces.

11.3.5 Do plants reduce absenteeism?

It appears that they do. Although studies are still ongoing, there is evidence of phenomenon building. Fortunately, this can be improved with the addition of indoor plants and other interior landscaping techniques. Recent studies look into a new concept in the workplace known as for being there, but do nothing to contribute to the company. Providing access to natural light and adding plants to offices takes steps to reduce this.

11.3.6 Which plants offer the best health benefits?

Having any kind of plants in the office can improve moods and provide some health benefits. Flowering and blooming plants can offer an even greater mood lift than those that do not. Anything that can break up lots of brown or plain white or gray that often adorn walls, floors and rooms in modern office buildings can help encourage wellness.

12. Tree Procurement

12.1 Overview

The geospatial study was done for the mapping of the existing and potential sites for the green area for the selected industrial parks. The total potential green area identified for each of the park is the area which requires the tree plantation in coming days. The total number of trees required by each park as per the type of the industrial park is also estimated considering the greenery guidelines. The geospatial techniques used in the estimation of the total count of trees required for plantation in which following criteria is considered -

12.1.1 Road Side and Road-Divide/Road-Median

For Road Side and road-median/divide, the trees are planted linearly and the distance considered between two trees is 3m. The total length of the road side and road-divide/median is calculated and based upon the length and the buffer distance between trees the count is estimated.

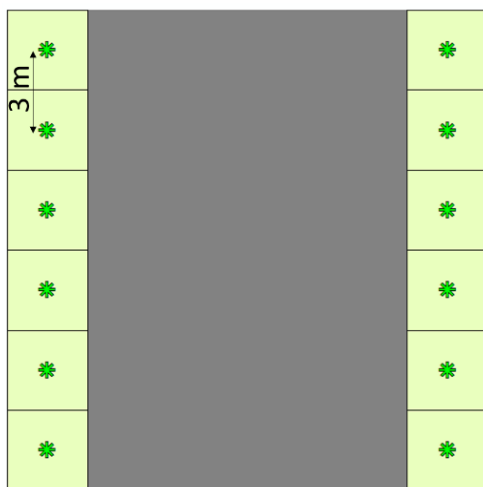


Figure 16 Road side plantation

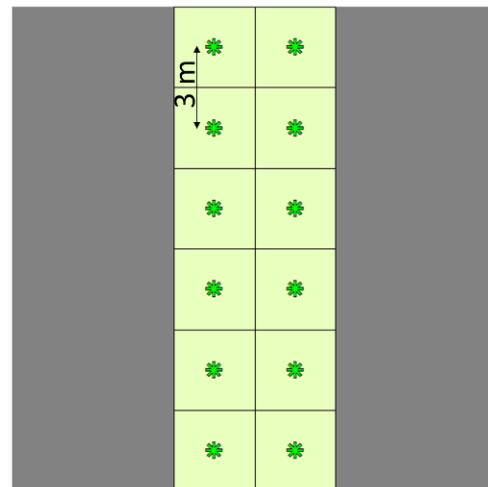


Figure 17 Road divide plantation

12.1.2 Industrial premises between 1 to 6 Ha

For Road Side and road-median/divide, the trees are planted linearly and the distance considered between two trees is 3m. The total length of the road side and road-divide/median is calculated and based upon the length and the buffer distance between trees the count is estimated.

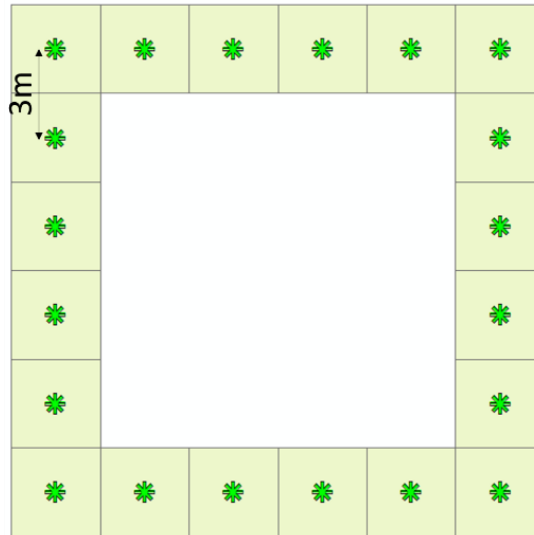


Figure 18 Proposed tree plantation in industrial premises between 1 to 6 Ha

12.1.3 Open Spaces

For open spaces, the trees are planted 5m apart. The distance between any two trees is 5m. The square grids are formed considering the tree is planted at its center. The total grids lying in the potential space is counted and is considered as the total number of the trees required.

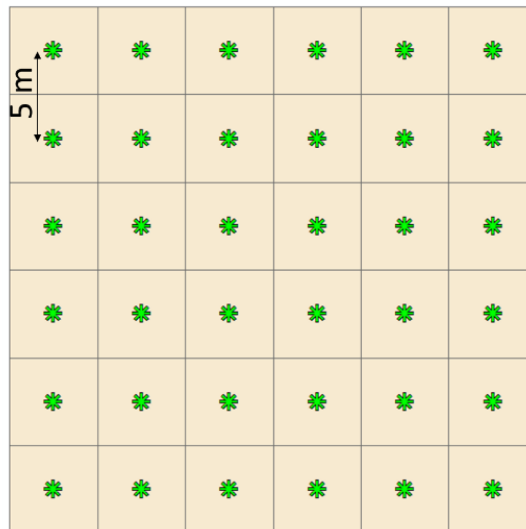


Figure 19 Proposed tree plantation in open space

12.1.4 Industrial premises greater than 6 Ha

For open spaces, the trees are planted 5m apart. The distance between any two trees is 5m. The square grids are formed considering the tree is planted at its center. The total grids lying in the potential space is counted and is considered as the total number of the trees required.

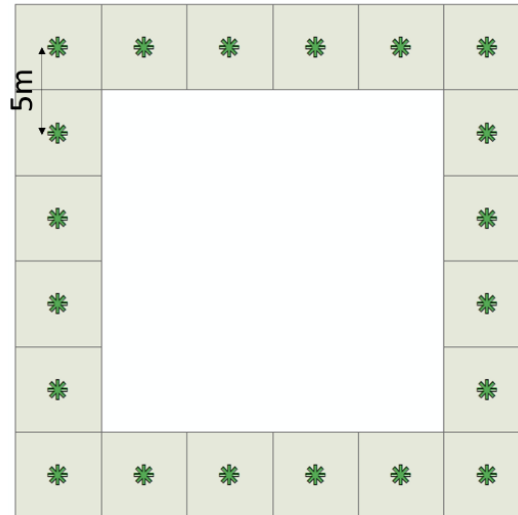


Figure 20 Proposed tree plantation in industrial premises greater than 6 Ha

Note:

It should be noted that in the present study as the plantation inside the industrial premise is completely considered as potential green space, while in reality this area may be having plantation done already.

12.2 Industries wise tree procurement recommendation:

12.2.1 IIE Pantnagar:

IIE Pantnagar requires a total of 48,027 trees to be procured. If industrial premises potential green space is not considered then at least 14,339 trees are required to completely develop the potential green space as per the greenery norms. The analysis showed that to just fulfill the greenery norms of IIE Pantnagar that is 15% area of the industrial park must come under the greenery norms. The authority has to procure at least 10% of the total trees required to be required as per this report. Considering the safety factor of 1.5 times, as all the saplings may not grow. The authority must procure 15% of the total trees which is 7200 trees. The table below shows the exact statistics of the number of trees required in the IIE Pantnagar according to different types of potential green space available in it.

Table 4 Procurement statistics of IIE Pantnagar

IIE PANTNAGAR	
Class	No. of Trees
Road dividers	0
Road side	1478
Industrial premises greater than 6 Ha	9137
Industrial premises between 1 to 6 Ha	24551
Open	12861
Total	48,027

12.2.2 IIE Sitarganj:

IIE Sitarganj requires a total of 67,416 trees to be procured. If industrial premises potential green space is not considered then at least 21,281 trees are required to completely develop the potential green space as per the greenery norms. The analysis showed that to just fulfill the greenery norms of IIE Sitarganj that 15% area of the industrial park must come under the greenery norms. The authority has to procure at least 40% of the total trees required to be required as per this report. Considering the safety factor of 1.5 times, as all the saplings may not grow. The authority must procure 60% of the total trees which is 40,500 trees. Hence the authority can first acquire the 21,281 trees required to develop potential green space other than which lie in the industrial premises. Further the need to rest 19219 trees depends upon the availability of trees inside the industrial premises. If already this requirement can be reduced. The table below shows the exact statistics of the number of trees required in the IIE Sitarganj according to different types of potential green space available in it.

Table 5 Procurement statistics of IIE Sitarganj

IIE Sitarganj	
Class	No. of Trees
Road dividers	85
Road side	2494
Industrial premises greater than 6 Ha	21192
Industrial premises between 1 to 6 Ha	24943
Open	18702
Total	67,416

12.2.3 IIE Kotdwar:

IIE Kotdwar which requires 10% of the industrial park area to be developed as a green belt is having around 22% of the area as green cover. That satisfies the greenery norms for the industrial park. But as explained in the existing greenery report the area is still under development phase it requires to be properly developed and maintained as per the greenery standards. The recommendations in the reports of the existing and potential green area must be followed. As per the current analysis all the open area is having dense vegetation but is mostly naturally grown. Hence for this analysis we consider such space as existing green space. But to enhance the vegetation according to the norms the IIE Kotdwar needs 1,385 trees to be procured. Whose details are given as under.

Table 6 Procurement statistics of IIE Kotdwar

IIE Kotdwar	
Class	No. of Trees
Road dividers	254
Road side	553
Industrial premises greater than 6 Ha	0
Industrial premises between 1 to 6 Ha	578
Open	0
Total	1,385

12.2.4 IIE Haridwar:

IIE Haridwar already has the sufficient greenery norms and has 19.51% of its industrial park area as green area, while required was only 15%. As per the field study IIE Haridwar is well developed and maintained as per the greenery infrastructure is considered. Very less of its potential green space is found to fall under non industrial premises type potential green space. It requires only 7,644 trees to be procured for the development of greenery in its open and road divide type potential green space. As per the analysis the potential green space inside the industrial premise is found to be requiring procurement of 27,926 trees. But these trees must be procured after the analysis of the trees already present inside the industrial premises. In all the IIE Haridwar has the potential to increase its greenery area up to 29.22% which can be achieved by procurement of trees as described as under.

Table 7 Procurement statistics of IIE Haridwar

IIE Haridwar	
Class	No. of Trees
Road dividers	137
Road side	0
Industrial premises greater than 6 Ha	6334
Industrial premises between 1 to 6 Ha	21592
Open	7507
Total	35,570

12.2.5 IT Park Dehradun:

IT Park Dehradun is having only 5.15% of the area as green area and needs to satisfy the norm by increasing it upto 10%. As per the analysis IT Park has the potential to increase the green area up to 11.26%. That would require 1,836 trees to be planted. Considering a safety factor of 1.5 times, 2,754 trees can be procured. Whose details are presented as under.

Table 8 Procurement statistics of IT Park Dehradun

IT Park Dehradun	
Class	No. of Trees
Road dividers	0
Road side	206
Industrial premises greater than 6 Ha	0
Industrial premises between 1 to 6 Ha	1630
Open	0
Total	1,836

Appendix A: Plantation Guide

List and images of some plants according to the norms of central pollution control board is presented below. This selections done on the basis of the agro-climatic zone of Utrakhand, soil type and average rainfall received in the region.

Acacia catechu, Wild



Acacia dealbata Link



Acacia leucophloea Wild



Acacia mellifera (Vahl) Beth



Acacia pennata Wild



Acacia senegal Wild



Acacia tortrirs Hayne



Acer campbellii Hook F. and Thoms



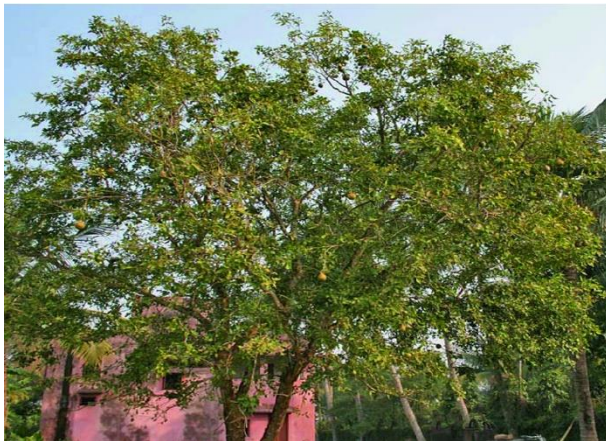
Acer negundo linn



Actinodaphne angustifolia Nees



Aegle mormelos (linn) Correa



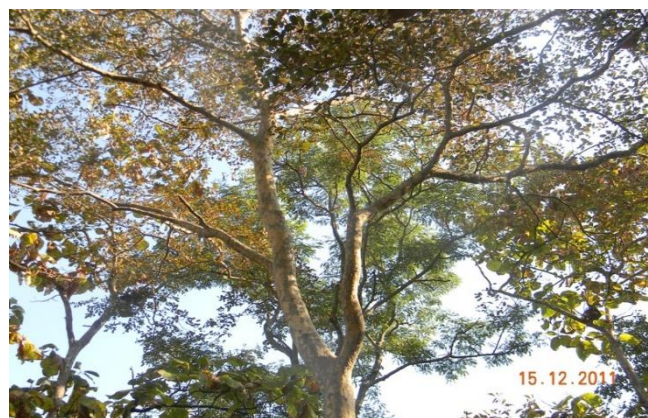
Alangium chinense (lour) Harms



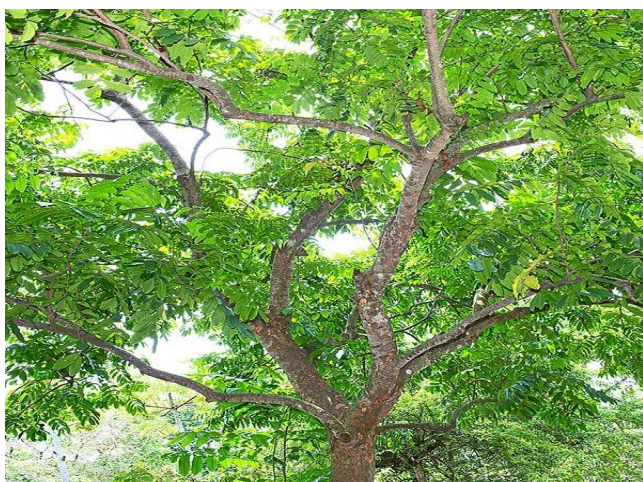
Alnus nitido Endl



Anogeissus latifolio Wall



Aphono mixis polystachya (Wall) Porker



Azadirachta indica A. Juss



Borringtonio ocutongu lo (L) Goertn



Bouhinio Acuminato Linn



Butea monosperma Lamk



Callistemon citrinus (Curtis) stapf



Calotropis procera (R.Br) Ait



Carissa spinarum Linn



The list of indoor plantation is as under

Peace Lily



Philodendrons



Pothos



Aglaonema



Nephtytis



Anthuriums



Dracaena



Palms



Ficus trees



Sansevieria



Succulents



ZZ plant





Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn und Eschborn

Friedrich-Ebert-Allee 32 + 36
53113 Bonn, Deutschland
T +49 228 44 60-0
F +49 228 44 60-17 66

E info@giz.de
I www.giz.de

Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Deutschland
T +49 61 96 79-0
F +49 61 96 79-11 15