THE BENGALURU
URBAN FOREST MANUAL
2025

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PREFACE

The Evolution of Urban Forestry in India

Urban forestry in India has evolved significantly from its historical roots. While ancient India had abundant natural forests, organized urban green spaces emerged during the Mughal era with royal gardens and parks - a tradition continued by the British Empire. Iconic spaces like Lal Bagh and Cubbon Park in Bengaluru exemplify this legacy that continues to enrich urban landscapes today.

Modern planned urban forestry began with Lutyens' Delhi in the 1920s and 1930s, featuring extensive green spaces and tree-lined avenues. Post-independence India saw this vision expand to cities like Chandigarh and Bhubaneswar in the 1950s, Gandhi Nagar in the 1960s, and more recently, Naya Raipur in the 2000s. These initiatives integrated street trees, parks, and gardens as fundamental components of urban planning, with dedicated percentages of land in new developments reserved for greenery, beautification, and recreation. The meticulous design of these spaces by town planners and horticulturists has garnered public appreciation, establishing greenery as a hallmark of modern urban development.

Contemporary Challenges

Rapid urbanization has led to environmental deterioration, necessitating large-scale tree planting over the past five decades. While foresters have been engaged to enhance urban greenery, their expertise has traditionally centred on natural forestry rather than urban environments. Urban trees face distinctive challenges: constrained spaces, pollution exposure, artificial lighting, limited root growth area, and branch expansion restrictions. The potential hazards of falling trees or limbs in populated areas create additional complexities. These factors make urban forestry a specialized discipline focused not merely on tree cultivation but on enhancing urban residents' well-being.

In recognition of these challenges, the Ministry of Environment, Forests, and Climate Change launched "Nagar Van," India's first national urban forestry scheme, in 2020. This initiative now operates across multiple cities nation-wide. Many local authorities had already established Urban Forestry Wings decades earlier to manage their cities' green spaces. Today, most major Indian cities maintain such departments that collaborate with town planning authorities and city engineers to preserve existing trees and expand urban greenery.

The Imperative for Structured Urban Forestry

Adequate green cover has become essential for securing good air quality and enabling groundwater recharge in urban areas. Climate change further intensifies these challenges, potentially causing more frequent droughts, floods, and urban heat islands. Forestry professionals must adapt to these evolving conditions to meet public expectations for sustainable urban environments.

About This Manual

This manual represents a comprehensive effort to address urban forestry needs, establish appropriate infrastructure and processes, and build capacity to achieve international standards. It comprises two main sections:

1. **Administrative Framework (10 chapters)**: Addresses administration, processes, and management systems
2. **Technical Guidance (15 appendices)**: Covers specialized forestry practices and applications

A glossary is included for quick reference. Together, these elements encompass the entire spectrum of contemporary urban forestry while establishing norms, standards, and technical specifications to advance the field in the coming years. The manual provides a robust administrative framework and guidelines for systematic urban forest management, including provisions for capacity building and interdepartmental coordination.

Development Process

Treelands Foundation, an organization comprising retired forest officers from Karnataka State, was commissioned by the Bruhat Bengaluru Mahanagara Palike (BBMP) to develop this manual. As the foundation's head, I led this initiative with dedicated effort, extensive expert consultation, and a vision to extend urban forestry principles across India. The project commenced in September 2024, with an initial draft outline shared with BBMP Officers in January 2025. Their feedback informed subsequent revisions, culminating in a dedicated workshop in February 2025. The final document incorporates valuable suggestions from workshop participants and further consultations with experts, field staff, and NGOs actively engaged in urban forestry and wildlife conservation.

This manual holds the distinction of being India's first Urban Forest Manual, functioning both as an educational resource and a prescriptive guide. I am confident it will prove valuable to urban forestry practitioners, stakeholders, and interested readers alike.

I extend my gratitude to Sri Tushar Girinath, Chief Commissioner of BBMP; Smt. Preeti Gehlot, Special Commissioner (Forests, Environment and Climate Change Management); Sri B.G.L Swamy, Deputy Conservator of Forests; and Sri Santhosh Kumar, Assistant Conservator of Forest, BBMP, for entrusting us with this significant responsibility. I also thank my colleagues at Treelands Foundation, Sri D.A. Venkatesh and Sri K.D. Udapudi, for their thoughtful contributions and insightful feedback. The NGOs and experts who generously shared their expertise have enriched this manual considerably. I sincerely hope it will meet stakeholder expectations and serve the urban society effectively.

April 2025 Dr K.N. Murthy

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Abbreviations Used in this Manual

Abbreviation	Full Form
ACF	Assistant Conservator of Forests
APO	Annual Plan of Operations
BBMP	Bruhat Bengaluru Mahanagara Palike
BIAAPA	Bengaluru International Airport Area Planning Authority
BMRDA	Bengaluru Metropolitan Regional Development Authority
DCF	Deputy Conservator of Forests
DRFO	Deputy Range Forest Officer
FG	Forest Guard
FNB	Field Note Book
KFD	Karnataka Forest Department
KIADB	Karnataka Industrial Area Development Board
KPT ACT	Karnataka Preservation of Trees Act 1976
KTPP ACT	Karnataka Transparency in Public Procurement Act 1999
MB	Measurement Book
NGO	Non-Governmental Organisation
RET	Rare, Endangered and Threatened Species
RFO	Range Forest Officer
SSR	Schedule of Sanctioned Rates

CHAPTER - 1

PRELIMINARY

1.1. Short Title

This Manual shall be called "The Bengaluru Urban Forest Manual 2025".

1.2. Nature of this Manual

This Manual shall be deemed to be:

1.2.1. Byelaws within the meaning of Section 318 of the Bruhat Bengaluru Mahanagara Palike Act 2020 (hereinafter BBMP Act 2020).

1.2.2. Byelaws within the meaning of Section 71 of the Bangalore Development Authority Act 1976 (hereinafter BDA Act 1976) for the areas coming under their jurisdiction outside the City limits.

1.2.3. Byelaws within the meaning of Section 75 of the Karnataka Town and Country Planning Act 1961 for the areas coming under the jurisdiction of the Bengaluru International Airport Area Planning Authority (BIAAPA) and any other similar body notified by the State Government,

and

1.2.4. Regulations made under Section 30 under the Bengaluru Metropolitan Region Development Act 1985 (hereinafter BMRDA Act 1985) for the areas coming under their jurisdiction.

1.3. Purpose of this Manual

1.3.1. The overall objective of this Manual is to develop the Green Infrastructure of Bengaluru City on par with international standards and integrate it strongly with urban planning and management.

1.3.2. Provide nature-based solutions to urban problems, enhance the environmental quality and contribute to the well-being of the citizens.

1.3.3. Set the norms and standards for sustainable management of urban forests and decentralise its administration and management.

1.3.4. Prescribe the procedures and technical guidelines to provide permanent green cover to the areas listed in the BBMP Act 2020 or to carry out certain activities intended under this Act:

(a) Sections 129 and 210: Vesting of certain properties in Bengaluru City Corporation along with trees. These trees must be managed.

(b) Section 238 (n): Promoting tree planting and maintenance of the trees on private properties.

(c) Section 254: Prohibition of nuisance by persons against trees.

(d) Section 257: Precautions to be taken in case of dangerous trees.

(e) Section 260: Removal of noxious trees.

(f) Section 262: Pruning of trees.

(g) Discharging core functions of the BBMP listed at serial number (VIII) in Part (A) to the First Schedule to the BBMP Act for the promotion of Urban forestry, protection of the environment, promotion of ecological aspects,

and

(h) Discharging the sectoral functions related to Environment and Social Forestry listed in Part C (II) of the First Schedule to the BBMP Act.

1.3.5. The BDA and BMRDA were constituted as statutory bodies to discharge the functions of the planning and development activities of Bengaluru City. This was done by inserting sections 80 (B) and 80 (C) in the Karnataka Town and Country Planning Act 1961. They are required to act in aid of the BBMP. BIAAPA was also established for similar purposes. All of them get parks, civic amenity sites, roads and other unassigned lands in the approved development layouts to BBMP once the development of the layouts is completed. Urban forestry similar to that of Bengaluru City has to be developed during the process of layout development. This Manual will guide the BDA, BMRDA and the BIAAPA to establish adequate green infrastructure to meet the local urban needs on par with Bengaluru City.

1.4. Effective date

Provisions of this Manual shall come into force immediately after it is published in the Official Gazette, as per sections 322 (1) and (2) of the BBMP Act 2020.

1.5. Applicability

1.5.1. The provisions of this Manual apply to urban forestry activities in Bengaluru City and its Peri-Urban areas, which are managed by BDA, BMRDA and BIAAPA. It may also be extended to streets, parks and other open areas of KIADB within the peri-urban areas.

1.5.2. Further, the State Government, by notification, may extend the provisions of this Manual to any other Urban Local Body or its Planning/Development authorities in and around Bengaluru City and also elsewhere in the State.

1.6. Definitions

1. **Amenity Tree** means and includes any tree grown in an urban area essentially to provide environmental services.
2. **BBMP** means Bruhat Bengaluru Mahanagara Palike (Bengaluru Metropolitan City Corporation in English).
3. **Chief Commissioner** means the Chief Commissioner of BBMP.
4. **Director** means the Director of Urban Forestry in BBMP.

5. **Hazard** means an event that is likely to cause harm to people or property, no matter how big or small.
6. **Hazardous tree** means a tree in proximity to people or property that could be harmed or damaged if the tree or its limbs were to fall.
7. **Inner City** means and includes all city zones at the centre of the city and is surrounded by other city zones on all sides.
8. **Juvenile tree** means a young tree aged more than three years, has a collar girth of at least 30 cm and a height of not less than 5 m.
9. **Nuisance tree** means and includes any tree that creates problems for the people living near them and harms.
10. **Outer City** means and includes all city zones located on the outskirts or periphery of a central city and have an interface with a peri-urban area.
11. **Peri-urban Area** is the area that is within the planning area limits but outside the limits of Bengaluru city.
12. **Private tree** means a tree found or grown on land granted or alienated in favour of private individuals or entities.
13. **Public tree** means a tree found or grown on land belonging to the city corporation, State or Central Government or their undertakings or to the local communities.
14. **Risk** means the likelihood of an event with potential adverse consequences taking place.
15. **Special Commissioner** means the Special Commissioner of BBMP in charge of the Urban Forestry Wing.
16. **State Government** means the Government of Karnataka.
17. **Tree Authority** means the Authority constituted under section 3 of the Karnataka Tree Preservation Act 1976 for Bengaluru Urban area.

18. **Tree Inspector** means a Deputy Range Forest Officer working under the administrative control of a Tree Officer.

19. **Tree Maintenance** means and includes all such activities that are intended to promote growth, maintain natural form, mitigate the risks and enhance the longevity of a tree.

20. **Tree Officer** means the forest officer notified as such by the competent authority under the Karnataka Preservation of Trees Act 1976 to be in charge of forestry affairs in a BBMP Zone.

21. **Tree Injury** means and includes killing the tree by poisoning, girdling, burning, uprooting, crushing, severing the trunk from the roots, throttling the root collar with concrete or metal, hard paving the root zone, excessive pruning or any action that may eventually lead to the death of the tree.

22. **Urban Forest** is a landscape of amenity trees within the geographical limits of an urban area and its peri-urban surroundings. It need not be a forest on record or be a notified forest. Hence, it will not attract the provisions of the Forest Conservation Act 1980.

23. **Urban Forestry** means and includes the professional practice of planning, planting, protecting, maintaining, regulating, removing and harvesting natural or planted trees in an urban or peri-urban area.

24. **Urban Forest Authorities** means and includes all forest officers working in urban and peri-urban areas dealing with Urban Forestry activities, not below the rank of a Tree Planting Supervisor.

25. **Urban wildlife** means and includes all such wild animal species listed in the schedules of the Wildlife (Protection) Act 1972 that inhabit urban areas or urban-rural interfaces.

Other definitions not listed herein shall have the same definition and meaning as in any other law, rule or regulation in force for the time being.

Key technical words used in this Manual have been defined and/or described in the glossary at the end of this Manual.

1.7. Interpretation

If any doubt arises on any technical word(s) used in this Manual, the matter should be referred to the Bengaluru Urban Tree Authority for resolution.

The Chief Commissioner or the Heads of respective planning or development authorities should resolve the procedural issues if there is any conflict between the procedure prescribed in this manual with the existing provisions in their respective organisational procedures consistent with the spirit of environmental conservation.

1.8. Issuing clarifications

The Chief Commissioner, after placing the matter before the Executive Committee on Urban Forestry constituted under proviso 2.1.2 of Chapter 2 of this Manual, may issue any clarification on any provision in this Manual consistent with the laws, rules, regulations and conservation ethos.

1.9. Amendments to this Manual

The Authority that approves this Manual alone will be competent to make any amendments to the provisions of this Manual.

1.10. Exclusions

Provisions of this Manual apply to urban forestry-related activities only. They do not apply to ornamental shrubs, climbers, horticultural crops or orchards grown on public or private lands.

1.11. Severability

If any provision of this Manual is found to be invalid or unenforceable, stayed or invalidated by a court of law, the remaining provisions will remain unaffected and therefore continue to be in force.

1.12. Applicability of Other Acts and Rules

This Manual is supplementary to the existing laws, rules, and regulations. In case of any contradiction between any law, rule or regulation, the provisions of this Manual will stand corrected to that extent.

CHAPTER – 2

ORGANISATION OF THE URBAN FORESTRY WING

2.1. Overview of the Organisational Structure

The cities are growing, and more people are migrating to urban areas. Rapidly expanding cities are coming under environmental stress. The existing administrative arrangements to manage urban forestry that are necessary to abate the environmental problems may not be able to meet challenges. A more holistic and comprehensive administrative arrangement on the following lines is necessary to meet future challenges. The Urban Forest Wing requires the following arrangements:

2.1.1. A Governing Council at the State level.

2.1.2. An Executive Committee at the Local Body level.

2.1.3. A Director for Urban Forestry.

2.1.4. Assistant Conservator of Forests to assist the Director.

2.1.5. A Coordination Committee at the Zonal Level.

2.1.6. Tree Officers at the Zonal Level.

2.1.7. Tree Inspectors and Tree Planting Supervisors.

2.1.8. A Tree Warden at the Ward level.

2.1.9. A Ward Forest Sub-Committee for Urban Forestry.

Of the above, the Director, Assistant Conservators of Forests, Tree Officers, Tree Inspectors and Tree Planting Supervisors shall be forest officers taken on deputation from the Karnataka Forest Department against sanctioned posts in BBMP.

2.2. Date from which the Above Authorities Come into Effect

If they are not already in existence, the above-listed authorities shall come into effect from the date this manual is approved by the competent authority. They shall discharge their functions accordingly.

2.3. Pre-existing bodies and authorities

The following organisations are already working in BBMP:

2.3.1. A Standing Committee constituted under Section 80 (G) of the BBMP Act 2020 deals with the Horticulture Department. It primarily consists of elected members of the City Council. They also deal with urban forestry matters, though it is not explicitly mentioned in the BBMP Act. They deal primarily with the budget, works of public interest and complaints and review the progress.

2.3.2. The Bengaluru Urban Tree Authority, constituted under Section 3 of the Karnataka Preservation of Trees Act 1976 in the GO no. FEE 49 FAF 2016 dated 18-08-2016 is responsible for discharging the duties prescribed under Section 7 of that Act. However, the resources for discharging their duties are not placed at their disposal. So, the Tree Authority has been playing a limited role in hearing appeals against the rejection of tree-felling permissions under Section 14 of the Act.

2.3.3. Tree Expert Committee: Further, based on a direction issued by the Hon. High Court of Karnataka, the State Government appointed an **Expert Committee** in GO no. FEE 41 FAF 2019 dated 01.08.2019 to examine if the trees in the city proposed for removal for development projects can be saved and advise the Tree Officer. This Expert Committee has been working with the BBMP Forestry wing since then. They inspect the trees to be removed in specific cases referred to them by the BBMP and give their opinion. Their opinion is placed before the Court before issuing tree felling permission.

2.4. Urban Forest Governing Council

2.4.1. Composition: The State Government may constitute a Governing Council for Urban Forests at the state level under the Chairmanship of the Additional Chief Secretary to Government of Karnataka in the Urban Development Department with such members as it deems fit and, on such terms, as may be considered appropriate.

2.4.2. Functions: The Governing Council will be responsible for shaping urban forestry in the State. It will be responsible for framing the law, policies, objectives, strategies, staffing, budget, and regulations for establishing the green infrastructure on a sound footing; determining the urban local bodies that will implement the Urban Forest Program, reviewing and taking stock of the progress annually, evaluation of the impacts and taking steps for making the urban forestry more effective.

2.5. The Executive Committee on Urban Forestry

2.5.1. Composition: There shall be an Executive Committee for Urban Forestry consisting of the following officers:

(a) The Chief Commissioner of BBMP.

(b) The Special Commissioner (Forestry, Horticulture and Climate Change Management)

(c) Chief Executive Officers of BDA, BBMP, BIAAPA and any other planning or development agency.

(d) The Director of Urban Forestry.

The Chief Commissioner shall be the Chairperson, and the Special Commissioner will be the Convenor. The Chairperson may invite heads of the Horticulture Department, Estates Wing, Engineering Wing and the Finance Department in BBMP to the meeting. Forest Officers heading the Urban Forestry Operations in BDA, BMRDA, BIAAPA and other agencies like KIADB may attend the meeting along with their chief executive officers.

2.5.2. Functions: The Executive Committee shall meet as often as necessary but at least once a quarter. The Executive Committee will:

(a) Set the targets to be achieved to meet the urban forestry goals and objectives laid down in this Manual and find the ways and means.

(b) Coordinate and integrate urban forestry activities with the works of other development wings in BBMP headquarters.

(c) Ensure that uniformity is maintained in the urban forestry operations across BBMP, BDA, BMRDA and BIAAPA.

(d) Guide the Zonal Coordination Committees for implementing the Urban Forestry Activities effectively.

(e) Make sure that urban forestry meets the expectations of citizens.

2.6. Chief Commissioner

As the Chief Executive Officer of BBMP, he will provide the overall supervision, guidance and support to the Urban Forestry Wing.

2.7. Special Commissioner

(a) He is the convenor of the Executive Committee on Urban Forestry.

(b) He will coordinate and personally supervise the activities of Forestry, Biodiversity, Climate Change, and Horticulture activities of BBMP. He will review their progress and guide the control of their activities.

(c) He will coordinate the activities of the above wings with the other departments and wings of BBMP.

2.8. Director of Urban Forestry

He is the highest-ranking forest officer deputed by the State Government in the rank of Deputy Conservator, Conservator or Chief Conservator of Forests to head the BBMP Forestry Wing. He is responsible for:

(a) Responsible for overseeing the implementation of urban forestry activities in urban and peri-urban areas according to Governing Council and Executive Committee directions.

(b) Ensures works are completed on time with proper quality, quantity, and adherence to prescribed procedures.

(c) Coordinates with other BBMP wing heads, extended organizations, Karnataka Forest Department, academic/research institutions, corporate sector, NGOs, and other key stakeholders.

(d) Reports to the Chief Commissioner through the Special Commissioner.

(e) Oversees urban forestry in peri-urban areas and reports progress to the peri-urban planning/development agency chief when no designated forest officers exist. He is responsible for the following forestry-related activities:

  (i) Preparing and implementing urban forest management plan

  (ii) Managing officer and staff appointments to the forest wing

  (iii) Enforcing discipline among staff

  (iv) Supervising subordinate officers

  (v) Managing tenders and contractor appointments

  (vi) Passing estimates and issuing work orders

  (vii) Controlling work quality

  (viii) Approving bills and recommending payments

(ix) Rendering monthly accounts

2.9. Assistant Conservators of Forests

Four Assistant Conservators of Forests will assist the Director in discharging his/her duties effectively. They will discharge the following functions:

2.9.1. Assistant Conservator of Forests (Plant Production): He shall oversee Plant Production Activities. Working with institutions and/or qualified contractors, he must ensure the production of high-quality juvenile trees representing at least 100 different species in sufficient quantities to meet planting requirements across urban and peri-urban Bengaluru. Officers managing urban forestry in peri-urban areas should obtain planting materials from BBMP. He must fulfil demands for compensatory planting materials and meet general public requirements. He bears responsibility for the bulk production of quality planting materials to satisfy all planting material demands.

2.9.2. Assistant Conservator of Forests (Urban Wildlife): He/she shall manage urban wildlife within BBMP areas. He/she will supervise Wildlife Rescuers and Wildlife NGOs operating in the city while coordinating closely with local Wildlife Officers and Police. He/she will be responsible for rescuing and rehabilitating trapped, sick, injured, or seized wildlife within city limits as per the Wildlife (Protection Act 1972) and guidelines from the Central Zoo Authority and Chief Wildlife Warden of Karnataka. He/she will participate directly or through volunteers in tree maintenance and removal operations to minimize urban wildlife disturbance and, where possible, create suitable habitats for urban wildlife to thrive. He/she must ensure prompt response to public calls and conduct activities to raise awareness about wildlife conservation among youth and the general public.

2.9.3. Assistant Conservator of Forests (Urban Forestry): Two Assistant Conservators of Forests (Urban Forestry) will operate, one in the north and one in the south. They shall oversee tree planting and maintenance across the city, with zones divided equally between them. They will work closely with the Zonal Commissioner and zonal heads of other BBMP wings to supervise forestry operations in their jurisdiction. Additional officers may be assigned to urban forestry operations based on workload requirements. If necessary, these positions may be relocated to the appropriate zonal headquarters.

The Assistant Conservator of Forests (Urban Forestry) shall supervise Range Forest Officers and also their subordinates, inspect and check-measure their works and ensure work quality and quantity. They will schedule activities according to the approved Urban Forest Management plan or, in its absence, follow the Director's instructions. They will address public grievances and dispose of them promptly.

2.10. Zonal Coordination Committees

2.10.1. Composition: The Zonal Coordination Committee shall consist of the following members:

(a) Joint Zonal Commissioner - Chairperson

(b) Zonal officers of Engineering, Estate, and Horticulture in BBMP

(c) Local heads of BESCOM, BWSSB, BSNL and other utility companies

(d) One wildlife NGO representative (nominated by Zonal Commissioner, 3-year tenure)

(e) One forest/environment NGO representative (nominated by Zonal Commissioner, 3-year tenure)

(f) Jurisdictional Assistant Conservator of Forests (Urban Forestry) - Convener

(g) Tree Officer of the zone - Invitee.

2.10.2. Functions of the Zonal Coordination Committee: The committee oversees the implementation of upcoming quarterly urban forestry projects in the zone and coordinates necessary preparations across BBMP wings and utility companies. They will convene as needed but no less than once per quarter. Any member may request a meeting. A detailed action plan will guide urban forestry work execution. Similarly, other members will present their work requirements and request Urban Forestry Administration assistance with tree-related matters. All members will collaborate to ensure smooth project execution without service disruptions, public inconvenience, or excessive tree damage or loss

2.11. The Tree Officers

Range Forest Officers posted on deputation to BBMP or its sister organizations will serve as Tree Officers. Due to the smaller size of city zones, each officer qualifies as a Tree Officer under section 5.2 (ii) of the Karnataka Preservation of Trees Act, 1976. The Chief Commissioner will formally designate them as Tree Officers to decentralize urban forest administration and provide prompt public services. Each Tree Officer shall be provided with an independent office within the BBMP zonal office, space for nursery activities, storage for harvested wood from the zone, and facilities for other forestry activities.

The Tree Officer reports to the Director through the Assistant Conservator of Forests. At least one Tree Officer will be assigned to each zone. Their responsibilities include supervising nursery activities, tree planting, maintenance, removal, disposal of harvested materials, wildlife management oversight, and all other urban forestry-related work. Their office serves as the zonal-level unit for all public contacts and urban forestry services, including tree removals and wildlife issues. All field staff working in the zone, Tree Wardens, and environmental and wildlife NGOs operate under their supervision and report to them. They prepare estimates, supervise subordinates and contractors, prepare bills, and arrange payments. They submit monthly accounts and progress reports to the Director through their respective Assistant Conservators.

2.12. Tree Inspectors

Deputy Range Forest Officers posted on deputation to BBMP will serve as Tree Inspectors. There should be at least one Tree Inspector per city zone, with a minimum ratio of one inspector per one lakh urban trees or a fraction thereof. Additional Tree Inspectors should be appointed in zones with higher tree populations. They are responsible for systematically inspecting all trees within their jurisdiction, reporting to the Tree Officer, obtaining necessary permissions, and implementing timely tree maintenance or removal through contractors appointed by the Director. Their duties include mitigating tree risks and minimizing potential harm to people and property. They must ensure the safe delivery of harvested materials to the depot, release sold materials with proper transit permits and maintain accurate wood depot accounts. They are responsible for protecting all trees and will initiate penal action against offenders under the Karnataka Tree Preservation Act 1976.

2.13. Tree Planting Supervisors

Forest Beat Guards posted on deputation to BBMP will serve as Tree Planting Supervisors. There should be at least one Tree Planting Supervisor for each zone. Their primary responsibility is to work closely with Tree Wardens to identify locations for planting at least 500 trees annually in each ward, prepare sites, and supervise contractor plantation work. Each Tree Planting Supervisor should facilitate the planting of at least 10,000 trees annually within their zone. If planting targets exceed this figure, additional Tree Planting Supervisors may be appointed on contract from retired Karnataka Forest Department staff. Tree Planting Supervisors are also responsible for monitoring planted tree performance, reporting any issues to the Tree Officer, supervising the contractor's plant production activities, and keeping the Tree Officer informed of developments. They will also support urban wildlife initiatives.

2.14. Tree Wardens

Tree Wardens are ward-level field staff appointed on contract by the Director, similar to contract staff in other BBMP wings (horticultural parks, lake protection, solid waste management, etc.). Initially, one Tree Warden may oversee 2-3 wards, with individual ward appointments possible if workload demands. Appointees should hold degrees in botany, forestry, agriculture, or horticulture. Eligible candidates include home guards, forestry graduates, retired Karnataka Forest Department staff, or ex-service personnel residing within that city zone. Hiring should be done through a human resource supply agency. Home Guards with botanical, forestry, or agricultural knowledge may be appointed under the same terms as other BBMP wings.

The Tree Warden serves as the interface between the public and Urban Forest Administration at the ward level. Each will be provided with a desk and computer terminal at the ward office and should maintain office hours on dates and times approved by the Tree Officer to receive applications, complaints, and representations from the public. Working with Ward Forest Sub-Committee members, they will survey ward trees, potential planting sites, local wildlife, etc., providing feedback to field staff and Tree Officers. They will monitor all trees within the ward, including those in public parks, and report problems (including wildlife issues) to the Tree Officer. Tree Wardens will fulfil the duties and responsibilities outlined in various chapters of this Manual and maintain systematic records.

2.15. Ward Forest Sub-Committees

Section 82 of the BBMP Act 2020 mandates the appointment of a Ward Committee. Sections 83, 84, and 85 prescribe the composition, nomination procedures, and meeting requirements. Functions are outlined in Section 86, including urban tree and park maintenance (section 86{o}). Section 88 allows for sub-committee appointments focused on specific topics. As urban forestry is a highly specialized and complex subject, a Ward Forest Sub-Committee shall be formed with 5 members one each from the north, south, east, west and central areas of each ward. The Director will appoint them with the help of local BBMP council members. If there are no such members, he will solicit applications from the public, evaluate candidates for suitability, and appoint them for 3-year terms. The Tree Warden will serve as the Sub-Committee Convenor.

This Sub-Committee will meet as needed but at minimum once fortnightly to discuss urban forestry issues in the ward and provide recommendations. Members will survey the ward to assess planting spaces, identify hazardous trees, report tree or wildlife violations, and communicate findings to relevant staff and the Tree Officer. Working alongside the Tree Warden, they will function as the Urban Forest Wing's monitoring system. Their reports will receive prompt attention. Members making significant contributions will receive annual recognition awards. Tree Planting Supervisors and Tree Inspectors may request their assistance when necessary while keeping them informed of ongoing urban forestry activities in the ward.

2.16. Office Staff

The BBMP will provide the required office staff to the Director and the Tree Officers who are required to run independent offices. The scale of staff should be commensurate with the office workload. In case of shortage, the Director, with the previous approval of the Chief Commissioner, may hire necessary staff on contract through human resources supply agency.

2.17. Organisational Chart and List of Duties and Responsibilities

An organisational Chart of the Urban Forestry Wing in BBMP is placed in Appendix I. The list of duties and responsibilities of each functionary abstracted from this Manual is placed in Appendix XV.

2.18. Organisational Arrangements in Peri-urban Areas

Administrative arrangements, rules, regulations, and functioning of BDA, BMRDA, BIAAPA, and KIADB which operate in peri-urban areas, differ from one another. While BDA may have forest officers, others don't. However, the provisions of this Manual apply mutatis mutandis to all these organizations.

To implement the provisions of this Act, the heads of these organizations may seek assistance from the Director and forest officers working in BBMP, or request the Head of the Karnataka Forest Department to nominate local officers. He may nominate local territorial officers to manage, maintain, or remove trees, and social forestry officers to plant trees in new layouts as per this Manual. Such nominated officers shall work closely with the Director, follow the provisions of this Manual and carry out the prescribed duties.

2.19. Functions of Urban Forest Wing

The Urban Forest Wing is responsible for executing a comprehensive range of urban forestry functions, including:

(i) **Tree census management:** Conducting systematic surveys and documentation of existing tree populations within urban boundaries.

(ii) **Urban forest planning:** Developing and implementing strategic management plans for sustainable urban forestry.

(iii) **Elite Tree Selection:** Identifying superior tree specimens and securing appropriate seed sources to maintain genetic quality.

(iv) **Plant production operations:** Establishing and maintaining nurseries to produce high-quality planting materials for urban forests.

(v) **Tree stock enhancement:** Implementing programs to improve the diversity, health, and sustainability of urban tree populations.

(vi) **Proactive tree care:** Conducting regular maintenance activities and implementing preventive management practices for urban trees.

(vii) **Urban wildlife conservation:** Managing and protecting wildlife populations within urban forest ecosystems.

(viii) **Public complaint resolution**: Addressing citizen concerns related to urban trees and forest management.

(ix) **Monitoring and evaluation:** Arrange for periodic monitoring and evaluation to improve the program delivery and its effectiveness.

(x) **Documentation:** Maintaining comprehensive records of all urban forestry activities, tree inventory, and management interventions.

They should serve the citizens with dedication.

2.20. Responsibilities of Urban Forestry Wing

The Urban Forest Wing is entrusted with achieving the following strategic long-term outcomes:

(i) **Enhancement of urban forest cover:** The Urban Forest Wing shall work toward increasing urban forest coverage to meet internationally recognized standards, ensuring adequate green cover throughout the urban landscape.

(ii) **Biodiversity restoration:** The Urban Forest Wing shall implement programs focused on improving and restoring native biodiversity, prioritizing indigenous plant species and creating sustainable habitats for local fauna.

(iii) **Green infrastructure integration:** The Urban Forest Wing shall develop comprehensive plans to connect existing green spaces, creating an integrated network of urban forests, parks, gardens, and other vegetated areas to maximize ecological benefits.

(iv) **Equitable access to recreational spaces:** The Urban Forest Wing shall ensure the fair distribution of recreational green spaces across all neighbourhoods, providing equitable access to natural environments for all urban residents.

(v) **Community engagement:** The Urban Forest Wing shall develop and implement mechanisms for meaningful community participation in urban forestry initiatives, fostering public stewardship and shared responsibility for urban forest resources.

CHAPTER - 3

BUILDING THE GREEN INFRASTRUCTURE OF BENGALURU CITY

3.1. The Need for Green Infrastructure

Bengaluru, as Karnataka's state capital and a significant economic hub, depends extensively on robust infrastructure to sustain its growth trajectory. This infrastructure encompasses physical elements such as transportation networks, commercial and residential buildings, government facilities, educational institutions, and healthcare centres. Additionally, the city's prosperity relies on intangible assets including skilled human capital and financial service providers.

The city's rapid urbanization and economic expansion have generated considerable challenges, including water scarcity, elevated pollution levels, environmental degradation, traffic congestion, and increased security concerns. These issues are particularly significant for Bengaluru, which historically earned recognition as India's "Garden City" due to its lush landscapes and pleasant climate.

Today, Bengaluru faces the critical dual challenge of maintaining economic momentum while preserving its environmental heritage. In this context, green infrastructure development represents an essential strategy for mitigating environmental concerns while enhancing urban liveability and long-term sustainability. By integrating natural elements into urban planning, the city can address ecological challenges while supporting continued economic development

3.2. Definition and Meaning of Urban Green Infrastructure

Urban Green Infrastructure (UGI) is a strategically planned network of natural and semi-natural spaces within urban environments that are designed to deliver a wide range of social, environmental and ecosystem services. More specifically, Urban Green Infrastructure is an interconnected system of natural, semi-natural, and constructed ecological elements that exist across public and private lands within an urban setting. This infrastructure functions as a holistic, planned network rather than isolated patches of greenery. It is connected to the natural landscapes in its neighbourhood.

3.3. Components of Urban Green Infrastructure

Urban Green Infrastructure consists of two primary components:

3.3.1. Green Component: This includes lands with perennial greenery, both public and private. Public lands encompass reserved forests, hills, riverine forests, grasslands, parks, green belts, and street trees. Private lands include institutional woodlands, orchards, farmlands, home gardens, and green roofs or walls.

3.3.2. Blue Component: This comprises water bodies and wetlands, such as rivers, lakes, ponds, streams, swaps and rainwater recharge structures.

3.3.3. Other dimensions: Urban Green Infrastructure also covers aspects like green buildings and climate mitigation strategies that extend beyond traditional urban forestry. They are beyond the scope of this manual.

3.4. Key Attributes of Urban Green Infrastructure

Urban Green Infrastructure has several key characteristics:

3.4.1. It is planned for the city level: It prioritizes environmental considerations and ecosystem services as primary design factors rather than afterthoughts. It should become an integral part of city planning and development. It is not to be treated as a fringe element.

3.4.2. Its elements are networked: It focuses on creating connected networks of natural, semi-natural, or artificial landscape features across public and private lands and does not just deal with isolated parks or green spaces. It spans the built environment, farmlands, watersheds and so on. For example, it may connect the waterscape in Thippegon-dananahalli reservoir in Magadi Taluk to the natural forests in Jadigenahalli in Hoskete Taluk and connect Banneraghatta National Park on the south to Hesaraghatta grasslands on the north through the street/roadside trees, which serve as corridors, and several public parks and private woodlots on the way, which serve as nodes. The flora and fauna can move through this network from one end of the city to the other.

3.4.3. It is multipurpose: It seeks to provide nature-based solutions to multiple urban challenges (like flooding, noise, dust or heat islands) rather than relying exclusively on engineered solutions. It also addresses the needs of multiple stakeholders. Each corridor or node of the green infrastructure may serve a different purpose, like giving shade to streetwalkers, serving as a recreational park for friends and families, protecting a stream bank or a lake, serving as a shelter for the local market, serving as an urban wildlife habitat, etc.

3.4.4. It is a collaborative effort: Green Infrastructure requires sectoral collaboration among diverse professional disciplines, including engineering, architecture, forestry, horticulture, agriculture, and ecology. It also requires collaboration across departments and agencies of the Central and State Governments and their numerous parastatals. The corporate sector and the NGOs also should collaborate. They all have to come together to discuss, plan and implement the green infrastructure holistically across the lands belonging to a multitude of parties.

3.4.5. It connects people and nature: Ultimately, the green infrastructure serves as a bridge between urban communities and nature, restoring essential connections often lost in city environments. This is an important reconnect that people need to save themselves from the daily stress of urban life. It is also a reconnect for all the people who have recently arrived in the cities from rural areas or those who live in slums and other congested locations and hardly have any free space around their homes.

3.5. Global Green Infrastructure Standards

Globally recognized standards for Urban Green Infrastructure, reflected in programs like UN Sustainable Development Goals and Smart Cities initiatives, include the following:

(1) Green canopy over 30 - 40% of the city's geographical area.

(2) At least 1 hectare of publicly accessible green space per 1,000 people living in the city.

(3) Green recreational areas should be accessible within a 15-minute walking distance from the home of any citizen.

(4) Recharge 30% of rainwater runoff into the ground to prevent flooding of low-lying areas.

(5) Conservation of wetlands and protecting them from pollution.

(6) Conservation and restoration of native flora and fauna.

(7) Networking blue and green infrastructure components.

(8) No net loss of the ecosystem capacity.

(9) Community involvement, cleanliness, safety, and open access to green infrastructure area.

These fundamental principles should underline the green infrastructure development in Bengaluru, which is already a megapolis (having a population of more than one crore) and facing several challenges.

3.6. Green Infrastructure Standard for Bengaluru City

Which of the above global standards to pursue can be very confusing. It is not easy to choose or leave either. Ideally, each city should have its own standards. Keeping in mind the specific context, the standard for Bengaluru City shall be encapsulated in the slogan "One tree for one Bengalurian". This is no doubt a big challenge. It can't be achieved quickly, given the baseline situation of having one tree for seven people at present. But it can be achieved in a phased manner through planned efforts.

3.7. Benefits of Urban Green Infrastructure

Human beings always lived in the company of trees and nature because they confer many benefits. Trees are particularly important in urban areas because they provide the following environmental benefits:

(1) **Improving air quality:** Trees absorb CO_2 and release oxygen, with one acre of mature trees absorbing the CO_2 produced by a car driven 26,000 miles annually. Each mature tree absorbs approximately 22 kg of CO_2 per year. Trees filter pollutants including sulphur dioxide, nitrogen oxides, and particulate matter, with mature trees capturing 120-240 kg of particulate pollution annually.

(2) **Mitigating urban heat island effect:** Trees counter the 4-8°C temperature increase in urban areas through shade and transpiration. Their cooling effect can reduce ambient temperatures by 4-5°C, providing critical relief during heat waves. Trees combat climate change effects including extreme heat, droughts, and floods, gaining value over time as living infrastructure. They are the most cost-effective nature-based solution to climate change.

(3) **Noise reduction:** Urban trees act as natural sound barriers, with their structure absorbing, reflecting, and scattering sound waves.

Dense tree belts can reduce noise pollution by 5-10 decibels, equivalent to halving perceived noise. A well-designed 30-meter tree belt can reduce noise levels by up to 50%.

(4) **Health benefits:** Green spaces reduce stress levels by 16% and depression rates by 7%. Tree-rich neighbourhoods report 20% lower rates of obesity and respiratory diseases. They promote physical activity and help stabilize blood pressure.

(5) **Enhanced water management:** Trees intercept rainfall, reducing stormwater runoff by 2-7% and decreasing flood risks. Their roots prevent soil erosion and improve groundwater quality. This natural water management reduces pressure on drainage systems and provides municipal cost savings.

(6) **Energy savings:** Strategic tree placement around buildings reduces air conditioning needs by 30%, saving ₹3,000-5,000 per household annually while lowering greenhouse gas emissions.

(7) **Property value enhancement:** Trees beautify spaces and mask unsightly views. Properties with mature trees command 10-15% higher prices in Indian cities, making neighbourhoods more attractive to buyers and renters.

(8) **Community building:** Tree planting initiatives strengthen neighbourhood bonds and create opportunities for engagement across diverse urban populations. Shared green spaces foster social interaction and improve quality of life.

(9) **Pavement longevity:** Street trees extend pavement life by 40-60% through reduced thermal expansion and contraction. With proper installation and species selection, trees become valuable infrastructure assets.

(10) **Vehicle protection:** Trees provide microclimate refuges for parked vehicles, keeping them up to 20°C cooler than those in

direct sunlight. This protects vehicle interiors and improves driver comfort.

(11) **Supporting street vendors:** Tree-shaded spots offer premium business locations, extending perishable goods' shelf life by 2-4 hours. Vendors report 15-25% longer working hours and higher customer retention, with consistently higher foot traffic throughout the day.

(12) **Providing recreational space:** Tree-lined streets attract 2-3 times more walkers, joggers, and cyclists. When connected with parks, they create green corridors that extend recreational opportunities throughout urban areas.

(13) **Traffic calming:** Street trees naturally encourage drivers to reduce speeds by 5-15 mph. Tree-lined avenues experience up to 40% fewer accidents with lower collision severity, and surveys indicate reduced road rage incidents.

(14) **Crime reduction:** Areas with more tree cover experience fewer crimes. Well-maintained green spaces signal community care and oversight while encouraging greater use of public spaces and increasing natural surveillance.

(15) **Biodiversity support:** Urban trees provide critical habitats for wildlife, supporting about 20% of avian biodiversity in cities. They maintain ecosystems for birds, insects, and small mammals, contributing to ecological balance.

(16) **Educational opportunities:** Schools with green campuses show improved academic performance. Urban forests serve as living laboratories for environmental education across multiple disciplines.

In rapidly urbanizing India, trees offer multifaceted solutions to pollution, heat, and a host of challenges. Integrating urban forestry into city planning creates more sustainable, resilient, and liveable spaces with environmental, economic, health, and social benefits.

3.8. Partnership is Necessary for Developing the Green Infrastructure

(1) **Current Challenges**: Despite regulatory requirements mandating that landowners allocate portions of their property for the development of greenery, several challenges impede effective implementation. Urban residents frequently demonstrate a reluctance to designate limited land resources for tree planting. Instead, they often transfer responsibility to municipal authorities such as BBMP and various government entities for both space allocation and resource provision.

(2) **Resource Constraints:** Government bodies face their own constraints regarding land availability and financial resources. This collective limitation has significant consequences for the urban environment. Bengaluru's expansion has resulted in the removal of established trees to accommodate infrastructure development and road widening projects. Unfortunately, compensatory planting initiatives and attempts to introduce vegetation in newly developed urban extensions rarely offset these losses.

(3) **Path Forward:** The development of adequate urban greenery requires coordinated action among multiple stakeholders. Without collaborative efforts between citizens, local municipal bodies, and government institutions, Bengaluru will continue to experience challenges in establishing the necessary green infrastructure to support environmental sustainability and quality of life. Public cooperation is required at many levels.

Effective urban forestry demands shared responsibility and concerted action. Only through such collaborative approaches can the city successfully develop green spaces that can deliver the wide-ranging benefits listed above.

3.9. Amenity Trees are the Building Blocks of Green Infrastructure

Although open grasslands, horticultural gardens, and farmlands also serve as components of green infrastructure, amenity trees and natural forests are the core of this framework. Natural forests are rare in urban landscapes. Amenity trees are the largest component. They form the backbone of green infrastructure. The diversity in species, size, shape and floristics become significant. Native species are particularly well-suited due to their adaptability to local climatic conditions and their role in supporting wildlife. Overall, a good understanding of the structure, functions, and behaviour of amenity trees is essential to building urban green infrastructure. This understanding allows urban planners and environmentalists to make informed decisions in building sustainable green infrastructure.

3.10. Understanding the Amenity Trees

Persons, staff and officers who handle the amenity trees should understand several technical features of trees. In particular, they should know:

(1) Parts and functions of a tree.

(2) Life stages of a tree.

(3) Ratios and proportions of different parts.

(4) Branching patterns.

(5) Crown architecture.

Comprehensive notes on the above aspects are furnished in **Appendix I**. The crown architecture of tropical trees is given in **Appendix II**. Anyone dealing with amenity trees must go through these appendices and familiarise themselves with these basics.

3.11. The Framework for Developing Green Infrastructure in Bengaluru

Creating effective green infrastructure in Bengaluru requires a structured approach integrating planning, implementation, maintenance, and community engagement. The following framework is prescribed:

(1) **Create a proper administrative structure:** Create an administrative system to manage green infrastructure projects at the ward and city levels, with clear rules and procedures.

(2) **Develop standards and guidelines:** Create technical specifications for green infrastructure suited to Bengaluru's local conditions, emphasizing native species and reducing maintenance needs.

(3) **Assess existing resources:** Conduct an inventory of existing trees, green spaces, and water bodies, mapping their health and ecological connectivity.

(4) **Arrange for maintenance of existing trees:** Many of the existing trees have several defects. Some are hazardous. Scheduled pre-monsoon canopy maintenance is essential to mitigate damage to life and property. The existing arrangements should be further strengthened and streamlined.

(5) **Develop a Master Plan:** Use the inventory data to develop a master plan for developing the green infrastructure and managing it. Set realistic goals for greening, enhancing biodiversity, and expanding recreational spaces, aligned with international standards. Identify priority areas and opportunities for retrofitting grey infrastructure with green infrastructure.

(6) **Build the implementation capacity:** Identify a proper institute that can train and build the capacity of all stakeholders through workshops, courses, and certification programs. At present, there is a near vacuum in capacity building. Conventional forestry

practices, which are unsuitable for the urban context, are being followed. This should be overhauled.

(7) **Secure sustainable funding:** Allocate a dedicated percentage of the municipal budget to green infrastructure, supplemented by additional earmarked funds.

(8) **Take up pilot projects:** Start with demonstration projects to showcase green infrastructure types and educate the public, considering equity and corporate contributions.

(9) **Plant amenity trees regularly and systematically:** The current planting practices can't assure the citizens of guaranteed outcomes. A radical change in planting practices will be necessary. The fundamental shift should be from planting seedlings to planting juvenile trees, which can assure us of success.

(10) **Foster inter-departmental cooperation:** Promote integrated governance by establishing protocols for planning, implementing, and maintaining green infrastructure across departments and utility companies instead of working at cross purposes.

(11) **Document the protocols and outcomes:** Establish maintenance schedules, standards for different kinds of activities, and strong protocols that will drive urban forestry. Monitoring and evaluation should lead to adaptive management practices.

(12) **Engage strongly with local communities:** Encourage community involvement through programs and incentives. Develop citizen science initiatives and partner with schools for educational programs that promote hands-on engagement with green infrastructure.

Necessary provisions have been made in this Manual to create a strong framework incorporating the above elements.

3.12. The Vision

Reimagining Bengaluru as a living and breathing “Garden City” where trees line every street, lush parks serve as its lungs, lakes pulse with life, and every citizen finds shade, serenity, and a shared connection to nature by 2040 is the vision for Namma Bengaluru. This Manual will help in heading that direction.

CHAPTER -4

TAKING STOCK AND PLANNING FOR THE FUTURE

4.1. The Need to Take Stock of Urban Green Resources

Urban forest tree inventories are essential management tools that systematically document trees in the city. The inventory provides critical data on tree quantity, species diversity, condition, and distribution. This information is essential to identify hazardous trees and scheduling tree maintenance. It will also help where to plant more trees. Beyond these operational benefits, inventories enable the authorities to quantify valuable ecosystem services such as carbon sequestration, air quality improvement, and stormwater management. Such inputs serve as the foundation for comprehensive Urban Forest Management Plans which will guide the course of action for the next decade. The inventory information will also support evidence-based budget allocation. Additionally, inventories enhance climate resilience planning by identifying vulnerabilities in species composition and distribution. Overall, comprehensive tree inventories transform urban forests from aesthetic amenities into quantifiable assets that contribute measurably to public health, safety, and environmental sustainability.

4.2. Areas Where Inventory is to be Taken up

The urban forest inventory must encompass all city areas to provide comprehensive data for management planning. This includes public spaces (mini-parks, parks), transportation corridors (streets and highways passing through the city), institutional properties (schools, hospitals, educational institutions, public office premises etc), commercial districts, residential neighbourhoods, natural areas (reserved forests inside the city) green belts around lakes and riparian corridors), and new development zones. Additionally, peri-urban areas at the city-rural interface should be included as they often contain significant tree resources or are devoid of tree vegetation but are on the cusp of establishing new urban forests.

Leaving out any area from the inventory may leave gaps that can't be filled up later on. This all-encompassing approach ensures that management decisions are based on complete data, enabling cities to accurately assess ecosystem services, allocate resources effectively, and develop strategic plans for maintaining and enhancing the entire urban forest network over time.

However, certain exemptions as discussed in paragraph 4.6.6 below may become necessary. In all such cases, alternative means of obtaining the data should be explored.

4.3. Metrics for Measurement

Urban green infrastructure should be assessed using two key metrics: canopy cover and tree cover of each ward and also the city as a whole. These metrics are essential for understanding the spatial distribution and structure of urban treescapes for informing conservation, urban planning, and ecosystem management.

4.3.1. Canopy cover: Refers to the total area covered by vegetation, including trees, palms, shrubs, and any other green spaces, such as rooftop gardens, visible from above. Mapping canopy cover helps identify green areas in the urban landscape.

4.3.2. Tree cover: Specifically refers to the proportion of land occupied by trees. It indicates land use. Tree cover is measured as the percentage of land dedicated to trees, including individual trees, clusters, parks, green belts or forests.

4.3.3. Urban Biodiversity Index: Several cities across the world are measuring their biodiversity in the form of an index. This index, also known as the Singapore Index on Cities' Biodiversity (CBI), is a standardized framework designed to measure and monitor biodiversity conservation efforts in urban environments. It comprises 23 indicators organised into three core components:

(1) Native Biodiversity in the City (10 indicators): These indicators measure the presence of native species and protected natural areas within the urban environment:

(i) Proportion of natural areas in the city

(ii) Connectivity measures between natural areas

(iii) Native biodiversity in built-up areas (birds)

(iv) Number of native plant species

(v) Number of native bird species

(vi) Number of native butterfly species

(vii) Number of native mammal species

(viii) Number of native reptile species

(ix) Number of native amphibian species

(x) Proportion of protected natural areas

(2) Ecosystem Services Provided by Biodiversity (4 indicators): These indicators assess the functional benefits that urban biodiversity provides:

(i) Regulation of water quantity (permeable surface proportion)

(ii) Climate regulation (carbon storage and cooling effect)

(iii) Recreation and education (area of parks)

(iv) Public awareness (frequency of nature visits)

(3) Governance and Management (9 indicators): These indicators evaluate institutional capacity and processes for biodiversity management:

(i) Budget allocated to biodiversity

(ii) Number of biodiversity projects implemented

(iii) Existence of local biodiversity strategy

(iv) Institutional capacity

(v) Participation and partnership

(vi) Education and awareness

(vii) Inter-agency cooperation

(viii) Public consultation processes

(ix) Formal biodiversity conservation networks

Scoring System: Each indicator is scored on a scale of 0-4 points, with specific criteria defined for each scoring level. The maximum possible score is 92 points (23 indicators × 4 points). Cities typically establish a baseline assessment, and then conduct follow-up evaluations periodically to monitor progress. The normal period is 3 years. Since it means a lot of work at short intervals, it may be done once in ten years at the time of doing the tree inventory.

The index is designed for cities worldwide. Its standardized methodology facilitates meaningful comparisons between cities while accommodating local conditions and priorities in biodiversity conservation.

Several cities globally have adopted this index as part of their urban environmental management frameworks. It is a very useful tool worth applying to Bengaluru city also at the time of preparing the Urban Forest Management Plan. The indicators may be modified as required.

4.4. Methods of Measurement

4.4.1. Canopy cover measurement: This is done using remote sensing images or aerial photographs. LiDAR (Light Detection and Ranging) technology, an advanced version of aerial photography, offers higher precision and more detailed, accurate data, making it the preferred method when cost allows. Drone photography can also be employed. Scanners can automatically detect tree defects and assign risk scores, helping in risk mitigation. The canopy cover assessment is required to make an overall assessment of the city's green cover. It is also useful to check the network connectivity between green corridors and nodes to ensure the entire system functions as an integrated unit.

4.4.2. Tree cover survey: This is typically estimated through ground-based surveys conducted by trained crews. This method involves counting trees and recording their girth, height, canopy spread, and other dimensions. It can be contracted work or carried out by Tree Wardens in a campaign mode at the ward level with the help of students and NGOs, typically taking about a month to complete.

4.5. Mapping the Urban Canopy Cover

The urban canopy cover should be mapped using remote sensing techniques once every ten years or at shorter intervals to ascertain the extent of canopy cover gained or lost and observe its present spatial distribution. Environmental services of canopy cover are needed in all parts of the city. By observing its distribution, it is possible to identify deficient areas and initiate action to add more canopy cover depending on available open spaces and the nature and density of roads and buildings. Areas with less canopy cover should be listed as priority areas in the Urban Forest Management Plan.

4.5.1. Area coverage: Canopy cover is estimated by its spread in square kilometres. When expressed as a ratio to the total ward or city area, it reveals the proportion of the urban landscape with canopy cover and identifies its exact locations.

4.5.2. Density parameters: Canopy cover varies in density from 0% to 100%. A density of 0% indicates no canopy, while 100% represents a fully closed canopy, which is rare. The following canopy density classes are commonly recognized:

Sl. No	Canopy Density	Quality Class
1	10%	Very low
2	11-40%	Low
3	41-70%	Medium
4	>70%	High

4.5.3. Geographical scale: Canopy cover density should be estimated for each ward. Ward boundaries are subject to change over time. Hence, ward boundaries, and canopy cover should be estimated both on the ward basis and also on one-minute by one-minute grids, covering the entire urban and peri-urban areas. The cover should be georeferenced and mapped on 1:50,000 maps.

4.5.4. Calculating the current canopy cover: To determine the current canopy cover, multiply the canopy density by the area for each grid. Sum the values within each grid, then total them for all grids, density class-wise.

4.5.5. Required canopy cover at the city level: To maintain ecological balance, the city should have at least 33% canopy cover. If the current cover falls below this threshold, additional planting should be done in available spaces. Over a period of time, the target of 33% canopy cover has to be achieved.

4.5.6. Schedule and methodology for canopy cover estimation: Due to its technical nature, this work can't be done in-house by the Urban Forestry Wing. It should be outsourced to a qualified public agency or tendered out to a private agency through a two-cover tender process as prescribed by the Karnataka Transparency in Public Procurement Act 1999 by the Director in time. The outputs from this study should be passed on to the agency preparing the Urban Tree Management Plan.

4.6. Tree Cover Estimation Through Tree Census

Until an alternative and reliable system of collecting data on individual trees remotely is available, the tree cover survey must be carried out through a physical survey. This involves an extensive process of visiting every tree in the city, marking it, and collecting the required data. This detailed survey complements the canopy cover mapping and should be carried out when preparing the Urban Tree Management Plan.

4.6.1. Outsourcing the tree census work to contractors: The Urban Tree Census is a major undertaking that cannot be completed internally by the Urban Forestry Wing. It should be entrusted to competent contractors who possess the required skills, labour, and resources to complete the work on schedule by the Director. It should be done through a two-cover tender system. The following guidelines apply to the tender.

(1) Each city zone shall be considered as one unit for the tree census work.

(2) To be eligible to bid, the bidders should have undergone basic training in tree census operations at an institution designated by the BBMP. A certificate copy should be attached to the bid form.

(3) Bidder must have a financial turnover of at least 50% of the bid amount as per their latest income tax returns.

(4) Contractors must demonstrate that they have skilled personnel for supervising the enumeration work, taxonomic identification of trees, and information technology for using mobile apps.

(5) Given the time-bound nature of the work, one bidder can be awarded a contract for only one zone.

(6) Cost estimation for tender purposes shall be calculated as the product of the estimated tree population in the zone and the average unit cost for enumerating and collecting data on a tree.

(7) The tendering process must be completed within 3 months and the contract agreement must be signed.

4.6.2. Timeline for completing the tree census operations: The tree census work must be completed in six months' time. Including the mobilisation time, the census work must be completed within 7 months from the date of signing the contract agreement.

4.6.3. Protocol to be followed for tree census: The contractor and his men should follow the protocol laid down in **Annexure IV** while carrying out the tree census.

4.6.4. Designing and deploying a mobile application: To enable census data to be captured in real-time, scrutinized, and accepted, the data should be collected via a mobile application. This is a parallel process to be undertaken and completed separately. The Director will commission an application designed with the help of a professional agency. If an application already exists, necessary improvements shall be made, and the application readied for use by the time labour teams are constituted.

4.6.5. Publicizing the tree census work: The tree census covers both public and private lands. Hence citizens' cooperation is important for a proper and complete census. In should be ensured in the following ways:

(1) Give wide publicity to the tree census operation: The Director should give widespread publicity about the proposed tree census through various media channels before inventory teams begin fieldwork. This publicity should seek cooperation from property owners for the enumeration work. Authorization letters must be provided to the field teams to facilitate entry into private properties for tree data recording.

(2) **Encourage Non-Governmental Organisations (NGOs) and the public to participate in the tree census:** Members of the Urban Forest Sub-Committee, ward residents, NGOs, academic and research institutions, volunteers, students, and others interested in participating in the tree census work may be permitted by the Director upon written application. The Team Manager should be informed of approved public participation. Participation certificates may be issued to participants.

(3) **Engage BBMP officers and officials:** Officers of the Urban Forest Wing, Horticulture Department, and BBMP officers working in respective zones should be associated with the tree census work.

4.6.6. Getting tree census data from restricted areas: Not all areas may be open to the contractor's teams to visit for tree census. The following course of action shall be followed in such cases.

(1) **Restricted Areas:** Entry into defence lands, premises of paramilitary forces, and certain sensitive public sector establishments is restricted. Secondly, these campuses may be large and have numerous trees. In such cases, the Tree Officer should work with these institutions directly, and if they agree, depute a subordinate staff member to conduct the tree census. If they don't agree to this also, the methodology for the tree census may be explained to them and they should be asked to conduct the tree census themselves and provide the required data. Initial training and handholding may be provided to them.

(2) **Reserved forests and plantations of Karnataka Forest Dept:** There are many reserved forests within the city limits. Some may contain natural forests while others may contain only plantations. The Forest Department conducts sample surveys and compiles forest

inventory once every ten years for working plan purposes. The total enumeration of trees in these forest areas is impractical because the areas are extensive. There is no need to conduct a census of these trees. The latest figures available from the Forest Department should be accepted as correct and incorporated into the BBMP tree census database.

(3) Large private estates: Similar situations may arise with large private estates. Unless there are valid and justifiable reasons for deviation, trees in all private estates must be accessed under the provisions of the Karnataka Tree Preservation Act 1976 and enumerated. When tree felling permission is sought by such estates, it shall NOT be granted unless the trees are enumerated and incorporated into the BBMP tree database. This requirement should be communicated to estate owners. If valid and justifiable reasons exist for not permitting the contractor's teams inside the premises, the same procedure outlined for restricted premises may be followed.

4.6.7. Assigning Unique Tree Identification (TID) Number: A unique Tree identification number should be assigned for all the trees accessed by the field teams of the contractor during the survey.

(1) All standing trees in the survey area, whether public or private, are to be included in the survey. Dead trees are to be excluded. If it was enumerated in the previous surveys, a suitable note should be made against its number.

(2) Each tree counted physically shall be given a permanent 8-digit unique autogenerated Tree Identification Number. The first three digits shall be three alphabets indicating the ward name. The next last five digits are the tree number.

(3) The tree number shall be painted on the bark at 1.5 m height from ground level on the side having good visibility from the roadside. If the bark is too rough, it may be slightly blazed.

(4) The background shall be painted in yellow oil paint over an area of 15 X 15 cm. The tree number should be written in black letters of 5 X 5 cm size.

(5) Multiple stems or shoots originating from a common root shall be considered as one single tree. The largest stem will be marked with the tree number. The rest will not be marked.

(6) Clusters of bamboo, palms, and similar vegetation shall be enumerated as single trees.

Unique tree numbers shall be permanent and non-transferable. They shall never be reused. If a tree is removed, windthrown, or dead, details will be recorded in the database and further recording discontinued. However, the record will never be removed from the database.

4.6.8. Basic data to be captured for each tree: For each tree the inventory team should capture the name of the species, girth, total tree height, crown width and tree health condition without fail.

4.6.9. Additional data to be captured: A few other parameters that are incorporated in the tree census mobile application also should be captured and uploaded online to the central server. This includes identifying elite trees (healthy specimens with ideal characteristics), heritage trees (vintage trees or those planted by notable figures), and problematic trees. In addition, space available around each tree should also be captured for future planting purposes.

4.6.10. Photographic documentation: Each tree should be photographed from at least two different angles, one capturing the label and the other capturing the maximum possible physical features of the tree.

4.6.11. Tree Officers and Tree Inspectors must oversee census work: Tree Officers and Inspectors must supervise the inventory work and provide appropriate guidance throughout the process.

4.6.12. Check measurement of tree enumeration work: Once all trees in the city wards are enumerated, summary details for each street, woodlot, green belt, etc., should be recorded in the measurement book and check-measured as per the norms prescribed in Chapter - 9 of this Manual.

4.7. Tree Inventory Data Analysis

Upon completing the tree canopy cover assessment and tree census across the city, the data and information should be used to generate key information for decision-making, such as canopy and tree cover percentage, spatial distribution, biodiversity index, species and girth class distribution, health status, common tree injuries, risk ratings, urgent maintenance needs, etc. This data will help planners prioritize goals and make suitable prescriptions in the Management Plan. The information should be generated in the manner explained below:

4.7.1. Total area under tree cover: Calculate the total areas covered by each tree on the ground based on its crown width and length, and sum it up for all the trees in a given area. Compare this to the total geographical area surveyed. This measure ensures the ecological health of the city. At least 30% of the total ward area should be dedicated to trees and woodlands, including street trees. Wards with the least tree cover should be prioritized for additional planting. Including canopy cover, the total area covered should be 33%.

4.7.2. Distribution of urban greenery: Tree cover should be evenly distributed across the city. Check how it is distributed now. If it is uneven, alternative means of increasing canopy cover in deficit areas should be explored with the help of the Horticulture Wing in BBMP.

4.7.3. Diversity: Tree cover should be diverse in terms of species, age, size, and distribution. No single species should exceed 10% of the total stock of urban trees. If in excess, the number should be reduced through properly planned thinning in the Management Plan, and appropriate native species should be planted.

4.7.4. Tree Equity: Tree equity addresses the unequal distribution of trees and their benefits across neighbourhoods, often influenced by socioeconomic factors. Wealthier areas tend to have more canopy cover, providing benefits like shade, cooling, and better air quality. Lower-income or densely populated areas typically lack these benefits and rely more on public trees. Priority should be given to increasing the number of public trees in these areas.

4.7.5. The 5:50:500 Rule

This Rule will be the standard for Bengaluru city:

(a) The population of any single species should not exceed 5% of the total stock.

(b) Each ward should have at least 50 native tree species, constituting about 80% of the total tree stock.

(c) Citizens should have access to a green lung space for walking and recreation within 500 meters of their residence.

4.8. Tree Inventory Data Shall be a Public Database

Tree inventory data will be publicly accessible. Any citizen or legal entity may request access as per the law. Individual tree data, including photographs, will be provided on a single page, while consolidated data will be available in tabular form under the Right to Information Act 2005.

4.9. GIS-Based Tree Inventory Data Shall be a Permanent Record

BBMP will maintain the time series tree census data as and when it is carried out. Tree census data shall never be deleted. This data should enable the

Urban Forest Wing to check how many trees have been removed since the previous tree census and if compensatory planting has been done. If not done, it should be completed at the earliest to ensure that the overall tree population in the city is either maintained or improved but never allowed to decline.

4.10. The Tree Inventory Data Should be Kept Updated Always

Tree census data is dynamic. Annually, many trees fall, some are removed, and several thousand are planted. Some may die and wither off. This data should be fed into the tree census database twice every year. All trees removed during the year should be entered into the database by the end of May. All new juvenile trees planted should be entered into the database at the end of November. Applications made by private landowners should quote the unique number of trees in the application itself. They will be verified, and if they conform to the data available, tree-felling permission should be issued. If the number is not quoted or if the numbers or details mismatch, necessary corrections should be made by the Assistant Conservator of Forests concerned before felling permission is issued. Thus, the tree census data should be constantly kept updated.

4.11. Urban Forest Management Plan

An "Urban Forest Management Plan" is necessary to develop and manage urban forests to meet their intended objectives. The plan includes both public and private trees within the city and its peri-urban areas. The inventory data gathered through canopy cover assessment and tree census forms the basis for preparing the management plan. The Urban Forest Management Plan is analogous to a Forest Working Plan, but its main purpose is not harvesting but expanding the green cover to meet environmental objectives.

4.11.1. Objectives of the Urban Forest Management Plan:

(a) Assess the canopy cover, tree cover, biodiversity, urban wildlife etc, once in ten years and check how far the urban forestry objectives have been met.

(b) Estimate the economic, environmental, social and cultural contribution of urban forests based on standard principles.

(c) Review the system of working and see what has worked and what has failed, the reasons and how they can be made up.

(d) Examine the losses, damages and public grievances related to urban forestry and incorporate the improvements required.

(e) Set the targets to be achieved during the next ten years.

(f) Break down the targets into annual programs of works and indicate where and how they should be executed.

(g) Suggest necessary changes to the policies and practices, including amendments to this manual.

Overall, the management plan is an occasion to infuse the principles of adaptive management and make timely changes.

4.11.2. Frequency of plan preparation: The Urban Tree Management Plan should be prepared once every ten years.

4.11.3. Agency for plan preparation: The plan should be outsourced to a competent retired forest officer of the rank of a Conservator of Forests or above, having experience in writing forest working plans or management plans. If necessary, limited tender may be called by the Director and the work should be assigned.

4.11.4. Timing for initiating plan preparation work: The tender process for the new plan should begin at least 18 months before the current plan expires. Appointment of a Planning Officer should be made before the inventory works begin. The officer entrusted with plan preparation must have an opportunity to be associated with the canopy cover assessment and tree census and be able to observe the planting and tree maintenance operations. The revised plan must be completed and approved before the current plan expires.

4.11.5. Director to provide the necessary data and information: The Director must provide data and records from the past ten years required for performance review and outcome assessment when preparing the plan. This review is crucial for future planning. The Director should give a personal briefing based on their understanding and arrange meetings with past officers.

4.11.6. Template for drafting the Urban Forest Management Plan: The Urban Forest Management Plan should follow the template provided in **Appendix V**. The template is simple and easy to understand. If there is any doubt, the corresponding provisions in the Working Plan Code issued by the Ministry of Forests, Environment and Climate Change, New Delhi should be referred to. The focus should be on tree maintenance, planting trees, biodiversity conservation, climate change mitigation and ecology.

4.12. Tree Inventory and Management Planning in Peri-Urban Areas

Unlike the municipal areas of the city, the peri-urban areas undergoing urban development as per the directions of local planning and development authorities are discontinuous parcels of land. Preparing a comprehensive forest management plan is difficult. However, these areas cannot be ignored because urban forest development should follow the same trajectory as city forests and eventually merge with them. Hence, peri-urban areas should follow the same working pattern but in a simpler way as follows:

(1) The tree inventory process in peri-urban areas shall be restricted to approved development layouts only. The Forest Officer responsible for tree maintenance operations in these areas will oversee the coordination of inventory activities and management plan preparation.

(2) Rather than conducting these activities independently, the Forest Officers in charge of the peri-urban areas shall collaborate with the Director of Urban Forestry at BBMP to utilize existing resources efficiently and work in parallel.

(3) To ensure consistency and cost-effectiveness, the Forest Officer shall engage the same contractor currently working with BBMP in adjacent areas to complete the inventory. Similarly, the Forest Officer shall take the services of the Management Plan Preparation Expert appointed by BBMP for preparing the management plan for peri-urban areas. The Management Plan for peri-urban areas will be written as a supplement to the BBMP Forest Management Plan.

(4) Regarding financial arrangements, BBMP shall initially bear the entire cost for both urban and peri-urban inventory and management planning activities. Subsequently, the costs specific to peri-urban areas shall be reimbursed to BBMP on a pro-rata basis, calculated according to the number of trees enumerated in those areas. This arrangement ensures financial clarity while maintaining operational efficiency.

(5) All rules and regulations applicable to urban forests under BBMP jurisdiction shall apply mutatis mutandis to these peri-urban areas, maintaining regulatory consistency across the urban-rural interface.

4.13. Urban Management Plan Approval

The Urban Forest Management Plan draft shall be reviewed by the Executive Committee of Urban Forestry. To this meeting, one representative from the Zonal Office of the Ministry of Environment, Forests and Climate Change (MoEFCC) and the officer heading the Working Plan Wing of the Karnataka Forest Department shall be invited. The plan shall be reviewed and recommended for approval within 2 months of receiving the draft. Based on their recommendation, the plan will be approved by the Urban Development Department of the State Government within a month.

4.14. Responsibility for the Implementation of the Approved Plan

The Director is responsible for implementing the approved Urban Forest Management Plan. The officers in charge of the peri-urban forest areas will be responsible for implementing the provisions in their respective areas. The Executive Committee on Urban Forests will review the implementation status annually when approving the action plan for the new financial year.

4.15. Deviations from the Approved Plan

Deviations from the approved plan should be avoided. Any deviations should be approved by the Executive Committee at its immediate next meeting. The officer deviating from the approved program of work will be responsible for any major deviations which are not approved by the Executive Committee. They will be liable for disciplinary action.

4.16. Mid-term Evaluation of the Plan and its Implementation

The Chief Commissioner may appoint a suitable consultant for the mid-term review and evaluation of the Urban Forest Management Plan. Necessary changes to the program content and schedule of works may be made with the approval of the Executive Committee.

CHAPTER – 5

URBAN TREE MAINTENANCE AND REMOVAL PROTOCOL

5.1. Urban Trees are More Vulnerable

Urban trees are more vulnerable to pests, diseases, and injuries than their counterparts. The factors responsible can be broadly classified into three types: environmental factors, human-induced factors, and legacy factors.

(1) Environmental factors: These are the current environmental factors the trees face. Urban environments are complex and somewhat unfriendly to trees. Trees suffer from the following environmental factors in cities:

(a) Limited root space: Urban trees often grow in confined spaces like tree pits or narrow strips between sidewalks and streets. This restricts root development, leading to poor stability and reduced access to water and nutrients.

(b) Soil compaction: Heavy foot traffic, vehicle parking, and construction activities compress urban soils, reducing oxygen availability and water infiltration that roots need to thrive.

(c) Poor soil quality: Urban soils lose their originality. They frequently contain construction debris, are highly alkaline from concrete leaching, lack organic matter, and may contain contaminants like road salt and pollutants.

(d) Water stress: Impervious surfaces like pavement and buildings divert rainfall away from tree roots, while the urban heat island effect increases water demand. Many trees experience physiological drought and occasional flooding.

(e) **Air pollution:** Vehicle emissions, industrial activities, and other urban pollution sources can damage leaf tissue and interfere with photosynthesis.

(f) **Light pollution:** Artificial lighting at night can disrupt natural growth cycles and seasonal responses in trees.

(g) **Heat stress:** The urban heat island effect creates higher temperatures that stress trees, especially species not adapted to such conditions.

(h) **Storm damage:** The wind velocity is high during the pre-monsoon and early monsoon showers. In areas surrounded by buildings, there is a tunnelling effect. Trees lose their foliage and branches. Many trees also fall.

(i) **Pests and diseases:** Urban trees are located in an environment that is abundant with pests and fungi. Any tree can become a victim at any time.

(2) Human-induced factors: Human beings inflict damage on the trees. They are of the following types:

(a) **Physical injuries:** Trees in cities face frequent injuries from vehicle hits, construction activities, hard pavements squeezing at the root collar, excessive pruning to reduce shade, etc.

(b) **Conflicts with infrastructure:** Trees must contend with overhead utility lines, underground cables and pipes, hard pavements and sidewalks, and concrete walls that restrict their growth. Roots or branches are badly pruned/hacked.

(c) **Vandalism:** Some people treat trees as obstructions and indulge in insidious acts like poisoning, girdling, stripping, burning, excessive pruning etc. Repeated dogs urinating on street trees is so common. It weakens the tree tissues and creates entry points for pathogens.

(3) Legacy issues and problems: Some events that took place a long time ago may impact the trees decades later. These are called legacy issues. There might be many such issues. But the following are common:

- **(a) Wrong choice of species:** Selecting trees unsuitable to local conditions. In the past, most of the trees planted were fast-growing tree species. Life span is short. Tree falls are high.
- **(b) Poor-quality planting stock:** Root coiling in the nursery stage, untended seedlings, and physical injuries in the early stages of tree life have lent a crooked appearance.
- **(c) Bad planting practices:** Improper planting techniques were followed, like planting too deep, inadequate pit size, poor soil preparation, heavy tree guards that lean on the tree, etc.
- **(d) Lack of biodiversity:** Planting very few exotic flowering tree species, which eventually could become vulnerable to new varieties of termites, pests, diseases or other stressors.
- **(e) Poor genetic composition:** Raising seedlings of unknown genetic sources. The result is weak and slow-growing progeny, etc.
- **(f) Inherent characteristics of the trees:** Some trees or branches may be brittle, some may be termite prone, some trees have sticky pods or rolling fruits and cause accidents on the roads, roots may be shallow and the trees are prone to windthrow.
- **(g) Inability to adapt to changing climate:** The weather conditions are changing fast and are becoming unpredictable due to climate change. Trees are unable to cope. This situation may be further exacerbated in future.

5.2. Common Defects Observed in Urban Trees

Vulnerability translates into tree defects first and eventually leads to the tree's decline and death. Tree defects can be several different types and can affect any part of the tree. They can be broadly classified into the following five categories:

(1) **Crown-related defects:** Asymmetrical crown, congested crown, parasite infested (e.g., Loranthus, Cuscuta), pest damaged, weak or dying canopy.

(2) **Branch-related defects**: Weak or defective branches (e.g. acute angle, included bark), kinked, rubbing, drooping or over-reaching branches, water sprouts (profusion of epicormic branches), borer infested, dead or dying, hollow, decayed, etc.

(3) **Trunk defects**: Multiple stems, twisted or curved trunks, vertical or horizontal cracks, hollowness, warts, heart rot, etc.

(4) **Root defects:** Root girdling, surface roots, invasive roots, kinked roots, root rot, etc.

(5) **Whole tree related:** Leaning tree (>30 degrees), sick trees, etc.

An exhaustive list of common defects observed in urban trees is given along with brief descriptions in **Appendix VI.**

5.3. Objectives of Urban Tree Maintenance

Unattended tree defects can lead to serious problems. They may cause fatal injuries or damage properties. Tree maintenance is necessary to remove the defects and keep the trees healthy and safe. The following are the aims and objectives of the tree maintenance:

(1) **Risk reduction and safety improvement:** Dead and falling branches and trees may injure or kill people and damage property. They need to be removed in time.

(2) **Infrastructure protection:** Timely pruning and root management are necessary to prevent damage to sidewalks, buildings and underground utilities.

(3) **Securing utility clearance:** Safety zone clearance is required for overhead electrical cables and underground internet cables to prevent service disruptions and accidents.

(4) **Enhancing the visibility of roads and traffic signals:** Trees or their branches may block visibility. It could lead to accidents. They need to be removed.

5.4. Types of Urban Tree Maintenance

There are five types of urban tree maintenance:

(1) **Contingent Tree Maintenance:** This is contingent on a request or a complaint from someone. It may pertain to any tree defect that bothers him/her. The request may be raised at any time of the year, including holidays, by anyone if it is urgent.

(2) **Preventive Maintenance:** Identifying hazardous trees in advance and carrying out necessary corrections to prevent the hazard from happening is preventive maintenance. Annual tree maintenance undertaken to prevent hazards during the forthcoming monsoon is a classic example.

(3) **Emergency Maintenance:** Emergency maintenance is undertaken after a cyclonic storm, earthquake, severe drought or massive pest attack that affects a large number of trees. It is aimed at restoring normalcy as quickly as possible.

(4) **Holistic Maintenance:** Scheduled, comprehensive care for all urban trees in an area at regular time intervals to improve the hygiene, health and vigour of the trees is called holistic maintenance.

(5) **Restoration Maintenance:** This is a specialised care of highly significant trees like heritage trees, sacred trees, and rare, endangered or threatened trees. Young trees severely damaged by cyclonic storms may also require restoration maintenance.

5.5. When Tree Maintenance is Necessary?

Tree maintenance requirements vary by the age of the tree, its location, the type of defect and the potential harm a failing tree or its limb can cause. There is no need to correct the tree defects if it is harmless to the tree, the people or their properties. Nature itself will correct many defects over time. Secondly, tree maintenance is an expensive and uneconomic operation. The expenses far exceed the returns. Hence, only those defects that pose a danger to the tree, human life or property need to be corrected during tree maintenance operations. The rest should be left untouched.

5.6. Responsibility for Tree Maintenance

In principle, tree maintenance is the responsibility of the landowner on whose property the tree or trees are standing.

(1) **BBMP is responsible for public tree maintenance:** The BBMP is responsible for maintaining all trees located on BBMP lands, including streets, parks, playgrounds, lakes, and other public spaces.

(2) **Govt agencies are responsible for trees on their lands:** State and central government departments and agencies are responsible for maintaining trees on their lands.

(3) **Private landowners:** Private landowners are responsible for trees on their properties.

(4) **Trees should not pose a risk to people or properties:** Every tree owner must maintain their trees in good condition and ensure that these trees do not pose serious adverse effects to others.

(5) **If the tree owner fails:** If any landowner fails to address maintenance issues and the tree or trees become hazardous, the jurisdictional Tree Officer, acting on behalf of the Chief Commissioner, may issue a written notice to the landowner under Section 257 of the BBMP Act, 2020. This notice requires immediate corrective action. Should the landowner fail to comply within the specified timeframe, or in cases of emergency, the Tree Officer may implement necessary measures to mitigate the danger and recover the associated costs as outlined in this section.

(6) **Exceptional circumstances:** If the tree risk has partially or fully transformed into a hazard, the affected party may remove it and inform the local tree officer in writing within 3 days with photographic evidence. He/she shall not incur any penalty.

5.7. Components of Tree Maintenance

Tree maintenance has three basic components namely defect identification, risk assessment and corrective action.

(1) **Tree defect identification:** This involves looking at the tree closely to find if anything could fall at any time or notice any defect or disease that could affect the tree's health or stability now or in future.

(2) **Risk assessment and hazard rating:** This is a process of assessing the likelihood of a tree or its parts failing. If it has the potential to cause harm, injury, or damage, whether it is small or big, to people or property, then the risk becomes a hazard. If there is no such possibility, it remains a risk.

(3) **Corrective action:** This is the action taken to correct the tree defect to reduce the risk or mitigate the hazard. There is a wide menu of corrective options. The most appropriate one is to be chosen and implemented.

5.8. Responsibility for Identification of Hazardous Trees and Reporting

(1) **Landowners:** Landowners are responsible for identifying the hazardous trees and mitigating the risks in time.

(2) **Citizens:** Tree defect identification may be undertaken by any citizen, regardless of whether he/she is directly affected by it or not.

(3) **BBMP:** Within the BBMP hierarchy, the following officials are responsible for tree defect identification and reporting:

(a) **The Ward Forest Sub-Committee Members:** The Ward Forest Subcommittee members shall be responsible for identifying and reporting the tree risks in their respective areas.

(b) **The Tree Warden:** The Tree Warden serves as the primary field assistant responsible for regularly surveying trees within his wards, identifying hazardous trees, and initiating the maintenance processes.

(c) **The Tree Inspector:** The Tree Inspector bears responsibility for identifying hazardous trees on busy roads, streets, and public places within their operational jurisdiction, doing so proactively rather than solely responding to complaints.

(d) **The Tree Officer:** The Tree Officer must ensure effective performance from subordinate officials and prompt attention to all tree-related complaints.

(4) **Overall responsibility to mitigate the hazards:** The Assistant Conservators of Forests (Urban Forestry) and the Director bear joint responsibility for the systematic identification and management of hazardous trees within their jurisdiction. Their duties encompass implementing timely risk mitigation measures

to ensure public safety and urban forest health. They shall conduct monthly reviews of all risk mitigation activities to confirm that:

(a) All personnel are fulfilling their designated responsibilities promptly and thoroughly.

(b) The work is progressing as planned in the field.

(c) Documentation and reporting procedures are being properly maintained.

(d) Resource allocation remains appropriate to address identified risks.

(e) Proactive monitoring systems are in place to identify potential future hazards.

The monthly review process shall include verification that established protocols for hazard assessment, intervention planning, and emergency response remain effective and are being properly executed across all operational areas.

5.9. Types of Risk Assessment

Risk assessment is an elaborate process. There are three types of risk assessment depending upon the different depth of inquiry.

(1) Visual risk assessment: This is done by ocular observation of defective parts. It is subjective and based on personal knowledge and experience. Anyone with reasonably good experience and exposure to the subject will be able to do a satisfactory job of those defects that are visible to the naked eye. To reduce subjectivity, visual assessment should be generally done by a group of 3 people. Photographs of the tree defects must also be attached. The Tree Warden, one Ward Forest Sub-Committee Member and one wildlife expert will do the visual assessment as a team.

(2) **Probing with hand tools:** If the visual risk assessment confirms the risk, then the next higher authority should probe a little deeper by using hand tools like binoculars, acoustic equipment like a rubber mallet, and handheld penetrometers that will help in detecting the decay. The Tree Inspector will apply this method. The Director shall equip him with the necessary tools.

(3) **Scientific investigation:** For elite trees, heritage trees, Rare, Endangered and Threatened species, etc, further investigation should be conducted by engaging a qualified scientist who will conduct a systematic inquiry using scientific equipment like Ground Penetrating Radar (GPR), X-ray tomography, etc and confirm the tree defects. The Tree Officer will decide in which cases the scientific inquiry is to be used. Visual observation and probing are sufficient to detect the tree defects in the ordinary course. Only in rare cases is scientific inquiry necessary.

5.10. Risk Assessment and Hazard Rating Scales

Risk and hazard are rated on a pre-defined scale to make them objective and to judge the likely implication of a tree or limb failure. There are standardised tools for risk assessment and hazard rating.

(1) **Risk Assessment Scale:** Risk assessment and hazard rating are the initial steps in identifying hazardous trees. Risk assessment involves evaluating the tree defects using three parameters, namely tree height, the part or parts that are likely to fail and the probability of failure. Each component should be assessed and rated using the following scales after visiting the tree and thoroughly inspecting it from the crown to the roots. It may require some basic tools like binoculars for observing the defects in branches which are difficult to see with the naked eyes.

Sl. No	Component	Risk Rating Scale
1	Tree height	Above 15 metres = 5

		12.1 to 15 metres = 4 9.1 to 12 metres = 3 6.1 to 9 metres = 2 Below 6 metres =1
2	Tree parts that are likely to fail	Root plate = 4 Trunk = 3 For each big branch (>30 cm girth at collar) = 2 For Small each small branch (<30 cm girth) = 1
3	Probability of failure within the next 3-6 months	Imminent = 3 Probable = 2 Remote = 1

The total score for the risk is the multiplication of the scores for the three factors. If many branches are already dead and decayed and therefore hazardous, the score will go up steeply.

(2) Hazard rating scale: After the risk rating is over, one should look around the tree and see what targets might be hit if the tree or its parts were to fail. Based on the target, the hazard rating should be done on the following scale:

Sl. No	**Target that may be impacted**	**Hazard Scale**
1	Injury or loss of human lives	5
2	Public utilities, government buildings and business establishments, temples and other public places	4
3	Vehicles/residential buildings	3

4	Generator/staircase/security cabin etc	2
5	Others	1

(3) Classification of hazards: Now, multiply the total risk assessment score by the hazard rating scale to arrive at the total score and classify the hazard based on the total score obtained.

Score	Hazard class
Above 150	Very High
101-150	High
51-100	Medium
31- 50	Low
Below 30	Negligible

The format to be used for tree risk assessment and hazard rating is given in **Appendix VII.** Each tree should be assessed using this format.

5.11. Protocol to be Followed for Tree Pruning and Maintenance

The procedure and the protocol to be followed for different types of tree maintenance listed in para 5.4 are as follows:

(1) Contingent tree maintenance: Contingent tree maintenance is initiated based on a complaint lodged by a citizen. The following protocol applies to contingent tree maintenance.

(a) Lodging complaint: Complaints may be submitted using:

(i) Short messaging service (SMS).

(ii) Email addressed to any forest officer in BBMP or any senior functionaries of BBMP.

(iii) Formal written complaint to the local Tree Warden addressed to the Jurisdictional Officer or any forest officer.

(iv) Oral complaint to the BBMP control room.

(b) Complaint processing: Any information or complaint received by anyone, including the control room, must be immediately forwarded to the local Tree Warden under intimation to the jurisdictional Tree Inspector and the Tree Officer.

(c) Case registration: The Tree Warden should register every complaint received from any source. The registration should be done online and a docket number given to each complaint.

(d) Quick site visit by the Tree Warden: When a tree-related complaint is received, the Tree Warden must conduct a site visit within 2 working days to assess the situation. The procedure then follows different paths based on ownership and risk level.

(e) For private trees: If the risk is substantial, the tree owner will be asked to arrange for risk mitigation at his cost as per para 7.5.3. If the owner refuses, the Tree Officer will take further action as per para 7.5.4. If the tree is to be removed, it may be done as per para 7.6. In any case, the matter should be fully addressed and the case should be closed within 2 months from the date of receiving the public complaint or report from the Tree Warden whichever is early. If the tree owner fails to do so, the Tree Officer shall take further action as per para 5.6. 5. The Director should review the performance periodically.

(f) For public trees: If the risk is substantial:

(i) The tree Warden should conduct a detailed visual assessment within 7 days of receiving the complaint. He should invite the local Ward Forest Sub-Committee Member and a local wildlife expert named by the Tree Officer and do a detailed visual risk assessment and hazard rating as a team, record the findings in the format prescribed in Appendix VII and submit to the Tree Inspector immediately.

(ii) The Tree Inspector must probe trees with hazard rating exceeding 50 points within 5 days and report to the Tree Officer immediately.

(iii) If the score exceeds 100 points, it requires immediate personal inspection by the Tree Officer. He should obtain necessary orders from the Assistant Conservator of Forests (Urban Forestry), entrust the maintenance work to the contractor and mitigate the risk within 15 days.

(iv) The entire process of risk mitigation from a public tree must be completed by the Tree Officer within 2 months from the date of receiving the application or public complaint.

(2) Preventive maintenance: Preventive maintenance operates as an annual program implemented consistently across all city wards. The process follows a structured timeline with clear responsibilities:

(i) Initiation and assessment phase: The Tree Warden must initiate the assessment process at the beginning of October each year. Working collaboratively with the local Urban Forest Ward Sub-Committee Member and a designated wildlife NGO representative, the Tree Warden conducts visual surveys of trees in high-traffic areas throughout the ward. Trees requiring maintenance undergo formal hazard rating assessment.

(ii) Reporting and verification process: The Tree Warden submits weekly progress reports on the identification of hazardous trees to the Tree Inspector, who must verify the hazard scores within one week and forward consolidated findings to the Tree Officer. To ensure quality control, the Tree Officer randomly selects and reviews a subset of risk assessments before submitting recommendations to the Assistant Conservator of Forests (Urban Forestry). In turn, after due verification, he will report to the Director and seek his orders to undertake the preventive maintenance works.

(iii) **Implementation timeline:** The order issued by the Director is transmitted to the Tree Officer and the contractor appointed by the Director for tree maintenance in the ward. The contractor must commence work within seven days of receiving the work order.

(iv) **Completion requirements:** All assessment activities must be completed by the Tree Warden by December 31st. The contractor is required to complete all scheduled tree maintenance work by the end of February, ensuring trees are properly maintained before the onset of spring growth.

(3) Emergency tree maintenance: Emergency maintenance procedures apply exclusively to trees affected by natural calamities such as cyclonic storms, floods, earthquakes, lightning etc. This protocol addresses situations involving fallen branches, toppled trees, and leaning trees that have disrupted essential services or blocked public thoroughfares.

(i) **Assessment process:** Standard risk assessment and hazard rating procedures are suspended during emergencies.

(ii) **Response procedure:** Following a natural calamity, the Tree Inspector must immediately visit affected areas to assess the situation, document damaged trees through photographic evidence, and prepare and submit a report to the Tree Officer.

(iii) **Tree Officer's role:** The Tree Officer must also personally inspect the affected area, evaluate the situation firsthand, submit a comprehensive report to the Assistant Conservator of Forests

(Urban Forestry), obtain his permission, and assign appropriate contractors to attend to the maintenance work.

(iv) Implementation requirements: Before commencing the maintenance works, the electricity supply and the Traffic Police must be informed of road blockages or closures. Appropriate signage must be installed around the work sites.

(v) Restoring normalcy is the priority: Emergency maintenance operations must aim at swift restoration of normal conditions, minimising public inconvenience, and quick restoration of essential services in the area.

(4) Holistic Maintenance: Holistic maintenance represents a comprehensive approach to tree care guided by the established Urban Forest Management Plan. This protocol is implemented exclusively within designated areas specified by the Plan and provides thorough care designed to address multiple aspects of tree health simultaneously. This work shall be entrusted to a separate contractor, and it must proceed independently of the other forms of tree maintenance.

(i) Assessment methodology: The Visual Tree Assessment, which forms the foundation of this protocol, is conducted by the contractor's crew manager using the officially prescribed format. The Tree Inspector subsequently reviews these assessments to ensure accuracy and compliance with established standards.

(ii) Procedural framework: Following assessment validation, the protocol follows the same structural approach as Preventive Maintenance, including the hierarchical review process, approval mechanisms, and implementation guidelines. However, unlike Preventive Maintenance, this protocol operates with flexible timelines to accommodate the comprehensive nature of the work involved.

(iii) Implementation guidelines: Holistic maintenance is focused on comprehensive tree care without interference from or dependence on concurrent maintenance schedules. This independence ensures thorough attention to all aspects of tree health within the designated areas.

(iv) Strategic integration: The holistic maintenance approach ensures systematic care that addresses both immediate concerns and long-term tree health objectives within the urban forest ecosystem.

(5) Restorative Tree Maintenance: Restorative maintenance constitutes a specialized category of tree care operations reserved exclusively for trees of significant cultural, historical, or ecological importance. This protocol typically applies to sacred trees in temple precincts, heritage trees, and other specimens of exceptional value to the community.

(i) Initiation process: Unlike standard tree maintenance procedures, restorative maintenance is initiated at the discretion of the Tree Inspector or the Tree Officer upon identification of a qualified specimen requiring specialized intervention. This process operates outside the regular maintenance schedule and is implemented on a need basis.

(ii) Methodological approach: Restorative maintenance employs highly specialized techniques tailored to the specific requirements of each tree and its particular location. The protocol diverges significantly from standard tree care practices and may incorporate:

(a) Installation of mechanical support structures.

(b) Application of specialized braiding techniques.

(c) Implementation of cable systems.

(d) Strategic placement of braces.

(e) Other custom interventions determined necessary.

(iii) Implementation requirements: All interventions must be custom-designed at the site based on a comprehensive assessment of the tree's specific needs by a group of specialists. Implementation of restorative techniques requires supervision by qualified specialists following rigorous risk investigations conducted by scientific personnel.

(iv) Monitoring: Following the implementation of restorative measures, the tree should undergo continuous monitoring to evaluate the efficacy of interventions at the hands of the Tree Officer. Should monitoring reveal suboptimal results or changing conditions, additional maintenance measures will be implemented to ensure the preservation of these valuable specimens.

5.12. Interventions for Effective Tree Maintenance

Interventions for correcting tree defects and maintaining the trees in good health and vigour fall into three primary categories.

(1) Tree pruning: It involves the removal of compromised parts while maintaining the tree's structural integrity, functioning essentially as a surgical procedure.

(2) Curative treatments: They encompass a range of interventions including pest management, disease control, and soil enhancement aimed at improving overall tree health and longevity.

(3) Tree removal: When pruning or curative treatments prove insufficient, tree removal and replacement with a young tree of the same or better species is a natural choice.

5.13. Tree Pruning

There are three different approaches to tree pruning.

(1) **Tree part-based approach:** This approach takes into consideration the tree part that is affected and therefore at risk. Each part of the tree is dealt with separately.

   (a) **Crown management:** It includes crown lifting, reduction, balancing, thinning, and restoration. These operations remove branches and foliage from various crown sections to enhance shape, establish balance, and mitigate risks.

   (b) **Branch remediation:** This involves addressing defects in the tree's middle section. It includes the removal of dead, dying, decayed, half-broken, lodged, hollow, deformed, forked, rubbing, epicormic branches and so on. Regular pruning of problematic branches constitutes the standard treatment.

   (c) **Trunk treatment:** Tree trunks frequently sustain damage from human activity and environmental factors. Common defects include collar throttling, canker formation, cracks, cavities, girdling, and multiple shoot development. Curative approaches are generally preferred for trunk issues.

   (d) **Root management:** Though largely invisible, root defects significantly impact tree health. Issues include confinement, decay, coiling, girdling, and inadequate development. Treatment options remain limited, with root pruning recommended only in exceptional circumstances.

   These approaches are adopted in contingent and preventive maintenance practices.

(2) **Life cycle-based approaches to pruning:** Pruning is to be customised to suit the age of the tree. Based on age, pruning is classified into three broad categories:

(a) Formative Pruning: This includes all types of pruning on young trees up to the age of about 15 years. Giving good shape is the focus of Formative Pruning.

(b) Structural Pruning: This is carried out on premature and mature trees. Improving physical strength by identifying and strengthening scaffolding branches, removing competition for them, and inducing flowering and fruiting are the objectives of Structural Pruning.

(c) Restoration Pruning: This pertains to over-mature, or senile trees, as well as young trees damaged by cyclonic storms. The primary objectives of restoration pruning are hazard reduction and lifespan extension. When performed on aged trees, it is called Sanitary Pruning, as it addresses hygiene concerns in specimens approaching the end of their natural lifecycle.

A special type known as **'Retrenchment Pruning'** is carried out on veteran trees that are fully normal in health and vigour but are unable to fit into the growing space available. It allows the tree to develop a more compact crown while preserving its structural integrity and physiological function

These approaches are adopted in emergency and holistic (structural) maintenance practices.

(3) Biomechanical approaches: This is a combination of biological and physical methods. In this approach, pruning operations will be minimal. The tree or its limbs will be supported using biomechanical interventions such as tree belts, braids, cables, slats, braces, artificial branch props and so on.

5.14. Curative Treatment of Trees

Trees may require treatment for:

(1) Pruning wounds.

(2) Pests and diseases.

(3) Root or stem poisoning.

(4) Mineral deficiencies.

(5) Physical damages caused by people, animals or vehicles.

Post-pruning wound dressing is generally not recommended, as treatment chemicals may harm tree tissues rather than benefit them. For young trees with fresh injuries, neem oil may serve as a protective coating.

Pest infestations are typically occasional and don't require special treatment. However, if a tree consistently causes allergies to people in the vicinity, it may be better to remove and replace it.

Fungal diseases affect many mature trees. Timely detection of infection is nearly impossible, as it often becomes apparent only when fungal fruiting bodies (known as conks) appear on the lower part of the trunk by which time treatment is too late.

Mineral deficiency is rare in Bengaluru city. Treatment may be necessary for tree poisoning and physical damage, though current knowledge on these subjects remains limited due to insufficient research. While ancient Indian texts contain some information, they may not be suitable for urban contexts today.

Further research is needed in this area. The Director may identify suitable agencies to conduct this work. If effective treatments are discovered, they may be implemented.

5.15. Suggested Maintenance Measures

In real-life situations, an integrated approach including tree replacements has to be adopted for sustainable urban forest management. A defect in a tree may be a symptom of an underlying cause, and often there may be more than one cause. Each defect necessitates thorough investigation and proper diagnosis to discover the underlying causes.

This analysis must be conducted on a case-by-case basis, requiring time, effort, and specialized skills that are not readily available at present. However, for the guidance of urban tree managers, a few generic defect correction and tree maintenance measures are furnished in Appendix VIII. Technical specifications for carrying out pruning and maintenance operations are furnished in Appendix IX. They may be followed with necessary modifications.

5.16. Authorities Competent to Issue Orders for Tree Maintenance

The Assistant Conservator of Forests (Urban Forestry) shall be competent to issue orders in respect of contingent tree pruning operations and emergency tree maintenance. In all other cases, the Director shall be competent to issue the orders.

5.17. Removal of Urban Trees - The Imperatives

Urban tree removal, while often viewed with concern by the public, constitutes an essential component of responsible urban development and also urban forest management. Removal becomes necessary when trees no longer contribute positively to the urban environment or when their potential for harm exceeds their ecological, social and environmental benefits.

The Karnataka Preservation of Trees Act 1976 recognizes this necessity and provides legal pathways for removal when justified. Each removal category represents trees that have either reached the end of their functional life cycle or create persistent problems that cannot be effectively managed through alternative measures.

Strategic tree removal decisions, when accompanied by appropriate compensatory planting help in maintaining the overall health, diversity, and resilience of the urban forest while ensuring public safety, protecting infrastructure, and accommodating urban development. A proactive approach to identifying and removing problematic trees and over-mature trees ultimately strengthens the urban forest ecosystem rather than diminishing it. This approach ensures the urban forest continues to provide maximum environmental, social, and economic benefits to the community while minimizing associated risks and maintenance costs.

(1) **Classification of trees that need to be removed:** Based on the reasons for removal, the trees shall be classified into the following five categories:

   (a) **Dead and dying trees:** Trees that have ceased biological functions or entered irreversible decline require removal. These specimens display extensive crown dieback, significant bark loss, and structural decay. Such trees present substantial safety risks in urban environments while no longer providing ecological benefits. Removal becomes necessary to mitigate imminent hazards to pedestrians, vehicles, and property.

   (b) **Hazardous and structurally compromised trees:** Living trees with severe structural deficiencies warrant removal when they present persistent safety concerns. These include specimens with severe leans, extensive decay in critical components, irreparable trunk damage, or multiple severe structural flaws that cannot be remediated through standard maintenance. Examples include brittle Mayflower trees susceptible to termite infestation and street trees with compromised root systems due to utility trenching operations. Removal is appropriate when these structural deficits create safety hazards that cannot be effectively mitigated. If not removed, they fall on their own accord. People may suffer and properties will get damaged.

   (c) **Nuisance trees:** Certain trees, though healthy, create persistent problems warranting their removal when negative impacts consistently outweigh benefits. These include specimens with aggressive root systems damaging infrastructure, those producing excessive debris or allergenic pollen, trees obstructing critical sightlines or building access, and those shading solar installations. Additional considerations include trees attracting problematic wildlife, emitting unpleasant odours, demonstrating invasive characteristics, or having growth patterns incompatible with available space.

(d) **Trees to be removed for developmental projects:** Development projects in the city across the private sector (building of apartment complexes, commercial buildings) and public sector (infrastructure, transportation systems, government facilities) require tree removal. While selective preservation is technically feasible, complete removal is often preferred for unimpeded development. Developers are willing to pay compensatory planting costs for all the trees removed. Authorities are required to grant tree removal permissions for development projects while enforcing appropriate mitigation measures and compensatory planting requirements as per applicable regulations. This has to be done in time to prevent project cost escalation.

(e) **Silviculturally mature trees:** Trees like any other living form, have a finite life, after which they are destined to deteriorate and die. Many trees in the city have reached the end of their lifespan. Given the complex environmental conditions prevailing in the city, 45 years is a reasonable lifespan for big trees and 30 years for other trees. The corresponding girth at chest height can be 2 m and 1.5 m. After this period, trees typically begin to display signs of senescence including reduced vigour, diminished annual growth, and declining structural integrity. They may still appear normal but they need to be removed and replaced with juvenile trees as a part of the renewal of urban greenery. It helps in establishing a new generation of younger, more vigorous and better species of trees that will provide enhanced ecosystem services for decades to come. This is inevitable. This fact has to be recognised and systematic replacements need to be provided.

(2) **Retention of hazardous public trees in certain cases:** If a hazardous tree is hosting urban wildlife and is located in an area with minimal human activity, it should be retained as a snag to support and benefit wildlife. The Director will decide about it.

(3) **Authority competent to order the removal of public trees:** The Director shall have the authority to issue orders for the cutting and removal of public trees.

(4) **Procedure for removal of private trees:** Private trees may be removed as per para 7.6.

(5) **Public consultation:** The opinion of the Tree Expert Committee shall be obtained if the number of trees to be removed exceeds 50, irrespective of the land ownership. They will issue a public notice, hear the interested public and advise the Director. The Director shall issue the tree-felling orders accordingly.

5.18. Execution of Tree Maintenance or Removal Work

Tree maintenance or removal in urban areas is a challenging task. It requires skilled labourers and effective supervision. These tasks should be carried out through a tendering process. The minimum contract period is 2 years. It is extendable by one year. Tenders must be invited by the Director, and the work assigned to contractors as per the procedures outlined in para 9.5 of this Manual. The Tree Inspector and the Tree officer shall supervise the work.

5.19. General Rules for Tree Maintenance and Felling

(1) **Best time for tree maintenance works:** Tree pruning and maintenance works are best taken up during winter before the new flush of leaves and flowers emerge.

(2) **Effective supervision of work:** Given the risks associated with tree and branch cutting in densely populated areas, all tree maintenance and cutting operations must be conducted under the supervision of the Tree Inspector. In cases where operations are being carried out simultaneously at multiple locations, retired forest staff, trained by the designated training institute, should be hired on a contractual basis to ensure proper oversight.

(3) **Pre-inspection by a wildlife expert:** If not done earlier, a pre-work inspection of the trees by a locally recognized urban wildlife expert nominated by the Tree Officer must be conducted to check if any wildlife is inhabiting the trees. If there are any nests with eggs/babies, those trees and the adjoining trees should be taken up for maintenance after they have hatched and/or left.

(4) **Inform traffic police:** The Tree Inspector should inform the local traffic police at least three days in advance of the work. While the operations are underway, the Tree Inspector should coordinate with traffic police to ensure smooth traffic flows during the work.

(5) **Inform BESCOM, etc:** So also, BESCOM and other relevant utility companies must be notified if their services are likely to be affected by the tree maintenance operations or tree felling work.

(6) **Inform the residents living near the work sites:** The adjoining building owners of the trees being worked should be informed of the tree maintenance operations and the likely disturbance to them.

(7) **Execute the work during the day:** Highly risky tree maintenance and cutting operations should be conducted during daylight hours. However, on main roads with heavy traffic, such works may be undertaken at night if necessary support is provided by the police and electricity authorities.

(8) **Check if it is OK to climb the tree:** The contractor's crew manager must check and make sure that the tree or its branches have the strength to bear the load of the crew member who is likely to climb the tree to execute the work. If not, he should ask the contractor to arrange for a vehicle with an elevated platform.

(9) **Start the maintenance work from the top:** Always start the maintenance work from the top of the tree and come down the tree. Never allow more than one team to operate on the same tree.

(10) **Cut the branch at the node:** Branch trimming should not harm the collar (slight bulge just below the branch union). Cutting should always be at a slight outward angle from the top so that rainwater flows away smoothly on the cut surface. Use the three-cut method to remove the branch. The bark should not peel off.

(11) **Which operation is to be done where on the tree?** Limit the crown maintenance operations to the upper and outer 1/3rd of the tree surface area; branch operations to the middle 1/3rd, and trunk operations to the lower 1/3rd of the tree in general.

(12) **Don't allow through fall of branches cut:** Heavy branches should not be allowed a freefall to the ground. It might damage other branches of the tree or the physical structures on the ground. They should always be brought down using a cable or a crane.

(13) **Procedure in case the tree is to be removed:** If the tree is to be removed, always strip the tree of all its branches first and give a directional cut to the trunk. If the trunk is long, cut it into shorter sections and bring them down carefully first and finally cut the trunk.

(14) **Prevent accidents:** Plan and execute tree maintenance and cutting operations smoothly so that they do not cause any damage or injury to people, utilities, buildings, property, pavement, and other trees.

BBMP will be liable to pay damages if any private property is damaged in the tree maintenance or removal operations.

(15) **Post-maintenance look of the trees:** After the maintenance operations, the tree should look clean, and fresh. There should be no half-cut or broken branches anywhere on the tree. There should be no injury marks on the retained part of the trees except for the branch removal scars. The tree should give an appearance as though nothing has been done.

(16) **Removal of debris:** No wood or debris shall remain on-site or in the public right-of-way at the end of the workday. Leaf litter and brushwood should not be burned. It must be collected, crushed into powder and delivered by the contractor to the nearest BBMP park where there is a facility for composting. If there is no such park, it may be taken to the forest nursery and used for composting.

5.20. Setting up BBMP Wood Depots

(1) **Opening of wood depots:** Each Tree Officer should set up a wood depot in his zone to receive the wood from tree pruning, maintenance and removal operations. One trained staff should be placed in charge of each depot. He will receive the fresh wood into the depot and allow the movement of wood sold out. He should keep a register and record the daily movement of wood.

(2) **Conversion of wood into timber and firewood:** At the site, hardwood suitable for timber should be cut into logs of suitable length, while the rest should be converted into firewood. The Tree Inspector should guide this process.

(3) **Transportation of wood:** The contractor must ship all the timber and firewood obtained in the tree pruning, maintenance and tree-cutting operations on the BBMP or Govt land to this depot under a transport permit issued by the Tree Inspector. He will be paid

additional rates for the delivery of wood to the depot at the agreed rates.

(4) **Classification and lotting of wood:** The timber shall be classified and lotted in the depot. The firewood shall be stacked. The timber depot rules of Karnataka Forest Department will apply mutatis mutandis to the BBMP wood depots also.

(5) **E-Auction of wood:** The wood stocked in the BBMP depots shall be auctioned periodically by the Assistant Conservators of Forests (Urban Forestry). It should not be allowed to deteriorate. The wood shall be e-auctioned periodically. The revenue generated shall be credited to the Urban Tree Fund.

5.21. Check Measurement and Completion Certificate

Completed tree pruning, maintenance and removal works should be entered in the Measurement Book and paid for in the manner prescribed in Chapter 9 of this Manual.

5.22. Mobile Application for Tree Maintenance and Felling Operations

The Director shall design and operationalise a comprehensive mobile phone-based application for internal use. It should systematically capture images of all the ongoing tree maintenance and felling operations, including the wood transport.

5.23. Compensation for Damage, Injuries or Loss of Life

Despite efforts to manage tree risks, not all tree hazards can be predicted accurately and eliminated. A few unexpected branches or tree falls are inevitable. However, vigilance over tree defects and health can help keep the risks within acceptable limits.

(1) **Acceptable threshold for branch and tree falls:** The threshold for acceptable limits in Bengaluru city shall be as follows:

(a) Not more than three branch falls per 1,000 trees in a year in a city ward.

(b) Not more than one treefall per 10,000 trees or a fraction thereof per year in a city ward.

(2) BBMP Forestry Wing will endeavour to abate the risks: All the forest officers working in the Forestry Wing of the BBMP will collectively and individually seek to minimise the tree hazards.

(3) BBMP to liable to compensate: If BBMP fails to resolve the tree risks within 60 days of receiving a written notice from any citizen or an organisation that is likely to be affected by a tree hazard, the victim will be entitled to compensation at the rates determined by BBMP or by a court of law from time to time.

(4) Procedure for claiming compensation: Any victim who suffered injury, property damage or loss of family members should submit the following documents to the Tree Officer within 30 days of the incident to claim compensation:

(a) Copy of his notice to BBMP with acknowledgement.

(b) Photographs of the accident scene with date and time stamps.

(c) Police complaint and FIR copy.

(d) Hospital certificate for treatment or post-mortem, and

(e) Value of the property damaged by a registered property valuer.

(5) The documents shall be duly verified by the Tree Officer, and compensation shall be paid by BBMP within 90 days from the date of submission of the claim.

5.24. Tree Pruning by Utility Companies

(1) Utility Companies must obtain prior permission for tree pruning: Utility companies should obtain prior permission for tree pruning from the Director by furnishing the details of the area and a list of trees that may be pruned.

(2) **They should employ contractors having trained crew:** They should engage contractors who are registered as forest contractors and have trained crew leaders for tree maintenance operations. Alternatively, they may hire the crew from the contractor who is already executing the forestry works in that area.

(3) **Utility companies should seek to minimise tree pruning:** BESCOM should use insulated overhead cables and minimise the pruning of tree canopies. Similarly, the underground utility companies should use hand tools, hydro or air spades to safely remove the soil without cutting the tree root, or use micro tunnels and covered conduits to draw the cables or pipes. They should avoid cutting the woody roots that may lead to tree falls.

(4) **Limits on pruning:** If any company removes the woody roots of a tree from one-third of its root zone or removes one-third of its crown volume, the tree is likely to become imbalanced and may eventually fall. Such trees need to be removed or felled quickly. Therefore, utility companies should be held liable for the cost of removing these trees. Additionally, they must bear the expense of compensatory planting at the prevailing rates set by the BBMP.

5.25. Maintenance and Removal in Peri-urban Areas

The tree maintenance and removal requirements are much lower in peri-urban areas compared to the city limits. The Executive Committee of the BBMP, in consultation with the Bengaluru Urban Tree Authority, will prescribe the procedure and also name the officers and staff who will discharge the responsibilities. The Director will extend necessary cooperation and support to them.

CHAPTER - 6

URBAN TREE PLANTING

6.1. Aims and Objectives of Urban Tree Planting

Urban tree planting initiatives serve multiple interconnected purposes that benefit the environment and citizens. The primary aims and objectives include:

(1) **Expanding green cover**: Increasing the overall tree canopy to the optimal and then to the most desired level.

(2) **Enhancing biodiversity**: Restore the native biodiversity and enhance it further.

(3) **Improving the urban environment**: ameliorate the urban environment and mitigate adverse impacts of climate change.

(4) **Supporting urban wildlife**: Establishing ecological corridors and habitats that enable birds, insects, and small mammals to survive within the city.

(5) **Beautifying the city**: Enhancing urban landscapes' look and aesthetic appeal and restoring the cultural links.

(6) **Reconnecting people with nature**: Creating better facilities for people to enjoy nature and improve their well-being.

(7) **Preserving the heritage of the Garden City**: Maintaining and enhancing the historical character and designation as a Garden City through continued commitment to urban forestry.

The BBMP is the owner of a vast array of public lands in the city that are not controlled by the Government, as per Section 129 of the BBMP Act, 2020. Roads, streets, parks and other open places in the custody of BBMP amount to about 40% of the total geographical area of the city. BBMP has an obligation not only to protect and conserve these lands but also to enhance the heritage and landscape of the city under Section 298. All unused lands of BBMP must be saved and improved by bringing them under tree cover by the Urban Forest Wing.

6.2. Authorities Responsible for Tree Planting

(1) **In the city areas:** All the officers and staff of the Urban Forest Wing except the Tree Inspectors are responsible for tree planting in city areas. The duties of each cadre are as follows:

(a) **Tree Warden and Ward Forest Sub-Committee**: Apart from protecting the existing trees, they are responsible for planting a minimum of 500 trees per ward annually and, in the process, increasing the biodiversity and the natural heritage in the ward.

(b) **Tree Planting Supervisor**: Along with the Tree Wardens and urban forest sub-committee members, he is responsible for tree planting. Once the planting is done, he independently monitors all trees planted in the last 3 years. He documents their progress regularly.

(c) **Tree Officer**: He is responsible for setting up the plant production centres (plant production centres), production of the required number of juvenile trees, and tree planting for developing an equitable urban forest cover throughout the city zone.

(d) **Assistant Conservator of Forests (Plant Production)**: He should guide and oversee the annual production of juvenile trees required for planting in the city and its peri-urban areas.

(e) **Assistant Conservator of Forests (Urban Forestry)**: He prepares the tree planting design for each location to meet the objectives and ensures that planting is done accordingly.

(f) **Director**: As the head of the Wing, he facilitates and oversees all the forestry operations in the city including tree planting. He should visit the field as often as possible and guide the staff.

(2) Planting in Peri-urban Areas

(a) **If there is a forest officer:** If a full-time senior forest officer works with BDA, BMRDA, BIAAPA, KIADB and other agencies, he and his team will follow the instructions in this chapter and complete the planting works. The senior officer will assign the responsibilities to his subordinates.

(b) **If there is no forest officer:** If there's no designated forest officer, heads of these organisations should request the PCCF (HOFF) to appoint a departmental officer to handle the planting works. The appointed officer will procure juvenile trees from BBMP plant production centres and carry out the planting as per the instructions contained in this manual.

6.3. Components of the Urban Tree Planting Program

The urban forest tree planting program has three components, namely plant production centre, planting, and post-planting maintenance.

6.4. Production of Juvenile Trees

(1) **The list of tree species to be planted:** The list of tree species to be planted in the urban forests in future is given in **Appendix X**. Out of the 300 species shortlisted, at least 100 species should be raised in the plant production centres and used for planting.

(2) **Number of plant production centres (nurseries) to be set up:** Each city zone must establish and maintain at least one plant production centre. The Tree Officer is responsible for establishing it and ensuring its efficient functioning.

(3) **Purpose of the plant production centres:** The city forest plant production centres should produce a sufficient number of juvenile trees required for field planting in the city and its peri-urban areas. Each plant production centre should raise juvenile trees from about 100 different tree species in air root pruning pots (Air pots for short). No single species should exceed 5% of the total stock in the plant production centre at any time.

(4) **Definition of a juvenile tree:** A juvenile tree is a more than 3-year-old plant, with a diameter of at least 10 centimetres at the collar (measured at 10 centimetres above the container) and a height of not less than 5 meters. It should be healthy and vigorous, featuring a raindrop-shaped crown and must have an active tip. It should have a well-balanced root-to-shoot ratio (of 1:1 by mass) and be free from defects. It should be able to stand upright without any support.

(5) **Plant production centre capacity:** Each plant production centre must produce at least 50 -75 thousand juvenile trees grown in air pots. It should be able to accommodate juvenile trees up to 3 years or more. They should have the necessary infrastructure. If sufficient space is not available in a single location, plants may be moved to places outside the nursery.

(6) **Seed source:** Plant production centre stock must be developed from good quality seed collected from elite trees maintained in a registry by the Director. He should ensure that a sufficient number of seed mother trees have been identified in the city and also outside, if necessary. Seeds to be collected from natural forests outside the city shall be sourced through the Research wing of the Forest Department.

(7) **Screening the seed for vigour:** Seeds procured must be sown in sand beds or trays. Only the first batch of sprouts will be transplanted directly into the air pots when the seedlings are 2-6 leaf stage. The

remaining seeds/sprouts should be discarded. Germination percentage should not be less than 50%.

(8) Ensure a healthy root system: The root system of juvenile trees should be well-developed, proportionate to the plant shoot size, and free from coiling, girdling, kinks, or other deformities.

(9) Grooming the juvenile trees in the nursery: The seedlings should be tended right from the beginning to ensure that good vigour, shape and growth are obtained.

(10) Agency to produce juvenile trees: Current knowledge in the production of juvenile trees in the nursery is limited. In light of the biodiversity objectives of urban forestry and the shortage of domain expertise among consultants and potential contractors, plant production centre production should be entrusted to any of the following agencies:

(a) Public institutions or not-for-profit private organizations having research capabilities, infrastructure and a minimum of 10 years of experience in tree seedling production.

(b) Private organizations engaged in tree seedling production in the last ten years and having an annual turnover of 50% of the contract amount. They should have a retired forest officer of the rank of ACF or above as an advisor.

(c) The minimum contract period is five years – the first three years for raising seedlings afresh and the last two years for seedling maintenance and supply.

(d) For private agencies the work should be entrusted on a competitive tender basis as per the procedure laid down in the Karnataka Transparency in Public Procurement Act 1999.

(11) Supervision of work: The Tree Planting Supervisor and the Tree Officer shall supervise the plant production activities regularly.

(12) Check measurement: The Assistant Conservator of Forests (Plant Production) will inspect once a fortnight, guide work and check-measure the works. He should ensure high quality and diversity are maintained in the plant production centres.

(13) Quality assurance: The plant production centre stock proposed for planting in the forthcoming monsoon shall be inspected and certified by a team consisting of the Director, the head of the Tree Expert Committee and one other member either from the Forest College or a senior forest officer from the Research Wing of the Karnataka Forest Department. Only the stock certified by them shall be utilised for planting during that monsoon.

(14) Technical specifications for plant production: The technical specifications laid down in **Appendix XI** shall be followed strictly for the production of juvenile trees in the plant production centres.

6.5. Desirable and Undesirable Features of Urban Trees

(1) Desirable tree characteristics: Trees chosen for planting in urban and peri-urban areas must be from the approved list of species. They must possess the following characteristics:

(1) Be a native species or a tested exotic.

(2) Evergreen or semi-evergreen in nature.

(3) Slow growing.

(4) Deep rooted.

(5) Have attractive crown architecture.

(6) Low water requirements.

(7) Minimal maintenance needs.

(8) Able to withstand drought conditions.

(9) Minimum lifespan of 30 years.

(2) Restricted species: Trees with the following characteristics are discouraged:

(1) Fast-growing tree species.

(2) Trees with brittle wood.

(3) Species that cause allergies.

(4) Trees that emit unpleasant odours.

(5) Species that produce too much litter.

(6) Trees that spread by suckers.

(7) Trees whose roots are invasive.

(8) Trees with long and overreaching branches.

(9) Exotic species that have not been tested.

6.6. Identification of Planting Locations

(1) BBMP to plant trees on public lands: The Urban Forest Wing manages tree planting on BBMP-owned public lands. Developers are responsible for planting in private layouts, and landowners must handle planting on private property. Public funds should not be allocated for planting in layouts not yet transferred to planning agencies or BBMP.

(2) Replacement planting: When trees are removed due to safety concerns, storm damage, development projects, or as part of the approved Urban Forest Management Plan, replacement planting should occur at the same location. Unless compelling reasons exist to do otherwise, every lost tree should be replaced after grinding and removing the old stump, preferably with the same or superior species. Compensatory planting should be done in compact blocks.

(3) Site identification process: The Tree Warden and Urban Forest Sub-Committee members must systematically identify potential planting sites through area-wise surveys and verify ownership according to BBMP records. The protocol for site identification is detailed in **Appendix XII.** All identified locations should be published on a mobile application.

(4) Coordination requirements: Planting site details must be shared with the BBMP Engineering Department and relevant utility companies. The Zonal Coordination Committee should closely oversee this coordination effort.

(5) Rainwater Integration: Where feasible or necessary, tree planting should incorporate Blue Green Cells to facilitate rainwater harvesting. Technical specifications for these cells and the procedure to be followed are furnished in **Appendix XIII**. Field-level coordination is essential for this integration.

(6) Boulevards and Tree Strips in new layouts: All future development layouts must designate specific areas for urban tree planting. Layouts exceeding 40 hectares should include tree boulevards along main roads. For side roads and smaller layouts, a one-meter Tree Planting Strip should be reserved beside the curb, with native soil left undisturbed. General plans for this are given in **Appendix XIV.** Developers must plant juvenile trees in these strips and designated parks and open spaces.

(7) Potential planting sites: The following are the potential planting sites:

- **(1) Community lands:** Gomala, gundu thopu, small ponds, cremation grounds, kharab lands, etc.
- **(2) City municipal properties and lands**: Free space available around the ward, zonal and head office premises of BBMP, staff colonies, public roads, streets, parks, playgrounds, stadiums, community halls, convention centres, exhibition grounds, all kinds of markets

and market yards, lakes, raja kaluves, civic amenity sites, burial grounds, crematoria, truck terminals and any other space that belongs to BBMP.

(3) **State Government properties**: Office premises, colonies, guest houses, training centres, hostels, and surrounding open spaces.

(4) **Central Government properties**: Defence and paramilitary campuses, railways, Govt officers, residential colonies etc.

(5) **Lands of Public Sector Undertakings**: Railways, HAL, BEL, and other central and state PSUs having land.

(6) **Public institutions**: Open space available with universities, research and academic institutions, colleges, schools, and hospitals.

(7) **Utility companies**: Open space available around KPTCL, BESCOM, BWSSB, BMTC, KSRTC, Metrorail, suburban railways, GAIL and other utility company offices and lands.

(8) **Land available with temples, religious, charitable and cultural organisations:** Open spaces belonging to reputed public cultural and religious or community-based institutions.

(8) Different types of planting Models: There are so many types of land in the city and its peri-urban areas. The planting model, the choice of species, the treatment required etc., vary. Different planting models and their detailed technical specifications are furnished in **Appendix XV**.

(9) Priority areas for planting: The following areas should receive priority in tree planting:

(1) Densely populated areas with low tree cover.

(2) Areas that have lost the tree cover heavily in recent years.

(3) Areas not yet planted with a sufficient number of trees

(4) Areas where the existing trees are too old and senile.

(10) Planting Approach

(1) Inner-city areas: In areas with space constraints, the planting strategy must focus on efficiently incorporating new trees within available spaces. Given the scarcity of dedicated planting zones, tree establishment should be integrated with rainwater harvesting systems. This dual-purpose approach maximizes the utility of limited urban space while addressing both vegetation and water management needs.

(2) Outer-city areas: Tree planting in these transitional zones must proceed concurrently with other development activities. The planting strategy should anticipate the environmental and ecological requirements these areas will face when fully developed. Forward planning ensures these areas will maintain adequate tree coverage as urbanization progresses, preventing retroactive and often costly interventions.

(3) Peri-urban areas: Planting in peri-urban regions must adhere to the same standards implemented inside the city areas. This consistency ensures seamless integration when these peripheral zones eventually merge with the urban core. Maintaining uniform planting protocols across all development stages creates a cohesive urban forest continuum and simplifies future management.

6.7. Planting Density

Including the existing trees, planting should aim at the following density:

(1) Residential areas: Average density of 40 trees per hectare of map area to achieve approximately 5-10% tree cover.

(2) Office, industrial, and educational premises: 50 to 60 trees per hectare in the available open spaces around the buildings.

(3) Roads and streets: 200 trees per kilometre, to be planted on both sides of the road in a quincunx pattern.

(4) Tree parks and woodlots: Maximum of 400 trees per hectare.

6.8. Planting Design Principles

Planting design involves the selection and arrangement of tree species for each planting site. The design should be such that the built environment of the urban areas appears nestled in natural woodland after the trees are fully established. It should create a visual harmony across the landscape. The following principles apply.

(1) Mix and match trees of different sizes and shapes: Tree planting should incorporate a balanced mix of small, medium, and large trees to maximize the utilization of available crown space at maturity. Keep in mind the size to which each tree would grow at maturity. Avoid monoculture and systematic /mechanical designs.

(2) Mimic nature in species combinations: Species combinations should replicate natural forest compositions. Selected species should correspond to recognized forest types, such as moist deciduous, semi-evergreen, or evergreen forests. Mixing species from different forest types should be avoided.

(3) Inter-tree spacing: Standard minimum spacing requirements, unless circumstances dictate otherwise, should be:

(a) Between two small-sized trees: 6 meters

(b) Between small and medium-sized trees: 7 meters

(c) Between two medium-sized trees: 8 meters

(d) Between medium and large-sized trees: 9 meters

(e) Between two large-sized trees: 10 meters

(4) Minimum setbacks: Maintain the following minimum setbacks:

(a) Building foundations, compound walls, underground utilities, street lights, etc: 1.5 metres.

(b) Electrical transformers and overhead electrical cables: 3 metres.

(c) Traffic signals and road curves: 5 metres.

(d) If the pavement width is 1.5 m or above, plant trees on the pavement immediately after the curb in a planting strip of 75 cm to 1 m. Leave at least 60-75 cm free lane on the pedestrians. If the pavement width is less than 1 m, plant small-sized trees along the road within a distance of 50 cm from the curb stones.

(5) Responsibility for planting design specifications: The Assistant Conservator of Forests (Urban Forestry) is responsible for microplanning species selection for each planting location. This requires substantial knowledge of natural forest composition. External experts like landscape architects or retired forest or horticulture officers may be consulted if necessary.

6.9. Critical Success Factors

The following factors are essential for successful tree establishment:

(1) Minimal root space: Each tree requires a minimum of 0.6 cubic meters of root space per square meter of mature crown spread area at ground level. The planting should design should ensure this.

(2) Good soil: The root area must contain natural soil of 2 to 3 feet depth. If it is not available, the planting pit should be enlarged appropriately and filled with garden soil.

(3) **Moisture availability:** Rainwater should percolate into the root zone freely. If not, arrangements should be made to collect the water at the tree collar and allow it to seep into the root zone.

(4) **Sunlight:** The tree crown should get sunlight for at least 3 hours daily in any season. If there is a tall building nearby that blocks the sunlight or the existing tree canopy is too dense to allow sunlight, then avoid planting the tree.

(5) **Proper planting depth:** Maintain the root collar at the same level as in the plant production centre. Tree planting should neither be deeper nor shallow.

6.10. General Specifications for Planting

(1) **Annual planting target:** The Director, in consultation with the Special Commissioner and Chief Commissioner of BBMP, will set annual planting targets based on funding, available juvenile trees, public demand, and other factors. Once the Urban Forest Management plan is implemented, annual targets must meet or exceed the approved plan.

(2) **Agency for planting:** Tree planting work should be assigned to reputed, experienced contractors selected through competitive bidding. These contractors will receive three-year turnkey contracts (preparatory year, planting year, and maintenance year) with performance-based payments tied to tree survival and growth rates.

(3) **Pitting:** To avoid accidents, do the pitting work just before planting. Planting should be completed within 3 days of pitting.

(4) **Pit size:** The depth of the pit should be equal to the height of the container and not more.

(5) **Time of planting:** Plant the trees during the first heavy pre-monsoon showers. The planting must be completed by the end of June before the soil loses its warmth to the repeated rains.

(6) **Planting juvenile trees:** Only juvenile trees, not saplings or seedlings, should be planted. The transition from planting seedlings or saplings to juvenile trees should be completed within 5 years from the date of approval of this manual.

(7) **Stakes and tree guards not required generally:** Juvenile trees typically do not require stakes or tree guards. BBMP will not provide for them. In high-traffic areas or locations susceptible to cattle damage, landowners or donors may provide tree guards according to Director specifications and the cost for installation. Then they will be installed. Donors may advertise on these tree guards as per the Director's specifications.

(8) **Watering:** Newly planted juvenile trees must receive one flood irrigation with 30 litres of water per plant immediately after planting. Thereafter, the trees will be able to rely on rainfall for their water needs. If there is a delay or failure of the monsoon, the Director may, as a special case, permit irrigation up to three times a year.

(9) **Supervising the planting work:** The Tree Planting Supervisor must be on-site daily to oversee the planting work, capture georeferenced images of each tree planted, and upload these images to the mobile application. This data should be automatically integrated into the tree census database.

(10) **Oversight of the planting works:** The Tree Officer, Assistant Conservator of Forests (Urban Forestry) and the Director should inspect the planting works as often as possible and guide the field staff and workers.

(11) **Check measurement:** The Tree Officer must complete the verification and check-measurement process within 30 days after the planting is over.

(12) **Cultural operations:** Newly planted juvenile trees require a minimum of one weeding and one hoeing. The Director may provide for two or three of them if necessary.

(13) **Watch and ward:** Landowners should protect their trees. The contractor will provide for the watch and ward for the municipal trees. One watchman may be permitted for about 5000 trees in the tender.

(14) **Survival rates required:** A minimum survival rate of 90% must be achieved at the end of the planting year. Failures will be replaced during the next monsoon at BBMP cost.

(15) **Action if the failure rate is significant:** If the failure rate is more than 10% at any time, the matter should be investigated by the Director, and necessary actions should be taken to recover the costs from the responsible parties as per the provisions in the BBMP Act 2020. If the failure is due to deficiencies on the part of the contractor, he should be held accountable, and costs should be recovered from him. If the failure rate exceeds 20%, the contractor should be disqualified from bidding on any future tree-planting contracts.

6.11. Tree Maintenance

(1) **Maintenance work to be done:** Maintenance is only for one year after the planting year. Replacements and soil work should be done in June. One weeding operation is to be done in October.

(2) **Check measurement:** The Tree Office should check-measure and clear the planting bills within a month.

(3) Survival rate: Survival at the end of the maintenance period should not be below 90%. If it is less, take punitive action.

6.12. Documentation of planting work

(1) Each ward's Tree Warden shall maintain a dedicated planting journal to document all planting-related activities. The Tree Warden must chronologically record these activities and obtain the Tree Planting Supervisor's countersignature for verification.

(2) Inspecting officers are required to document their findings and instructions in this journal during site visits. Additionally, they must verify whether appropriate follow-up actions have been taken on previous instructions during subsequent inspections.

(3) The Tree Warden or Tree Planting Supervisor must invariably present this journal to inspecting officers during their visits for review and documentation purposes.

CHAPTER – 7

REGULATION OF PRIVATE TREES

7.1. Obligation of the landowners in the city to plant trees

7.1.1. Individual site owners in residential layouts: According to the BBMP Revised Master Plan 2015 (proviso no. of 3.16 (xv), planting of a minimum of one tree is mandatory for a site measuring more than 2400 sft and a minimum of 2 trees for a site measuring more than 4000 sft in a residential layout. It applies to all zones in the city, including the BDA, BMRDA and BIAAPA areas. Many property owners have already raised trees, including horticultural species.

7.1.2. Apartment complexes and other gated communities: A large number of apartment complexes have already been built in Bengaluru City. Many more will come up. When the apartments are constructed, existing trees are removed. After the construction is over, trees at the same rate as above should be planted around the complex as a green belt. They should plant trees. Generally, palms, bamboo, ornamental plants, etc., are planted which are not equivalent in any manner to the trees that were removed. This needs a closer look and better understanding. Apartment complexes also should contribute to the city's greenery.

7.1.3. Non-Residential layouts: There is no specific mention of how many trees are to be grown per hectare on the non-residential layouts. Assuming an average plot size of 1/2 hectare for simplicity, a perimeter of 250 m per hectare and a spacement of 10 m between trees, about 25 trees can be grown on non-residential lands. On a per-hectare basis, about 50-60 trees can be planted.

7.1.4. Corporate and Industrial spaces: There is no specification. They should consider raising at least double the number of trees prescribed for non-residential layouts – about 100 per hectare. If they don't have open spaces, they can sponsor tree planting elsewhere.

7.1.5. All other landowners: All other categories of landowners should also plant trees along the property boundaries and in other open places. The average tree density should not be less than what is prescribed in para 7.1.1. It is mandatory under section 9 of the Karnataka Preservation of Trees Act (KPT) 1976.

7.2. BBMP will survey the trees on public and private lands periodically

7.2.1. Survey of trees planted on private lands: The BBMP will conduct a tree census periodically in the city. The survey *inter alia* includes a plot-to-plot survey of available trees on all private properties and checks if trees have been planted as per Sections 9 and 10 of the KPT Act. Horticultural trees will be treated as trees under this section. The property owners must extend their cooperation. The survey team will record the number of trees present on the property. If no trees are found or if the number is inadequate, they will check the space available and advise how many and what kind of trees can be planted and where.

7.2.2. Refusal to give entry: Despite the advance notice given, if any property owner or his agents refuses to give entry to the Tree Officer or his staff on the appointed date, it will be deemed that there are no trees on the property. The Tree Officer will take further action as per section 13 of the KPT Act.

7.2.3. Issuing notice: If there are no trees or if their number is inadequate, the Tree Officer shall issue a notice under section 9 or 10 of the KPT Act 1976, as the case may be, and ask the landowner to plant trees.

7.3. Landowners must comply with the notice

The landowner must comply with the notice within the time limit prescribed. They may plant the trees on their own and reply with photographic evidence. Alternatively, they may pay the prevailing cost to BBMP and seek the help of the Tree Officer to plant trees. He will do so with the help of the contractor who is planting trees in the ward. The local Tree Warden and the members of the Urban Forest Sub-Committee will guide the landowners and render necessary support. While planting trees, landowners must ensure a minimum setback of 1.5 metres from the compound wall, and a distance of not less than 5 M from plant to plant should be maintained.

7.4. If space is not available for planting trees

If space is not available, the private landowner can either pay the Tree Officer to plant the required number of trees on the pavement in front of his building or adopt existing trees at the same cost. In either case, the Tree Officer will issue a tree adoption certificate. Necessary entries will be made against the ID number of the trees in the tree census database. If adoption is not possible, the landowner should pay compensatory planting costs to BBMP and get suitable entries made in his property khata documents. The Tree Officer will inform the landowner about the number of trees, the kinds, and the locations after the tree planting is done. This requirement is, however, not applicable to public institutions.

7.5. Maintenance of Private Trees

7.5.1. Maintaining private trees: It is the responsibility of the tree owner. He should make sure that his trees are not a source of nuisance to his neighbours or the public.

7.5.2. When a private tree should be considered risky or a nuisance: If a private tree or its branches are:

(a) Dead, decayed and might fall anytime and damage property or cause harm to other trees or people.

(b) Harming or damaging the pavements, and walls or interfering with the utilities of the tree owner, a neighbour or a utility company.

(c) The tree or its parts restricts the flow of pedestrian or vehicular traffic or visibility of any public street, park, or public place.

(d) obstructing the view of any streetlight, traffic control signal, or public street intersection.

(e) Harbours harmful insects or animals of nuisance value.

(f) Any other reason that the Tree Officer considers reasonable.

7.5.3. How to maintain private trees? The tree owner may seek the help of the local Tree Warden if he has any difficulty in resolving the tree risks. The local contractors may be requested to attend to the problems subject to the condition that the cost will be paid by the tree owner to the contractor directly. Permission from the Tree Officer is necessary only for tree removal and not for maintenance.

7.5.4. If the tree owner fails to maintain the trees: If any complaint is received about any private tree being a risk or a nuisance and the tree owner refuses to act, the Tree Officer may get the tree inspected by the Tree Warden and get it resolved with the help of the Ward Forest Sub-Committee. If the tree or trees were found to be a nuisance or risky, and if the problem could not be resolved at the ward level, the Tree Officer may issue a notice under Section 257 of BBMP Act 2020 to the owner asking them to take action. If he fails to do so within the time limit given, the Tree Officer may carry out the work through his subordinates and contractors, charge the bills to the tree owner and recover the cost as per the law.

7.6. Felling of Private Trees

7.6.1. The felling of private trees is governed by the provisions in the KPT Act 1976. In addition to the reasons listed under section 8 of this Act, private trees in urban and peri-urban areas may be felled and removed for:

- **(1)** Extension of an existing building, construction of a new building or re-development of the property.
- **(2)** Removing trees for a city development project, and
- **(3)** Formation of a new layout.
- **(4)** Eliminate hazardous trees.
- **(5)** For any other reason the Tree Officer considers justified.

The applicant must submit BBMP Khata and the latest receipt for the tax paid as proof of land ownership. A boundary survey shall be necessary if the private land shares its boundaries with a tree bearing Govt land. Objections if any from the coparceners of the property must be settled by the authorities competent.

7.6.2. Before taking up the matter for consideration, the Tree Officer must first check if the trees proposed for felling are found in the tree census list of BBMP. If they are not found, they must be inspected, and included in the tree census list first and then the application should be processed for issuing tree felling permission. This is essential to ensure that all the private tree owner come forward to get their tree included in the tree census and update the database.

7.6.3. The Tree Officer will issue the tree-cutting permission with the prior approval of the Assistant Conservator of Forests (Urban Forestry) if the number of trees proposed to be felled exceeds ten and with the previous approval of the Director if the number of trees to be felled exceed twenty. If the number exceeds, 50, the opinion of the Tree Expert Committee shall be obtained first and tree felling permission shall be issued accordingly.

7.6.4. The yield obtained belongs to the owner. He may sell the materials or give them to the Tree Officer and receive the value. In case of any land or boundary disputes, or for any other valid reason, permission may be declined under a speaking order.

7.7. Appeals

Applicants aggrieved by the rejection order of the Tree Officer may appeal to the Tree Authority under Section 14 of the KPT Act, 1976. Further action shall be taken according to their orders.

7.8. Transport permits

Transport permits are not required for moving wood obtained from the tree or its branches within city limits. For transportation outside city limits, a permit as prescribed in the KPT Act 1976 shall be necessary. The Tree Officer or his authorised subordinate will issue the transport permit upon a written request.

7.9. Liability for damages during tree maintenance operations

Tree owners are responsible for any damages, injuries, or fatalities caused by their trees to neighbours or the public. Compensation terms should be mutually agreed upon by the parties concerned. If unresolved, the matter should be taken to court. The BBMP shall not be liable to settle such disputes or pay compensation.

7.10. Compensatory planting requirements

If a private tree has been removed for a public purpose, the tree owner shall be compensated at the same rates as the Government trees. The amount will be paid to the tree owner. He should plant new trees in place of the trees lost if he has the space. Otherwise, he may take action as per para 7.4 above.

CHAPTER - 8

OTHER TECHNICAL MATTERS

8.1. Capacity Building in Urban Forest Management

8.1.1. The Nature of Urban Forestry: Urban Forestry has evolved significantly from its historical focus on city beautification and recreation. With massive urban migration, cities face exploding infrastructure demands and shifting priorities toward meeting basic needs over aesthetics.

Today's urban residents contend with winter air pollution and summer heat islands. In response, Urban Forestry is undergoing radical transformation to address these environmental challenges, transferring management responsibility from landscape architects and horticulturists to professional foresters

8.1.2. Traditional Forestry vs Urban Forestry: Traditional forestry manages flora and fauna sustainably in largely uninhabited natural landscapes, primarily concerned with meeting urban timber demands. Urban forestry presents a complete contrast in both approach and environment. Cities lack original ecosystems, as urban development continuously alters landscapes through clearing, excavation, and construction. The dynamic nature of urban environments challenges conventional sustainability concepts that guide traditional forestry practices.

This fundamental difference explains why urban forestry has historically been absent from traditional forestry education. As foresters now take responsibility for urban forest management, they face significant knowledge gaps requiring urgent capacity building -not only for forestry professionals but also for communities, NGOs, wildlife specialists, contractors, and other stakeholders involved in urban forest management. Their capacity, as well as those of other stakeholders who work for urban forestry must be built up.

8.1.3. Elements of capacity building: There are five elements to capacity building:

- **(a)** Building the relevant body of knowledge and skills.
- **(b)** Identify the key stakeholders who need them most.
- **(c)** Find an institution that can package properly and transfer the knowledge and skills effectively.
- **(d)** Impart the knowledge and skills in small and meaningful modules which the stakeholders can absorb easily.
- **(e)** Repeat the process till the knowledge and skills are completely transferred and fully internalised by the stakeholders.

This manual represents the first step in capturing essential urban forestry knowledge. While identifying key stakeholders is straightforward - forest officers, Ward Forest Sub-Committee members, city engineers, planners, contractors, crew managers, NGOs, community advocates, educators, and students, developing practical skills requires expert guidance in specific work areas.

Stakeholder acceptance will depend on how effectively knowledge and skills are packaged and delivered to early adopters, and how successfully they can apply these lessons in real-world situations. This institutional aspect is critical; without a partnership with an effective capacity-building institute, urban forestry cannot keep pace with growing urban environmental needs

8.1.4. Selecting a Training Institution: A suitable Bengaluru-based institution will be identified through a formal RFP process open to eligible South Indian institutions. The selected organization will develop specialized curricula and serve as a knowledge hub for transitioning from ornamental landscaping to ecological urban forestry. The institution will maintain demonstration sites featuring both traditional and recommended alternative species. The Urban Forestry Executive Committee will establish selection criteria, evaluate proposals, and select the training institution. BBMP will enter into a five-year contract with the chosen institution.

8.1.5. Curriculum Development and Training: The selected institute will develop targeted curricula for various stakeholders and conduct ongoing training programs with certification. Only certified individuals will be authorized to undertake urban forestry activities or contribute to its discourse. BBMP will cover course development costs and training expenses for officials, field staff, Tree Wardens, Ward Sub-Committee members, community leaders, and educators, while subsidizing costs for other participants. Special emphasis will be placed on practical training modules for contractors and crew leaders covering quality nursery practices, scientific planting techniques, and urban maintenance protocols. Structured participant feedback will inform curriculum revisions.

8.1.6. Contractor Certification Requirements: Only contractors who complete mandatory training will be eligible to bid on urban forestry projects. Certifications will require periodic renewal through refresher training, creating a qualified contractor pool with specialized knowledge to improve urban forestry outcomes.

8.1.7. Sustainable Employment Initiatives: The institute will conduct outreach activities to identify opportunities for utilizing wood from maintenance operations for various products. They will also develop methods for converting leaf litter into marketable organic manure for BBMP nurseries and commercial sale. These sustainable activities can generate employment if dedicated spaces in CA sites or parks are allocated for these operations.

8.2. Management of Urban Wildlife

8.2.1. Definition: Urban wildlife encompasses all free-ranging wild animals (mammals, birds, reptiles, fish, insects, etc.) found in urban areas, whether as permanent residents or visitors. Cities host various wildlife, including rare and endangered species.

8.2.2. The need to conserve urban wildlife: Urban wildlife forms an integral component of urban forest ecosystems, contributing to ecological stability and sustainability. Notable examples include:

1. Slender loris populations residing in inner-city woodlots
2. Owl species inhabiting stag trees
3. Eagles (natural rat control) requiring dead trees for nesting
4. Peripheral areas supporting pangolins, porcupines, and jungle cats.
5. The number of birds, butterflies etc is quite high.

Many urban wildlife species are protected under the Wildlife (Protection) Act 1972 and Karnataka Rules 1973.

8.2.3. Challenges: Urban wildlife faces significant challenges due to the inherent tensions between development and ecological preservation, including progressive tree loss in inner cities, habitat fragmentation from urban expansion, pollution, and resource scarcity. Human-wildlife conflicts manifest through primate residential intrusions, rock bee colonies on high-rises, displaced snakes during floods, bird injuries from recreational activities, and occasional incursions of larger mammals creating public safety concerns. While the BBMP Control Room receives regular wildlife incident reports, existing resources comprising limited trained personnel, vehicles, and equipment and so on remain inadequate to address the scale of these challenges, and despite the presence of reputable wildlife NGOs with specialized capabilities, there is a notable absence of coordinated interface between municipal authorities and these organizations, further complicated by unauthorized wildlife handlers operating without proper oversight.

8.2.4. Administrative arrangements for handling urban wildlife: Urban wildlife issues may aggravate in future as the city expands and loses more and more mature trees. The following administrative arrangements shall be made for handling the wildlife concerns:

(1) A separate Wildlife Cell should be created within the BBMP, led by an officer of Assistant Conservator of Forests rank to oversee all wildlife-related matters. He will report to the Director. All the Wildlife Rescuers, vehicles and infrastructure should be placed under his control.

(2) The existing BBMP Wildlife Rescuers should be co-located in the zonal forest offices. They should work under the supervision of Tree Officers. They should be equipped with the necessary tools (e.g., vehicles, cages, nets). All of them should be insured.

(3) All wildlife NGOs recognized by the Central Zoo Authority operating in the city should be integrated into the Urban Wildlife Management Cell. The ACF will serve as the convenor. This cell will meet monthly under the Chairmanship of the Director to decide on protocols for each species, which will then be approved by the Chief Wildlife Warden. The Cell will review activities and take further action as necessary. NGO field staff should collaborate closely with BBMP staff, and all personnel should undergo joint training.

(4) A common dashboard or mobile application should be developed by the Wildlife Cell to handle wildlife matters. This tool should provide essential information to enable rescuers to respond promptly to complaints. The dashboard or app should allow anyone, including control room staff, to immediately post public complaints.

(5) The Zonal Wildlife Rescuer of BBMP is responsible for addressing wildlife complaints. If they are unable to do so, they should request the assistance of local NGO rescuers. The Wildlife Cell will monitor the situation until the case is resolved.

(6) Animals captured should be released at suitable locations as directed by the ACF (Urban Wildlife) as soon as possible. Injured animals should be treated at local veterinary hospitals, while orphaned or sick animals should be taken to the nearest rehabilitation centre managed by a partner NGO.

(7) The partner NGOs should establish rescue and rehabilitation centres in the designated zones of the city. BBMP will provide financial assistance to these centres at a scale approved by the Central Zoo Authority. They will treat injured animals and temporarily rehabilitate orphaned or sick animals. If an animal does not recover within one month, it should be transferred to the Bannerghatta Rehabilitation Centre for further care.

(8) A post-mortem should be conducted on the animals that died in captivity. A report should be submitted to the ACF (Urban Wildlife) within seven days.

(9) The ACF (Urban Wildlife) will submit a monthly report to the Chief Wildlife Warden of Karnataka, detailing the number of animals captured and released, those under treatment, and those that have died

8.2.5. Wildlife conservation measures to be taken by the Director: The Director should take the following action to conserve urban wildlife:

a. Keep the wildlife habitat requirements in mind while planting trees or maintaining them in urban areas. If any signs of wildlife are found on the trees due for maintenance, the work should be delayed till they move to a safe location.

b. Connect green belts, street trees, parks, and woodlots to nearby natural wildlife areas, such as Bannerghatta Biological Park, Hesaraghatt grasslands, the Cauvery River and its tributaries, Thippegondanahalli Reservoir, and reserved forests in and around the city, creating a broad network of natural areas which will facilitate the animal movement.

c. Provide training for Tree Wardens, field staff, and contractors on best practices for urban wildlife conservation.

d. In collaboration with wildlife experts and NGOs, raise awareness among youth and children through wildlife walks, bird watching, etc. A permanent record of wildlife species found in different areas should be maintained.

8.2.6. Action against illegal wildlife activities: Any violation of established protocols or the provisions of the Wildlife Protection Act, 1972 will result in appropriate penal action. The ACF (Urban Wildlife) will initiate legal proceedings against offenders and their supporters.

8.3. Registry of Special Trees for Conservation

Certain trees in the city need to be preserved for their high value and utility. Each category should be maintained in a separate registry.

8.3.1. Elite Trees: These are large, elegant trees with superior characteristics including straight trunks free from defects, healthy and attractive crowns, dense foliage, regular fruiting, and freedom from pests and diseases. Selection criteria may vary by species. Seeds from elite trees will be used for seedling production. The Tree Office should select at least 10 elite trees per species in each BBMP zone. After approval by the Director, entries will be made in the tree census data. A separate register will maintain complete details of each tree, including zone name, serial number, and identification year. Staff must collect seeds only from these identified trees, mark seed lots with the tree number, and send them to the nursery. If a tree dies or is removed, it will be struck off the register.

8.3.2. Heritage Trees: Heritage trees possess significant cultural, historical, or ecological value, distinguished by their age, size, rarity, or historical connections (e.g., trees planted by historical figures or known for exceptional size, such as the Dodd Alada Mara). These highly valued trees often attract visitors, as evidenced by several specimens in Lal Bagh. Tree Officers must document and maintain these trees separately. The Karnataka Biodiversity Board or National Monuments Authority (NMA) should issue appropriate notifications to secure legal protection for their conservation. The Director will register and maintain these trees in a separate registry. A metal plate displaying the tree's history should be installed nearby. Trees will be removed from the heritage list upon death.

8.3.3. Rare, Endangered and Threatened (RET) Tree Species: Several tree species are classified as rare, endangered, or threatened by the International Union for Conservation of Nature (IUCN). These declining populations require careful protection and conservation. Taxonomists familiar with these species should be consulted immediately after tree census completion to identify RET specimens. This list should be distributed to field staff to prevent disturbance during maintenance operations. Special efforts must be made to collect seeds from RET species for propagation in their natural habitats and elsewhere when possible. The Director will maintain documentation of all RET species in the official Registry.

8.4. Prevention of cruelty to trees

8.4.1. Cruelty to trees prohibited: Trees are living entities and must be treated with care and respect for life, whether they are private or public trees. Wanton acts of cruelty to trees are a heinous crime.

8.4.2. Act of cruelty: The following acts shall be considered as cruelty to trees:

- **(a)** Causing any injury to the tree or trees by way of hacking, setting fire, poisoning, girdling, debarking, uprooting, or using any other method intended to injure or kill a tree.
- **(b)** Mutilating roots or branches, excessive pruning (lion-tailing), pollarding, tipping or topping or creating crown imbalance.
- **(c)** Dumping garbage, construction materials, sewage, etc., around trees and physically harming a tree or crushing a sapling.
- **(d)** Hard paving around the tree collar region, hindering the tree growth and water seepage.
- **(e)** Fixing nails, screws, pegs, bolts, or using trees as anchors for shelters, hoardings, notices etc.
- **(f)** Drawing barbed wire directly on the trees, encircling live electric fences, cables, or ropes tightly around the tree.
- **(g)** Painting on the bark, fixing electrical lights to the trees, or applying harmful chemicals that may damage, infect, or cause stress to the tree.

8.4.3. Penal action for cruelty against trees: Any person who commits an act of cruelty or an offence against a tree or trees shall be liable for penal action under section 22 of the Karnataka Preservation of Trees Act 1976 or Section 254 of the BBMP Act. The Tree Officer shall be competent to take the penal action.

8.4.4. Saving: However, bracing a tree for safety, pruning for hygiene, health and vigour, or removing a tree after obtaining permission from the competent authority shall not be considered as cruelty.

8.5. Other Issues

8.5.1. Public participation: Public participation in urban forest expansion and management should be encouraged by all means. The following are suggested. More can be added.

- **(a)** Formation of nature clubs in the schools and colleges and organising forest bathing, nature walks, bird watching, tree seed collection and sowing, weekend picnics to parks and lakes etc., should be taken up through NGOs.
- **(b)** All schools, colleges, nature clubs, and NGOs should be encouraged to partake in annual tree-planting programs.
- **(c)** Citizens' grievances should be addressed promptly. If there are more or very frequent complaints from a specific area or about a particular problem, it should be examined in detail, affected people should be invited for a meeting and solutions should be found by mutual consultation.

8.5.2. Public-Private-Partnerships: As urban forestry expands, numerous public-private partnership (PPP) opportunities may emerge. Organizations might offer funding for tree planting on BBMP or government lands, provide land for BBMP tree planting at no cost, or sponsor public events. The Director should personally evaluate these opportunities and, when feasible, present them to the Executive Committee for implementation approval. For afforestation of private lands, agreements should be established requiring tree protection for at least ten years and maximizing public access before project initiation. The detailed instructions in paragraph 6.25 regarding CSR planting also apply to PPP projects and must be followed.

8.5.3. Sale of Non-Timber Forest Products (NTFPs): Some wards contain woodlots producing commercially valuable fruits (e.g., tamarind) or seeds (mahua, honge, etc.). The unorganized collection often damages trees. To protect tree health and streamline the collection, the Assistant Conservator of Forests should identify potential areas, estimate yields, and conduct local auctions. Successful bidders should receive official authorization letters with instructions for scientific harvesting methods.

8.5.4. Evaluation: Urban forestry requires significant investment from the city. Results should be evaluated every five years. The Director should collaborate with the Karnataka Monitoring and Evaluation Authority and the Karnataka Forest Department to conduct scientific assessments of urban tree planting and maintenance activities. The final evaluation report should be presented to the Executive Committee, with subsequent actions based on its recommendations.

8.5.5. Legal suits against BBMP Forest Officers: Forest officers face litigation from citizens claiming negligence. Officers must understand the potential damage and loss from falling trees and follow manual guidelines to minimize risks. The procedures for risk mitigation and compensation claims are outlined in paragraph 5.23 of this Manual and must be followed. BBMP Legal Counsels should defend forest officers against unwarranted private complaints. Officers should only be held personally liable for losses if proven to have failed in their duty as determined by court order. Existing government rules providing this protection must be followed.

8.5.6. Awards and rewards: The BBMP shall establish appropriate awards and rewards recognizing outstanding contributions to urban forestry, wildlife, environment, and ecology. Recipients may include officers, staff, Tree Wardens, members of Urban Forest Sub-Committees, private or public institutions, NGOs, and individuals. These awards shall be presented by a Constitutional Functionary during Independence Day celebrations.

CHAPTER - 9

GENERAL REGULATIONS

This chapter addresses the procedural aspects of executing works and the associated office tasks.

9.1. Budget for Urban Forestry

9.1.1. Funding norms for Urban Forestry: There shall be a separate budget head within the BBMP dedicated to urban forestry. It shall be at least 3% of the total budget.

9.1.2. Preparation of Annual Budget Estimates: The Director will prepare budget estimates for the upcoming financial year, detailing projected income and expenditure across various work items and activities. If an approved Urban Forest Management Plan exists, the scheduled works for the next financial year will form the basis for the expenditure budget. In the absence of such a plan, the Director will request Tree Officers to compile a list of obligatory works for the upcoming year and incorporate their total cost into the budget estimate. The budget should also include allocations for wildlife management, publicity and extension, planning, monitoring, evaluation, research, and collaborative project grants. Any anticipated revisions to scheduled work rates should be accounted for. The Director will submit these budget estimates to the Budget Section within the specified timeframe.

9.1.3. The Budget approval process: The budget estimates will be scrutinized and incorporated into the annual budget proposals by the Chief Commissioner. Once the budget is approved, a copy will be forwarded to the Director. The Director will inform subordinate officers, and instruct them to implement work accordingly. Projects will be prioritised based on necessity before implementation. Spill-over works will get priority in implementation over fresh works.

9.2. Schedule of Sanctioned Rates (SSR)

The Urban Forestry Wing will adhere to the Schedule of Standard Rates (SSR) prescribed by the Karnataka Forest Department. Given that urban forestry works are significantly more complex than traditional forestry operations and labour costs are higher in urban areas, the Director should request the Karnataka Forest Department to establish a dedicated section within the departmental SSR specifically for Urban Forestry Works and approve special rates. Necessary test work should be conducted, and the corresponding rates for various work items should be incorporated into the SSR.

9.3. Annual Plan of Operations (APO) Process

Each Tree Officer will prepare an APO detailing proposed works based on the approved Urban Forest Management Plan or other requirements, including itemized cost estimates and total budget needs for their zone. The APO will consist of two sections: the first covering continuing obligations such as nursery maintenance of juvenile seedlings and upkeep of existing plantations; the second outlining new initiatives planned for the year. Tree Officers must submit their APOs within 15 days after receiving budget allocation information from the Director. The Director will review and approve these plans within 15 days of receipt and communicate approvals back to the Tree Officers.

9.4. Preparation of Cost Estimates (CE)

Tree Officers shall prepare detailed cost estimates for each work item based on the model cost norms provided by the Director and submit these alongside their Annual Plans of Operation (APOs). These estimates will undergo a two-step review process: first scrutinized and countersigned by the Assistant Conservator of Forests (ACF), then scrutinized and approved by the Director. Following approval, copies will be distributed to both the Tree Officer and ACF for their records. If actual costs deviate by 10% or more from the estimate, a revised estimate must be prepared and submitted.

9.5. Procurement and Contracting Procedures

9.5.1. Manner of calling tenders: For works exceeding the threshold limits established in the Karnataka Transparency in Public Procurement Act, 1999, and its Rules, the Director will initiate tenders through the Karnataka Public Procurement Portal using either a two-cover or two-stage system as appropriate, and subsequently award work contracts. Tenders must be issued for complete projects rather than segmented components. The contract tenures shall be as prescribed in the respective chapters of this Manual. It ensures that a single agency assumes full responsibility for project completion and outcomes. Partial work contracts are prohibited. Works with costs below the KTPP Act thresholds may be executed either through quotations or by departmental staff.

9.5.2. Eligibility: For contracts valued up to ₹25 lakhs, prior experience is not mandatory, but completion of required training is essential. For contracts exceeding this threshold, bidders must demonstrate prior experience in executing forestry work. Eligible contractors include those who have performed similar work for the BBMP, Karnataka Forest Department, any Forest Corporation, or other public undertakings involved in forestry activities, provided they have undergone the mandatory urban forestry training at the designated institute.

9.5.3. Number of contracts that can be awarded to one bidder: Only one contract can be awarded to one bidder. If the same bidder has succeeded in more than one zone or more than one work within the same zone, he can choose any one contract. Other contracts shall be awarded through negotiations to the next eligible bidder at the same price offered by the successful bidder.

9.5.4. Sub-normal bids shall be rejected: Any bidder who submits a bid below the approved cost estimate by more than 20% shall be considered sub-normal and rejected outright because the quality of work cannot be maintained at such low rates.

9.6. Execution of Work by the Contractors

9.6.1. Commencing the work within one month: Contractors should commence the work within one month of signing the contract agreement. No advance will be paid for any work.

9.6.2. Hiring a trained crew manager/supervisor is mandatory: The contractor should hire only trained and certified crew managers or supervisors. This shall be a prequalification for commencing the work. If he can’t find a trained person, the tender may be cancelled.

9.6.3. Procedure laid down in this manual to be followed for works: The procedure laid down in the manual shall be followed while executing the works. Three days advance intimation should be given in case it involves other departments or agencies.

9.6.4. Maintaining work quality/standard: Contractors should maintain the standards specified in the contract. For sub-standard work, he will not be eligible for any payment.

9.6.5. Termination or extension of contract: The contract may be terminated at any time if there is an abnormal delay in work execution, if work quality remains unsatisfactory despite written notice, or if the contractor engages in any malpractice. If work completion is delayed for legitimate reasons, a time extension not exceeding 6 months may be granted on terms deemed appropriate by the Director. No additional work may be assigned during this extension period.

9.6.6. Supervision of works by the field staff: Works executed by contractors shall be closely supervised and guided by the Tree Wardens, Tree planting supervisors, Tree Inspector and Tree Officers on a day-to-day basis. The Tree Officer and the ACF shall check the quality of work and the progress as often as necessary.

9.7. Recording the Completed Work

9.7.1. When to record the work: Whenever a substantial part of a work can be considered an independent component, or a part of the work that could be completed in a certain time interval like, for example, a month, the details should be recorded by the contractor.

9.7.2. Recording the works: The quantity and quality of completed works must be recorded in the Measurement Book (MB). When contractors wish to submit bills and claim payment, they must first document completed works in the MB. These books are maintained at the Tree Officer's office. Whenever the contractor wants to record a work, he should ask for it through the supervising staff. They will be provided. For survey-related work, data must first be entered in the Field Note Book (FNB) before summarizing in the MB.

FNBs and MBs are classified as secured stationery and are obtained from the Karnataka Forest Department. The Director is responsible for procuring sufficient quantities and distributing them to Tree Officers. Each distinct work requires one dedicated FNB/MB, with all related components recorded in that same book. Survey works require both an FNB and MB, while other projects need only an MB. The number of active MBs at any time will correspond to the number of ongoing works in each Zone. Both closed FNBs and MBs should be recorded in a permanent register. The movement of each active FNB/MB will be recorded each time it is issued. When work documentation occurs through digital means using mobile applications, the FNB requirement is waived. But the MB remains mandatory. It is a legal document for the work quality and quantity.

9.7.3. Details to record by the Contractor: The following details should be recorded by the contractor each time he uses it:

Record of works completed		
1	Month and year	
2	Work code	
3	Sl. No. in the cost estimate	
4	Description of the work	
5	Date of commencement	
6	Expected date of completion	
7	Quantity of work carried out	
8	Name of the contractor	
9	Signature of the contractor	

9.8. Preparation of Bills

Bills for the completed works will be prepared by the contractor on his invoice or bill forms. A summary will be entered in the bill format prescribed by BBMP, signed and given to the supervisor in triplicate. One copy will be retained by the Tree Officer. The second copy will be retained by the Director. The original will go to the Accounts Department of the BBMP for payment. The bill, along with the MB, will be returned to the work Supervisor.

9.9. Check Measurement and Counterchecking

9.9.1. Check measurement: The work supervisor should check the work 100% and make necessary entries in the MB just below the contractor's entries.

- **a.** Name of the work supervisor:
- **b.** Designation:
- **c.** Certificate: I certify that I have checked the work 100% and found the quantity recorded by the contractor correct.
- **d.** Quality rating: Good ☐ /Satisfactory ☐ / Poor ☐
- **e.** Signature:
- **f.** Date:

9.9.2. Counter-checks: The works should be counter-checked without any overlap by the officers on the following scale.

Sl no	Designation	Counter check %
1	Tree Officer	50%
2	Assistant Conservator of Forests	20%
3	Director	3% if the cost of work is more than Rs.25 lakhs

Counter-checking at the prescribed percentage shall be mandatory before the payment of the final bill.

9.10. Payment of Bills

9.10.1. Procedure for payment of bills: The Tree Officer will submit the bills and Measurement Books (MBs) to the Director every month before the 20th or after the work is completed. The office of the Director will check them, and if found in order, they will be passed for payment. The Director will check the details, admit the expenditure by countersigning them, and transmit the original bills to the Accounts Department of the BBMP for payment. They will pay the bills and inform the Director. Based on this communication, the entries in the MB that have been paid will be crossed with two horizontal lines across the page and recorded as "Paid in Voucher no: ____" between the two lines. This completes the payment process. The MBs will be returned to the Tree Officer for making further entries. This process will continue until the work is completed. After the work completion, the MBs will be archived.

9.10.2. Bills should be paid for the actual quantity of work: Payment of bills should be for actual work done in the field and if the work quality and quantity meet the standards specified in the contract. No payments shall be made for substandard works. Taxes as applicable shall be recovered from the bill payments.

9.10.3. Final payment: Final payment can be made after the work is fully completed in all respects and the bills are accompanied by a work completion certificate issued by the contractor. The works should be duly checked and countersigned by the Tree Officer and the Assistant Conservator of Forests.

9.11. The Urban Tree Fund

9.11.1. Constitution of Urban Tree Fund: An earmarked fund in the name and style of "Bengaluru Urban Tree Fund" shall be created within the BBMP accounting system.

9.11.2. Amounts that can be credited to the Urban Tree Fund: The following amounts should be credited to this account:

- **a.** Compensatory planting costs received for removing public trees for development projects.
- **b.** Revenues earned from the sale of seedlings / juvenile trees.
- **c.** Revenue obtained from the sale of wood.
- **d.** Compounding fees, fines and penalties collected from public.
- **e.** CSR and other project-based donations.
- **f.** Any other revenue the Chief Commissioner may permit.

The actual funds shall be maintained by the Accounts Department of BBMP. They will release funds for approved works like the regular BBMP funds.

9.11.3. Utilisation of the Fund: The Tree Fund shall be utilised in the following manner:

- **a.** Funds received for specific projects shall be utilised only for those projects.

b. 95% of the remaining funds may be utilised for establishing theme parks on the lands of public institutions.

c. About 5% may be utilised for research, extension, and educational activities.

d. About 1% may be utilised for third-party evaluation of works.

9.11.4. Keeping a ledger account of the Fund: The Director shall keep a ledger account of the Tree Fund. The actual work done and the fund flows shall be entered into this ledger. The unutilised funds will be carried over to the next financial year. It shall be a permanent account of the Urban Forest Wing.

9.12. Submission of Monthly Accounts Statements

All the Tree Officers shall compile a monthly statement of accounts indicating the revenue from various sources and expenditure and expenditure on works plus other contingencies in the format prescribed and submit the same to the Director before 5th of the succeeding month. The Director will check the correctness, consolidate the statements of all the Tree Officers, add details of his office and submit a consolidated statement of monthly income and expenditure to the Commissioner before the 15th of the month.

9.13. Audit of Annual Accounts

Annual audit of the accounts will be carried out by the same team and in the same manner as provided in the BBMP Act 2020.

9.14. Digital Databases to be maintained

Several mobile applications and digital databases are prescribed in different chapters of this manual. The Director shall be responsible for designing the mobile applications, and digital databases, and the proper storing, preservation, management, and utilization of the data. All the data will be deemed legacy data. Nothing should be deleted unless it has been examined by a Technical Committee of the IT Department and approved by the Chief Commissioner.

9.15. Offices of Record

9.15.1. Registers and files: The Ward Forest Office, and offices of Tree Officers shall be primary offices of original records for the field works carried out. They shall be maintained in hard copy. Various registers and records prescribed in different chapters of this manual shall be maintained in hard copy. Copies of all these records shall be obtained by the Director and maintained systematically such that even if any original record has been lost, it can be rebuilt.

For all the matters originating from the Director, his office shall be the office of records. Copies of these records shall be provided to the respective ACFs and Tree Officers who shall preserve them.

9.15.2. Inspection minutes book: The Tree Warden shall maintain an Inspection Minutes Register at the ward level. This register must be presented to any higher officer conducting an inspection of works or offices for recording instructions under their dated signature. One left-hand page shall be reserved for each officer's instructions. The responsible staff or officer must implement necessary follow-up actions, document these actions on the opposite page, and report completion as promptly as possible. During subsequent inspections, the concerned officer should verify compliance and provide any additional written instructions in the register.

9.15.3. Digital databases: The office of the Director shall be the office of Record for digital databases for security reasons.

9.16. Annual Report

An Annual Report shall be prepared in the manner and format prescribed by the Chief Commissioner and submitted to him. It should cover the list of officers who headed different offices, tree planting and maintenance activities carried out during the years, other events like tree falls, education and extension activities, public petitions resolved, court cases handled, and so on should be briefly summarised in the report. It should reflect the forestry activities completely. A copy shall be submitted to the Tree Authority.

9.17. Management of Records

All papers, files, documents, registers, and soft copies of files shall be current when being pursued. They shall be organized and maintained in the respective offices as per the prevailing practices in the BBMP. One year after the matter has been concluded in all respects, the relevant documents shall be sent to the record room. A separate section in the record room shall be reserved for the documents of the Urban Forestry Wing. A printout of important files available in soft copy form shall be taken, properly bound, and sent to the record room for preservation. Soft copies of all documents that are no longer required shall be archived on the BBMP portal.

9.18. Classification and Preservation of Records

The records shall be classified into A, B, C, D and E classes as per he manual of office procedure of the Karnataka Forest Department or the Govt of Karnataka, each class bundled separately and sent to the record room. A register of records sent to the record room shall be maintained by the Director in his custody.

CHAPTER - 10

DUTIES AND RESPONSIBILITIES

Following are the duties and responsibilities of various functionaries of the Urban Forestry Wing of BBMP abstracted from different chapters of this Manual. This is to facilitate an easy and quick understanding of the duties of each functionary or the committee. For more information, the respective paragraphs should be read and understood.

10.1. The Urban Forestry Executive Committee

Para. No	Duties and Responsibilities
2.3	General powers and functions.
4.13	Review the draft Urban Forest Management Plan and recommend it for approval to the State Government.
4.14	Review the implantation status of the approved Urban Forest Management Plan.
4.15	Approve the deviations from the approved Urban Forest Management Plan.
4.16	Approve modifications to the approved Urban Forest Management Plan after the mid-term evaluation.
5.25	Ensuring uniformity in tree maintenance and removal in urban and peri-urban areas.
6.16	Approve additional theme park projects if it is in the public interest.
8.14	Identify a suitable capacity-building institution, the curriculum and the annual training calendar.
8.5.2	Approve Public-Private-Partnerships in Urban Forestry.
8.5.4	Review the evaluation reports and action taken reports.

10.2. Chief Commissioner of BBMP

Para. No	Duties and Responsibilities
2.3	Head of the Urban Forestry Executive Committee. In that capacity, he/she will ensure uniformity of tree planting and maintenance activities in urban and peri-urban areas.
2.6	Provide the overall supervision, guidance and support to the Urban Forestry Wing.
2.7	Get the Range Forest Officers working at the Zonal level as the Tree Officers of that zone.
2.11	Get the RFOs designated as Tree Officers.
2.12	Approve hiring of office staff.
4.16	Appoint a suitable consultant for the mid-term review and evaluation of the Urban Forest Management Plan
6.10	Determine annual planting targets.
8.28	Approval of the Urban Forest Management Plan.
9.1.3	Provide for the Urban Forestry in the annual budget.
9.11	Authorise the constitution and operation of the Urban Forest Fund.

10.3. Special Commissioner (Forest, Environment and Climate Change)

Para. No	Duties and Responsibilities
2.5	Convenor of the Urban Forestry Executive Committee.
2.7	Overseeing the functioning of the Urban Forestry Wing and arranging for necessary coordination with other departments and divisions in BBMP.
6.10	Determine the annual planting target.
8.28	Member of the Committee to approve the Urban Forest Management Plan.

General	He/she will closely oversee the functioning of the Urban Forest Wing, and advise and support them in discharging their duties effectively.

10.4. Director of Urban Forestry

Para. No	Duties and Responsibilities
2.8	General duties and responsibilities.
2.14	Appointment of Tree Wardens
2.15	Appointment of members to the Ward Forest Sub-committee.
2.16	Appointing office staff on a contract basis.
2.18	Guide the urban forestry activities in peri-urban areas.
4.5.6	Appointing an agency for urban forest cover estimation.
4.6.1	Appointing contractors for tree census work.
4.6.4	Designing and employing mobile phone applications for tree census.
4.6.5	Giving publicity to tree census work and encouraging public participation.
4.11.3	Appointing an agency for Urban Forest Management Plan preparation.
4.11.5	Provide necessary information for the preparation of the Urban Forest Management Plan.
4.14	Implementation of approved Urban Forest Management Plan.
5.8.4	Taking the overall responsibility for tree hazard mitigation.
5.9.2	Training and equipping the officers and staff for tree risk assessment.
5.11.1	Reviewing the risk mitigation action over private trees.
5.11.2	Issuing orders for preventive tree maintenance.

5.14	Promoting research on the curative treatment of trees.
5.16	Issuing orders for tree pruning in certain cases.
5.17.2	Approve conversion of dead trees into snags.
5.17.3	Issuing orders for the removal of public trees.
5.17.5	Consulting the tree expert committee if the tree removal exceeds 50 tree and issuing final orders.
5.18	Appointing contractors for tree maintenance.
5.22	Designing and operationalising a mobile application for tree maintenance and felling operations.
5.24	Permitting tree pruning by utility companies.
5.25	Guiding tree maintenance and removal in peri-urban areas.
6.2.f	Facilitating and overseeing all planting operations in the city.
6.4.6	Maintaining a registry for elite trees, ensuring that seed is collected from these trees and used in the nurseries and evaluating nursery stock annually.
6.4.13	Inspect and certify the juvenile trees fit for planting.
6.10.1	Determining the annual planting targets in consultation with higher officers, arranging for tree guards if necessary, permitting watering of plants in special cases, providing general oversight to planting activities, investigating and fixing responsibility if the failure rate is high.
6.10.7	Specify the designs and advertising modalities for tree guard being donated by sponsors.
6.10.8	Decide about additional watering to juvenile trees planted in case of draught etc.
6.10.10	Inspect planting works and guide the field staff and workers.

6.10.12	Provide for additional cultural operations to planted trees.
6.10.15	Take action if there is significant failure of planted trees.
6.16	Promote theme parks in the city, sign the MoUs and work with the land owners.
6.19	Advise the Lakes Engineer on the design of lake shore planting and make sure that trees are planted on 10% of the lake side areas.
6.21	Work with and advise the utility companies on raising strip plantations on their lands.
6.22	Work with the Road Works Engineers and achieve convergence between green and blue infrastructure in the city and peri-urban areas. Provide juvenile trees for planting on private layouts in peri-urban areas.
6.23	Advise, decide and approve the planting designs for other planting models not specified in the Urban Forest Manual.
6.26	Look into the failure of transplanted trees and guide the contractors in future to achieve better results.
7.6.3	Approve the felling of private trees if the number exceeds 20 and get the opinion of the Tree Expert Committee if the number exceeds 50.
8.1. 4	Identify a suitable institute and build the capacity of staff, contractors and other key stakeholders.
8.2.4	Establish an Urban Wildlife Cell and oversee its functioning.
8.2.5	Promote urban wildlife conservation.
8.3	Maintain a registry of special trees, and guide the field staff in identifying them and handling them.

8.5.2	Promote public-private partnerships in urban forestry and arrange for external evaluations.
8.5.4	Plan for and organisation evaluation of urban forestry works.
9.1.	Preparing annual budget estimates and submitting them to the Budget Section of BBMP, communicating the budget finally approved to the Unit Officers and ensuring that they work accordingly.
9.2	Getting the Schedule of Sanctioned Rates for all urban forestry works from the Karnataka Forest Department.
9.3	Approving the Annual plan of Operations of Unit Officers.
9.4	Sanctioning the works estimates.
9.5	Appointing contractors for different works by calling tenders.
9.6	Contracts management.
9.7	Procuring the required number of Field Note Books and Measurement Books from the Forest Department and distributing them to Unit Officers.
9.8	Admitting the expenditure on works.
9.9	Counter-checking the field works.
9.10	Payment of bills and keeping a ledger account.
9.11	Maintaining a ledger account of Urban Tree Fund.
9.12	Submitting monthly accounts to the Chief Commissioner.
9.14	Maintaining a digital database related to urban forestry.
9.16	Preparing and submitting annual reports to the Chief Commissioner in time.
9.18	Classification and preservation of records.

10.5. Tree Expert Committee

Para. No	Duties and Responsibilities
2.3.3 5.17 7.6.3	Inspect the trees to be removed in specific cases referred to them by the Director, hear the public, and give their opinion. Their opinion is placed before the Court before issuing cutting permission
6.4.13	Participate in the evaluation of planting stock

10.6. Assistant Conservator of Forests (Plant Production)

Para. No	Duties and Responsibilities
2.9.1	General duties and responsibilities.
6.2.d	Guide and oversee the annual production of at least 1,000 plantable-size juvenile trees from each one of the 300-odd native tree species in BBMP nurseries within Bangalore City
6.4.12	Supervising and check measurement of juvenile tree production in the nurseries to meet public as well as private demand on a sustained basis.
9.4	Scrutinise and countersign the cost estimates.
9.9	Check measurement of works.
General	Procurement of forest tree seed from across Karnataka State from identified seed mother trees and ensure adequate supply to meet the biodiversity needs and plant production specification and annual targets

10.7. Assistant Conservator of Forests (Urban Forestry)

Para. No	Duties and Responsibilities
2.9.3	General duties and responsibilities

2.10	Work as the convenor of the Zonal Coordination Committee
4.10	Keep the tree census data updated
5.16	Issuing orders for contingent and emergency tree maintenance.
6.8.5	Preparing tree planting designs for each planting location.
6.10	Overseeing the planting activities.
6.11	Check measurement of planting works.
7.6.3	Approve private tree felling if the number is above 10 but below 20. For 20 or more, recommend to the Director.
8.5.3	Identify blocks of NTFP trees and conduct an e-auction or sale.
9.4	Scrutinise and countersign the cost estimates.
9.9	Check measurement of works.

10.8. Assistant Conservator of Forests (Urban Wildlife)

Para. No	Duties and Responsibilities
2.9.2	General duties and responsibilities
8.2.4	Head the Urban Wildlife Cell. Handle all wildlife-related matters in the city with the help of Tree Officers, Wildlife Rescuers, NGOs and the general public. Report to the Director and the Chief Wildlife Warden.
9.4	Scrutinise and countersign the cost estimates.
9.9	Check measurement of works.

10.9. Joint Zonal Commissioner

Para. No	Duties and Responsibilities
2.10.1	Head of Zonal Coordination Committee. He will coordinate the tree planting and maintenance activities with the different departments of the BBMP and also the utility companies to ensure smooth implementation of forestry works, minimise the damage to trees and utility company assets, minimise tree risks and ensure better greenery.
General	He/she will generally oversee the functioning of the Urban Forest Wing, and advise and support them in discharging their duties effectively.

10.10. Zonal Coordination Committee

Para. No	Duties and Responsibilities
2.10	The Zonal Coordination Committee will coordinate the execution of urban forestry works quarterly and decide the preparation to be done by various wings of BBMP and the utility companies. All the members of this committee will support each other in executing the works smoothly without interruption of the services or causing public inconvenience or damaging or losing too many trees.

10.11. Tree Officer

Para. No	Duties and Responsibilities
2.11	General duties and responsibilities.
2.12-16	Supervise the work of field and office staff and members.

4.6.6	Getting trees in restricted areas enumerated.
4.6.11	Oversee tree census operation works of the contractors
5.6.5	Ensure that private trees are properly maintained.
5.8.3	Timely identification of hazardous trees.
5.9.3	Arrange for scientific investigation into defects in special categories of trees.
5.11	Getting risk assessment done and elimination of hazards.
5.18	Supervising the tree maintenance works.
5.17	Setting up BBMP wood depots.
5.23	Processing compensation claims.
6.2.c	Responsible for establishing and maintaining plant production centres and plant growth centres.
6.4	Overseeing the work of production of juvenile trees.
6.10	Overseeing tree planting works, planting works and check measurements.
7.2	Securing entry into private premises for tree census.
7.3 & 7.4	Get juvenile trees planted on private property on a payment-of-cost basis.
7.5	Resolve private tree risk and hazard conflicts.
7.6	Give tree felling permission to private land owners and help them in the marketing of wood.
7.8	Issue transport permits for private wood.
8.2.4	Support the Wildlife Rescuers and wildlife NGOs.
8.3	Identify elite trees and report to the Director to evaluate and take them to registry.
8.4	Prevent cruelty to trees and take penal action against offenders.
9.1	Prepare and submit the annual budget proposals to the Director.

9.3	Prepare and submit the annual plan of Action to the Director.
9.4	Prepare and submit the detailed cost estimates for all the works to the Director.
9.6	Oversee nursery and planting activities of the contractors.
9.7	Holding the stock of field note books and measurement books, recording the works and check measurement.
9.9	Counter-checking the planting works.
9.10	Countersign and present the works bills to the Director for payment.
9.12	Render monthly accounts to the Director.
9.15	Maintain basic records.

10.12. Tree Inspector

Para. No	Duties and Responsibilities
2.12	General duties and responsibilities.
4.6.11	Supervise the tree census work of the contractor.
5.8	Tree defect identification.
5.9	Tree risk and hazard rating.
5.10	Taking up appropriate tree maintenance activities as required.
5.18	Supervising the tree maintenance works and local coordination with wildlife experts, police etc.
5.19	Coordinating the tree maintenance works with local authorities and utility companies.
5.20	Oversee the conversion of wood and issuing passes for transporting wood and managing the wood depot.

9.6	Guide and supervise the contractor's labour teams.
General	Lead and supervise the tree maintenance works

10.13. Tree Planting Supervisor

Para. No	Duties and Responsibilities
2.13	General duties and responsibilities
6.2	Guide the Tree Warden and Ward Sub-Committee in tree planting and independently monitor the trees planted in the last three years.
6.10	Supervising the planting work daily, fixing stakes and tree guards to young trees if required, capturing images of young trees and uploading them to the tree census database, and advising private landowners on tree maintenance.
6.12	Recording the tree-planting works and journaling their progress.
9.6	Guide and supervise the contractor's labour teams.
9.8	Check and countersign the contractor's planting bills.
9.9	Recording the planting works in the measurement books.
General	Lead and supervise the tree planting activities.

10.14. Tree Warden

Para. No	Duties and Responsibilities
2.14	General duties and responsibilities.
4.4.2	Participate in the tree census work.
5.8	Assist in tree defect identification.
5.9	Carry out visual tree risk assessment and hazard rating.

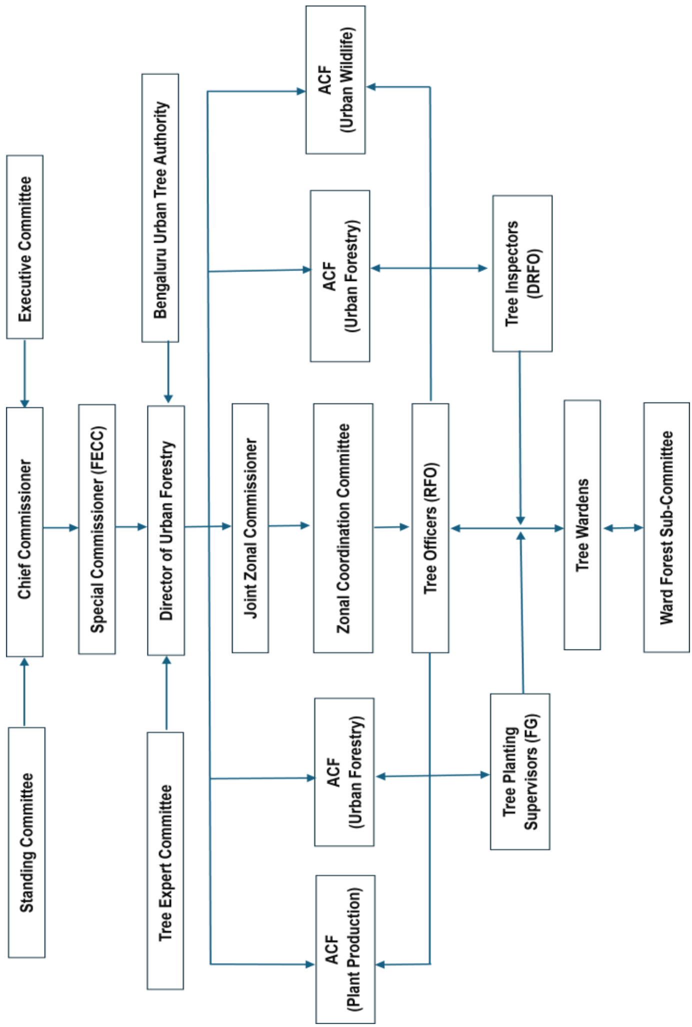
5.11	Registering complaints related to tree risks, site visits and visual tree risk assessment and overseeing the mitigation work.
6.2	Identify tree planting sites and assist the Tree Planting Supervisor for planting a minimum of 500 trees per ward.
6.6	Identifying suitable places in the ward to plant trees and documenting them.
6.12	Maintaining the basic records of urban forestry at the ward level.
7.3	Guide the private landowners on tree planting.
7.5	Assist the tree owners in maintaining private trees.
9.6	Guide and supervise the contractor's labour teams.

10.15. Ward Forest Sub-committee

Para. No	Duties and Responsibilities
2.15	General powers and functions.
5.8 & 5.9	Tree risk assessment and hazard rating responsibility.
5.11	Visual tree risk assessment and hazard rating of public trees.
6.2	Identifying locations and planting at least 500 juvenile trees annually in the ward and increasing the biodiversity with the help of the Tree Planting Supervisor.
7.5	Advise and guide the private land owners on tree planting and resolve disputes between neighbours.

APPENDIX - I

ORGANISATIONAL CHART OF BBMP URBAN FORESTRY WING



APPENDIX – II

UNDERSTANDING THE TREES AND TREE COMMUNITIES

(Refer to paragraph 3.10)

3.12.1. What is a tree?

A tree is a perennial woody plant with an elongated stem or trunk that supports branches and leaves. There is no universally agreed definition of a tree. The common understanding is that it is a woody, self-supporting plant having a diameter of not less than 10 centimetres (girth of 30 centimetres) at 135 cm height above the ground level; and has a single erect, unbranched, and self-supporting trunk of about 5 metres in height.

3.12.2. How many types of trees are there?

Globally, there are an estimated 70,000 to 100,000 species of trees. They are classified in different ways.

(i) **Gymnosperms and Angiosperms:** Gymnosperms (naked-seeded plants) include conifers like pines and Christmas trees. They are more primitive, have fewer species, and typically grow in temperate regions with some exceptions. Angiosperms (covered-seeded plants) are flowering plants comprising around 300,000 species, of which approximately 60,000 are trees. Angiosperms predominate in tropical regions.

(ii) **Evergreen, Semi-Evergreen and Deciduous trees:** Angiosperms are further classified by how they manage their foliage. Deciduous trees (e.g., Terminalias) shed all leaves in winter and regrow them in spring. Evergreen trees (e.g., jack, mango) retain their leaves year-round. Semi-evergreen trees (e.g., sampige) simultaneously produce new leaves while shedding old ones. These different forest types typically develop in distinct geographical regions and rarely converge in a single location.

(iii) Tree Sizes: Trees are also classified based on their size:

- **(a) Small trees:** Measure up to 7.5 M in height from the ground level. Girth depends on the species and age.
- **(b) Medium trees:** Measure up to 12 M from ground level.
- **(c) Big trees:** Measure more than 12 M from ground level

There are many other ways of classifying the trees. However, for this manual, the above three classifications are sufficient.

3.12.3. What does a tree do?

At its most fundamental level, a tree lives for its own sake. It manufactures its food by photosynthesis. For this, it takes energy from the visible spectrum of sunlight, carbon dioxide from the air, and water and minerals from the soil. This is the most fundamental biological process common to all plants on earth. Part of the food manufactured is used immediately or stored in different plant plants. Plants germinate, grow, live, reproduce autonomously and ultimately die.

3.12.4. How do the trees help the ecosystems?

Trees function as fundamental ecosystem engineers, simultaneously serving multiple vital roles in our environment. They regulate atmospheric conditions by converting carbon dioxide to oxygen, reduce ambient temperatures through shade and evapotranspiration, and enhance humidity levels for more comfortable microclimates. Trees improve soil quality by transferring deep minerals to surface layers, contributing organic matter that increases moisture retention, and preventing erosion through their root systems. Additionally, they support biodiversity by providing food resources and creating diverse microhabitats for countless organisms. This comprehensive ability to passively modify and sustain balanced ecosystems distinguishes trees from all other living organisms.

3.12.5. How are urban forests different from natural forests?

They may look similar externally. But there is nothing common between natural forests and urban forests. The following table illustrates this.

Sl. No	Natural Forests	Urban Forests
	1. Location and Context	
1	Remotely located in relatively undisturbed, natural landscapes surrounded by rural areas.	Located in densely populated urban areas. Surrounded by roads, buildings and people.
2	Tend to cover large, contiguous areas with similar crop composition.	Fragmented - consisting of various elements like street trees, parks and pocket gardens.
	2. Composition and Structure	
3	Species composition is determined by natural ecological succession.	Selected non-native and ornamental species planted. No natural regeneration.
4	Exhibit high biodiversity	Have lower biodiversity.
5	Have more complex vertical layering (canopy, understory, shrub, and ground layers)	There is no community structure. There is hardly any interaction among the plants.
6	Future is shaped more by natural processes like climate, wildlife, soil conditions etc, and less by human interference.	Heavily influenced by human activity, including land development, pollution, and infrastructure expansion.

	3. Functions	
7	Trees are meant for general and long-term ecosystem services like biodiversity conservation, hydrological services and some goods like wood and NTFPs.	Trees are exclusively meant for delivering immediate ecosystem services like cooling cities, shade, filtering air pollution, recreation, and improving human well-being.
	4. Management Interventions	
8	Passively managed. Largely left to natural evolution.	Actively managed by pruning, removal and replacement.
9	Face natural stressors like competition, wildfires, diseases, droughts etc., occasionally.	Suffer routinely from air pollution, limited root space, water shortage, physical damages etc.
10	Requires general protection but hardly any individual care.	Need individual care and also regular management.
11	Both goods and services are highly valued at all times.	Only services are valued. Goods like wood and fruits have hardly any value.

3.12.6. Why the forest trees are better for urban greening?

Forest trees are typically more resilient, adapting better to the disturbed and artificial environments found in urban areas. These species offer diverse sizes, shapes, and characteristics, making them versatile for various urban settings. They generally exhibit greater resistance to pests, diseases, and physical disturbances while requiring minimal maintenance.

Forest trees excel at delivering environmental benefits including air quality improvement, carbon sequestration, stormwater management, and biodiversity support due to their larger size and more leaf area. Their robustness allows them to provide superior environmental services compared to horticultural species. They are best suited for public spaces.

Horticultural trees and ornamental plants are shorter-statured, have shorter life spans and require more intensive care (making them costlier to maintain with typically shorter lifespans) but they serve important purposes in specific contexts (e.g. breadfruit, butter fruit). They perform best in highly designed spaces where appearance and size control are priorities such as small courtyards, formal gardens, narrow streets, or congested areas, particularly in private spaces where landowners can provide dedicated care and also get some direct benefits from them.

Both tree types have their place in urban forestry. Horticultural varieties remain valuable in space-constrained areas where big forest trees cannot be accommodated, or in designed landscapes where specific aesthetic qualities are essential. The most effective urban forestry strategies strategically incorporate both forest and horticultural trees based on site conditions and planting objectives. Forest trees are good for public space while horticultural trees are good for private spaces.

3.12.7. Benefits from urban forests

Urban forests provide numerous benefits. A detailed account has been provided in paragraph 3. 7. It may be referred to.

3.12.8. Life Stages of a Tree

There are nine stages in the life of a tree.

(1) **Seed:** This is the embryonic form with a complete genetic code and packed with enough food supply for growing into a seedling.

(2) **Seedlings:** It is below one in age and up to 1 metre in height.

(3) **Sapling:** From one year to two years of age, height up to 3 mts.

(4) **Juvenile Tree:** Three to seven years in age, height up to 7 mts.

(5) Pole: Eight to 15 years of age, height above 7 mts. Up to this age, the apical bud is sharp and active, and the tree will have a leading shoot. The bark will be smooth.

(6) Semi-mature Tree: Age 8-15 and up to 25 years depending on species. The apical bud slows down. There are many branches. Crown formation visible. Bark cracks. Flowering and fruiting begin.

(7) Mature Tree: A mature tree has reached its full height and assumed its characteristic crown shape. Flowers and fruits regularly.

(8) Over-Mature or Senescent Tree: It is past its peak age. The age varies by species. The tree sheds its branches. Leaves become sporadic. Flowering and fruiting are occasional.

(9) Snag: A dead-standing tree that may serve as the habitat for insects, birds, fungus etc., before it decomposes into soil.

3.12.9. Parts of a Tree and Their Functions

There are five parts to a tree namely the roots, trunk, branches, leaves, flowers and fruits. Since flowers transform into fruits eventually, they are considered one part. All of them are equally important.

(1) Roots – structure and functions: Roots anchor the tree and absorb water and nutrients from the soil. They provide stability and nourishment. There are three categories of roots:

(a) Woody Roots: Woody roots emerge from the base of the tree trunk. They are spread over a distance of 1.5 to 2-meter radius near the soil surface and then enter the soil. Only the tap root goes straight down into the soil for a short distance of 2-3 m. The common belief that some trees send their tap roots down by several metres and suck the groundwater is incorrect. Taproot is just for mechanical support. It does not go very deep. The rest are horizontal roots. These roots are hard, thick, and contain heartwood. Including taproots, all woody roots put up secondary growth and keep growing in size. They support the weight of the standing tree and distribute it evenly to the soil. A mature tree typically develops 4-15 woody roots extending in all directions, forming what is called the "**Root Plate**."

Trees function as natural structural engineers. The root plate develops in response to the tree's weight distribution requirements. When branches grow unevenly, the trunk may develop flutes or ribs to transfer the load effectively. The woody roots beneath these features strengthen accordingly to bear the additional weight. If some woody roots are chopped off, the tree becomes unstable. Sooner or later, it will fall. When it falls, the remaining root plate fractures and comes out of the soil.

(b) Anchoring Roots: These roots extend outward from the woody roots, typically reaching 2-3 meters in length in mature trees. Anchoring roots are responsible for transferring dynamic loads (such as bending forces caused by wind pressure on the canopy) to the soil. They measure approximately 15 -25 centimetres in circumference and are characterized by a reddish, flaky bark with a relatively tender appearance. When a tree falls, these anchoring roots typically snap and stay inside the soil. They don’t come out.

(c) Feeder Roots: Feeder roots are those with a diameter of 1 centimetre or less. They originate at the end of the anchoring roots. They are typically found in the top 15-25 centimetres of soil. These roots branch extensively, forming a network throughout the tree's root zone. They terminate in fine, fibrous white tips measuring 5-10 centimetres in length, which represent the active growth regions. These roots continuously expand outward and, as they age, mature and develop a brown colouration. The feeder roots keep growing outward all the time.

(d) Root hairs: The root tips are covered with numerous fine "**Root Hairs**". They have a brief lifespan, lasting from a few days to approximately two weeks, and are continuously replaced as the root grows. They develop in the region behind the root tip known as the root hair zone. As the root extends, older root hairs die while new ones are borne further along the root. Root hairs absorb moisture and minerals for transport to the canopy. In exchange, all the living cells in the roots receive nutrients manufactured by the leaves. The overall health and vigour of the plant are largely dependent on the total active root biomass and its capacity to absorb water and minerals.

(e) Mycorrhiza: Often, beneficial fungi, called "Mycorrhizae", naturally occur near active root zones and form extended attachments to root tips. These fungi assist plants in absorbing water and minerals like the root hairs while receiving nutrients from the roots in return. This symbiotic association benefits both organisms. There exist hundreds of mycorrhizal fungal species, with specific tree species typically forming associations with particular species of fungus. Additionally, some broad-spectrum mycorrhizae can form beneficial relationships with most tree species. Mycorrhizae complement the function of root hairs, operating for longer periods and extending over wider areas than root hairs. They support the tree roots more efficiently than the root hairs.

(f) Nitrogen-fixing bacteria: Certain tree species in the Leguminosae family develop specialized structures called "Root Nodules" that host nitrogen-fixing bacteria, predominantly from the genus Rhizobium. These bacteria establish a symbiotic relationship with the plant, converting atmospheric nitrogen (N_2), which is unavailable to plants, into ammonia (NH_3), a nitrogen form readily absorbable by plants to support growth. This process, known as biological nitrogen fixation, provides substantial benefits to the plant. In exchange, the plant provides the bacteria with food and maintains a protected environment within the nodules for hosting the bacteria. This mutually beneficial arrangement helps both.

(g) **Root spread:** The total root spread of a tree is less well understood. A tree's root system comprising woody roots, anchoring roots, and feeder roots forms an intricate network that spreads radially outwards from the tree. So long as the tree keeps growing, the root network also keeps expanding. At the minimum, this network reaches the dripline (the outer perimeter of the tree canopy). In unrestricted environments, roots may extend significantly farther, with the total ground area occupied by the root network potentially covering 2-3 times the width of the canopy. The root space required for any tree species depends on its canopy size at maturity. The minimum root area that is required (called critical root zone or CRZ) is 1 to 1.5 feet of radius per inch of trunk diameter. This much space has to be provided for the roots to grow normally. Otherwise, the tree growth will suffer. Inter-planting space should be provided keeping in mind the size a tree will reach upon its maturity and the corresponding critical root zone requirement.

In urban settings, spatial limitations often restrict root expansion. Any impediment to root development directly impacts the tree's canopy development and overall health. The relationship between root system development and canopy growth illustrates the interconnected nature of tree structures and the importance of providing adequate growing conditions for optimal tree health.

(h) **Natural soil and root growth:** Natural soil is an amazing medium. Ideally, it should have about 50% pore space for the roots to penetrate and grow easily. This pore space is filled with air and moisture. Out of the 50% pore spaces, about 10-20% contains oxygen; 20-25% contains moisture. The rest is free space (void). The actual mineral matter is only 40 to 45% by volume. The rest 5 to 10% is organic matter. Healthy soil environments contain abundant beneficial fungi and bacteria that support plant growth. Roots are living structures that require oxygen for respiration. This oxygen is primarily available in the upper 30 centimetres of soil. Despite adequate moisture availability in deeper soil layers, feeder roots cannot survive, grow and function without sufficient oxygen. If the pore space is less than 15% or the oxygen level is below 5%, the feeder roots get suffocated. They stop functioning. Similarly, compacted soils with inadequate aeration impede root development. The ideal growing conditions combining adequate moisture, nutrients from organic matter, and oxygen exist predominantly in the top 30 centimetres of soil. Consequently, this zone contains the majority of a tree's active root system. Damage to this critical area significantly impairs tree growth and development.

(i) **Roots behaviour:** Roots are hydrotropic. They are always searching for moisture and minerals. They will enter even a small crevice, will grow along to a faraway place if there is a guarantee of finding moisture. They can also sense water flow in pipes and keep growing in the direction of water flow and eventually find a joint where they can get inside and take water. This is facilitated by small crevices that get created along the pipes, cables etc., due to seasonal soil expansion and contraction. Urban soils are hard and compacted. Pavements create artificial scarcity of water. Hence, the roots are always in search of water and at the earliest opportunity invade sumps and water tanks. It's remarkable how tree roots adapt and persist, even navigating through tough terrain to find moisture. Unless rainwater seeps in and the tree gets sufficient moisture, the root invasion will always remain a challenge.

(2) The Trunk, its structure and functions: The trunk connects the tree's roots and canopy. It supports the heavy weight of the crown which can run into several tons. In trees with symmetrical or balanced crowns, the trunk typically maintains a circular in cross-section. However, when crown weight is unevenly distributed, the trunk may develop an irregular shape to effectively transfer branch loads to the woody roots. Trees possess inherent structural engineering capabilities that enable them to support asymmetrical crowns and transfer weight seamlessly to the soil.

Beyond its structural support function, the trunk facilitates the bidirectional exchange of nutrients between roots and crown through the phloem layer located immediately beneath the bark. Damage to either the bark or phloem disrupts this essential exchange. Additionally, the trunk stores residual physiological compounds along its core. This is commonly known as heartwood. It has distinctive characteristics such as unique aromas, patterns, or grain textures that determine its commercial value because of the physiological residues stored in it. It is species-specific (e.g. sandal).

The trunk lifts aloft the crown to get adequate sunlight. The trunk height is determined by both genetic factors and environmental conditions. Trees growing in groups typically develop taller trunks due to lateral competition, whereas those in open areas tend to be shorter. In urban settings, the trunk is invariably shorter. It may impede visibility, necessitating early pruning of lower branches. The trunk's form and dimensions directly correspond to taproot quality - straight, deep taproots produce erect, tall trunks, while damaged or coiled taproots result in similar or corresponding defects in trunk development. Therefore, maintaining taproot integrity is essential if sound and tall trunk development is desired.

(3) Branches: Branches establish the distinctive shape and architecture of a tree's crown. Each tree species exhibits characteristic branching patterns that can be classified hierarchically as primary (first order), secondary (second order), tertiary (third order), quaternary (fourth order), and occasionally fifth order branches. The terminal branches called twigs support leaves, flowers, and fruits while facilitating nutrient distribution throughout the tree. The branching pattern and resulting crown shape are particularly significant considerations in urban tree planting, where trees should be selected based on available overhead space. Four principal branching patterns can be identified based on the arrangement and development of primary branches on the trunk:

- **(a) Excurrent or Monopodial Branching:** This pattern features a tall, straight trunk that extends continuously to the tree's apex. Relatively small branches grow outward from this central trunk, resulting in a columnar crown architecture. *Teak, mahogany etc.,* exemplify this branching pattern.

- **(b) Decurrent or Sympodial Branching:** In this pattern, the trunk divides into multiple substantial branches above a certain height, eliminating the central leader. These branches predominantly spread outward, creating a rounded or spreading crown form. The Banyan tree and most horticultural trees illustrate this branching pattern.

- **(c) Whorled Branching:** Trees with this pattern maintain a single trunk from which multiple branches emerge at regular intervals in circular arrangements called whorls. At each whorl point, several branches radiate in different directions, creating a layered crown appearance. *Terminalia catappa* is a good example of this.

(d) **Dichotomous Branching:** This distinctive pattern involves each branch bifurcating into two approximately equal branches forming Y-shaped divisions. The resulting crown typically develops an umbrella-like shape with ornamental qualities. *Plumeria alba* exemplifies this branching pattern.

(e) **Mixed type branching:** Several mixed patterns also can be seen. The branching pattern and the crown shape assume importance in urban tree planting. Based on the overhead space available, the trees should be retrofitted.

(f) **Node and the branch collar:** The point where a branch connects to the trunk or another branch is called a **Node**. The xylem fibres that provide structural strength run longitudinally through the trunk or branch but are disrupted at nodes due to branch insertions, creating structural weak points.

Trees compensate for this vulnerability by developing a small bulge on the lower and lateral sides of the node. It is known as a **Branch Collar**. Sometimes it is also called as 'Flange'. It contains living tissue capable of regeneration if the branch breaks. Damage to the collar area, whether from storms or improper pruning techniques, prevents wound closure and creates entry points for insects and fungi, potentially leading to heart rot. Although collars may not always be visually apparent, proper identification and protection during pruning operations is essential for tree health.

(4) Leaves: Leaves, varying widely in shape and size, provide aesthetic beauty while performing vital functions for trees. Through photosynthesis, leaves produce food and facilitate gas exchange with the atmosphere. They also transpire a lot of water to reduce the effect of heat from the sun. The Leaf Area Index (LAI), representing total leaf surface area, directly correlates with a tree's photosynthetic abilities and its growth potential.

When selecting urban trees, species with high leaf area indices are preferable. Trees should always be allowed to retain their foliage. Pruning should remove no more than 20% of the total leaf area.

Shade represents a significant benefit of urban trees. The arrangement of leaves and overall leaf area index are crucial considerations when selecting species for planting. Some species distribute leaves primarily along the canopy's outer layer, while others maintain foliage both inside and outside of the crown. Shade from such trees is denser and more soothing.

Though 50% of solar radiation is photosynthetically active, trees utilize only 1% for food production. So, trees require approximately six hours of sunlight daily to manufacture their food. Light levels, if it falls below 50% of this duration, can cause decline and eventual death. Tree leaves act as selective filters for incoming light, creating cone-shaped shadows approximately 60 times the leaf diameter behind them. Beyond this distance, again sunlight becomes available. Leaves located will get sunlight for photosynthesis. Trees with leaves at multiple layers and levels are photosynthetically more efficient than others. The shade is also very dense.

When sunlight passes through multiple leaf layers within the canopy, less light reaches the ground level, creating denser, more comfortable shade. The light quality from tree shade differs significantly from building shade. Trees absorb blue and red wavelengths while reflecting the pleasant green wavelength. In contrast, building shade contains higher proportions of blue and red/far-red frequencies, which is less comfortable for humans.

When selecting tree species, considering internal leaf arrangement optimizes shade quality and enhances the urban experience.

(5) **Flowers/Fruits:** Flowers and fruits are reproductive organs. Flowers are ornamental and often attract bees, squirrels, birds and other animals for pollination. Fruits may be big or small. Some may be edible. They store tasty food materials for animals that eat the fruits and disburse the seeds. Those that don't have edible pulp have other mechanisms like forceful cracking, small flaky seeds, or seeds having wings, etc., for easy seed dispersal. Amenity trees with heavy flowers (e.g. Spathodia), fruits or seeds may hurt people or vehicles parked underneath. Stone throwing at edible fruits by children which may harm other pedestrians, window glasses etc. Fleshy fruits dirty the floors. They also attract bats. Fruits with sticky or soapy pulp should not be planted on the streets or roadsides as the vehicles, particularly the two-wheelers tend to skid when it rains. They can also dirty the roads and pavements. These factors should be considered while planting trees in public places like streets.

3.12.10. Ratios and proportions of different parts of a tree

The shape and size of trees are determined genetically but are influenced by factors such as age, site conditions and management practices. In a free-growing tree, the relationship between different parts of the tree is often expressed through certain ratios. Maintaining optimal ratios in tree growth ensures the tree's health, stability, and overall functionality. Balanced ratios can be achieved through site-species matching, proper spacing, and applying good management practices. Those responsible for urban tree management should be aware of the following key ratios:

(1) **Root-to-Shoot Ratio:** This ratio represents the balance between the root mass (below-ground) and the above-ground parts (shoots, branches, leaves). For young trees, a root-to-shoot ratio of 1:1 is considered healthy. Mature trees typically have a ratio of 1:2 and old trees have 1:3. This means that the root biomass should be roughly equal to the shoot biomass in young trees. It should be at least half of the shoot biomass in

mature trees. A healthy root-to-shoot ratio ensures that the tree can support itself, absorb enough water and nutrients, and sustain its canopy. It is relevant for nurserymen and those who transplant trees.

(2) **Height-to-Diameter Ratio:** This ratio compares the tree's height to the diameter of its trunk at chest height. It is an indicator of the tree's stability. For many tropical tree species, an optimal height-to-diameter ratio (also known as the slenderness coefficient) is 30:1 for mixed groves and 50:1 for monoculture plantations subject to species-specific variations. Trees with a higher ratio (tall and thin) are more vulnerable to wind stress and may bend or break. This condition often results from congestion, excessive fertilization, heavy overhead shade or over-pruning.

(3) **Trunk height-to-canopy height Ratio:** This ratio measures the relationship between the height of the tree trunk (trunk) up to the first major branch (where the canopy begins) and the canopy width (measured on the ground). The optimal value for this ratio is 1:5 for young trees and 1:3 for mature trees, meaning the clear trunk length should be one-fifth in the young trees and one-third in semi-mature and mature trees. This principle is important for tree pruning.

(4) **Leaf Area to Root Area Ratio:** While this ratio is theoretical and difficult to calculate precisely, it helps understand the tree's needs. The optimal range for this ratio varies but typically falls between 3:1 and 10:1, meaning the total leaf area should be 3 to 10 times the root area. Maintaining this ratio ensures that the tree can photosynthesize effectively while supporting adequate root growth for water and nutrient uptake. This ratio should be considered when training young trees in nurseries or when manipulating the crown during field maintenance.

3.12.11. How does the urban tree behave at the Individual level?

Urban trees demonstrate sophisticated individual behaviours that allow them to adapt to and thrive within challenging city environments. These behaviours manifest through several key mechanisms and adaptations.

(1) **Growth pattern adaptation:** Trees in urban settings actively modify their growth in response to the constraints of urban life. They navigate around artificial light conditions, adapting their phototropic responses to maximize light capture despite building shadows and artificial illumination. Their morphological development differs from forest counterparts, with altered branching patterns and crown shapes that accommodate spatial limitations.

(2) **Adaptive root systems:** Urban trees exhibit remarkable problem-solving capabilities in their root development. They navigate complex underground environments filled with compacted soils mixed with debris and infrastructure barriers, seeking water sources through available pathways. These roots demonstrate directional growth toward moisture and nutrients. They carefully skirt these obstructions and problem areas. In water-limited conditions, they regulate transpiration rates and modify water retention strategies. It is a part of their survival strategy.

(3) **Environmental stress management:** Urban trees produce specific volatile organic compounds when experiencing pollution, construction damage, or pest attacks. These compounds enhance the tree's resilience against urban stressors. During heat waves intensified by urban heat island effects, trees employ specialized physiological processes to maintain internal homeostasis.

(4) **Strategic resource allocation:** Individual urban trees demonstrate dynamic prioritization in resource management. When faced with limited soil volume or nutrient availability, they reallocate internal resources to essential functions and survival mechanisms. This includes

transferring carbohydrates and other compounds between different parts of the tree to maintain critical processes.

Urban trees function as highly responsive living systems capable of significant adaptation rather than being passive elements of the cityscape, demonstrating remarkable biological sophistication at the individual level.

3.12.11.1. How does the urban tree behave at the community level?

Jagadish Chandra Bose (1858-1937) demonstrated that plants have sensory capabilities similar to animals. They can feel the pain and understand affection. Further research is underway. Like the people in urban areas, the urban trees also come from an assortment of places but settle down and find peaceful ways to coexist, celebrate the best of times and share the hardship during worst times. While not experiencing community in the human sense, urban trees demonstrate collective co-existence and communication capabilities at a certain level. For example:

(1) In urban parks and less disturbed green spaces, trees maintain extensive **mycorrhizal** fungal networks through their root systems. These underground connections serve as **communication highways** that facilitate resource distribution and information exchange. Through these networks, well established trees can direct water and nutrients to younger seedlings or struggling neighbours during periods of stress. This resource optimization helps the entire tree community respond more effectively to drought, flooding, or temperature fluctuations common in urban environments. During monsoon seasons, the communication networks become very active, with tree communities coordinating water uptake and storage.

(2) Chemical communication represents another significant community behaviour. Trees in proximity exchange airborne volatile organic compounds that serve as warning signals when individuals face threats from pollution, pests, or other stressors. This early warning system enables pre-emptive defensive responses across the community, allowing trees to collectively activate protective mechanisms.

The strength and nature of these community interactions vary significantly. Park trees typically maintain robust interconnections due to continuous soil connections, creating more cohesive communities. Street trees face greater isolation but still attempt chemical communication through airborne signals. Wood lots represent intermediate communities with partial network preservation.

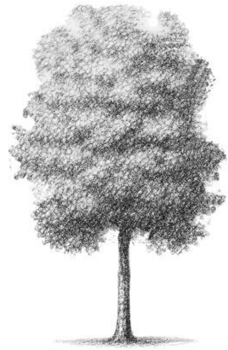
Human management practices significantly impact urban tree communities. Soil compaction, root barriers, and urban fragmentation disrupt natural community functions. Conversely, preserved soil corridors and diverse species plantings can enhance community connectivity.

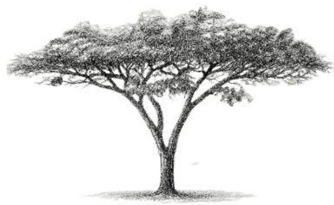
APPENDIX – III

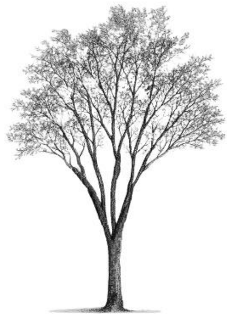
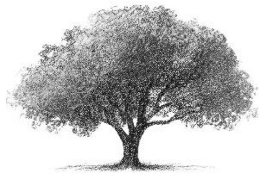
ARCHITECTURE OF TROPICAL TREES

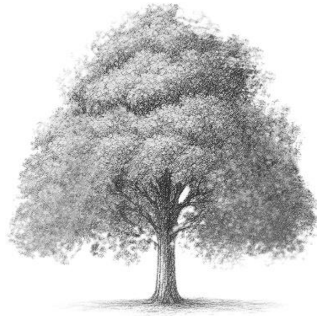
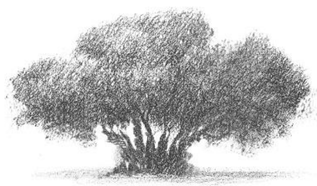
(Refer to Paragraph 3.10)

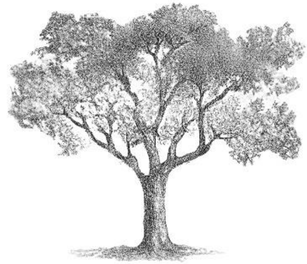
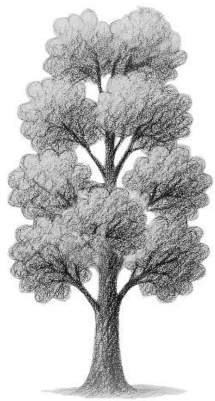
Sl. No.	Description	Image
1	**Columnar Crown** (i) Tall and narrow crown (ii) Short and dense branches (iii) Crown spread is limited (iv) Looks like a green pillar Example: False Ashoka (*Polyalthia longifolia)*	
2	**Triangular Crown** (i) Tall tree (ii) Crown limited to the upper half of the trunk (iii) The crown is triangular (iv) Foliage is dense Example: Kiral bogi (*Hopea indica)*	

3	**Cylindrical Crown** (i) The tree is tall (ii) The crown is wide and circular (iii) Top and bottom flat (iv) Crown diameter same from bottom to top Example: Maddale (*Alstonia scholaris)*	
4	**Spherical Crown** (i) Circular crown (ii) Crown compact (iii) Fully closed (iv) Dense crown Example: Dhupa (*Vateria indica*)	
5	**Oval Crown** (i) Elongated crown (ii) Slightly narrow at the bottom and top (iii) Wider in the middle (iv) Smooth outer edges without any gaps Example: Rose apple (*Syzygium jambos*)	

6	**Pyramidal Crown** (i) Triangular shape (ii) Wider at base and sharp tip. (iii) Strong central leader. (iv) Short and dense branching Example: Christmas tree (*Araucaria bidwillii*)	
7	**Umbrella Crown** (i) Flat-topped (ii) Spreading canopy (iii) Single layer of branches (iv) Excellent shade providers Example: Rain Tree (*Samania saman*)	
8	**Layered Crown** (i) Distinct horizontal layers (ii) Tiered branching pattern (iii) Pagoda-like appearance (iv) Architectural interest Example: Kadu badami (*Terminalia catappa*)	

9	**Vase-Shaped Crown** (i) Narrow at base (ii) Spreading wider at the top (iii) Upward arching branches (iv) Semi-circular at the top Example: Honne (*Pterocarpus marsupium*)	
10	**Spreading Crown** (i) Wide horizontal spread (ii) Branches extend outward (iii) All are big branches (iv) Each branch is long Example: Sausage Tree (*Kigelia africana*)	
11	**Weeping Crown** (i) Pendulous branches (ii) Drooping growth habit (iii) Graceful appearance (iv) Decorative look Examaple: Bottle Brush (*Melaleuca viminalis*)	

12	**Bell-shaped Crown** (i) The outline of the crown is bell-shaped (ii) Thick and spreading branches at the bottom (iii) Branches short and thin towards the top (iv) Typically, large trees Example: Tamarind (*Tamarindus indica*)	
13	**Compressed Crown** (i) Trees short in height (ii) Crown spread is wide (iii) Branching at low level (iv) Growth largely lateral Example: Kunt nerale (*Syzygium caryophyllatum*)	

<table>
<tr><td>14</td><td>Irregular Crown
(i) Does not fit into any of the shapes defined above
(ii) Crown outline is rough
(iii) Some branches may be big and some small
(iv) Crown may have openings here and there.
Example: Copper pod (Peltoforum pterocarpum)</td><td></td></tr>
<tr><td>15</td><td>Type 15. Lobed
(i) The tree is very tall.
(ii) Branches spread in some directions.
(iii) Each branch looks like a lobe
(iv) Each branch has its outline independently.
Example: Heddi (Adina cordifolia)</td><td></td></tr>
</table>

APPENDIX - IV

URBAN TREE INVENTORY PROTOCOL

(Refer to Paragraph 4.6)

A.4.1. Introduction

This appendix outlines the protocol for conducting a comprehensive urban tree inventory for the Urban Forest Management Plan. The inventory shall be conducted decennially (once every ten years). The tree census encompasses all trees situated on both public and private lands within the boundaries of Bengaluru City and its peri-urban areas. Preparation for the tree census work must begin one year in advance of the Urban Forest Management Plan development. A complete inventory of all trees in the city must be available before planning work commences.

A.4.2. Constituting the Work Teams

Two types of work teams are to be appointed by the Contractor hired for the tree census work:

(1) **Inventory Team:** This team shall consist of three members—one for marking the tree with its number, the second for taking measurements and observing the required tree features, and the third for recording data on the mobile device.

(2) **Backend Team:** The backend team shall consist of a Manager, one data operator, and one taxonomist. The Manager will assign work and monitor all inventory teams on a daily basis. The data operator will verify collected data to ensure completeness and proper recording, making necessary corrections to the database if required. The taxonomist will assist the inventory team in correctly identifying tree species.

A.4.3. Number of Inventory Teams to be Hired

One inventory team is expected to survey approximately 250 trees per working day and about 50,000 trees during the inventory period. The contractor should appoint sufficient inventory teams to complete the work in the urban and adjacent peri-urban areas within 6 months.

A.4.4. Training to the Teams

Tree census is a specialized task that cannot be carried out by untrained or illiterate workers. All personnel employed for census work and back-end data management shall receive necessary training provided by the contractor with assistance from BBMP officers or the designated training institution. Further, handholding should be done during the first few weeks in the field by the Tree Officer and his staff.

A.4.5. Equipment and logistical support

Field teams need transportation to and from work sites, potentially requiring temporary accommodation and meals. They require mobile devices loaded with relevant applications and measuring tools such as tapes, height-measuring instruments, carry bags, etc. All logistical support required for fieldwork shall be provided by the contractor.

Team formation, provision of tools, training, and logistical support should be completed within one month after the contract agreement is signed.

A.4.6. General Guidelines for the Tree Census Data Collection

(1) **Planning and scheduling the work ward-wise:** The Tree Officer should meet with the contractor and Team Manager, using the zonal map to schedule tree census operations by ward and area. Allowance should be made for unexpected delays. Tree census operations must proceed according to schedule. Once agreed upon, this becomes the contractor's responsibility. All public and private trees must be enumerated according to the schedule.

(2) Where to begin the inventory work in each ward

(a) In approved layouts: Commence survey on main roads, following street numbers in chronological order. Subsequently proceed to side roads or streets, maintaining chronological order.

(b) In areas without proper layouts: Initiate the survey from the southwest corner of the ward. Progress eastward or northward until the entire area is comprehensively covered.

(c) In parks or woodlots: Enumerate trees in 10-meter-wide strips. Proceed in U-turn patterns until all trees within the designated area are surveyed.

(d) For green belts or strip plantings: Begin in the southwest corner. Proceed northward, then eastward, and finally return to the starting point.

(3) What type of trees to include in the survey

(a) Trees to be enumerated: Enumerate forest and horticultural trees that measure 30 cm in girth and total height of 5 m vide para A.2.1 of this manual only need to be enumerated.

(b) Exclusions: The following should not be enumerated:

i. Climbers and shrubs and weeds even if they meet the criteria.

ii. High-density and short-rotation commercial plantations like Eucalyptus, Casuarina, etc., which are likely to be harvested at short intervals.

iii. Invasive species like *Broussonetia papyrifera*, subabul, etc., are likely to be removed when they become too numerous and troublesome.

iv. Any tree species with a lifespan of less than 10 years.

(4) Information to be collected about each tree

For each tree, the following data shall be collected and recorded directly on the mobile application:

Sl. No	Feature	Particulars
1	Tree Identification Number (automatically assigned)	
2	Geo-reference	------
	i. Latitude (to 7 decimals)	
	ii. Longitude (to 7 decimals)	
3	Planted or natural tree	
	If planted, the year of planting	
4	Species identification (local and botanical nomenclature)	
	i. Botanical name	
	ii. Local name	
5	Ownership classification	Public/private
6	Girth at breast height (cm)	
7	Clear bole height in metres (up to first major branch)	
8	Total tree height (m)	
9	Crown area in square metres (diameter measured on ground east-west and north-south)	
10	Crown density (0.1 to 1)	
11	Health status	Excellent/good/average/poor
12	Tree injuries if any	
13	Ocular hazard rating	Very high/high/medium/low

14	Immediate maintenance requirements	YES/NO
	If yes, details.	
15	Special features of the tree if any	
16	Any problems faced by people on account of the tree	
17	Is space available around the tree for future planting	
	If yes, how many sqm are available?	
	In which direction?	
18	General remarks if any	

(5) Photographic documentation

(a) GPS-enabled cameras shall be utilized for photographic documentation of each tree enumerated.

(b) Each tree shall be photographed from a minimum of two different angles to ensure optimal visibility.

(c) Geographic coordinates shall be automatically captured and integrated into the database.

(d) Each tree location shall be digitally plotted on the municipal map.

(e) Tree attributes shall be accessible via the interactive map interface upon selection of the corresponding tree icon.

(f) Backend database modifications shall be permitted for the correction of enumeration errors if any up to 3 months. Thereafter the data should be finalised.

A.4.7. Getting Tree Census Data from Restricted Areas

In respect of premises/campuses where the contractor's field teams are not permitted, the protocol laid down in paragraph 4.6.6 shall be followed.

A.4.8. Conducting tree census in peri-urban areas

The peri-urban areas also need management plans. The green cover estimation and tree census must be conducted in the same manner as the city area but limited only to the development layouts approved by the local planning and development authorities. The tree census contractor should work in the nearest peri-urban area based on the directions issued by the Director. The costs should be shared as per paragraph 4.12 of this manual. BBMP will forward the bills for payment. They shall be paid by the respective agencies in charge of the areas.

A.4.9. Tree Census Data Uploading and Management

(1) **Upload the data every day:** The data collected must be uploaded every day to the server from the mobile application.

(2) **Reviewing the data:** Fresh data received from the field should be screened thoroughly by the data operators the next day. Errors and anomalies if any should be communicated to the Inventory Teams on the same day so that they can recheck and confirm the data.

(3) **Correcting the data errors:** Fresh data received from the field should be thoroughly screened by data operators the following day. Errors and anomalies should be communicated to the Inventory Teams promptly so they can verify and confirm the data.

(4) **Identification of species:** Inventory teams will record local names of trees. Corresponding scientific names available in the survey should be assigned to each tree. If a species name is unknown or doubtful, teams should send close-up images of leaves, flowers, bark, and other necessary features to the taxonomist for identification. The taxonomist should identify the species and inform the data operator.

APPENDIX - V

URBAN FOREST MANAGEMENT PLAN TEMPLATE

(See Paragraph 4.11.6)

The Urban Forest Management Plan referred to in the above paragraph shall be drafted based on the following template.

A copy of the order of approval of the management plan should be placed immediately after the inner cover of the plan document for serving as a permanent reference.

Messages
Foreword
Table to Contents
Executive Summary
Part I – The Background
1. Brief history of Bengaluru city forests.
2. Existing system for urban forest management.
3. Summary of results achieved in the last ten years.
4. Climate change impacts and tree response in the last 10 years.
5. State of Urban Forest Resources.
6. Arrangements for education, outreach, and partnerships.
7. Tree inventory, data analysis, economic valuation of the urban forests and the B/C ratio of the investment.
8. Global and national trends in urban forestry.
9. Challenges in urban forestry.
Part 2 – Action Plan for Future Management
10. Need assessment and the vision for the plan period.
11. Specific goals and objectives to be achieved.
12. The working cycle for urban tree maintenance.
13. The tree planting program for the plan period.

APPENDIX – VI

COMMON DEFECTS OBSERVED IN URBAN FOREST TREES

(Refer to Paragraph 5.2)

A defect is a condition that can reduce a plant's utility or value. It may or may not be a hazard. Following is the classified list of common defects (in alphabetical order) found in different parts of the urban forest trees:

A.6.1. Crown Defects

(1) **Asymmetric or Imbalanced Crown:** An uneven crown with growth concentrated on one side. It may be a result of competition for light from adjoining trees, previous bad pruning practices, or environmental factors like prevailing winds.

(2) **Dense and Overcrowded:** Excessive branching and dense foliage prevent adequate light penetration and air circulation through the canopy. The crown is very compact and too dense. It may harbour insects and fungi of certain kinds.

(3) **Crown Dieback:** Dieback is the progressive death of branches from the tips inward toward the trunk in response to root problems, disease, pest infestation, drought stress, soil compaction, deep planting or root rot/death.

(4) **Storm/Wind-Damaged Crown:** Physical damage to the crown from a severe cyclone can include broken branches, torn bark, stripped foliage, and structural failures of some parts.

A.6.2. Branch Defects

(1) **Branch stubs:** Branch segments extending beyond the branch collar due to improper pruning practices.

(2) **Broken branch:** Branches exhibiting physical fractures while maintaining partial attachment to the parent trunk or stem.

(3) **Clustered branches:** Multiple branches originating from proximate points on the same trunk or a main branch.

(4) **Codominant branches:** Two or more apical branches of approximately equivalent diameter growing at a narrow-angle and competing for apical dominance.

(5) **Cracked:** Branches exhibiting longitudinal or transverse fissures in the woody tissue, resulting from mechanical stress, environmental factors, or structural defects.

(6) **Dead or dying branches:** Branches exhibiting complete cessation of biological functions or indicating the progressive inability to discharge normal functions.

(7) **Decayed branch:** Branches exhibiting deterioration of woody tissues due to fungal colonization, cavities, reduction in wood density, or visible decomposition of structural components.

(8) **Deformed:** Branches exhibiting abnormal morphology including curvature, angular distortion, or irregular cross-sectional profiles resulting from environmental stressors, mechanical damage, uneven load distribution or physiological disorders.

(9) **Forked:** Branch unions that are characterized by acute attachment angles of less than 45 degrees relative to the parent branch, resulting in a weak joint with the parent branch.

(10) **Heavy lateral:** Long horizontal branches exhibiting disproportionate terminal weight.

(11) **Included bark:** Bark tissue embedded within the junction of two stems or between a branch and trunk, preventing the formation of proper branch bark ridges. Such joints are prone to failure.

(12) **Lion-tailed:** Branches subjected to excessive interior foliage removal while retaining terminal tuft of twigs.

(13) **Moribund:** Branches exhibiting advanced physiological decline characterized by progressive tissue necrosis, vascular dysfunction, and imminent complete mortality.

(14) **Peeping branches:** Branches in the upper part of the crown growing too close to the buildings.

(15) **Pest-infested:** Branches exhibiting evidence of insect colonization as indicated by larvae, excavation galleries, frass accumulation, bark disruption, or direct observation of insect presence, often accompanied by a progressive decline in health.

(16) **Rubbing:** Branches coming in physical contact with another branch, creating wounds that compromise defensive barriers and facilitate pathogen ingress.

(17) **Tangling branches:** Branches intertwining, knotting, or becoming twisted together in a messy or complicated way.

(18) **Water sprouts (also called Epicormic Branches):** Adventitious vegetative shoots emerging from dormant or newly formed buds on the trunk or major scaffold branches, characterized by rapid vertical growth, weak attachment, and often associated with stress responses or improper and excessive pruning.

A.6.3. TRUNK DEFECTS

(1) **Abnormal taper:** Sudden and uneven taper of the trunk at short intervals without any reason.

(2) **Basal abnormalities:** Throttling caused by hard pavement around the trunk, canker formation due to repeated injuries, scalding due to dog urination, buried or floating collar due to deep/shallow tree planting and any other deformity that is found at the base.

(3) **Bleeding trunk:** Exudation of liquid substances from vascular tissues indicating internal pathological processes, mechanical damage, or physiological stress responses.

(4) **Borer-infested:** Trunk colonized by insects, resulting in gallery formation, tissue consumption, and potential introduction of secondary pathogens.

(5) **Burls**: Large outcrops of live wood on the trunk surface. Generally harmless. But may cause defects in wood.

(6) **Cankers:** Localized dead bark found over the wood. It is often caused by fungal or bacterial pathogens.

(7) **Cavities and decay:** Hollows or degraded woody tissues found in the trunk.

(8) **Cracks and splits:** Linear separations of woody tissues vertically or horizontally in the trunk.

(9) **Crooked trunk:** Trunk with an irregular shape, bends, twists and turns and other directional irregularities.

(10) **Dead or dying:** The trunk is already dead and dry or on its way.

(11) **Deep fluted**: Pronounced longitudinal furrows and ridges along the trunk surface exceeding typical species characteristics, often indicating irregular growth or mechanical stress.

(12) **Fig infested:** Trunk or scaffolding branches invaded by *Ficus* roots on the inner side or outer side surface.

(13) **Girdled:** Bark removed as a ring deliberately to kill a tree by a person or a circular wound caused by right ropes, wire cables, metal tree guards or other materials affixed on the trunk.

(14) **Half broken:** Solid or hollow trunk that is half broken due to wind or rain, or damaged while cutting a nearby tree.

(15) **Half burnt:** The trunk is burnt partially at the bottom or on one side throughout its length.

(16) **Heart rot:** Heartwood infested heavily by heart rot fungi. Fruiting bodies called conks are visible on the lower parts of the trunk.

(17) **Hollow:** Empty, tube-like trunk, closed on all sides or opened partially but having no solid core inside.

(18) **Included bark:** Vertical seams where the bark is trapped between co-dominant stems, creating structural weakness in the trunk.

(19) **Leaning:** Trunk growing at an angle rather than vertically from the ground, which may indicate root problems, soil movement, or severe competition from adjoining trees.

(20) **Lightning damaged:** Vertically oriented wounds or strips of missing bark due to lightning strikes.

(21) **Missing or loose bark:** Areas where the bark has separated or fallen from the trunk.

(22) **Multiple stems:** A group of two or more stems emerging from the same root collar, or the trunk below the chest height.

(23) **Partially dead:** Trunk displaying signs of death on one side throughout the length or at intermittent heights.

(24) **Physically damaged:** Trunk injured by external mechanical forces, including vehicular hits, human recreational activities, disrupting protective bark layers and the sapwood.

(25) **Slender trunk:** Thin, lean and tall trunk of trees grown in shade and susceptible to failure.

(26) **Sunscald:** A flattened, dried, or sunken area of the bark resulting from sudden overexposure to the sun.

(27) **Twisted trunk:** The trunk is twisted around a central axis due to the spiralling of wood fibres**.**

A.6.4. Root Defects

(1) **Buried root collar:** The root collar (point touching the trunk at the ground level) is very sensitive and prone to fungal infections. It should always remain 5 to cm above the ground level.

(2) **Confined root:** Roots growing in a highly congested, strongly enclosed space that restricts normal root growth.

(3) **Decayed roots:** Roots partially or fully decayed due to fungal or nematode attack, compromising the structural integrity and functional capacity of the root system.

(4) **Deflected roots:** Roots that change direction upon encountering obstacles such as rocks, concrete walls or other physical obstructions.

(5) **Girdling roots:** Roots that circle and constrict other roots or the collar of the same tree, restricting the vascular flow of sap/nutrients.

(6) **Invasive roots:** Aggressive roots penetrating building foundations, fresh water tanks, septic tanks, walls, concrete structures, entering pipelines, cables conduits or other infrastructure, causing structural damage.

(7) **Kinked roots:** Roots with sharp bends or folds that restrict vascular flow and create structural weaknesses.

(8) **Missing roots:** Roots cut off due to trenching, construction, or utility work, which can significantly reduce a tree's structural stability and nutrient uptake capacity.

(9) **Physically injured:** Woody exposed roots that are physically damaged by the vehicles, pedestrians, equipment etc., passing over them.

(10) **Root coiling:** Roots rotating in circles along the inner surface of an impenetrable nursery container, a root well or any other impenetrable barrier built around the root zone.

(11) **Root heaving:** Upward movement of roots causing soil displacement, typically occurring during freezing and thawing cycles or from expanding root diameter over time.

(12) **Root plate crack:** A condition where the root plate separates from the surrounding soil, indicating compromised tree stability and increased risk of tree failure.

(13) **Root suckering:** Shoots emerging from the root system away from the main trunk, creating competing stems and potentially weakening the parent tree's resources.

(14) **Termite-prone roots:** Termites attack green trees of certain species and increase their chances of tree fall.

APPENDIX - VII

URBAN TREE RISK ASSESSMENT AND HAZARD RATING FORMAT

(Refer to Paragraph 5.10)

Instructions for Use:

1. Tree risk assessment and hazard rating apply only to public trees.
2. It should be done for all tree pruning and maintenance works except emergency maintenance.
3. The template provided below must be used for risk assessment and hazard rating at the site where the tree is standing.
4. It should be done on the mobile app. If the mobile app is not available, it may be done in the hard copy.
5. Please observe the tree closely and score the tree risks.
6. If the hazard rating score exceeds 50 points, the Tree Inspector should inspect the tree, investigate using appropriate probes, and submit findings to the Tree Officer within 5 days.
7. The Tree Officer will personally inspect any tree with a hazard rating score above 100 points and submit a report to the ACF (Urban Forestry) within 7 days.
8. The ACF will issue orders for tree maintenance within 7 days and notify both the Tree Officer and Tree Inspector.
9. The Tree Officer will immediately assign the work to an approved contractor. The contractor shall complete the required tree-pruning operations within 7 days.

10. The entire risk mitigation process should be completed within 2 months from the date of receiving the application or complaint.

Part A. Preliminary Information		
Sl No	**Item**	**Particulars**
1	Tree ID no. as per BBMP census data	
2	Tree Location (full details including plot no, main road, cross rod, ward no.)	
3	Tree species	
4	Ownership (Public/ Private)	
5	Tree girth at dbh (cm)	
6	Total tree height (m)	
7	Trunk height up to 1st branch	
8	Who complained? (full address and contact details)	
9	Date of complaint	
10	Nature of complaint (summary)	
Part B: Visual Risk Assessment Team Details		
1	Date of field visit	
2	Time	______AM/PM
3	Name and designation of team members who inspected the tree and assessed the risk.	Member 1:
		Member 2:
		Member 3:
4	Whether the complainant was present during the inspection time?	YES/NO

Part C. Visual Tree Risk Rating Assessment						
Tree Part	**Nature of defect**	**Max score**	**Risk Score of Mem 1**	**Risk Score of Mem 2**	**Risk Score of Mem 3**	**Average Risk score**
1. Height of affected part on tree top (m)	----	1 to 5				
2. Parts likely to fail	----	----	----	----	----	----
A. Branches (mention direction, girth, height from ground and nature of defect for each branch)	1.	1 to 2				
	2.	1 to 2				
	3.	1 to 2				
	4.	1 to 2				
	5.	1 to 2				
B. Trunk		1 to 3				
C. Roots		1 to 3				
3. Failure Probability		1 to 3				
Total Risk Rating Score		**-----**				
Scoring range	*1. Height of risky part: First 5 m = 0. Thereafter 0.5 point for every 1 m height up to the last risky branch.*					
	2. Branches: If the branch collar girth is >10 cm but below 30 cm = 1; >30 cm = 2.					
	3. Trunk: Major defect (crown at risk) = 3, medium (part of the crown at risk) =2 and minor defect= 1					
	4. Roots: Major defect (tree may fall) = 3, medium (tree may lean) = 2 and minor defect = 1					
	5. Failure imminent = 3; Probable = 2; and Remote = 1					

Part D. Hazard Assessment Rating				
Sl. No	**Target that may be impacted**	**Hazard Scale**	**Risk rating from part C above**	**Total Hazard Score**
1	Injury or loss of human lives	5		
2	Public places, Public utilities, Govt buildings, business establishments, temples, markets etc	4		
3	Vehicles, residential buildings, car garages etc	3		
4	Generator, security cabin, staircase etc	2		
5	Compound wall and any other minor property	1		
	Total Hazard Assessment Score	-----	-----	

Signature of Member 1	Signature of Member 2	Signature of Member 3
Designation:	Designation:	Designation:

Certified that I have inspected the above tree and re-checked the hazard assessment using ______________ ____ ______ tools. I am satisfied that the visual hazard assessment rating is correct/not correct. My assessment rating is marked on the page margin.

Or Certified that I have not inspected the above tree but I agree with the visual hazard assessment rating of the team.

Date:	Signature of Tree Inspector:
Place:	Name of the Section/Zone:

APPENDIX – VIII

RECOMMENDED TREE DEFECT CORRECTION MEASURES

(See Paragraph 5.15)

Note: These are suggested generic measures. Specific defect correction measures should be taken after a detailed examination of the tree defects and the environment in which the tree is placed. If the recommended mitigation measures are unsuitable, any other action may be taken with the Director's prior approval.

A. Crown Defects			
Sl. No	**Defect**	**Recommended Mitigation Measures**	**Technical Terminology**
1	Asymmetric or imbalanced crown	Young trees: Remove competing vegetation. Mature trees: Implement directional reduction cuts. Heritage or RET trees: Install dynamic support systems.	Structural pruning, mechanical augmentation
2	Dense and overcrowded	Selective removal of tertiary branches with foliage. Maximum permissible foliage removal is: Young trees: 30% Semi-mature trees: 20% Mature and over-mature trees: 10%.	Crown thinning and foliage management

3	Crown dieback	Check for biotic/abiotic stressors like girdling, poisoning etc. Address soil chemistry and check the root conditions.	Curative treatments and soil treatment
4	Storm or wind-damaged	If the tree can be retained, structural pruning should be done. Consider complete removal if structural integrity is compromised.	Structural pruning or tree removal

B. Branch Defects			
Sl. No	**Defect**	**Recommended Mitigation Measures**	**Technical Terminology**
1	Branch stubs	Remove the stubs close to the branch collar.	Sanitary pruning
2	Broken/lodged	Remove hanging sections first. Then prune at the branch collar.	Hazard abatement
3	Clustered branches	Retain one or two dominant branches and remove the rest.	Structural pruning
4	Codominant branches	Early identification and removal of one of the stems.	Formative pruning
5	Cracked branches	Remove affected sections using proper reduction cuts. Install support systems for sacred tree species.	Reduction cut and Structural support installation.
6	Dead or dying	Remove the branch at the branch collar.	Sanitation pruning

7	Decayed	Remove the branch at the branch collar.	Sanitation pruning
8	Deformed	Prune and remove the curved or crooked branches.	Structural pruning
9	Forked branch	Prune the smaller branches and leave only the bigger ones.	Pruning and bracing
10	Heavy lateral	Reduce end weight through reduction cuts. Install props, cables or braces if necessary.	Load reduction
11	Included bark	Identify and remove smaller branches as early as possible.	Formative pruning
12	Lion-tailed	Implement gradual crown restoration over multiple seasons.	Crown restoration
13	Moribund	Implement reduction cuts to healthy lateral branches. Investigate root zone conditions	Sanitary pruning
14	Peeping branches	Reduction cut of branches to remove the hazard.	Utility pruning
15	Pest infested	If it is an annual process, remove the tree. Else spray systemic/contact pesticide.	Remove or treat.
16	Rubbing	Prune subordinate or smaller stems and leave the bigger one.	Structural pruning
17	Tangling	Selective removal based on branch hierarchy, size and straightness. Retain the straight-growing one.	Structural pruning

18	Water sprouts	Remove epicormic branches slightly above the branch. Address underlying stress factors responsible for the sprouts.	Crown cleaning, and cultural operations.
19	Obstructing Visibility	Selective pruning of branches to maintain clear sight lines. Establish clearance zones near traffic signals and curves.	Vista pruning
20	Blocking light to solar panels	Selective pruning of small branches. If the shade lasts more than 4 daylight hours, remove the tree.	Utility pruning

C. Trunk Defects			
Sl. No	**Defect**	**Recommended Mitigation Measures**	**Technical Terminology**
1	Abnormal taper	Correction is generally not possible. If the tree is young, check the space available for roots.	Retain or remove
2	Basal abnormalities	Remove the hard pavement around the collar. Open if the root collar is buried. Put a warning notice for dog urination.	Cultural operations.
3	Bleeding trunk	Identify causal agents. Implement appropriate treatment.	Curative treatment
4	Borer infested	If the tree is young, try systemic insecticides.	Insecticide treatment.

5	Burls	Check the cause. If it is caused by external objects, remove them immediately. Otherwise, leave it. Burls are harmless.	Remove external causes if any
6	Canker	If the tree's stability is compromised, remove the tree. Otherwise, retain it.	Retain or remove
7	Cavities and decay	Test the extent of hollowness or cavities. If the outer shell is complete all around, retain the tree. Otherwise, remove it.	Retain or remove
8	Cracks and splits	Check if they can be saved using tree belts, braids, cables, slats, and braces. If not remove the trees.	provide bio-mechanical supports or remove
9	Crooked trunk	No remedial measures are possible. If it is not hazardous, leave it.	Retain or remove
10	Dead or dying	Assess structural integrity. If good for wildlife snag, retain. Remove the tree if the tree is on a pathway or park.	Retain or remove
11	Deeply fluted	Check the underlying factors – of roots and also branch distribution and take corrective measures to balance the tree weight evenly. If not hazardous, leave the tree.	Structural pruning.
12	Fig infested	Remove the Fig plant completely along with its roots.	Cultural operations.

13	Girdled	Remove constricting elements. Assess cambial damage. Check if correction is possible.	Tree surgery
14	Half broken	If the tree is young and capable of regenerating, retain it. Else remove.	Restorative pruning or removal.
15	Half burnt	Assess cambial damage. Treat the wound.	Curative treatment
16	Heart Rot	Instrumental testing for advanced decay for structural integrity assessment. If structural integrity is compromised remove the tree. Otherwise, retain it.	Probe the structural integrity. Retain or remove
17	Hollow trunk	If the outer shell is complete all around, retain the tree. Otherwise, remove it.	Reduce crown load and retain or remove the tree
18	Included bark	Do bracing or remove the smaller branch.	Bracing or remove
19	Leaning tree	Check the root plate. If there is any crack in the soil, cable and retain or remove the tree. if the lean is more than 30^{o} and if it is likely to be affected further by wind, remove the tree.	Cable and retain or remove
20	Lightning damaged	If the full crown and part of the trunk are damaged remove the tree. Otherwise, treat it.	Tree surgery or removal.

21	Missing or loose bark	Do a risk assessment and hazard rating. If there is no hazard, leave it. Else remove it.	Retain or remove
22	Multiple trunks	Retain the best and most significant one. Remove the rest.	Structural Pruning
23	Partially dead	Do a risk assessment and hazard rating. If risky, remove it.	Retain or remove
24	Physically damaged	Remove immediately if the tree trunk is obstructing the carriageway or free movement of vehicle or people.	Retain or remove
25	Slender trunk	Remove the overhead shade if the tree is young. Remove if it is a mature or over mature tree.	Shade regulation. Remove or retain.
26	Sunscald	Do a hazard assessment. If it is not hazardous, retain.	Retain or remove
	Twisted	Assess mechanical stress indicators. If not hazardous, retain.	Retain or remove

D. Root Defects			
Sl. No	**Defect**	**Recommended Mitigation Measures**	**Technical Terminology**
1	Buried root collar	Open up the collar by removing the soil at the base of the collar open to the air	Physical removal of soil at the tree base
2	Confined root	Increase the soil volume if possible.	Increase the root zone or

		Otherwise, replace the tree with a smaller tree.	remove the tree
3	Decayed roots	Check for fungal infection and mushrooms. If the tree is too weak and failing, remove it. Else, treat it.	Curative treatment, Retain or remove
4	Deflected roots	Trim them at the point of deflection. Facilitate new rooting.	Root pruning.
5	Girdling roots	Air spade excavation and pruning of girdling roots.	Root Pruning
6	Invasive roots	Prune interfering roots and Install root barriers.	Root Pruning and barrier installation
7	Kinked roots	Trim roots at the point of the bend. Facilitate new rooting.	Root pruning.
8	Missing roots	Check the tree stability. Reduce the crown load or remove the tree if it is hazardous	Crown reduction or Tree removal
9	Physically injured on the surface	Raise the soil level or apply mulch cover to the tree roots.	Root Protection
10	Root coiling	Common in nursery bags. Remove the outer one inch of root mass by cutting with a sharp knife.	Remove the outer layer of roots.
11	Root heaving	Implement flooring grade change by adding soil around the root zone. Selective root pruning at appropriate distances.	Raise the floor level or Root Pruning

12	Root plate crack	It will imbalance the tree and lead to tree fall. Cable or remove the tree	Cable or remove the tree.
13	Root suckering	Avoid planting the trees with suckering habit.	Remove suckers.
14	Termite prone	It is a natural character. Avoid planting such trees.	Remove
15	Aerial roots	Prune if they are obstructing the passage. Otherwise, allow them to grow and serve as props.	Prune the aerial roots. Trim branches.
16	Inundated roots	Drainage improvement by trenching in between the trees.	Surface Drainage improvement

APPENDIX - IX

TECHNICAL SPECIFICATIONS FOR TREE PRUNING AND MAINTENANCE

(Refer to Para 5.15)

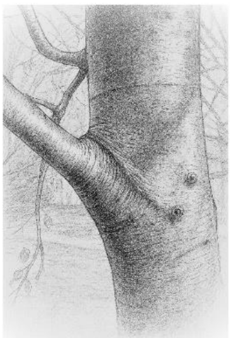
A.9.1. Introduction

Pruning is the selective removal of specific plant parts. Shedding limbs is a natural part of a tree's life cycle. However, in urban environments, this process presents significant risks to people and their property. These risks must be mitigated through regular pruning and tree maintenance practices. Beyond safety concerns, regular pruning contributes substantially to tree health, vigour, structural integrity, and aesthetic appeal. It helps in developing straight trunks and shapely crowns and optimizes the benefits of sunlight and airflow. Without such care, urban trees may develop structural weaknesses and health issues or become safety hazards. The longevity of the trees and their environmental benefits may be compromised. Therefore, after tree planting, pruning and maintenance are important throughout the life of an urban tree.

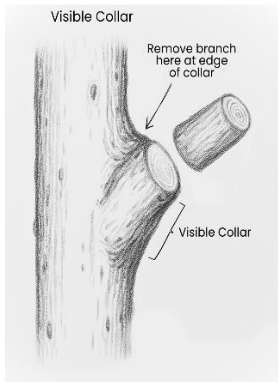
A.9.2. Fundamental Principles in Tree Pruning

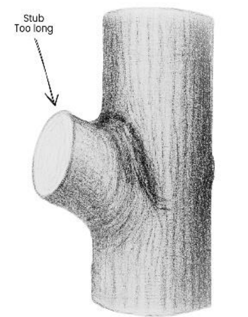
Certain fundamental principles apply to crown and branch pruning. They must always be kept in mind while carrying out the tree pruning activities.

(1) Location where pruning is to be done: Pruning should always be done at the node where the branch originates from the trunk or another parent branch. There is a visible branch bark ridge at the point of union of the branch with its parent branch on the upper side. A slight bulge on the trunk or the main branch just below the branch union can also be seen. This is called the Branch Collar or the flange. It provides mechanical support to the branch. It should be protected during the pruning operations. The cambium tissue around the branch collar can regrow fast and cover the pruning wound. Any branch pruning should therefore be done slightly (2-3 cm) away from the bark ridge on the upper side and further away (about 3-5 cm) from the branch collar at the bottom. This approach minimizes the total wound surface area and helps the cambium to grow and close over the wound completely over time. It prevents the entry of fungus and bacteria through the wound area.

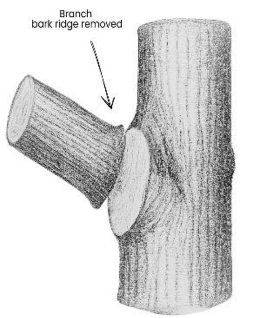


Typical Bark Ridge and Branch collar



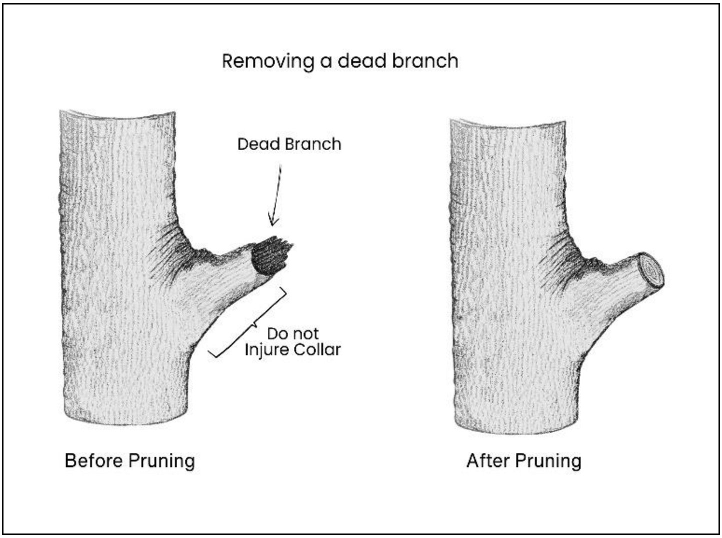


Stub Cut : An incorrect Cut



Flush Cut : An incorrect Cut

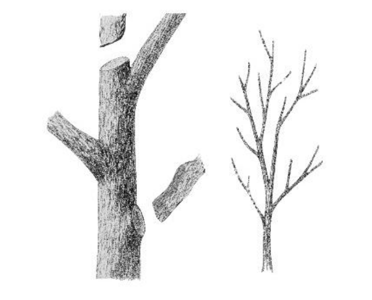
(2) **Pruning of dead branches:** As the tree grows and lifts its crown, the lower branches get pruned naturally. Smaller branches pose no risk while they are shed. However, as the tree achieves its full height and reaches maturity, some larger branches may also be shed. They may break at any weak point along their length, leaving a dry stub (a small part of the dead branch). The tree tries to cover the branch union with cambial tissues from the periphery, and eventually, the stub will also wither away. This process takes time, though. If a dead branch is to be pruned before the stub naturally drops off, pruning must be done beyond the point of cambial growth.



(3) **Pruning of live branches:** Based on purpose, pruning is classified into three types:

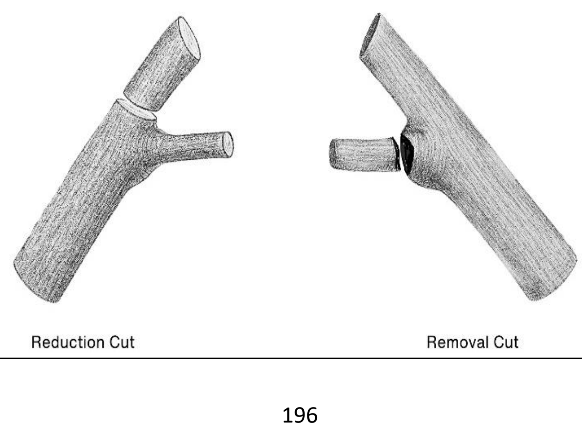
(i) **Heading Cut:** This reduces the height of the tree. The leading branches at the top of the crown are pruned to lower-order (smaller size) branches growing laterally. The retained branches should be about 1/3rd the size of the branches being cut.

(ii) Reduction Cut: This reduces the width of the crown. Larger branches growing toward the lateral side are removed while upward-growing smaller branches are retained. The retained branches should be at least 1/3rd of the girth of their parent branches or the trunk, as applicable.



Heading Cut

(iii) Removal Cut: This thins the entire crown to improve light penetration and air circulation without altering the overall crown size. Also called a Thinning Cut, it involves removing smaller branches that are less than 1/3rd the size of the parent branch. Pruning should be done at the branch union.



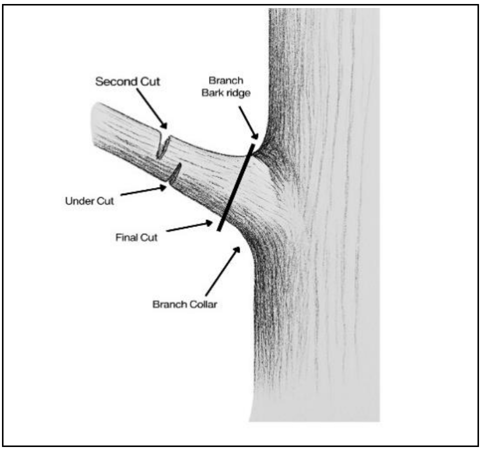
Reduction Cut Removal Cut

All cuts should be made at an outward angle, so rainwater drains easily, preventing infection.

(4) The three-cut principle for live branches: When pruning a live branch, the bark should never peel off at the branch union. If it happens, the exposed soft tissue on the lower portion of the branch collar may die, preventing proper healing of the pruning wound. This creates an entry point for fungal and insect infections. Canker formation may occur in the injured area, causing permanent damage to the tree trunk or parent branch. To avoid this, follow the three-cut method:

(i) Under-Cut or the First Cut: Make an undercut approximately 45 cm from the branch union, reaching halfway through the branch thickness.

(ii) Top Cut or Second Cut: Create a top cut 5 cm further away from the first cut, also to half depth. These two cuts work together to allow the branch to break off cleanly without tearing the bark.



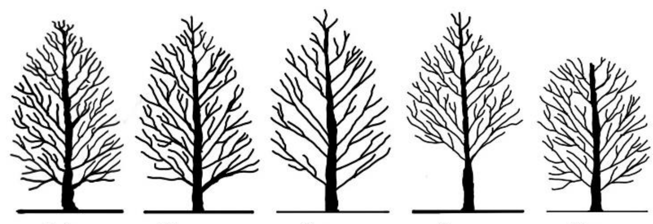
(iii) Stub Cut or the Final Cut: Remove the remaining stub with a slight outward angle at the branch collar. This cut must be clean and precise to promote effective wound healing.

(5) Types of pruning: Based on the objective to be achieved, branch pruning has been classified into the following types:

(i) Crown cleaning: This involves the removal of non-beneficial branches, particularly dead, dying, broken, and hanging branches. Live branches are not removed. The purpose is to reduce risks and improve the tree's health and appearance.

(ii) Crown thinning: This involves the selective removal of live branches to reduce crown density while maintaining crown form. The purpose is to increase light penetration and air movement and reduce wind resistance. Only branches that are less than 1/3rd of the girth of the parent branches are removed without compromising the shape of the tree.

(iii) Crown raising: In this thinning, all lower branches up to 2.5 m height from the ground level on pedestrian pathways and up to 5 m on the carriageways from ground level are removed to provide clearance for the movement of pedestrians and vehicles. However, this should not reduce the live crown ratio to the total tree height to below 60%. This means crown raising is possible only on the lower 1/3rd of the trunk height and not beyond.



(iv) **Crown reduction:** This thinning is meant to reduce the overall size of the tree while maintaining the tree's form/shape using reduction cuts. The purpose is to fit trees into a smaller available space. This is generally applied to big trees that have been planted in small spaces. The entire crown is pruned to keep the size in check. This can be repeated multiple times.

(6) **The Pruning Dose:** Pruning removes leaves that manufacture food for the tree. Excessive pruning will reduce the tree's food manufacturing capacity and weaken it. As the tree uses a certain level of production to supply food to various parts including roots, the reduction of food supply may create stress. To prevent excessive stress, pruning should not exceed the following limits:

(i) **Young trees:** Maximum loss of foliage should not exceed 30%.

(ii) **Semi-mature and mature trees:** Not more than 20%.

(iii) **Over mature and veteran trees:** Not more than 10%.

Trees that were never maintained in the past may require higher doses of pruning. In such cases, pruning should initially be restricted to the above limits, then the tree should be given a rest of 3-5 years. The balance of pruning should be completed in the next round. However, pruning should never exceed the limits prescribed above.

A.9.3. Technical Specifications for Cycle-Based Pruning

Formative Pruning, Structural Pruning and Restoration Pruning are the three life-cycle-based pruning. They should be carried out in the manner specified below.

A.9.4. Formative Pruning of young trees

During the first year after planting, no pruning should be done to avoid stress on the plant. Flowering and fruiting indicate successful establishment at the planting site. Depending on the planting time, quality of planting, rainfall or irrigation support, and freedom from injuries, the juvenile trees planted will typically flower and fruit within three years. After the first flowering/fruiting begins, formative pruning (if necessary) can be implemented as part of the holistic tree maintenance described in paragraph 5.11.4. The best time for pruning is during the winter months and before new bud break. The following maintenance activities should be carried out during this time:

(1) **Crown cleaning and shaping:** Remove the dead, dying, broken, weak and physically damaged branches close to the trunk but without stripping the bark or leaving any stub.

(2) **Remove codominant branches**: Look to the tip of the young tree. There should be only one main leading shoot. If there are more than one, the best one should be retained, and the rest should be pruned (removal cut) to eliminate competition for the leader.

(3) **Set the ground clearance:** Determine the required clearance from the ground level for the free movement of pedestrians, vehicles, view line clearance, etc. Prune all branches found in this space.

(4) **Identify scaffolding branches and prune the rest:** Those branches that will become permanent branches and stay on the tree until maturity are called scaffolding branches. They should have the following characteristics:

(i) They originate directly from the trunk.

(ii) They are distributed evenly along the height of the trunk.

(iii) The gap between one branch to the next is not less than one metre or 1/20th of the expected tree height at maturity whichever is more.

(iv) Together all the branches cover 360^{o} space of the crown without leaving any gap.

(v) Branches are free from defects like sharp curves/bends, cross over or rub other branches, or grow towards the trunk.

(vi) Branches are growing at an angle of 45^{o} or more to the trunk.

(vii) The trunk and branch taper is uniform throughout.

(viii) The trunk and branches are free from any defects.

(ix) All branches should be standing free.

(x) Sunlight and air must freely pass through the crown.

(5) Crown shape after the pruning: After pruning, the crown must be in a teardrop/raindrop shape.

(6) No physical damage: There should be no physical damage to the trunk or any of the retained branches on account of the pruning operations.

A.9.5. Structural Pruning of Semi-Mature and Mature Trees

Structural pruning is a comprehensive and holistic approach that should be carried out periodically on semi-mature and mature trees. This work is taken up on an area basis. If there is an approved Urban Forest Management Plan, structural pruning should be implemented in the areas designated in the plan for each year. Otherwise, all trees in the city should undergo structural pruning ward-by-ward on a five-year cycle. As a holistic approach, structural pruning involves a combination of pruning techniques, maintenance procedures, and curative treatments.

(1) Regular pruning: The following types of branches should be pruned:

(i) Low-hanging branches
(ii) Codominant stems
(iii) Clustered branches
(iv) Tall, thin and long branches
(v) Deformed, crooked, or twisted branches

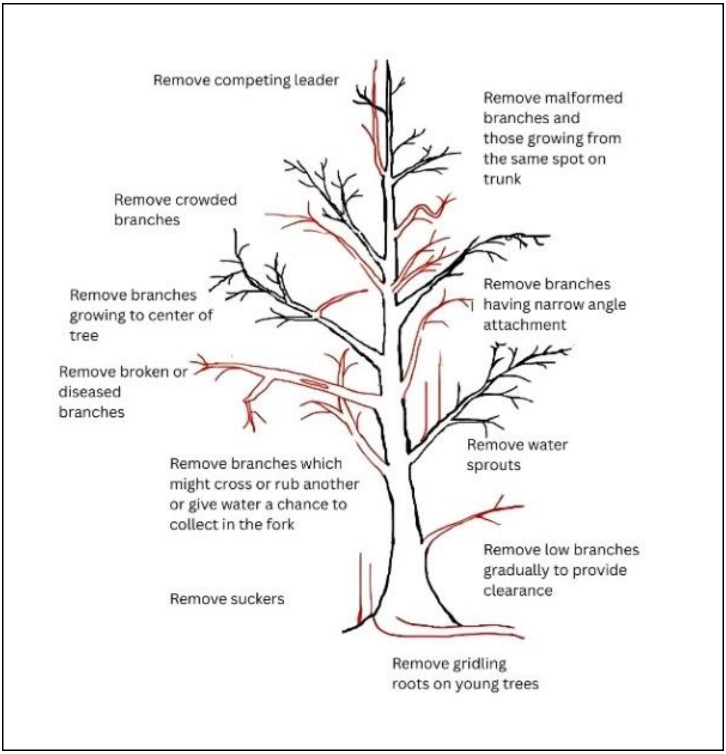
(vi) Rubbing or crossing branches
(vii) Damaged or half-broken branches
(viii) Suppressed and weak branches
(ix) Branches with acute angles or weak attachments
(x) Epicormic shoots
(xi) Branches with included bark
(xii) Drooping branches

(2) Special pruning: If amenity trees have not been maintained for a long period, semi-mature and mature trees may require the following special categories of pruning.

(i) Crown balancing: Some trees may have imbalanced crowns due to lack of growing space, shade, improper thinning, vandalism, etc. Crown balancing pruning addresses uneven canopy weight distribution to correct lopsided growth patterns, distribute weight more evenly, improve aesthetic appearance, and prevent structural failures. This technique involves thinning denser crown areas, reducing over-extended branches, and light pruning on the lighter crown side to achieve balanced proportions. The aim is to restore the natural crown architecture of the species.

(ii) Utility pruning: Trees co-exist with city utilities. Overhead electrical cables pass through tree crowns. Electricity companies require certain clearances to be maintained around live cables to prevent hazards. This is a statutory requirement that must be maintained. These companies undertake annual pruning at their own cost. However, regrowth is common. That must be removed every year. At the time of structural pruning, selected major branches can be carefully pruned so that annual maintenance will not be necessary. The illustrations given below indicate how this pruning is to be carried out

(iii) Vista pruning: Vista pruning is associated with maintaining the visibility of road signs, traffic signals, historical sites, etc. It requires the removal of branches that block lines of sight. These requirements should be addressed during structural pruning. If necessary, trees that completely block visibility may be removed.



(3) Removal of epiphytes and parasites: If harmful epiphytes like Ficus that could ultimately kill the host are present, they should be removed and cleaned. Parasites like Loranthus found on end branches should be removed by pruning the affected branches and their parent branches.

(4) **Examine the trunk and roots also:** If the trunk has any defects listed in Appendix VI or has suffered physical damage, treat according to the methods suggested in Appendix VIII. Similarly, inspect for defective roots and carry out required corrective measures.

(5) **End goals of structural pruning:** After the structural pruning is completed, the tree should display these characteristics:

   (i) The tree and its crown should maintain its characteristic appearance.

   (ii) Only healthy scaffolding branches remain on the tree. They should be evenly distributed along the trunk /crown.

   (iii) There should be no half-broken branches or injuries to the remaining branches of the tree.

   (iv) Light and air must pass through the tree freely.

   (v) The tree must be able to flower and fruit normally.

A.9.6. Restoration pruning and preservation of urban trees

As the tree ages, pruning requirements decrease but overall maintenance will increase. Pruning becomes a smaller component of tree maintenance work. It can help with risk reduction and partial restoration of the tree's natural form. The majority of maintenance relates to tree preservation aimed at enhancing longevity. Tree preservation work can be time-consuming. Preservation of individual trees or groups of trees in an area can become a project spanning 2-3 years. As this is an expensive operation, it should be limited to the following categories of trees:

(i) Restoration of immature or mature storm-damaged trees.

(ii) Restoration of sacred trees, heritage trees, and rare/endangered/ threatened tree species.

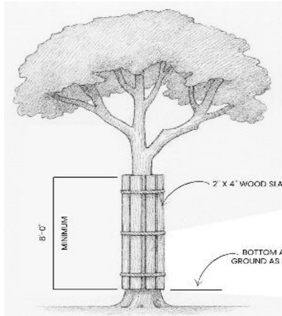
(iii) Conversion of over-mature or veteran trees into urban wildlife snags.

The following operations are to be carried out in the restoration pruning of trees:

(1) Crown restoration: Crown restoration is undertaken to rehabilitate trees damaged by cyclonic storms, improper topping, vandalism etc, that may compromise the tree's structure, functions and longevity. The restoration aims to re-establish the tree, gradually improve its health and appearance, and reduce the risk of future failure. It involves the selective removal of broken and compromised branches and strategic reduction cuts on the remaining branches. A few damaged branches may be retained to maintain foliage essential for photosynthesis.

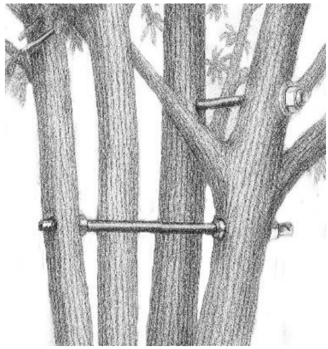
(2) Preservation of special category trees: After sanitary pruning of branches, preservation of sacred trees, heritage trees, and rare/endangered/threatened trees shall be implemented using biomechanical means. Metal props for low-level branches, metal belts for split trunks, wooden or metal braids for cracked trunks, braces with external metal flats for acute-angled branches, and cables for weak branches may be used as appropriate for saving the tree or its parts. It is possible to use one or a combination of these mechanical supports. They can be used to bind parts of the same tree or bind one tree or its parts to a neighbouring tree. Elastic materials like nylon and rubber belts should be preferred over metal materials. This is a task that is to be planned in great detail with the help of experts and also to be executed under their close supervision. It is also quite expensive and should be taken up rarely.

Tree belts



Preserving a tree trunk with slats

Tree Cable



Bracing

A.9.7. Other Categories of Tree Pruning and Maintenance

There are many other types of tree pruning and maintenance practices. Among them, the following two are relevant to Bengaluru city.

(1) Retrenchment Pruning: Retrenchment pruning is a specialized pruning technique designed to preserve tall veteran trees with heavy limbs. The longevity of full-grown Raintrees and Peltoforum trees in Bengaluru city can be enhanced using this method. It decreases biomechanical stress while maintaining structural integrity, ultimately extending the tree's functional lifespan. Retrenchment pruning involves the following steps:

(i) Initial reduction of upper crown branches while maintaining sufficient leaf area for photosynthesis.

(ii) Selective removal of longer, heavier branches extending from the outer canopy.

(iii) Reduction of end-weight on horizontal limbs prone to failure.

(iv) Preservation of the tree's natural form despite overall size reduction.

(v) Implementation in phases over several years (typically 3-5-year intervals)

(vi) Allowance for the development of epicormic shoots or adventitious buds to form a new, lower canopy.

Unlike standard crown reduction, which involves a one-time significant size reduction, retrenchment pruning is a long-term management strategy that works with the tree's natural ageing process. Crown reduction aims for immediate size management of generally healthy trees, while retrenchment focuses on stimulating new growth patterns in declining specimens.

(2) Converting dead or dying trees into urban wildlife snags: Over-mature and veteran trees that are already being used by birds and other urban wildlife must be converted into snag trees in low-traffic areas for the benefit of urban wildlife. The following prescriptions apply to such trees:

(i) Check the overall strength of the tree. It should be able to last for at least 5-7 years.

(ii) Restrict public access around the tree by setting up a barrier around the tree.

(iii) Install sign boards about the snag tree. Put up a list of dos and don’ts on the sign board.

(iv) Remove hazardous lower limbs. Maintain safe snag height (15-20 feet).

(v) If necessary tie the weak branches to strong branches using metal cables.

A.9.8. Tree Trunk Maintenance

Trunk problems are fewer than crown issues but require curative treatments and mechanical support. The solutions vary widely. They cannot be exhaustively covered here. Indicative solutions to major problems are listed below.

(1) **Bark damage and girdling:** Remove damaged bark back to healthy tissue using sterile tools, shape wounds elliptically (1:2 width-to-length ratio), apply growth hormones to wound edges, treat exposed cambium with anti-desiccant, and apply fungicidal dressing only to the cambium. For ring debarking, use bridge grafting with scions from the same tree inserted under the bark above and below the wound and secure them with grafting tape covered with sealing wax.

(2) **Cracks and splits**: Use metal or flexible bracing with threaded galvanized/stainless-steel rods or carbon fibre rods (10-16mm diameter). For vertical splits, use metal plates perpendicular to the crack plane. For horizontal cracks, install break-prevention braids with wooden reapers or metal strips placed along the trunk length and secured with non-abrasive rope. Seal narrow vertical cracks with fungicidal treatment and waterproof sealant.

(3) **Hollow Trunks and Cavities:** Remove decayed wood to live tissue, create drainage channels at the bottom of the cavity, apply fungicidal treatment, and install rain excluders above large cavities.

(4) **Heart rot:** This is caused by a massive and long-time fungal infection of the heartwood. For heart rot (evidenced by fungal fruiting bodies on the lower parts of the trunk), assess the remaining wall thickness using sonic tomography. If less than 30% of the trunk radius, reduce crown load or remove the tree.

(5) **Canker Treatment:** Remove infected tissue (minimum 5 cm beyond visible infection), apply copper-based fungicide, and monitor quarterly. Improve soil to boost tree vigour.

(6) **Fire Damage:** Remove charred bark and wood completely, test cambium viability, apply anti-desiccant to exposed viable cambium, provide temporary shade, apply diluted white latex paint, reduce crown load if necessary, apply deep root fertilizer, and use mycorrhizal soil drenches.

(7) **Solutions for structural issues:** Solutions suggested in part C of Appendix VIII can also be tried.

A.9.9. Tree Root Maintenance

Following are the common root problems and how they need to be resolved:

(1) **Sidewalk lifting and cracking:** Tree roots growing beneath sidewalks can lift and crack concrete, creating trip hazards and accessibility issues. Resolve by selectively pruning problematic surface roots while maintaining the tree's structural stability.

(2) **Root invasion of water and sewer lines:** Roots seek water sources and can penetrate the cracks in ageing pipes, causing blockages and damage. Prune problematic roots at an appropriate distance from pipelines and install root barriers to direct future growth away from utilities.

(3) **Girdling roots: T**hese roots grow around the trunk rather than outward, constricting vascular flow and weakening the tree. Expose and carefully trim visible girdling roots.

(4) **Poor drainage and root rot:** Poor drainage, especially around water bodies, may lead to tree death. Install subsurface drainage systems in problem areas to prevent inundation.

(5) **Buried root collars:** Deep planting or hard paving up to the tree trunk can bury the root collar area, promoting infection and girdling roots. Keep root collars exposed to air. Where trees are deeply planted or collars are covered by pavement, open the area around the tree. Raising soil mounds around tree collars is prohibited.

(6) **Root damage from utility excavation:** Utility work often severs critical roots, destabilizing trees and creating entry points for disease. The following steps must be taken to minimize the damage:

(i) Avoid open trenching near trees.

(ii) Use air spades, hydro-excavation, or directional boring.

(iii) Draw utilities through concealed pipes below woody roots.

(iv) Avoid trimming roots in the critical root zone (1.5 feet radius per inch of tree diameter).

(v) Consider a tree "technically dead" if more than 20% of its main roots are lost.

(vi) Require compensatory planting from utility companies when damage occurs.

(vii) Survey the leftover roots using appropriate technology.

(viii) Remove trees that have lost 40% or more of woody roots and replace them with new plantings.

A.9.10. Good Practices for Urban Tree Pruning and Maintenance

(1) Start early and be consistent in tree pruning

(i) Begin pruning at the nursery stage to develop a single straight, cylindrical stem.

(ii) Create a trunk strong enough to support a well-formed crown and withstand wind.

(iii) Nip branch buds to a height of 4-5 meters during nursery growth

(iv) Continue regular pruning up to ten years after planting.

(v) Prune young branches before they reach 10 cm in diameter to avoid delayed pruning.

(2) Time the pruning appropriately

(i) Prune during dormancy periods (after leaf shedding or before new leaf flush).

(ii) Most crown maintenance should be performed during the dormant season.

(iii) Consider ecological impacts when timing pruning (e.g., nesting season for birds).

(3) Adopt systematic crown pruning techniques

(i) Start from the top of the tree and work downwards.

(ii) Maintain a single dominant leader. Remove codominant shoots that compete for the leader position.

(iii) Ensure appropriate spacing between successive branches.

(iv) Remove branches growing at an acute angle (<less than a 45° degree angle to the stem or to its parent branch)

(v) Remove all dead, crossing, or rubbing branches.

(vi) Prune small branches over 2/3 of the length of retained branches.

(vii) Remove branches less than 1/3 the girth of the trunk or the parent branch.

(4) Follow the proper branch removal technique

(i) First cut: 30 cm away from the main branch on the upper side.

(ii) Second cut: 20 cm away from the main branch on the lower side.

(iii) Final cut: Close to the branch collar—about one inch away from the main branch at the top and three inches at the bottom.

(iv) Make the final cut smooth, and slanted downward and outward.

(v) Ensure the bark on the main branch doesn't peel.

(5) Post-Pruning considerations

(i) Natural tree sap, gums, and resins from cut ends serve as the tree's defence.

(ii) Avoid wound dressings as they often prove detrimental due to fungal infections.

(6) Common mistakes to avoid

(i) Over-thinning that exposes branches to sunscald.

(ii) Improper cuts that create entry points for decay.

(iii) Aggressive reduction that stimulates excessive water sprouts.

(iv) Uneven thinning creating wind pockets.

(v) Excessive pruning that stresses the tree.

(7) Safety considerations

(i) Regular inspection of hazardous branches.

(ii) Assessment of tree stability before climbing.

(iii) Proper rigging techniques for large branch removal.

(iv) Maintaining safe distances from utilities.

(v) Using appropriate personal protective equipment.

(8) Special situations

(i) Heritage trees require more conservative approaches

(ii) Trees near structures need regular risk assessment

(iii) Fruit trees require specialized pruning for production

(iv) Storm-damaged trees need immediate attention

(9) Long-term management

(i) Develop a multi-year maintenance plan.

(ii) Document work performed and tree response.

(iii) Monitor for signs of stress or disease.

(iv) Adjust care based on tree response.

(v) Plan for eventual tree replacement when necessary.

(10) Environmental considerations

(i) Consider the impact on wildlife habitat.

(ii) Protect nesting birds during breeding season.

(iii) Manage pruning debris responsibly.

(iv) Consider the surrounding vegetation.

(v) Evaluate effects on the local ecosystem.

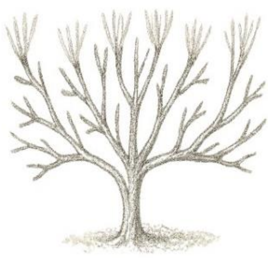
A.9.11. Harmful Tree Pruning Practices to Avoid

Pollarding, Topping, and Tipping of trees are not allowed. The meaning and purpose of these practices are as follows:

(1) Pollarding involves cutting the branches back to the trunk or main stems when the tree is still young. This process is repeated again and again, and it creates a knob or "pollard head" from which new shoots grow. This is a method for the production of firewood from trees.

(2) Topping of a tree is a pruning technique that involves cutting back all the main branches of a tree at the same height. The goal is often to reduce the tree's height.

(3) Tipping means clipping all the branch tips of a certain size of the entire tree. This is done to control the overall size or shape of a tree and to encourage denser, bushier growth.

	
Tree Topping	Tree Tipping

The above practices are not allowed due to the following reasons:

(i) They remove the entire crown and severely disrupt photosynthetic capacity. It also eliminates the defence mechanisms against pathogens present in branches are eliminated. The tree becomes susceptible to disease, pest infestations, and environmental stresses

(ii) It results in rapid production of numerous weak shoots that grow abnormally fast taking away all the reserve food in the tree. The tree gets exhausted very fast.

(iii) These practices reduce the lifespan of the trees. Better Alternatives

In general, the need for severe crown reduction often indicates improper species selection or incorrect placement of trees. The solution lies in choosing appropriate species for the available space considering the size at maturity at the time of tree planting. This is called retrofitting of trees. When pruning becomes necessary, the techniques suggested here should be followed and the required balance should be achieved over a period of time instead of resorting to heavy, hurried and harmful practices.

APPENDIX – X

LIST OF RECOMMENDED TREE SPECIES FOR URBAN PLANTING

SI no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
1	*Acrocarpus fraxinifolius**	Balanje	Vase-shaped	Big	Semi-deciduous	Feb-Apl	Woodlot lakeside
2	*Actinodaphne lanceolate (syn. Actinodaphne hookeri)*	Wild Cinnamon	Rounded	Rounded	Small	Greenish-white	Park, lakeside
3	*Adenanthera pavonina**	Aanegulaga nji	Spreading	Medium	Deciduous	Apl-May	Park, avenue tree
4	*Adina cordifolia* (syn. *Haldina cordifolia)**	Heddi	Broad, Rounded	Big	Deciduous	May-Jul	Park, Avenue tree

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5	*Aegle marmelos**	Bilwa	Rounded	Medium	Deciduous	Feb-Apl	sacred tree
6	*Aglaia elaeagnoidea**	Wild Olive, Thottilu	Compact	Small	Evergreen	Feb-Apl	Woodlot, lakeside
7	*Ailanthus triphysa* (syn. *Ailanthus malabarica)**	Halmaddi	Palm	Medium	Evergreen	Feb-Apl	Avenue tree, Parks, Woodlot
8	*Alangium salviifolium**	Ankole	oblong	Medium	Deciduous	Apl-May	Park, woodlot
9	*Albizia lebbeck**	Baage	Broad, spreading	Big	Deciduous	Apl-May	Avenue tree, park
10	*Albizia odoratissima**	Bilwara, Kadubage	Round	Big	Deciduous	Apl-May	Woodlot, avenue tree
11	*Albizia procera**	Bellati, Bili-bage	Rounded	Small	Deciduous	Feb-May	Park, avenue tree

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
12	*Alseodaphne semecarpifolia*	Mashe, Neltare	Compact	Small	Evergreen	Feb-Apl	Woodlot, lakeside
13	*Alstonia macrophylla**	Seeme saptha parni	columnar	Big	Evergreen	Apl-May	Avenue
14	*Alstonia scholaris**	Maddale	Columnar	Big	Evergreen	Feb-May	Avenue tree, park
15	*Amherstia nobilis**	Anegida	Oval	small	Evergreen	Feb-Apl	Park, Woodlot
16	*Andira inermis**	Bastard Mahogany	Rounded	Big	Deciduous	Feb-Apl	Park, woodlot
17	*Anthoshorea roxburghii* (syn. *Shorea roxburghii*)*	Jalari	Pyramidal	Big	Evergreen	Mar-May	Park
18	*Aphanamixis polystachya**	Banta Kepulu	Rounded	Big	Evergreen	Feb-Apl	Woodlot, lakeside

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
19	*Aporosa cardiosperma* (syn. *Aporosa lindleyana*)*	Challe	Compact	Small	Evergreen	Feb-Apl	Woodlot
20	*Araucaria bidwillii*	Christmas tree	Conical	Big	Evergreen	-	Avenue, Parks
21	*Araucaria heterophylla**	Christmas tree	Conical	Big	Evergreen	-	Avenue, Parks
22	*Artocarpus altilis**	Breadfruit, Divi Halasu	Rounded	Medium	Evergreen	Feb-Apl	Parks and wood lots
23	*Artocarpus heterophyllus**	Jackfruit	Spreading	Big	Evergreen	Feb-Apl	Park, Woodlots, private lands
24	*Artocarpus hirsutus**	Hebbalasu	Rounded	Big	Evergreen	Feb-Apl	Woodlot, lakeside, privatae lands

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
25	*Artocarpus hypargyreus**	Kai Mukhi	Compact	Medium	Evergreen	Feb-Apl	Park, other
26	*Artocarpus lacucha* (syn. *Artocarpus lakoocha)*	Wate Huli, Unde Huli	Spreading	Big	Evergreen	Feb-Apl	Parks, other
27	*Azadirachta indica**	Neem, Bevu	Rounded	Big	Deciduous	Feb-Apl	Avenue tree, park
28	*Bambusa ventricosa*	Buddha bamboo	cylindrical	Small	Deciduous	Not applicable	Parks
29	*Bauhinia purpurea**	Basavanapa da	Rounded	Small	Semi-evergreen	Sep-Nov	Avenue tree, park
30	*Berrya cordifolia**	Chakranike	Compact	Medium	Evergreen	Feb-Apl	Woodlot, other
31	*Berrya javanica**	Java Berrya	Rounded	Medium	Evergreen	Feb-Apl	Woodlot, lakeside
32	*Bischofia javanica**	Java Cedar	Round	Big	Evergreen	Feb-Apl	Avenue tree, woodlot

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
33	*Bixa orellana**	Aarnatu,Ba ngaara kaayi	Mushroo m	Small	Evergreen	Feb-Apl	Avenue, Park, woodlot
34	*Bombax ceiba* (syn. *Bombax malabaricum)**	Red Silk Cotton	Broad, spreading	Big	Deciduous	Dec-Feb	Park, Woodlot
35	*Boswellia serrata**	Guggula mara,Doop a	Irregular	Small	Deciduous	Feb-Apl	Woodlot, Woodlot
36	*Brachychiton australis**	Chowda	Pyramidal	Big	Deciduous	Feb-Apl	Avenue tree, park
37	*Bridelia retusa**	Mul-honne	Round	Medium	Deciduous	Feb-Apl	Woodlot, lakeside
38	*Brownea coccinea**	Kailara	Rounded	Small	Evergreen	Feb-Apl	Park, Woodlots
39	*Buchanania axillaris*	Chironji	Spreading	Small	Deciduous	Feb-Apl	Avenue, Wood

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40	*Buchanania cochinchinensis**	Kole Mavu	Rounded	Small	Deciduous	Feb-Apl	Avenue, Park, Woodlot
41	*Butea monosperma**	Muttaga	Spreading	Medium	Deciduous	Feb-Apl	Park, Avenue tree
42	*Byrsonima crassifolia**	Mara Sebu	Rounded	Small	Evergreen	Feb-Apl	Woodlots
43	*Calophyllum inophyllum**	Hole Honne	Spreading	Small	Evergreen	Feb-Apl	Lakeside, Park, Woodlot
44	*Calophyllum tomentosum*	Sura Honne	Mushroom	Big	Evergreen	Feb-Apl	Woodlot, lakeside
45	*Cananga odorata**	Kathhe sampige	Spreading	Medium	Evergreen	Feb-May	Avenue, park
46	*Canarium strictum**	Karidhupa, Raldhoop	Rounded	Big	Evergreen	Feb-Apl	Avenue, Park, Woodlot

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
47	*Caryota urens**	Baini	Palm	Big	Evergreen	Feb-Apl	Park, woodlot
48	*Casimiroa edulis**	Bili Sapote	Rounded	Small	Evergreen	Feb-Apl	Park, Woodlot
49	*Cassia fistula**	Kakke	Rounded	Small	Deciduous	Apl-May	Avenue tree, park
50	*Cassia javanica**	Nili Arali	Spreading	Medium	Deciduous	Feb-Apl	Avenue tree, Park
51	*Castanospermum australe**	Kammara	Broad, spreading	Big	Evergreen	Feb-Apl	Avenue,Park, Woodlot
52	*Catunaregam spinosa* (syn. *Gardenia latifolia*)*	Wild Gardenia	Rounded, Dense	Small	Semi-deciduous	May-Jul	Park, Woodlot
53	*Cedrela odorata**	Spanish Cedar	Rounded	Big	Deciduous	Feb-Apl	Avenue tree, woodlot

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
54	*Ceiba pentandra**	Bilibooruga,	Broad, spreading	Big	Deciduous	Feb-Apl	Parks, Woodlot
55	*Ceiba speciosa**	Reshme Mara	Rounded	Big	Deciduous	Sep-Nov	Park, other
56	*Centrolobium tomentosum**	Arariba	Spreading	Medium	Deciduous	Feb-Apl	Park, woodlot
57	*Cerbera manghas**	Chende	Compact	Small	Evergreen	Feb-Apl	Lakeside
58	*Chrysophyllum cainito**	Ale, Jokali	Rounded	Small	Evergreen	Feb-Apl	Park, other
59	*Chukrasia tabularis**	Kalgarige	Spreading	Big	Deciduous	Feb-Apl	Park, woodlot
60	*Cinnamomum malabatrum*	Kaadu daalchinni	Compact	Small	Evergreen	Feb-Apl	Avenue, Park, woodlot
61	*Cinnamomum tamala**	Lavanga pathri, Thaej pathre	Compact	Small	Evergreen	Feb-Apl	Avenue, Park, woodlot

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
62	*Cinnamomum verum**	Daalchini,Lavanga	Rounded	Small	Evergreen	Feb-Apl	Avenue, Park, woodlot
63	*Citharexylum spinosum* (syn.*Citharexylum fruticosum*)*	Fiddlewood	Spreading	Medium	Evergreen	Feb-May	Avenue, Park
64	*Cochlospermum religiosum**	Arishina booraga	Spreading	Medium	Deciduous	Apl-May	Park, Woodlot
65	*Colvillea racemosa**	Colville's Glory	Rounded	Medium	Deciduous	Sep-Nov	Avenue tree, park
66	*Cordia dichotoma**	Bheku, Challe	Spreading	Medium	Deciduous	Feb-Apl	Avenue, Park, woodlot
67	*Cordia macleodii**	Bili challe, Doddachalle	Rounded	Medium	Evergreen	Feb-Apl	Avenue, Park, woodlot

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68	*Cordia myxa**	Bheku challe,	Rounded	Medium	Deciduous	Mar-May	Avenue, Park, woodlot
69	*Cordia sebestena**	Scarlet Cordia	Spreading	Small	Evergreen	Year-round	Avenue, Park
70	*Corymbia citriodora*	Lemon-scented Gum	Columnar	Medium	Evergreen	Apl-May	Avenue tree, woodlot
71	*Corymbia torelliana* (syn. *Eucalyptus torelliana*)	Cadagi	Pyramidal	Medium	Evergreen	Oct-Dec	Avenue tree, Woodlot
72	*Couroupita guianensis**	Cannonball Tree	Broad spreading	Big	Evergreen	Feb-May	Park, botanical garden
73	*Crateva religiosa**	Adhiraaja,Maavalanga	Rounded	Medium	Deciduous	Feb-Apl	Park, religious sites

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74	*Cupressus sempervirens*	Italian Cypress	Narrow columnar	Medium	Evergreen	Feb-Apl	Avenue, Park
75	*Cyathocalyx zeylanicus**	Ceylon Cyathocalyx	Rounded	Medium	Evergreen	Feb-Apl	Park, Woodlot
76	*Cynometra travancorica**	Vagai	Rounded	Big	Evergreen	Feb-Apl	Woodlot, native forest
77	*Dalbergia lanceolaria* (syn. *Dalbergia paniculata*)*	Pachaali, Pachaari	Rounded	Medium	Deciduous	Feb-May	Avenue, park
78	*Dalbergia latifolia**	Indian Rosewood	Broad spreading	Big	Deciduous	Feb-May	Avenue, woodlot
79	*Dalbergia sissoo**	Sheesham	Rounded	Big	Deciduous	Feb-Apl	Avenue tree, park
80	*Dendrocalamus giganteus*	Giant Bamboo	Clumping	Big	Evergreen		Avenue, Park, Woodlot

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81	*Dillenia indica**	Kadu Kanagal	Irregular	Medium	Deciduous	Feb-Apl	Park, botanical garden
82	*Dillenia pentagyna**	Kanagal	Broad spreading	Big	Deciduous	Feb-Apl	Avenue, Park, Woodlot
83	*Dimocarpus longan**	Kendale	Rounded	Medium	Evergreen	Feb-Apl	Avenue, Park, Woodlot
84	*Diospyros buxifolia**	Dhula	Compact	Medium	Evergreen	Feb-Apl	Avenue, Park, Woodlot
85	*Diospyros ebenum*	Karimara, Ebony	Compact	Medium	Evergreen	Feb-Apl	Avenue, Park, Woodlot
86	*Diospyros malabarica**	Antina mara	Rounded	Medium	Deciduous	Feb-Apl	Avenue, Park, Woodlot

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87	*Diospyros melanoxylon**	Thupra	Compact	Big	Deciduous	Feb-Apl	Avenue, Park, Woodlot
88	*Diospyros montana* (syn. *Diospyros cordifolia)**	Jagalaganti	Rounded	Medium	Deciduous	Feb-Apl	Avenue, Park, Woodlot
89	*Dolichandrone atrovirens**	Belundare,Chithodi	Spreading	Medium	Deciduous	Apl-May	Avenue, Park, Woodlot
90	*Duabanga grandiflora**	Assam Duabanga	Spreading	Big	Semi-Evergreen	Apl-May	Park, Woodlot
91	*Dysoxylum malabaricum**	Bili daevadaar	Rounded	Big	Evergreen	Feb-Apl	Park, Woodlot
92	*Elaeocarpus angustifolius**	Rudhraakshi mara	Broad	Big	Evergreen	Feb-Apl	Park, Woodlot
93	*Elaeocarpus floribundus**	Jalplu Mara	Rounded	Medium	Evergreen	Feb-May	Park, Woodlot

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94	*Elaeocarpus lacunosus**	Pitted Elaeocarpus	Rounded	Small	Evergreen	Feb-Apl	Park, Woodlot
95	*Elaeocarpus serratus**	Ceylon Olive	Compact	Medium	Evergreen	Feb-May	Woodlot, park
96	*Elaeocarpus tuberculatus**	Bhootha rudhraakshi	Rounded	Medium	Evergreen	Feb-Apl	Avenue, park
97	*Elaeocarpus variabilis**	Dande Mara	Spreading	Medium	Evergreen	Feb-May	Park, Woodlot
98	*Elaeodendron glaucum* (syn. *Cassine glauca)**	Broad-leaved Cassine	Compact	Medium	Evergreen	Feb-Apl	Woodlot, Lakeside
99	*Elaeodendron paniculatum*	Panicled Spikethorn	Rounded	Small	Evergreen	Feb-Apl	Woodland
100	*Enterolobium cyclocarpum*	Ear Pod Tree	Broad spreading	Big	Deciduous	Feb-Apl	Avenue, park
101	*Eriobotrya japonica**	Lokate	Rounded	Small	Evergreen	Dec-Feb	Park, Woodlots

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102	*Erythrina mitis* (syn. *Erythrina umbrosa)**	Shade Coral Tree	Broad	Medium	Deciduous	Feb-Apl	Park, avenue
103	*Erythroxylum monogynum**	Chembula	Rounded	Small	Evergreen	Mar-Apl	Park, Avenue tree
104	*Eugenia uniflora**	Surinam Cherry	Compact, Rounded	Small	Evergreen	Apl-Jun	Park, Lakeside
105	*Falconeria insignis* (syn. *Sapium insigne)**	Jujabendi	Compact	Small	Evergreen	Jan-Mar	Woodlot
106	*Ficus amplissima**	Bilibasiri	Spreading	Big	Evergreen	N/A	Woodlot, Park
107	*Ficus arnottiana**	Bettada arali	Spreading	Medium	Evergreen	N/A	Woodlot, Park
108	*Ficus auriculata**	Elephant Ear Fig	Broad, Spreading	Medium	Evergreen	Year-round	Park, Lakeside
109	*Ficus benghalensis**	Ala	Massive, Spreading	Big	Evergreen	N/A	Park, Woodlot

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110	*Ficus benjamina**	Javatti	Weeping, Drooping	Big	Evergreen	N/A	Park, Avenue tree
111	*Ficus carica*	Anjoora	Rounded, Open	Medium	Deciduous	Apl-Jun	Park, Lakeside
112	*Ficus curtipes**	Creek Sandpaper Fig	Spreading, Round	Medium	Evergreen	N/A	Woodlot, Lakeside
113	*Ficus drupacea**	Goni	Broad, Spreading	Medium	Evergreen	Year-round	Park, Woodlot
114	*Ficus elastica**	Indian Rubber	Broad, Columnar	Big	Evergreen	Rare	Avenue tree, Park
115	*Ficus exasperata**	Rough-leaved Fig	Spreading, Irregular	Medium	Evergreen	Year-round	Woodlot, Park
116	*Ficus krishnae*	Krishna's Buttercup Fig	Compact, Rounded	Medium	Evergreen	Occasional	Park, Garden

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117	*Ficus lyrate* (syn. *Ficus pandurata*)*	Fiddle-leaf Fig	Columnar, Upright	Medium	Evergreen	Occasional	Park
118	*Ficus microcarpa**	Gudde goli	Spreading, Wide	Medium	Evergreen	Year-round	Avenue tree, Park
119	*Ficus mollis**	Kadu Atti	Broad, Spreading	Small	Evergreen	Year-round	Woodlot, Park
120	*Ficus racemosa**	Atti	Spreading, Round	Medium	Evergreen	Year-round	Park, Woodlot
121	*Ficus religiosa**	Arali	Spreading, Umbrella-like	Big	Deciduous	N/A	Park, Religious sites
122	*Ficus tsjakela**	Kari basari	Rounded, Compact	Medium	Semi-Evergreen	Year-round	Woodlot, Park
123	*Ficus virens**	Basari	Broad, Spreading	Big	Semi-Evergreen	Year-round	Avenue tree, Park

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124	*Filicium decipiens**	Kaadu hoovarasi	Compact, Rounded	Medium	Evergreen	Mar-May	Avenue, Park
125	*Firmiana colorata**	Bilisoolige	Broad, Umbrella-shaped	Medium	Deciduous	Apl-Jun	Avenue tree, Park
126	*Garcinia gummi-gutta**	Murugana Huli	Compact, Rounded	Small	Evergreen	Jan-Mar	Park, Lakeside
127	*Garcinia indica**	Punarpuli	Compact, Dense	Small	Evergreen	Feb-Apl	Park, Woodlot
128	*Garcinia xanthochymus**	Arasina Gurugi	Spreading, Rounded	Medium	Evergreen	Mar-May	Avenue, Park
129	*Gardenia gummifera**	Adavi Bikke	Compact, Rounded	Small	Evergreen	Apl-Jun	Park, Lakeside
130	*Garuga pinnata**	Goddamte	Spreading, Rounded	Medium	Semi-Evergreen	Feb-Apl	Park, Woodlot
131	*Gmelina arborea**	Shivani	Broad, Spreading	Medium	Deciduous	Apl-Jun	Avenue tree, Park

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132	*Goniothalamus angustifolius* (syn. *Polyalthia angustifolia)**	Narrow-leaved Polyalthia	Columnar	Medium	Evergreen	Jan-Mar	Avenue tree, Park
133	*Grewia tiliifolia**	Dhaman, Tadasal	Rounded, Dense	Medium	Deciduous	Apl-Jun	Park, Lakeside
134	*Guazuma ulmifolia**	Bastard Rudraksha	Spreading, Irregular	Medium	Evergreen	Mar-May	Avenue tree, Woodlot
135	*Gustavia angusta**		Compact, Columnar	Small	Evergreen	May-Jul	Avenue, Park
136	*Handroanthus chrysanthus* (syn. *Tabebuia spectabilis)**	Spectacular Ipê	Broad Conical	Medium	Deciduous	Mar-May	Avenue tree
137	*Handroanthus chrysotrichus* (syn.	Golden Trumpet Tree	Oval to Rounded	Small	Deciduous	Mar-May	Avenue, Lakeside

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	*Tabebuia chrysotricha)**						
138	*Handroanthus impetiginosus* (syn.*Tabebuia impetiginosa)*	Pink Ipê	Broad Conical	Medium	Deciduous	Jan-Mar	Avenue, Park, Woodlot
139	*Handroanthus impetiginosus* (syn.*Tabebuia impetiginosa)**	Purple Ipê	Broad Spreading	Small	Deciduous	Dec-Feb	Avenue tree
140	*Hardwickia binata**	Kamar	Narrow, Columnar	Medium	Deciduous	Feb-Apl	Woodlot, Avenue tree
141	*Heptapleurum actinophyllum* (syn. *Brassaia actinophylla)**	Umbrella Tree	Umbrella-shaped	Medium	Evergreen	Apl-May	Avenue

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142	*Heritiera littoralis**		Broad, Spreading	Medium	Semi-Evergreen	Mar-May	Lakeside
143	*Holigarna arnottiana**	Male Geru	Spreading, Irregular	Medium	Semi-Evergreen	Jan-Mar	Woodlot, Park
144	*Holigarna grahamii**	Hole Geru	Compact, Rounded	Medium	Evergreen	Feb-Apl	Park, Lakeside
145	*Holoptelea integrifolia**	Thapase	Spreading, Rounded	Medium	Deciduous	Mar-May	Avenue tree, Park
146	*Hopea indica* (syn. *Hopea parviflora*)*	Kiral Bogi	Compact, Pyramidal	Big	Evergreen	Apl-Jun	Woodlot, Forest
147	*Hopea ponga**	Karmara	Broad, Spreading	Medium	Evergreen	May-Jul	Park, Lakeside
148	*Hura crepitans**	Sandbox Tree	Broad, Irregular	Big	Deciduous	Mar-May	Woodlot, Large parks

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149	*Hydnocarpus castaneus* (syn. *Hydnocarpus anthelminthicus)**	Chaulmoogra Tree	Rounded, Compact	Small	Evergreen	Mar-May	Medicinal garden, Park
150	*Hydnocarpus pentandrus**	Wild Almond	Spreading, Rounded	Medium	Evergreen	Apl-Jun	Woodlot, Lakeside
151	*Hymenodictyon orixense**	Jungle Geranium	Compact, Rounded	Medium	Deciduous	Feb-Apl	Avenue, Park
152	*Jacaranda acutifolia**	Jacaranda	Broad, Spreading	Medium	Deciduous	Apl-Jun	Avenue tree, Park
153	*Joannesia princeps**	Anda Tree	Spreading, Rounded	Medium	Deciduous	May-Jul	Woodlot, Large parks
154	*Juniperus procera*	African Pencil Cedar	Narrow, Columnar	Medium	Evergreen	N/A	Avenue tree, Park

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155	*Khaya grandifoliola**	African Mahogany	Broad, Rounded	Big	Deciduous	Mar-May	Avenue, Park, Woodlot
156	*Khaya senegalensis**	Senegal Mahogany	Spreading, Broad	Medium	Deciduous	Apl-Jun	Avenue tree, Park
157	*Kigelia africana**	Sausage Tree	Spreading, Broad	Medium	Deciduous	Apl-Jun	Park, Botanical garden
158	*Knema attenuata**	Raktamara	Compact, Rounded	Medium	Evergreen	Mar-May	Forest, Woodlot
159	*Lagerstroemia microcarpa**	Nandi, Nana	Compact, Rounded	Big	Deciduous	Jun-Aug	Park, Avenue tree
160	*Lagerstroemia speciosa**	Giant Crape Myrtle	Broad, Spreading	Medium	Deciduous	May-Jul	Avenue tree, Park
161	*Lannea coromandelica**	Gojjal	Spreading, Irregular	Medium	Deciduous	Feb-Apl	Woodlot, Park

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162	*Lepisanthes tetraphylla**		Rounded, Compact	Small	Evergreen	Mar-May	Park, Woodlot
163	*Libidibia coriaria* (syn. *Caesalpinia coriaria)**	Divi-divi	Compact	Small	Deciduous	Apl-May	Avenue, Park, Woodlot
164	*Libidibia ferrea* (syn. *Caesalpinia ferrea)**	Kailasagi	Rounded	Medium	Deciduous	Feb-Apl	Avenue tree, park
165	*Limonia acidissima**	Bela	Rounded, Dense	Medium	Deciduous	Apl-Jun	Park, Woodlot
166	*Litchi chinensis**	Lychi	Rounded, Dense	Medium	Evergreen	Feb-Apl	Avenue, Park
167	*Litsea coriacea**	Laurel	Compact, Rounded	Small	Evergreen	Mar-May	Woodlot, Forest
168	*Litsea ligustrina* (syn. *Litsea deccanensis)**	Hemundi	Spreading , Open	Small	Evergreen	Apl-Jun	Park, Woodlot

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169	*Lophopetalum wightianum**	Banate	Rounded, Dense	Medium	Evergreen	Feb-Apl	Avenue, Woodlo
170	*Macadamia integrifolia**	Macadamia Nut Tree	Compact, Rounded	Medium	Evergreen	Mar-May	Avenue, Park
171	*Machilus macranthus**	Gulmav	Pyramidal	Big	Evergreen	Jan-Mar	Avenue tree, Park, Lakeside
172	*Madhuca bourdillonii**		Broad, Spreading	Big	Evergreen	Apl-Jun	Forest, Avenue tree
173	*Madhuca insignis**	Wild Mahua	Rounded, Dense	Medium	Evergreen	Feb-Apl	Forest, Avenue tree
174	*Madhuca longifolia var. latifolia**	Ippe	Broad, Rounded	Big	Deciduous	Apl-Jun	Avenue, Park, Woodlot

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175	*Madhuca longifolia**	Sanna Ippe	Spreading, Broad	Big	Deciduous	Mar-May	Forest, Avenue tree
176	*Magnolia champaca* (syn. *Michelia champaca)**	Sampige	Conical	Big	Evergreen	Apl-Jun	Avenue, Park tree
177	*Magnolia grandiflora**	Dodda Bili Sampige	Pyramidal, Dense	Small	Evergreen	May-Jul	Avenue, Park
178	*Mammea suriga**	Wild Kandis	Compact, Rounded	Small	Evergreen	Apl-Jun	Woodlot
179	*Mangifera indica**	Mavu	Broad, Spreading	Big	Evergreen	Jan-Mar	Park, Woodlot
180	*Manilkara hexandra**	Khirni	Rounded, Dense	Small	Evergreen	Feb-Apl	Woodlot, Park
181	*Melaleuca viminalis* (syn. *Callistemon viminalis)**	Weeping Bottlebrush	Weeping	Small	Evergreen	Feb-May	Avenue, Park

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
182	*Melia azedarach**	Hiribevu, Kiribevu	Rounded, Spreading	Medium	Deciduous	Apl-Jun	Avenue tree, Park
183	*Melia dubia**	Hebbevu	Broad, Spreading	Big	Deciduous	Mar-May	Woodlot
184	*Memecylon sessile* (syn. *Memecylon malabaricum*)*	Ironwood	Compact, Rounded	Small	Evergreen	Feb-Apl	Avenue, Park, Woodlot
185	*Mesua ferrea**	Naga Sampige	Pyramidal	Medium	Evergreen	Mar-May	Avenue tree, Park tree
186	*Miliusa tomentosa* (syn. *Saccopetalum tomentosum*)	Vom	Rounded	Medium	Evergreen	Feb-Apl	Avenue and Woodlot
187	*Millettia peguensis**	Burmese Lantern Tree	Spreading	Small	Deciduous	Feb-Apl	Woodlot, Park tree

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
188	*Millingtonia hortensis**	Akashmallig e	Columnar	Big	Deciduous	Aug-Oct	Avenue tree, Park tree
189	*Mimusops elengi**	Bakul, Ranjal	Rounded	Big	Evergreen	Mar-May	Avenue, Park tree, Lakeside, sacred tree
190	*Mitragyna parvifolia**	Kalam	Spreading	Big	Deciduous	Apl-Jun	Park tree, Woodlot
191	*Monoon coffeoides*	Wild Cinnamon	Rounded	Small	Evergreen	Jan-Mar	Park tree, Understor y
192	*Monoon fragrans* (syn. *Polyalthia fragrans)**	Kakechapya	Spreading	Small	Evergreen	Feb-Apl	Avenue tree, Park

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
193	*Monoon longifolium* (syn. *Polyalthia longifolia*)*	Mast Tree	Columnar	Medium	Evergreen	Mar-May	Avenue tree, Park
194	*Morinda tinctoria*	Indian Mulberry	Rounded	Small	Evergreen	Apl-Jun	Woodland, Park tree
195	*Morus alba**	Bili Hippu Nerala	Spreading	Medium	Deciduous	Mar-Apl	Avenue tree, Park tree
196	*Muntingia calabura**	Singapore Chrerri	Rounded	Small	Evergreen	Continuous	Avenue, Park tree
197	*Myristica dactyloides**	Kadu Jai Kai	Pyramidal	Medium	Evergreen	Jan-Mar	Lakeside, Woodlot
198	*Myristica fragrans**	Nutmeg	Pyramidal	Medium	Evergreen	Feb-Apl	Lakeside, Woodlot
199	*Myristica malabarica**	Rampatre	Conical	Medium	Evergreen	Mar-May	Lakeside, Woodlot

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
200	*Neolamarckia cadamba**	Kadamba	Spreading	Medium	Deciduous	Apl-Jun	Park tree, Avenue tree
201	*Nothopegia castaneifolia* (syn. *Nothopegia racemosa)*	Wild Cashew	Rounded	Small	Evergreen	Feb-Apl	Woodland
202	*Nyctanthes arbor-tristis**	Parijata	Spreading	Small	Deciduous	Sep-Nov	Avenue, Park
203	*Ochroma pyramidale* (syn. *Ochroma lagopus)**	Balsa	Rounded	Medium	Deciduous	Mar-May	woodlot
204	*Olea europaea**	Olive Tree	Rounded	Small	Evergreen	Apl-Jun	Woodlot
205	*Oroxylum indicum**	Bili saroli	Spreading	Small	Deciduous	Feb-Apl	Park, Woodland
206	*Ougeinia oojeinensis* (syn. *Ougeinia dalbergioides)*	Indian Mast Tree	Compact	Small	Deciduous	Mar-May	Avenue and Woodlot

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
207	*Pachira aquatica**	Money Tree	Pyramidal	Small	Evergreen	May-Jul	Woodlot, Lakeside
208	*Palaquium ellipticum*	Hadasale	Rounded	Medium	Evergreen	Jan-Mar	Woodlot, Lakeside
209	*Pandanus tectorius**	Screw Pine	Columnar	Small	Evergreen	Continuous	Lakeside
210	*Parkia timoriana**	Tree Bean	Spreading	Big	Deciduous	Apl-Jun	Park
211	*Peltophorum pterocarpum**	Golden Shower Tree	Spreading	Big	Deciduous	Mar-May	Avenue tree, Park tree
212	*Phyllanthus assamicus* (syn. *Glochidion ellipticum*)	Hirachelli	Compact, Rounded	Small	Evergreen	Mar-May	Lakeside, Park
213	*Phyllostachys nigra**	Black bamboo	Vase-shaped	Medium	Deciduous	Not applicable	Park

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
214	*Pithecellobium dulce**	Kadu Gilebi	Rounded	Medium	Deciduous	Feb-Apl	Park, Roadside tree
215	*Platycladus orientalis* (syn. *Thuja orientalis)**	Oriental Arborvitae	Narrow Conical	small	Evergreen	Mar-Apl	Avenue tree
216	*Pleiogynium timoriense**	Burdekin Plum	Spreading	Medium	Evergreen	Mar-May	Avenue tree, Park
217	*Plumeria obtusa**	Deva Kanagalu	Compact	Small	Deciduous	Continuous	Avenue tree, Park
218	*Podocarpus macrophyllus* (syn. *Podocarpus chinensis)**	Chinese Podocarp	Conical	Medium	Evergreen	Feb-Apl	Avenue tree, Park
219	*Poeciloneuron indicum*	Balagi	Rounded	Medium	Evergreen	Mar-May	Avenue, park and lakeside

SI no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
220	*Pongamia pinnata**	Honge	Spreading	Small	Deciduous	Feb-Apl	Avenue tree, Park
221	*Premna serratifolia**	Bastard Teak	Rounded	Small	Semi-Evergreen	Mar-May	Woodlots
222	*Premna tomentosa*	Narabe	Compact	Small	Evergreen	Apl-Jun	Park
223	*Prioria pinnata* (syn. *Kingiodendron pinnatum*)*	Chorapaini	Rounded, Dense	Big	Evergreen	Mar-May	Woodlot, Forest
224	*Pseudobombax ellipticum**	Shaving Brush Tree	Rounded	Big	Deciduous	Jan-Mar	Park
225	*Pterocarpus dalbergioides**	Andaman Redwood	Spreading	Big	Deciduous	Mar-May	Avenue, Woodlot
226	*Pterocarpus indicus**	Kalpine	Rounded	Big	Deciduous	Feb-Apl	Avenue tree, Park
227	*Pterocarpus marsupium**	Honne	Spreading	Big	Deciduous	Mar-May	Avenue and Woodlot

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
228	*Pterocarpus santalinus**	Rakta Chandana	Compact	Medium	Deciduous	Feb-Apl	Avenue and Woodlot
229	*Pterocymbium tinctorium**	Kariyat	Spreading	Medium	Deciduous	Apl-Jun	Woodlot
230	*Pterospermum acerifolium**	Kanakchampa	Spreading	Medium	Semi-Evergreen	Mar-May	Avenue, Park
231	*Pterospermum diversifolium**		Spreading	Medium	Semi-Evergreen	Feb-Apl	Park, woodlot
232	*Pterospermum reticulatum**		Rounded	Medium	Semi-Evergreen	Mar-May	Park, woodlot
233	*Pterospermum rubiginosum**		Compact	Medium	Semi-Evergreen	Apl-Jun	Park, woodlot
234	*Pterygota alata**	Kotte, Tabe-mara.	Spreading	Big	Deciduous	Jan-Mar	Avenue, park
235	*Putranjiva roxburghii* (syn. *Drypetes roxburghii*)*	Menasina kale	Rounded	Medium	Evergreen	Feb-Apl	Park, Woodlot

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
236	*Putranjiva roxburghii**	Putranjiva	Rounded	Small	Evergreen	Mar-May	Avenue, Park
237	*Quassia amara**	Bitter Wood	Compact	Small	Evergreen	Continuou s	Medicinal garden, Landscape
238	*Radermachera xylocarpa**	Genasinga	Columnar	Big	Evergreen	Mar-May	Avenue, Park
239	*Roystonea regia**	Royal Palm	Columnar	Big	Evergreen	Mar-May	Avenue tree, Landscape
240	*Salix tetrasperma**	Nir Gunji	Spreading	Medium	Evergreen	Jan-Mar	Lakeside
241	*Samanea saman**	Rain Tree	Spreading	Big	deciduous	Apl-Jun	Park, Avenue tree
242	*Santalum album**	Shrigandha	Compact	Small	Evergreen	Mar-May	Private lands
243	*Sapindus emarginatus**	Antuvala,	Rounded	Medium	Deciduous	Feb-Apl	Park, woodlot

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
244	*Sapindus mukorossi**	Soap Nut	Rounded	Medium	Deciduous	Apl-Jun	Park, woodlot
245	*Sapindus trifoliatus* (syn. *Sapindus laurifolius*)*	Laurel-leaved Soap Nut	Spreading	Medium	Deciduous	Mar-May	Park, woodlot
246	*Saraca asoca**	Seetha Ashoka	Compact	Small	Evergreen	Feb-Apl	Park
247	*Saraca cauliflora* (syn. *Saraca thaipingensis*)*	Thaiping Saraca	Compact	Small	Evergreen	Mar-May	Avenue
248	*Schleichera oleosa**	Sagadi, Kusum	Spreading	Medium	Semi-Evergreen	Feb-Apl	Avenue, Woodlot
249	*Semecarpus anacardium**	Kadu Geru, Gudda Geru	Compact	Small	Deciduous	Jan-Mar	Park, Woodlot
250	*Senegalia ferruginea* (syn. *Acacia ferruginea*)*	Banni	Rounded	Small	Deciduous	Dec-Feb	Sacred tree

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
251	*Sideroxylon inerme**	White Milkwood	Rounded	Medium	Evergreen	Feb-Apl	Park tree
252	*Simarouba glauca**	Paradise Tree	Spreading	Medium	Evergreen	Mar-May	Landscape, Medicinal garden
253	*Solanum macranthum*	Mara Badane	Spreading	Small	Semi-Evergreen	Continuous	Ornamental, Garden
254	*Spathodea campanulata**	African Tulip Tree	Rounded	Big	Evergreen	Mar-May	Avenue tree, Park
255	*Spondias pinnata* *	Amte	Rounded to Spreading	Medium	Deciduous	Feb-Apl	Lakeside, Avenue tree
256	*Sterculia balanghas**	Wild Almond	Umbrella-shaped	Big	Deciduous	Jan-Mar	Park, Woodlot
257	*Sterculia foetida**	Bastard Poon Tree	Broadly Conical	Big	Deciduous	Dec-Feb	Avenue tree, Park

SI no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
258	*Sterculia guttata**	Happu-savaga	Irregular Rounded	Big	Semi-Evergreen	Jan-Mar	Avenue, Woodlot
259	*Sterculia rubiginosa*	Rusty Sterculia	Broad Spreading	Medium	Deciduous	Feb-Apl	Park, Lakeside
260	*Sterculia villosa**	Savage,Cha uri	Dense Rounded	Medium	Semi-Evergreen	Dec-Feb	Avenue tree
261	*Stereospermum chelonoides**	Karasing, Mukarti	Vase-shaped	Medium	Semi-Evergreen	Feb-Apl	Park, Woodlot
262	*Stereospermum kunthianum**	White Trumpet Tree	Broad Spreading	Medium	Deciduous	Jan-Mar	Avenue tree, Lakeside
263	*Strychnos nux-vomica**	Kasarka	Irregular Rounded	Medium	Deciduous	Jan-Mar	Woodlot
264	*Swietenia macrophylla**	Big-leaf Mahogany	Broad Conical	Big	Deciduous	Feb-Apl	Park, Avenue tree
265	*Swietenia mahagoni**	Mahogany	Oval to Rounded	Big	Deciduous	Dec-Feb	Avenue tree

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
266	*Syzygium aqueum**	Water Apple	Varies by Species	Varies	Evergreen	Througho ut Year	Lakeside
267	*Syzygium caryophyllatum**	Kunt-neral	Dense Rounded	Small	Evergreen	Mar-May	Park, Lakeside
268	*Syzygium cumini**	Nerale	Broad Spreading	Big	Evergreen	Jan-Mar	Avenue tree, Park, Lakeside
269	*Syzygium hemisphericum**	Panneral	Compact Rounded	Small	Evergreen	Feb-Apl	Lakeside, Woodlot
270	*Syzygium jambos**	Rose Apple	Umbrella-shaped	Medium	Evergreen	Dec-Feb	Park, Lakeside
271	*Syzygium nervosum**	Nervose Myrtle	Oval to Rounded	Medium	Evergreen	Jan-Mar	Avenue tree
272	*Syzygium stocksii* (syn. *Syzygium travancoricum*)*	Travancore Myrtle	Dense Conical	Big	Evergreen	Feb-Apl	Woodlot

Sl no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
273	*Tabebuia aurea**	Golden Trumpet Tree	Rounded Spreading	Small	Deciduous	Feb-Apl	Avenue tree, Park
274	*Tabebuia pallida**	Pale Ipê	Vase-shaped	Medium	Deciduous	Feb-Apl	Park
275	*Tabebuia rosea**	Pink Trumpet Tree	Dense Rounded	Big	Deciduous	Jan-Mar	Woodlot, Lakeside
276	*Tamarindus indica**	Hunase	Wide Spreading	Big	Deciduous	Jan-Mar	Park
277	*Taxodium distichum**	Bald Cypress	Pyramidal	Big	Deciduous	Mar-Apl	Avenue Lakeside, Woodlot
278	*Tecomella undulata*	Desert Trumpet	Irregular Rounded	Small	Deciduous	Feb-Apl	Park
279	*Terminalia anogeissiana** (syn. *Anogeissus latifolia*)	Dindaga	Rounded	Big	Deciduous	Feb-Apl	Woodlot, avenue tree

SI no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
280	*Terminalia arjuna**	Hole-matti	Spreading Umbrella	Big	Deciduous	Mar-May	Lakeside, Avenue tree
281	*Terminalia bellirica**	Taare, Shanti	Broad Rounded	Big	Deciduous	Jan-Mar	Park, Woodlot
282	*Terminalia bialata**	Mountain Terminalia	Conical Spreading	Medium	Deciduous	Feb-Apl	Avenue tree
283	*Terminalia catappa**	Kadu Badami	Tiered Horizontal	Big	Deciduous	Dec-Feb	Avenue, Park, Lakeside
284	*Terminalia chebula**	Alale	Rounded Spreading	Medium	Deciduous	Jan-Mar	Woodlot
285	*Terminalia elliptica* (syn. *Terminalia tomentosa*)*	Mathi, Banapu	Wide Spreading	Big	Deciduous	Mar-May	Park, Woodlot lakeside
286	*Terminalia mantaly*	Madagascar Almond	Dense Rounded	Medium	Evergreen	Mar-May	Avenue, Park

SI no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
287	*Terminalia microcarpa**	Small-fruit Terminalia	Broad Spreading	Big	Deciduous	Feb-Apl	Avenue tree
288	*Terminalia procera**	Large Terminalia	Umbrella-shaped	Big	Deciduous	Jan-Mar	woodlot
289	*Tetrapilus dioicus* (syn. *Olea dioica)**	Wild Olive	Compact	Small	Evergreen	Feb-Apl	Woodlot
290	*Thespesia populnea**	Hoovarasi	Rounded Compact	Medium	Evergreen	Dec-Feb	Avenue
291	*Thuja plicata*	Western Red Cedar	Pyramidal	Small	Evergreen	Mar-Apl	Avenue
292	*Thyrsostachys oliverii*	Oliver's Bamboo	Clustered Clump	Medium	Evergreen	Jan-Mar	Woodlot
293	*Toona ciliata**	Gandha Garige	Broad Spreading	Big	Deciduous	Feb-Apl	Park, Avenue tree
294	*Vachellia nilotica* (syn. *Acacia nilotica)**	Gobli, Karijali	Umbrella-shaped	Medium	Deciduous	Dec-Feb	Lakeside

SI no	Botanical name	Common Name	Crown Shape	Size at Maturity (M)	Nature	Flowering time	Best for Planting on
295	*Vateria indica**	Dhupa	Dense Rounded	Big	Evergreen	Jan-Mar	Park, Woodlot
296	*Vepris bilocularis**	Munguppe	Compact Rounded	Small	Evergreen	Feb-Apl	Avenue tree
297	*Vitex altissima**	Naviladi	Broad Spreading	Medium	Deciduous	Mar-May	Park
298	*Wrightia tinctoria*	Hale	Dense Rounded	Small	Deciduous	February-April	Roadside
299	*Xylia xylocarpa**	Jamba	Wide Spreading	Medium	Deciduous	Mar-May	Park, Avenue tree
300	*Zanthoxylum rhetsa**	Jummanaka i	Irregular Rounded	Small	Deciduous	Jan-Mar	Woodlot

* Tree species recorded from various locations in Bangalore by Shankara Rao, K. (2025) in his book:

Trees of Bengaluru, Indian Academy of Sciences (Pb), Bengaluru, 560080. For more information, please refer to this book (Vol I & II)

APPENDIX - XI

TECHNICAL SPECIFICATIONS FOR PLANTING STOCK PRODUCTION

(Refer to Paragraph 6.4)

Part A. Infrastructure Requirements

A.11.1. The Need for Quality of Planting Materials

In urban areas teeming with people and environmental challenges, the importance of using high-quality planting materials cannot be overstated. The success of urban forestry depends critically on selecting high-quality planting stock with a well-balanced shoot-to-root ratio, a strong, stout and well-formed trunk, and a properly developed root system. Such trees establish relatively quickly, have higher survival rates, require less maintenance, and enjoy greater longevity. They are also more resilient to environmental stressors and provide superior ecosystem services over time. In the long run, they are also cost-efficient.

A.11.2. Key Characteristics of High-Quality Planting Material

High-quality planting materials for urban forestry are defined by:

(1) Structurally sound trunk and crown

(a) Sturdy and vigorous juvenile trees not less than 5 m in height.

(b) Has a collar diameter of not less than 5 cm at 10 cm height, 7.5 cm in case of a medium-sized tree and 10 cm for a big tree.

(c) Strands erect without the support of a stake.

(d) Can withstand normal wind pressure.

(e) Has a single, straight and fast-growing leading shoot.

(f) Has well-spaced scaffold branches with wide branch angles.

(g) Has Tear drop-shaped crown.

(2) Well-developed root system

(a) Strong, fibrous, and well-distributed root system.

(b) Proper shoot-to-root ratio (typically 1:1) by mass.

(c) White, healthy root tips indicating active growth on the surface of the root ball.

(d) No defects like J-rooting or girdling around other roots.

(e) No root coils along the container walls.

(3) Other characteristics

(a) Should have a high leaf area index (dense foliage)

(b) Resilient to urban stressors like pollution, drought, and heat.

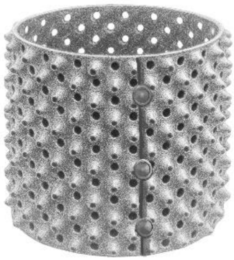
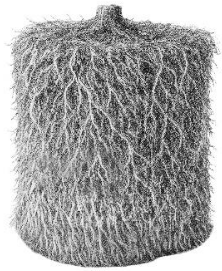
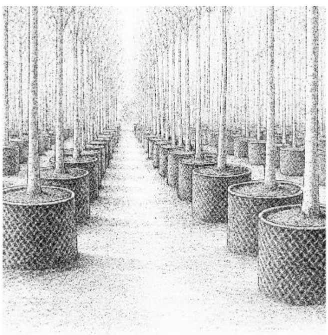
(c) Should be low on maintenance requirements.

(d) Should not be susceptible to pests and diseases.

(e) High on biodiversity (at least 30 different species)

A.11.3. Production Methodology

It is not possible to produce the high-quality planting stock described above in standard containers such as polythene bags, grow bags, plastic pots, etc. Root coiling and stagnation are inevitable in such containers. To avoid this problem, the planting stock should be raised in air root pruning pots, called in short as **Air-Pots**. These are specialised containers designed to improve the root development of plants. They are made of plastic and have small holes or cones projecting along their sides, which allow air to pass through the soil. This helps in the air pruning of roots and keeps their length under control. The tips of roots stop growing when exposed to air. As a result, the plant develops a healthier and more robust root system that is ready to hit the ground immediately on planting instead of a few long, coiled roots. They should be used for growing juvenile trees. They come in various sizes. They are reusable and easy to assemble or disassemble. They should be used for producing juvenile trees in the plant production centres.

 Air Pruning Pot (Air-pot)	 Root mass in the Air-pot
 Air Pot-Based Nursery	 Juvenile Tree in Air Pot

A.11.4. Estimation of Planting Stock Requirement

(1) Every year, a minimum of 500 to 1000 juvenile trees have to be planted in each ward of Bengaluru City.

(2) It takes a minimum of three years to produce a juvenile tree.

(3) The minimum planting stock required for BBMP = Number of wards X 500 X 3 years.

(4) Add an average of 10% for compensatory afforestation, 10% for planting in peri-urban areas and 10% for sale to the general public.

(5) The planting stock requirement = Number arrived at step 3 + 30 for step 4 above. Assuming 245 wards in the city, the planting stock at any time in the nurseries should be 4.78 lakhs or say 5 lakhs.

(6) If there are any other requirements, they should be planned at least 3 years before. Alternatively, a buffer planting stock of 20% must be included in the requirement.

(7) On average, each zone in Bengaluru city must produce a planting stock of 50 – 75 thousand juvenile trees.

A.11.5. How Many Species of Plants to be Produced

Seedlings of the tree species recommended for planting in urban areas are given in **Appendix X.** Seedlings of these species or any other changes approved by the Urban Forestry Executive Committee should only be raised. Out of the 300 species, at least 100 different species should be raised annually, and they should be rotated. The stock of any single species of tree should not exceed 5% of the total stock. Priority should be given to big trees of evergreen species, particularly those that have become rare in the natural forests. They should be conserved ex-situ.

A.11.6. Where to Produce the Planting Stock

The required stock of juvenile trees must be produced in the BBMP nurseries. Only when there is a shortage due to some unanticipated contingency, juvenile trees produced by private nurseries may be purchased, if they meet the specifications laid down in this manual.

A.11.7. Space Required for Producing the Planting Stock

Each juvenile tree requires a minimum of 1 square metre of space. Plant-to-plant and row-to-row working space of 0.5 m should be provided. For producing 1000 juvenile trees, 1.5 hectares of area is required. For producing a planting stock of 5-6 lakh required for Bengaluru City and its peri-urban areas, substantial space is required. In each zone of the city, It may be difficult to find the required space in one single location. But it can be found around the lakes and open areas available with the BBMP and its associated development agencies. Space available with public institutions like universities and public sector enterprises may also be utilised on mutually agreeable terms. The Director will find the space required.

A.11.8. Plant Production Infrastructure Development

Plant production requires two types of locations.

(1) **Plant Production Centre:** This should be a larger space of about 3-5 hectares, preferably on a lakeside with good water supply potential. It should be divided into three parts.

   (a) **Stockyard:** This is a small area where a seed store room, tool room, resting space, along with toilets for the workers and potting ingredient stockyard, etc., are to be provided.

   (b) **Working Area:** This is a shade house covered with 50% shade net for germinating the seeds, filling the air pots with ingredients, transplanting the sprouts into the air pots and curating them for about 3 -4 weeks.

(c) **Curating Area:** This is an area covered with a 25% shade net. Seedlings in the air pots will be held here for about 3-4 months till they reach about 1 m in height. Then they will be shifted to open sunlight areas, which are called 'Plant Growth Centres'.

(2) **Plant Growth Centres:** This area can be anywhere within the BBMP Zone. Lakes should be the first choice. Air pots should be arranged in any open area and also along the jogging path/walking track where sunlight is available. They have to be provided with drip irrigation. Security staff will keep a watch on the stock. As many air pots as possible should be located around each lake. For the rest of the plants, space has to be found in any other land belonging to BBMP or any public institution or public sector undertaking. Each growing area is to be given a suitable name, and an account of the air pots set up should be maintained.

A.11.9. Number of Nurseries to be Established by BBMP

The Plant Production Centres and Plant Growth Centres are facilities. They are not plant nurseries in the conventional sense. The entire network of plant production areas and Plant Growth Centres in a BBMP zone will be considered a **Networked Nursery**. There will be as many nurseries as there are BBMP zones. This network ensures the good growth of juvenile trees. They will be available across the zone for planting in different locations. Public visibility will be high and access easy in case citizens want to buy and plant trees. It will inspire tree planting across the city.

A.11.10. Administrative Arrangement for Planting Stock Production

The Director will determine the annual production targets and distribute it among the zones. The Zonal Tree Officers are responsible for plant production. The Assistant Conservator of Forests (Plant Production) will guide and supervise the production work closely. He is responsible for ensuring the species diversity, quality and quantity of the planting stock. The Tree Planting supervisors will keep a watch on the progress of plant production and report to the Tree Office every week, and also to the ACF (Plant Production). The ACF (Plant Production) will consolidate and submit a monthly progress report of all zones to the Director. Space problems, if any, will the resolved with the help of the Zonal Commissioners and the Special Commissioner (Forest, Environment and Climate Change).

A.11.11. Agency to Produce the Planting Stock

The juvenile tree production work may be entrusted to reputed public agencies or NGOS. If there are not enough of them, they may be tendered to reputed nursery expert agencies as per para 6.4.8 of this manual.

Part B. Seed Procurement

A.11.12. Sourcing the Seed

A.11.13. Seeds for the plant production centre should be procured from the registered elite trees in each zone. For this purpose, a sufficient number of elite trees should be identified, evaluated and registered with the Director under para 8.3.1. For those species that are not available in the City, the ACF (Plant Production) should identify suitable locations in the Western Ghats Region with the help of the senior officers of Karnataka Forest Department, work with the local Range Forest Officers, identify seed mother trees, and arrange for the collection and supply of seed regularly. Natural forests in Makut in Coorg, Agumbe in Shovamogg and Gerusoppa in Uttara Kannada District are a rich repository of big evergreen tree species. A few other places may be identified by the Director. Seeds of evergreen and semi-evergreen species must be collected from these locations through dependable local staff. Seed collection is a skilled job and should be undertaken by trained people. Only select-grade seeds should be collected and used. Recalcitrant seed (sensitive to drying or freezing) should be sown immediately. Orthodox seeds can be dried, stored and used. For moist deciduous and deciduous species that require prolonged seed treatment, because of the uncertainty about germination, arrangements may be made to produce stumps on open seed beds in the plant production centres. Select-grade stumps should be used for the production of juvenile trees.

A.11.14. Maintaining a Record of all the Seed Sources

The ACF (Plant Production) is responsible for seed procurement from various sources and distributing them among the zones. He should maintain a record of the seed sources and the pictures of mother trees. The collection of seed from seed supply contractors and also from unknown or unregistered elite/mother trees is prohibited. If treatment is necessary, he should get it done in one central location and distribute the treated seed.

A.11.15. Germinating the Seeds

Seeds should be used immediately after they arrive at the plant production centres. Soak them overnight, then remove any floating seeds the next morning. Sow large seeds (10 mm diameter or larger) in germination trays or net pots/cups filled with cocopeat and embed them in sand beds. Smaller seeds should be planted in drills on sand mother beds. Sow the seeds to a depth no greater than their thickness. Irrigate by misting and not by any other means.

A.11.16. Minimum Germination Percentage

Germination of seeds depends on many factors like seed maturity, dormancy, treatment efficacy, viability, method of sowing, environmental conditions and so on. In any case, it shall not be less than 60%. Bills for the purchase of seeds shall not be paid if germination is below 50%.

A.11.17. Preparing the Airpots

(1) **Air pot sizes to be used:** Air pots come in different sizes. Use the following pot dimensions for raising juvenile trees. Please see paragraph A.2.2. (iii) for tree size definitions.

  (a) Use air pots 45 cm in diameter and 60 cm in height for small-sized trees.

(b) For medium-sized trees, use air pots of 60 cm diameter and 80 cm height.

(c) For big-sized trees: Use 90 cm diameter and 120 cm height.

Air pot sizes available in the market may vary. The nearest sizes by volume available in the market may be used. The diameter-to-height ratio of 3:4 should be maintained. The bottom plate should be fixed at least 10 cm above the ground level. This is to prevent roots from reaching out to the soil.

(2) Setting up the air pots: The air pot has three parts - the main body which is a reusable sheet of plastic cones, the bottom grill and the side screws. All are made of plastic parts and come in modules. Pots have to be assembled in the plant production centre as per the instructions given by the seller.

(3) Filling media: Filling media is important for many reasons, such as it should support the plant for 3 years, should be of lightweight and being able to hold moisture, etc. It should be filled with a lightweight pot-filling mixture of cocopeat, biochar and vermicompost/organic compost in a 1:1:1 ratio. This should form 90% of the filling material. The rest 10% should be good quality garden soil. All of them should be mixed thoroughly, and the pot should be filled. This will support the plant for a year. In the second and third years, farm yard manure to the extent of 10% by volume must be used for topping the pots. It will provide the nutrients to the plant to reach the juvenile stage.

A.11.18. Transplanting the Sprouts into the Air Pots

(1) Time of transplanting: This is an important stage in the plant's life. The sprouts should be transplanted very carefully into air pots at the four-leaf stage (after two-leaf but before six-leaf) stage in holes that are exactly the size of the young root. Any delay, even of one or two days, may require pruning of the radical (root), which harms the sprout. Semi-dry or dry zone species will have a long radical, often 3-4 times the shoot size. It grows very fast, and every day matters. Transplanting should be done on time to prevent bending or cutting of the radical (tap root).

(2) **Follow the "keep the best and kill the rest" principle:** When selecting seedlings from germination trays or net pots/cups for transplantation, choose only the strongest, fastest-growing specimens. A seedling's initial vigour significantly influences the tree's lifelong development trajectory. This vigour manifests during germination, indicating that only robust seedlings from large seeds should be cultivated into mature trees. Selecting weaker or second-quality sprouts invariably produces inferior trees. Rather than expending time, financial resources, and efforts attempting to improve underperforming seedlings later, it is more efficient to eliminate them during the transplantation phase. The transfer of seedlings into air pots represents a critical opportunity for grading and selection of future trees. The Tree Officer should directly supervise this process and ensure all substandard seedlings are removed at this stage, preventing numerous complications in subsequent development phases.

A.11.19. Keeping the Transplants Under 50% Shade Net

The transplants should be lightly watered with a fine rose can and continued to be held under 50% shade net for 3-4 weeks. Inside the shade net, they should be watered by misting only. Seedlings are sensitive to weeds and excessive watering. Both must be kept under careful control.

A.11.20. Shifting to the Curating Area

Once the seedlings reach 20 - 30 cm in height, they should be moved to the curating (25% shade net) area. They should be arranged close to each other. Watering should be done by aerial misting. They should be held there till the seedlings reach 1 m height. Axillary buds should be nipped and should not be allowed to develop into branches.

A.11.21. Labelling Individual Plants

The next step is moving them to the Plant Growth Centres. Before that, each plant should be labelled with the following details engraved on an aluminium foil and tied to the edger of the air pot using a strong nylon thread that can last 4 years. Lost tags should be promptly replaced.

1. Name of the zone:
2. Name of the Plant Production Centre:
3. Name of the species:
4. Plant no, batch number and year of production:
5. Source of seed:
6. Date of transplanting into air pot:
7. Name of the Plant Growth Centre:

A.11.22. Entering the Details in the Plant Production Journal

The Tree Officer must closely oversee the seedling production process as frequently as possible but at least once in 15 days. ACF (Plant Production) should inspect at least once a month. The Tree office will decide to which Plant Growth Centre the plants will be moved to. Accordingly, the seedling production agency or the contractor will move them carefully without harming the seedlings. Before moving the seedlings, he should enter relevant details in the Plant Production Journal, and get it signed by the Tree Planting Supervisor and the Tree Officer. These details must be preserved as permanent data.

Part C. Grooming the Plants at the Growth Centres

A.11.23. Grading and Arranging the Seedlings Species-wise

The same agency or contractor responsible for plant production will continue their services at the Plant Growth Centres. After the seedlings in the air pots are taken to the new place, they will be sorted out by species and batch-wise. Places for arranging each batch will be identified. They will be placed in linear rows or grids, giving not less than 1 m space for each plant and 0.5 m space for moving around each plant and carrying out weeding, manuring and other cultural operations. Details will be entered in a register batch-wise and placed with the security staff. The contractor will provide the labour for maintaining the plants at the Growth Centre.

A.11.24. Providing Drip Irrigation from the Local Tube Well

All the plants will be irrigated by the drip method. Each plant should be irrigated with the required amount of water every day, once in the morning and once in the evening.

A.11.25. Regular Weeding and Manuring

Weeding should be carried out regularly as and when necessary. Any gaps created on top of the air pot should be filled regularly with powdered cow dung /sheep/poultry manure to keep it topped as and when required.

A.11.26. Prohibition of the Use of Chemical Fertilisers and Stakes

The use of chemical fertilisers and stakes is prohibited. Trees should grow freely and independently on their own strength. In case any seedling bends due to heavy breeze, a split bamboo, 1 cm thick, 2 cm wide and of required height may be tied to the trunk 60 cm from the top of the air pot using jute thread. It should not be fixed to the air pot. This is just to prevent the sapling from bending. The bamboo supports should be removed once the plant gains strength and can stand erect. The bottom plates of air pots should be kept under observation. If roots come out, place a thick plastic sheet below and see that they are not able to penetrate the soil.

A.11.27. Formative Pruning and Maintenance of Seedlings

Removing leaves from the trunk or the branches at any stage is not permitted. Branch buds appearing in the axils of the leaves on the trunk should be nipped up to 2.5 m in height, excluding the height of the air pot. Beyond the 2.5 m, the side branches may be allowed to grow up to 50 – 60 cm in length. Thereafter, the terminal buds of branches must also be nipped. The space between one branch to the next upper branch on the plant should not be less than 50 - 60 cm (or 5% of the tree's height at its maturity). Bud or sprouts in between should also be nipped. A juvenile tree of 5 m height can have only 5-6 branches distributed equally on all sides of the trunk. The nursery staff should be alert and do this on time with their bare hands. Knife or secateurs should not be used. Juvenile trees shall not have injuries, broken or deformed branches.

A.11.28. Quarterly Growth Monitoring and Stock Taking

The ACF (Plant Production) will monitor the growth of the plant and advise the contractor on any remedial measures that have to be taken. Since the production cost of juvenile trees is substantial, every seedling has to be accounted. At this time of quarterly growth measurement, he will also take stock of the plants, account for variation if any variation in the number of seedlings, fix the responsibility and update the inventory.

A.11.29. Expected Average Growth Rates of Plants

During the first 4 quarters, the average height growth should be around 50 cm each. During the next 4 quarters, it will be 45 cm and in the last four quarters, it will be about 40 cm each. By the end of the third year, the average tree height should be 5 m or more, depending on the species. Similarly, the diameter increment shall be an average of 0.5 to 0.75 cm per quarter. If these growth rates are not achieved, the ACF (Plant Production) should investigate the reasons, consult the Director and advise the contractor suitably to improve the growth by using organic methods. The contractor shall implement the advice and prepare the plants for field planting on time.

Overall, at the end of the 3 years, when the plant will be called a juvenile tree, it should measure not less than 5 m in height and 7.5 cm in diameter at the collar girth at the minimum. Medium and bigger size trees will measure even bigger. A ready-to-plant juvenile tree should meet the specifications laid down in paragraph 6.4.3 of this manual.

A.11.30. Stock Taking of Juvenile Trees Before Despatch

During March, the team mentioned in para 6.4.10 will inspect the 3-year-old planting stock due to be planted in the field in the forthcoming monsoon and approve the stock that meets the specifications. The contractor will get full payment if the stock meets the specifications. Else he shall be paid the pro rata price determined in the contract. The Director will plan to utilise the available juvenile trees to meet the city requirements, both public and private. He will also reserve trees for BDA, BMRDA, BIAAPA, KIADB and other public agencies and purposes listed in the Manual or agreed to by the Director. He will make the allotment and issue instructions to the officers concerned. Surplus if any should be allowed to be sold by Tree Officers at the price fixed by the Director to the general public for bona fide use.

A.11.31. Issuing Juvenile Trees for Field Planting

Juvenile trees will be issued for BBMP planting by the Tree Officers based on the orders issued by the Director. The planting contractors will lift them from the designated Plant Growth Centres. Unutilised stock, if any, at the end of September shall be moved to one common place for further maintenance and disposal as per the orders of the Director. If there is any shortage of seedlings for planting, two-year-old plants that meet the specifications may be utilised if the above team permits.

APPENDIX – XII

SURVEY AND IDENTIFICATION OF TREE PLANTING SITES IN THE CITY

(See Para 6.6.3)

A.12.1. Responsibility for the Survey and the Timeline

1. The Tree Warden and members of the Ward Forest Sub-Committee are responsible for identifying space for planting at least 500 – 1000 trees per ward annually as per paragraph 6.2.1. (a). This number may increase if the ward is bigger and the current tree density is lower. Each member of the Ward Forest Sub-Committee is responsible for identifying locations for planting a minimum of 100 trees or more in their area annually.

2. Members should walk around and identify potential planting sites and inform the Tree Warden during the first week of September. If there are insufficient ward forest subcommittee members, the Warden may seek volunteers. If volunteers are also unavailable, the Warden may enlist NSS or NCC students to complete the task in time.

3. The Tree Warden will visit the identified sites along with the ward subcommittee member, meet landowners, seek their consent, and if they agree, identify the exact spots and record the georeferenced locations for each planting pit and inform the Tree Planting Inspector. If landowners are not agreeable, the Warden should proceed to the next location.

4. The Tree Planting Supervisor will visit the spots, verify the data, confirm its accuracy, and submit it to the Tree Officer for further action. He will check the correctness online and pass on the details

to the planting contractor for digging the pits at the right time. The Tree Officer should resolve if there are any problems.

5. If finding space for 500 trees proves difficult, the Tree Officer should consult BBMP land records, identify major landholders, check the tree inventory data for those parcels, and if tree coverage is insufficient, issue notices to ensure the required number of trees are planted.

6. By adopting an appropriate method, the Tree Officer must find space for planting at least 500 trees in every ward annually if the existing tree cover does not meet the requirements specified in this manual. If adequate green cover already exists in the ward, the annual requirement of 500 trees may be reduced.

A.12.2. The Director may design a mobile app for the survey work

The Director should design and implement a suitable mobile application for this purpose. This will facilitate seamless data sharing across hierarchical levels and keep all stakeholders updated on the progress of survey work. The data will support planning for additional initiatives such as Blue Green Cell construction, juvenile tree preparation in nurseries, and scheduling of planting work.

A.12.3. Format to be used for the Survey

Use the following format for the survey:

Tree Planting Site Survey Form for Block Planting

Sl no.	Item	Particulars
Part - I		
1	Date of survey	
2	Surveyed by (name)	
3	Designation	
4	Name of the city ward/layout	

<table>
<tr><td>5</td><td>Name of the main street</td><td></td></tr>
<tr><td>6</td><td>Name of the cross/side road</td><td></td></tr>
<tr><td>7</td><td>Specific name of the location</td><td></td></tr>
<tr><td>8</td><td>Property ID number</td><td></td></tr>
<tr><td>9</td><td>Land ownership</td><td>BBMP/Public/Private/Other</td></tr>
<tr><td>10</td><td>Name of the landowner</td><td></td></tr>
<tr><td rowspan="5">11</td><td>Boundary land landmarks</td><td>------</td></tr>
<tr><td>a. East</td><td></td></tr>
<tr><td>b. West</td><td></td></tr>
<tr><td>c. North</td><td></td></tr>
<tr><td>d. South</td><td></td></tr>
<tr><td>12</td><td>Total area available for tree planting (in square metres)</td><td></td></tr>
<tr><td>13</td><td>How many trees can be planted?</td><td></td></tr>
<tr><td>14</td><td>Have you uploaded a photograph of the site / drawn a hand sketch in part II of this form? (Any one is ok)</td><td>YES / NO</td></tr>
<tr><td>15</td><td>Have you marked the georeferenced pits in part III of this form?</td><td>YES / NO</td></tr>
<tr><td>16</td><td>Is the landowner willing to plant trees?</td><td>YES / NO</td></tr>
<tr><td>17</td><td>What is his choice of species?</td><td></td></tr>
<tr><td>18</td><td>General remarks if any</td><td></td></tr>
<tr><td colspan="3">I certify that I inspected this plot, met the owner and collected information that is true and correct to the best of my knowledge

Signature of the Tree Warden Signature of the Tree Planting Supervisor</td></tr>
<tr><td colspan="3">The above particulars are correct. We are willing to partner with BBMP and plant trees on our land and protect them for the environmental benefits.

Signature of the Land Owner</td></tr>
</table>

Part - II Note: Space for drawing a hand sketch of the location

Part - III Marking Locations for the Planting Pits						
Pit Sl. No.	Latitude	Longitude	Soil depth	Over-head objects	Free radial space (M)	Remarks

APPENDIX – XIII

CREATING SPACE FOR TREES THROUGH BLUE-GREEN CELLS

(For the Street Tree Planting in the Inner City)

(Refer to Paragraphs 3.5 and 6.6.5)

A.13.1. Definition of Blue-Green Cell

Blue Green Cell is a small underground chamber that serves multiple purposes, like supporting healthy tree root growth, harvesting rainwater, facilitating bio-reclamation, and recharging groundwater, while maintaining the functionality of city pavements.

A.13.2. Objectives of setting Blue-Green Cells

(1) **Integrating the blue and green infrastructure of the city:** Connect green (vegetation) and blue (water) systems of the city.

(2) **Facilitate city-wide greening:** Expand green cover to space-constrained areas using underground cells that provide optimal soil conditions for healthy tree growth.

(3) **Groundwater recharge:** Harvest, filter, and recharge at least 50% of rainwater annually into the soil.

(4) **Flood prevention:** Reduce flooding through canopy interception, capturing runoff, and stormwater moderation.

(5) **Minimise tree falls:** Reduce the tree falls gradually by on the space conflict and multiple agencies working at cross-purposes.

(6) **Climate Control:** Mitigate urban heat island effects through nature-based solutions.

(7) **Retain the surface functionality:** Preserve existing land uses without compromise.

A.13.3. Locations Where Blue-Green Cells are to be Constructed

Blue Green Cells are designed specifically for public trees and should be strategically placed in the following locations of the inner city:

(1) Pavements with a few or no trees in residential areas.

(2) Gap filling of trees on the arterial and sub-arterial roads.

(3) Frontage areas of commercial plazas and office premises.

(4) High-traffic zones requiring simultaneous hard pavement, rainwater management, and tree shade.

A.13.4. Priority Areas for Implementing the Blue-Green Cell Concept

(1) Areas with less than 10% greenery.

(2) Sloped areas with high runoff.

(3) Groundwater-depleted zones.

(4) Areas with non-potable groundwater.

(5) Busy locations which were recently deforested.

(6) Locations having only aged tree populations. In these areas, the generation trees should be raised in Blue-Green Cells.

(7) Sites from where windfallen or mature trees were removed.

Blue-Green Cells should be built by chipping and removing the stumps of old trees. These cells provide not only the space for planting young trees of the same or better species but also harvest rainwater.

A.13.5. Determining the number of Blue-Green Cells to be built annually

The construction of Blue-Green Cells is an ongoing process until all parts of the city are adequately covered in terms of planting a sufficient number of trees to provide dense tree shade and harvesting and recharging at least 30 - 40% of the rainwater. Subject to budget availability, a few thousand cells should be built across the city annually. The Assistant Conservator of Forests (Urban Forestry) and the jurisdictional civil engineer of BBMP should decide the priority areas. Once an area is chosen, as many Blue-Green Cells as possible should be built in that area.

A.13.6. Technical considerations for the Blue Green Cells

(1) Tree Root Zone: Tree roots inhabit the upper 60 cm of soil for growth. This part should have good-quality garden soil. The remaining portion of the cell is intended for rainwater harvesting.

(2) Shape of the cell: Trees spread their crowns and roots laterally in all directions. The Blue-Green Cell shape should ideally be a round or square. If space is a constraint, a square shape is also acceptable if the minimum root space is available.

(3) Blue-Green Cell dimensions

(i) Minimum radius is 2 m. For square cells, the minimum length and width are 2 × 2 meters.

(ii) If the length is 3 m or more, a reduction in width up to 30% is permissible.

(iii) Irrespective of the length and width, the standard depth is 2 m. It shall not be less than this.

(4) Soil volume requirements of a tree: This should be calculated for the tree, considering its size at maturity and not based on the size at the time of planting. Approximately 0.6 cubic metres of soil (60 cm depth and 1 sqm area) is required for every square crown spread area (measured at ground level). Minimum soil volume should not be less than 3 cubic metres.

(5) **Species selection:** Tree selection should be determined by available root zone space. Efforts should be made to maximise the cell size and use them for planting larger-sized trees because they offer far greater ecological benefits compared to small trees. If space is a constraint, small-sized trees may be planted.

A.13.7. Components of a Blue-Green Cell

(1) A pit of suitable dimensions.

(2) Steel column structure to transfer the load of the road or pavement to the ground.

(3) Side walls that serve as root barriers.

(4) Layered filling materials for the pit.

(5) Covered deck on top that will serve as a road or pavement.

(6) Rainwater inlets into the cell.

(7) A spillway for the overflow of excess rainwater.

(8) A tree well for planting a juvenile tree.

(9) A pipe conduit for the passage of cables, if any.

(10) Other accessories include a jute mat or a woven geotextile.

A few diagrams showing the key components of the Blue-Green Cell are given on the next page.

A.13.8. Technical specifications:

(1) **Structural framework:** This should be designed by the Civil Engineer based on the load. Tube well pipe sections filled with concrete are ideal. The metal columns should be interconnected at the bottom, middle, and top levels using appropriate L-angles to keep them in their permanent positions.

(2) **Side walls:** Side walls shall be built with interlocking cement (pavement) bricks. Bricks used for the lower half of the walls should have weep holes to allow the rainwater to percolate.

(3) **Layered filling materials:** The pit has two functional halves:

(a) **Bottom half (1-meter depth):** It is meant for rainwater recharging. It is to be filled with standard materials like bigger size aggregates at the bottom, a second layer of smaller size aggregates, then a layer of river sand or charcoal. The quality of these materials should comply with the norms prescribed in Schedule XII of the BBMP Building byelaws.

(b) **Upper half (60 cm):** This should be filled with good quality garden soil approved by the Tree Officer. The pit top should be one foot lower compared to the road level or pavement level so that rainwater can reach it and percolate down.

(4) **Covered deck:** The pit will be topped with a deck fitted to a steel frame. This frame will be covered with removable RCC slabs. These slabs shall have 5 cm diameter holes for rainwater infiltration. Effectively, the pavement is a floating one.

(5) **Rainwater inlet:** Rainwater from the surrounding paved area will be diverted to the cell through a grilled pipe inlet. Debris should not be allowed to reach the percolation pit.

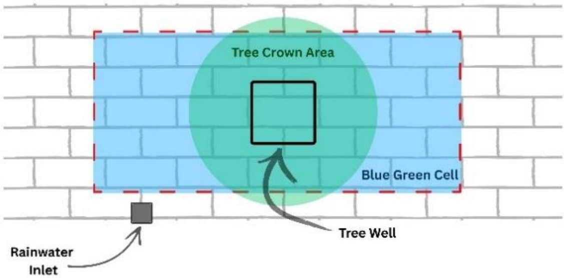
(6) **Spillway for the overflow of excess rainwater**: For heavy rainfall, overflow should connect to the nearest covered drainage line via appropriately sized piping.

(7) **Tree-well:** A 90 × 60 cm cut out in the middle of the top deck serves as the tree well for planting juvenile trees during monsoon.

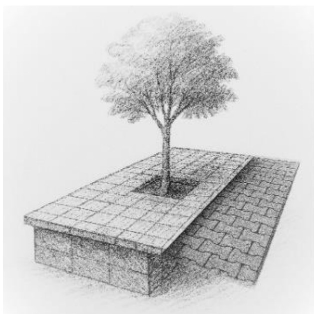
(8) **Cable conduits:** A rubber or plastic pipe of suitable diameter should run along the cell's length or breadth at an appropriate depth for

future electrical or telecommunication cables. This provision allows utility companies to install services without disturbing the cell or tree roots. Existing larger water pipes may remain within the cell, with their surfaces suitably reinforced by the utility company to prevent rupture for at least 10 years.

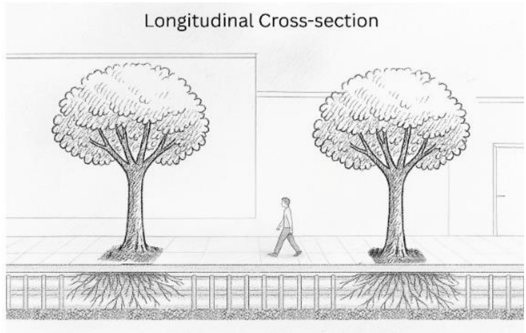
(9) Accessories: This includes a jute net or woven geotextile cloth to cover the soil surface on top and RCC tree grill to cover the tree well. They should be of a good standard to last at least ten years.

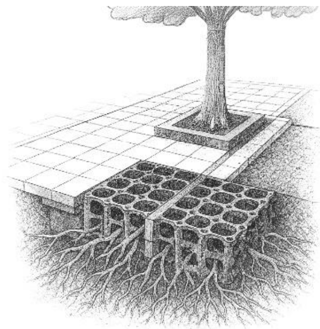


The plan



The Elevation





Cross Section

A.13.9. The Construction Process

1. **Survey and identification of suitable locations:** The process begins in September with the Tree Planting Supervisor surveying potential locations with the help of local Tree Wardens and Ward Forest Sub-Committee members. Suitable locations are reported to the Tree Officer for verification.

2. **Cross verification by the Engineering Department:** The Tree Officer will feed this information to the local Civil Engineer and relevant utility companies. If necessary, the matter will be placed in the Zonal

Coordination Committee, and the number of cells to be built and their locations will be finalised.

3. **Undertaking the Blue-Green Cell construction:** The local civil Engineer will get the cell constructed as per their departmental norms and procedures.
4. **Timeline for completing each cell construction work:** Construction work should be considered as a turnkey project. Each cell should take no more than 3-4 days to construct.
5. **Garden soil certification requirement:** The Tree Officer must certify the quality of garden soil before filling, as trees must survive on a limited quantity of soil for a long time. Payment for soil is contingent upon this certification.
6. **Quality assurance:** The Civil Engineering Department is responsible for quality maintenance in the construction.
7. **Intimating the details of completed Cells:** As soon as all the Cells in a given locality are completed, the Tree Officer should be informed.

A.13.10. Tree Planting and Maintenance of Blue-Green Cells

The Assistant Conservator of Forests (Urban Forestry) will determine appropriate tree species for each pit based on site conditions, root space available and aesthetics. The Tree Officer will plant juvenile trees accordingly. This will be maintained by the tree planting contractor.

The Blue Green Cells will be maintained by the Civil Engineering Department in consultation with the Tree Officer. Maintenance includes the decennial replacement of jute or geotextile cloth, during which the Engineering Department will remove pavement blocks, clear any clogged rainwater entry and exit points, remove debris, and install new cloth without disturbing the trees in any way.

APPENDIX - XIV

BOULEVARDS AND TREE STRIPS FOR PLANTING TREES

(in Outer City and Peri-Urban Areas)

(Refer to Paragraph 6.6.6)

A.14.1. Creating Tree Strips for the Street Trees

Street trees in urban environments often struggle due to the complete replacement of native soil and insufficient root space, both of which significantly impair tree health and growth. These challenges can be addressed in outer city and peri-urban areas by incorporating street trees into the initial planning stage itself. Land in these areas is comparatively more affordable than in inner-city zones, providing greater flexibility in design. Approximately 40- 45% of land in new development layouts is already designated for common uses like roads, streets, parks, recreational areas, and civic amenities. A dedicated portion of the pavement space should be specifically allocated for street trees. This is a cost-effective solution compared to the construction of Blue-Green Cells.

The following specifications shall apply to street tree implementation in outer city and peri-urban areas. This should be ensured by the authorities approving the plans.

A.14.2. Boulevards in layout exceeding 40 ha in the peri-urban areas

All the development layouts exceeding 40 hectares must incorporate designated boulevards along main roads with the following specifications:

(i) There should be a tree belt on either side of the main road of the layout. Both sides together will constitute the Tree Boulevard.

(ii) The width of the tree belt on each side should be equal to or greater than the width of the main road. This space is reserved for planting a tree belt.

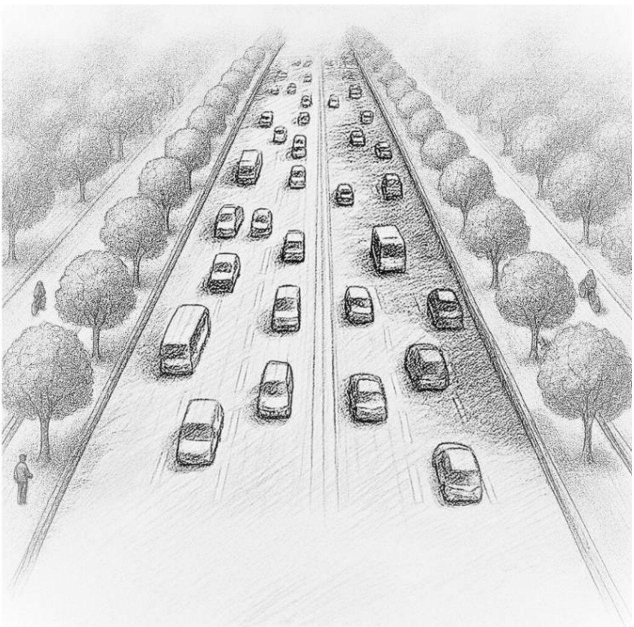
(iii) However, one pedestrian-cum-cycling pathway of 2 m width may be provided in the middle of each tree strip.

(iv) Boulevard should be slightly elevated relative to road level.

(v) Big trees should be planted on the periphery of boulevards.

(vi) The inside can be of mixed-size trees to give it the appearance of a natural forest

(vii) Boulevards must connect to the street trees on either side.



The Tree Boulevard

A.14.3. Mandatory 1-Meter Wider Tree Strip for all the Streets

(i) All new street tree plantings in peri-urban areas of Bengaluru must maintain a minimum of a 1-meter tree planting strip next to the curb.

(ii) This is a dedicated space only for the planting of trees. Spacing between trees should meet the critical root zone requirements of the trees.

(iii) The original soil in this strip shall not be disturbed. The surface soil must remain exposed. It shall not be paved.

(iv) Street trees on the same principles as that of the city shall be planted on this strip.

(v) Residents residing in the nearest house will be entitled to adopt the trees and maintain them in the same way as in the city.

(vi) All utilities must pass through the space between the tree-planting strip and the individual sites. They should not disturb the tree strip.

The Tree Strip

Appendix - XV

TREE PLANTING MODELS AND TECHNICAL SPECIFICATIONS

(Refer to Paragraph 6.6.8)

A.15.1. Introduction

Urban forestry is a relatively new concept. But it must establish itself as the "Green Infrastructure" of cities. Without any dedicated space, urban forestry must compete with hard infrastructure like roads, buildings, factories and markets. For more information on this, please see Chapter 3.

Despite this challenge, urban forestry is essential. Without it, city life becomes sterile. The good news is that urban forests can coexist with other land uses, with trees planted in portions of spaces designated for different purposes. Urban forestry must adapt itself to available spaces. A comprehensive list of such places is furnished in paragraph 6.6.7.

Urban foresters face the complex task of developing forests across varied land parcels with different sizes, shapes, ownerships, primary land uses, and environmental conditions. A toolkit of planting models to effectively utilise each potential site is necessary, which is provided in this Appendix.

A.15.2. Classification of Urban Forestry Planting Models

Urban forestry planting approaches can be organised into three primary categories:

(1) Block planting, and
(2) Strip planting,
(3) Other models.

Each category contains several variants designed to address specific site conditions and objectives. Collectively, these models provide solutions for virtually any land available for tree planting within the city limits.

Block planting transforms entire land parcels into wooded areas, creating cohesive forest-like environments. Strip planting, by contrast, establishes trees in linear configurations along roads, lakeshores, and similar corridors. Specialised planting addresses unique contexts that fall outside these standard approaches. Each model serves distinctive environmental, aesthetic, and social functions. They are not mutually exclusive, but collectively exhaustive to cover any land parcel in the city.

A.15.3. Block Planting Models

Block planting comprises four distinct models, each serving different purposes and requiring specific implementation approaches. They are given code numbers like B1, B2, B3, B4, etc, for quick reference purposes.

(1) **B1 - Mini Tree Parks:** Compact green spaces within residential neighbourhoods providing accessible nature experiences for residents.

(2) **B2 - Tree Parks:** Larger forest-like areas designed to recreate natural woodland environments with high canopy density and biodiversity.

(3) **B3 - Theme Parks:** Specialised green spaces developed through institutional partnerships to serve educational, cultural, or ecological purposes.

(4) **B4 - Tree Enclaves:** Conservation woodlots in areas with limited public access, designed primarily as undisturbed habitats for urban wildlife.

The aims and objectives for each model differ substantially. The technical specifications, implementation requirements, and management approaches are distinct for each model.

A.15.4. Mini Tree Parks (B1)

(a) **Size and Purpose:** Mini tree parks are compact green spaces up to 0.5 hectares located within residential layouts. They serve as neighbourhood green spaces where residents can connect with nature, relax, and socialise in a peaceful, pleasant and natural environment.

(b) Design Features: Mini Parks should be equipped with the following:

(i) A protective boundary wall encircles the park, providing security and defining the space.

(ii) Trees are planted 1.5 meters away from the boundary wall, creating a green perimeter.

(iii) A walking path runs along the inside of the boundary, providing exercise opportunities for residents.

(iv) The interior contains multiple clusters of 10-12 trees of a rare tree species, creating natural gathering spaces.

(v) Each tree cluster includes a central seating area that accommodates 7-8 people, encouraging social interaction.

(vi) Connecting pathways link the tree clusters to the perimeter walking path, ensuring accessibility.

(c) Implementation Process:

(i) Developing mini-parks requires coordination between the Engineering and Forestry departments. The Engineering Department first constructs the civil infrastructure (boundary walls, seating areas, paths, lighting, toilets etc), after which the Tree Officer manages tree planting.

(ii) Tree planting begins with establishing boundary trees using a thoughtful combination of small, medium, and large species for visual interest and biodiversity.

(iii) Species selection emphasises diversity, including rare, endangered, and threatened tree species to enhance conservation value.

(iv) Trees in one cluster visually connect with neighbouring clusters, creating a seamless forest-like experience.

(v) The Urban Forest Sub-Committee oversees day-to-day management, including park opening and closing times.

A.15.5. Tree Parks (B2)

(a) Size and Purpose: Tree parks are larger areas (0.5+ hectares) that distinguish themselves from standard horticulture parks by focusing on trees rather than ornamental plants. They aim to recreate natural forest environments with at least 80% of land dedicated to trees and a minimum 70% canopy density, prioritising evergreen and semi-evergreen tree species to support local biodiversity and comfort to park users.

(b) Design Features: It includes the following:

(i) A compound wall protects the park perimeter.

(ii) Extensive walking and jogging paths provide recreational opportunities.

(iii) Essential amenities include lighting, comfortable seating arrangements, clean toilets, and drinking water stations.

(iv) Shade structures like pergolas and raised stone platforms for meditation to enhance visitor comfort.

(v) Sustainable features include groundwater tanks for collecting treated wastewater for irrigation and compost pits for organic waste.

(vi) Recreational elements include outdoor fitness stations and children's play equipment.

(vii) Comprehensive waste management facilities ensure cleanliness.

These amenities are thoughtfully distributed throughout the park with independent access points.

(c) Implementation Process:

(i) The Engineering Department handles the planning and construction of infrastructure before tree planting begins.

(ii) The Forest Department manages tree planting using a balanced combination of small, medium, and large tree species.

(iii) The Horticulture Wing later adds ornamental plants along paths and beneath trees to enhance visual appeal.

(iv) Species selection prioritizes trees that support urban wildlife through food, nesting sites, and shelter.

(v) Park boundaries are reinforced with columnar trees at close spacing or flowering climbers on mesh screens atop the compound wall.

(vi) Open to all city residents, with day-to-day management overseen by the Urban Forest Sub-Committee.

A.15.6. Theme Parks (B3)

(a) Purpose: Theme parks are specialised green spaces developed through collaborative partnerships between the BBMP and land-owning agencies. The partnership should be structured on a case-by-case basis by the Director. Funding will be limited to the establishment of a theme park over a period of five years. Thereafter, the landowners should take care of the maintenance. Theme parks serve specific educational, cultural, or ecological functions while remaining accessible to the public for at least 10 years. They represent the broader environmental infrastructure of a metropolitan city.

(b) **Types of Theme Parks:** There can be many theme parks. The following is considered appropriate in the urban forest context. Others like rock gardens, Palmarium, Archidarium, etc., are in the horticultural domain.

(1) **Biodiversity Parks:** These parks transform existing commercial plantations in reserved and protected forests into natural forest ecosystems. They preserve local biodiversity, provide habitat for native flora and fauna, serve as living laboratories for ecological research, offer recreational spaces, and promote environmental education. Their development involves a comprehensive ecological assessment, removal of non-native species, and reintroduction of native vegetation.

(2) **Botanical Gardens:** Established by academic and research institutions on at least 2 hectares of land, these gardens maintain living collections of plants for scientific study. They provide educational opportunities for students and visitors while also serving as seed sources for urban plant production centres. Projects must be prepared by the Botany Department and can receive funding for up to 20 hectares of area.

(3) **Danvatari Vanas:** Government or recognised private institutions teaching Indian medicine can establish these specialised medicinal plant gardens on their lands. These gardens conserve and propagate medicinal plant species, promote traditional medical knowledge, provide raw materials for Ayurvedic and other traditional medicines, offer educational resources, and support research on medicinal plant properties. Funding can cover up to 10 hectares of planting.

(4) **Sacred Groves:** Temples and religious institutions with at least one hectare of land can receive assistance to establish sacred groves that align with their cultural traditions. These groves preserve

cultural heritage, protect religiously significant plant species, maintain traditional ecological knowledge, provide spaces for spiritual contemplation, and contribute to urban biodiversity. Smaller temples requiring fewer than 100 trees can receive free plants and planting assistance.

(5) **Smrithi Vanas:** These memorial forests are established on pre-identified public lands where individuals can plant trees to commemorate loved ones or celebrate special occasions. They create emotional connections between citizens and urban forests, encourage public participation in greening efforts, and establish long-term green legacies. Sponsors cover costs for seedlings, planting, maintenance, and commemorative markers, and receive annual photographs of their trees. Donations should be handled through Urban Tree Fund.

(c) Implementation Process:

(i) Projects are developed under the Director's guidance and submitted to the Executive Committee on Urban Forestry for approval.

(ii) A formal memorandum of understanding establishes responsibilities between parties.

(iii) The implementing agency makes initial investments, with bills reimbursed quarterly after verification.

(iv) Regular progress reporting occurs quarterly during the implementation phase.

(v) Independent evaluations are conducted annually during implementation and every five years thereafter.

(vi) Permanent records document each theme park's development and growth.

(d) Utilisation of Theme Parks:

(i) These parks should serve as limited-use public parks. The public, students and researchers must be allowed to visit the place, learn about plants and their uses during working hours.

(ii) They must generate seedlings and sell them to the public on a no-profit-no-loss basis.

(iii) They should provide seed free of cost to BBMP if required.

A.15.7. Tree Enclaves (B4)

(a) Purpose: Tree enclaves are conservation woodlots established in areas with restricted or limited public access. They serve as undisturbed habitats for urban wildlife, providing crucial refuge areas where trees and animals can thrive with minimal human interference. BBMP should establish them on their lands. Partnering with other landowners is strongly recommended.

(b) Suitable Locations:

(i) Defence lands, paramilitary installations, and public sector organisations with restricted access.

(ii) Burial grounds, crematoria, sewage treatment facilities, and solid waste processing areas that receive limited public visitation.

(iii) Any underutilised public lands not required for regular public use.

These woodlots are particularly suitable for compensatory afforestation funds as they best fulfil conservation objectives by creating undisturbed green spaces that benefit urban biodiversity and wildlife.

A.15.8. Strip Planting Models

Urban strip planting utilises linear spaces along infrastructure corridors to create green connections that enhance environmental quality while requiring minimal land dedication. They interconnecting the block urban forest areas. They provide temperature moderation, improved air quality, noise reduction, stormwater management, and serve as wildlife corridors. They are given code numbers like S1, S2, S3, S4, etc, for quick reference.

There are four key strip planting models:

(1) **Lake Shore Planting (S1):** Creates buffer zones around urban water bodies that filter runoff, prevent erosion, and establish habitat for water birds while enhancing recreational opportunities.

(2) **Green Belts (S2):** Transforms infrastructure corridors, including highways, utility routes, pipeline paths, playground perimeters, and railway corridors into productive urban forest assets that connect fragmented urban forest habitats.

(3) **Street Tree Planting (S3):** Integrates trees into existing streetscapes despite challenges of limited soil volume and utility conflicts, providing direct benefits to densely populated areas.

(4) **Boulevard Planting (S4):** Incorporates designated planting strips in newly developed areas, creating signature green corridors with sufficient space for trees to reach full potential.

When implemented systematically, these complementary approaches create an interconnected green network that significantly enhances urban environmental quality and liveability.

A.15.9. Lake Shore Planting (S1)

(a) **Purpose:** Lakeshore plantations create crucial buffer zones around water bodies that serve multiple ecological functions. They enhance biodiversity, protect water quality by filtering runoff, provide critical habitat for wildlife (especially water birds), create recreational spaces, and enhance the aesthetic beauty of urban lakes.

(b) Design Specifications:

(i) A minimum of 10% of the lake area should be dedicated to green belt development along the lake periphery.

(ii) The Lakes Engineer must consult with the Director regarding the overall plan and space allocation for tree planting at the time of developing the lake.

(iii) Tree planting occurs after the completion of major lake development activities to avoid damage to trees.

(iv) Trees are planted between walking paths/jogging tracks and the lake fence.

(v) A 3-meter setback is maintained between engineering structures and trees to prevent future root conflicts.

(vi) Metal boundaries around lakes are enhanced with ornamental climbers by the Horticulture Wing.

(c) Species Selection:

(i) Evergreen riverine tree species form the foundation of these plantings as they naturally thrive in moist environments.

(ii) Selected trees must tolerate periodic inundation, consistently wet soils, and humid conditions.

(iii) Species beneficial to urban wildlife are prioritised, particularly those supporting water birds, bats, primates, and pollinators.

(iv) A balanced composition includes 50% shade-tolerant understory trees, 30% medium-sized trees, and 20% large trees to create a natural forest structure.

(v) Flowering shrubs are incorporated as ground flora to support butterflies and other low-flying insects.

Regular weeding is crucial until the tree canopy closes completely, as the moist lake environment promotes weed growth.

A.15.10. Green Belts (S2)

(a) Purpose: Tree belts provide shade and environmental benefits in open spaces that receive high public use. They create comfortable microclimates in public buildings, playgrounds, markets, drainage channels, and visually improve the utility corridors. All gated communities and apartment complexes built on 1 hectare or more of land area must establish tree belts along the periphery.

(b) Location-Specific Design:

(i) **For playgrounds:** A single row of large trees with spreading crowns is planted 2 meters from the compound wall or behind gallery areas. These trees provide essential shade for children and parents while minimising interference with play activities.

(ii) **For APMC yards and markets:** Avenue trees along roads combined with strategically placed shade trees create comfortable conditions for vendors and shoppers. The design accommodates commercial activities while providing relief from heat and sun.

(iii) **For raja kaluves (drainage channels):** Bamboo or appropriate wetland tree species are planted where space and soil quality permit. These plantings stabilise banks, filter water, and create green corridors through urban areas.

(iv) **For utility corridors:** Where BWSSB water lines, KPTCL power lines, gas lines, railways, or metro infrastructure leave available space, compatible tree belts are established through formal agreements with utility companies.

(c) Species Selection:

(i) Trees for playgrounds feature non-invasive roots and minimal fruit/flower drop to ensure safety and reduce maintenance.

(ii) Market areas receive trees with spreading canopies, minimal maintenance requirements, and high pollution tolerance.

(iii) Drainage channels are planted with wetland-adapted species appropriate for specific soil conditions.

(iv) A mixture of evergreen and deciduous species maximizes year-round environmental benefits.

(v) Low-allergen species are prioritised in populated places to prevent health concerns.

(d) Maintenance Requirements:

(i) Failed plantings are promptly replaced to maintain the continuity and effectiveness of the tree belt.

(ii) Annual risk assessments identify and address potential hazards from tree failures.

(iii) Regular pruning regimes are tailored to each location's specific needs and safety requirements.

A.15.11. 4. Street Tree Planting (S3)

(a) Significance: Street trees constitute the largest and most visible component of urban greenery. They provide critical ecosystem services, including pedestrian shade, temperature reduction, decreased road surface heating, improved air quality, noise reduction, headlight glare mitigation, and wildlife corridors, while enhancing urban aesthetics and neighbourhood character.

(b) Challenges and Context:

(i) Roads and streets constitute about 30% of the total city area, with approximately 300 km of highways and 14,000 km of streets in Bengaluru.

(ii) These spaces have potential for planting approximately 3 million trees.

(iii) Roads and streets are the ideal places for harvesting and recharging groundwater in a big way.

(iv) Street trees face unique challenges: competition for space with utilities, hostile soil conditions with poor aeration and building debris, frequent pruning of roots and branches, vulnerability to removal, and generally low priority in infrastructure planning. Utility companies keep hacking the canopy and the woody main roots. This is the root cause of tree falls in the city. The number of tree falls is alarming.

(v) Despite these challenges, street trees remain essential for maintaining Bengaluru's reputation as a green city and mitigating climate change impacts.

(c) Technical Solutions:

(i) **Integration with blue infrastructure:** Rainwater recharge pits constructed beneath pavements with street trees planted directly above create "Blue-Green Cells." These structures efficiently harvest rainwater, recharge groundwater, and provide essential root space for urban trees while filtering pollutants. **Appendix XIII** is dedicated to this. Please refer to more details.

(ii) **Dedicated planting strips:** In developing areas, pavement width should increase to 2 meters, with 1 meter allocated exclusively for tree planting along the kerbside. This approach prevents future conflicts between trees and infrastructure.

(d) Implementation Guidelines:

(i) Street tree planting requires both artistic vision and scientific knowledge to match tree selections with the unique character of each street.

(ii) Private developers should consult with BBMP or BDA experts rather than implementing haphazard plantings.

(iii) Large trees are prioritised on arterial and sub-arterial roads, connecting tree canopies to parks and lake areas to create wildlife corridors.

(iv) Even narrow streets should include appropriately sized trees, with slow-growing, small-sized tree species placed 50 cm from the kerb when pavement space is limited.

(v) Species selection and planting density should ensure that at least 50% of the street surface is shaded throughout the day.

(vi) Tree adoption programs encourage neighbouring property owners to care for street trees, with tax incentives for participation.

A.15.12. Boulevards (S4)

(a) Purpose: Boulevards in new residential layouts create prominent green corridors that improve the local environment while enhancing property values. They serve as signature green features that define neighbourhood character while providing shade, clean air, and aesthetic benefits. **Appendix XIV** is devoted to this topic. Please refer to it for more details.

(b) Design Specifications: The following are its essential features:

(i) Required in new residential layouts of 40+ hectares to ensure substantial green infrastructure.

(ii) The boulevard width must equal the main road width and be surrounded by roads on all sides for accessibility.

(iii) A central 3-meter-wide walking and cycling path encourages active transportation.

(iv) Tree planting aims for 70% canopy density to maximize environmental benefits and shade.

(v) Tree planting must be completed before residential sites are sold to ensure green infrastructure is established from the beginning.

(c) Implementation Process:

(i) Developers bear the cost of boulevard establishment as part of layout development.

(ii) Developers can deposit funds with BBMP or BDA to establish the boulevard if they prefer not to manage it themselves.

(iii) Where feasible, micro-irrigation systems support tree establishment and long-term health.

(iv) Species selection emphasises medium and tall evergreen trees that provide year-round benefits.

(v) Trees with diverse flowering seasons ensure continuous aesthetic appeal throughout the year.

(vi) Native species with cultural significance are incorporated where possible to strengthen local identity.

A.15.13. Other Planting Models

This section presents three additional tree planting models that complement traditional approaches. Each model serves specific purposes within the comprehensive urban forestry models. They are given the code names OM1, OM2, and OM3.

(1) **Compensatory Planting (OM1):** Replaces trees removed during development, typically requiring multiple new trees for each mature specimen removed based on size, species, and ecological value.

(2) **CSR Planting (OM2):** Involves businesses in urban forestry through financial support or direct participation, creating mutual benefits through environmental commitments and community engagement.

(3) **Tree Transplantation (OM3):** Preserves mature specimens by carefully relocating established trees to new locations. Though more challenging and expensive than conventional planting, it preserves a few valuable trees.

A.15.14. Compensatory Tree Planting (OM1)

(a) **Purpose and Principle:** Compensatory planting mitigates environmental impacts when trees must be removed for development. Rather than using a simple one-to-a few trees replacement, a "centimetre-for-centimetre" approach ensures ecological equivalence: the total collar girth of new seedlings required to be planted must equal the girth of removed trees.

Example: A removed tree with 120 cm girth at chest height requires either six juvenile trees with 20 cm girth each or twelve seedlings with 10 cm girth each.

(b) **Biodiversity Requirements:**

(i) For each local tree species removed, at least five trees of the same species must be included in the compensatory planting.

(ii) The remaining compensatory plants should include other native species, with no more than five plants per additional species to ensure biodiversity.

(c) Implementation Process:

(i) The responsible agency must identify appropriate planting locations and obtain necessary permissions from landowners.

(ii) Costs are calculated based on current BBMP rates for raising juvenile trees, planting, and one year of maintenance.

(iii) Planting begins with the next monsoon season after tree removal and should be completed in a single phase when possible.

(iv) Annual progress reports include detailed location information, species inventories, and georeferenced data for each planted tree. The planted trees must be added to the tree census data.

A.15.15. Corporate Social Responsibility Projects (OM2)

(a) Framework: The Companies Act 2013 recognises tree planting as an eligible Corporate Social Responsibility activity. Companies can fulfil CSR obligations through urban tree planting initiatives in collaboration with municipal authorities or partner NGOs.

(b) Implementation Models:

(i) Direct BBMP Collaboration: Companies consult with BBMP to establish project parameters, deposit funds directly into the Bengaluru Urban Tree Fund, and receive recognition through identification signage at planting sites. BBMP will plant only juvenile trees.

(ii) NGO-Facilitated Implementation: Companies and NGO partners jointly approach BBMP, develop planting designs collaboratively, and manage implementation with the NGO handling funding, seedling procurement, and planting coordination. Only juvenile trees procured from BBMP or private sources certified by BBMP can be used for planting. NGOs must submit inception reports detailing planting activities and provide quarterly monitoring reports for two years. BBMP will only offer the space, provide the technical guidance and monitor the outcomes.

(c) Performance Standards:

(i) NGOs must achieve a minimum 70% success rate for planted trees.

(ii) Organisations failing to maintain a 50% success rate become ineligible for future CSR tree planting projects.

(iii) Independent verification ensures compliance with established standards. The CSR funding agency must get this done at its cost through a BBMP-approved third party.

A.15.16. Tree Transplantation (OM3)

(a) Context and Considerations: Tree transplantation is an expensive, labour-intensive operation with uncertain outcomes. The process stresses trees by removing anchoring and feeder roots and crown portions. It is similar to amputating limbs and asking the person to live happily. For more information on this, please refer to Appendix II. Compensatory planting is generally more effective and economical, making transplantation appropriate only for heritage trees, sacred trees, or rare and endangered species. The only objective is to save the species or a specific tree because of the emotional or conservation value.

(b) Procedure:

(i) Professional assessment evaluates the tree's health, species, size, and transplantation feasibility.

(ii) Root and branch pruning occurs gradually over 3-4 months, preferably when the tree is leafless.

(iii) The receiving site is prepared with suitable soil conditions and a correctly sized pit.

(iv) The tree is carefully wrapped, lifted by crane in the evening, transported overnight, and planted before 8 AM.

(v) Intensive care includes watering with cow dung decant to stimulate root growth, shade netting for the crown, and stabilisation cables.

(vi) Monitoring continues for 6 months to 3 years until the tree re-establishes itself.

(vii) If transplantation fails, compensatory planting is required according to standard protocols.

Conclusion: This comprehensive framework provides practical guidance for systematic urban forestry development across multiple contexts. If more planting models are required, the Urban Forestry Executive Committee may approve and add to this list. By implementing these models thoughtfully, cities can enhance their green infrastructure, improve environmental conditions, and create lasting natural assets for current and future generations. We will be able to pass on a legacy to our future generations that can make them proud of the legacy they inherited and their previous generations who toiled and established it.

Glossary of Technical Words

B

Boulevard: A broad tree-lined street, where the width of the area devoted to trees on either side is not less than that of the road.

Branch Bark Ridge: A ridge of bark found just above the branch union as a result of the merging of bark from the stem and branch.

Branch Collar: A "shoulder" or bulge formed at the base of a branch by the annual production of overlapping layers of branch and stem tissues.

Branch Protection Zone: A thin zone of starch-rich tissue at the base of a branch where chemicals are deposited to retard the spread of discolouration and decay.

C

Canker: A dead area of bark and cambium anywhere on the tree, often affecting the wood beneath it. Cankers can be caused by fungi, insects, weather or mechanical damage.

Canopy Cover: The area of ground covered by the vertical projection of the outermost perimeter of the tree canopy.

Codominant Stem: A stem growing at about the same rate, and with nearly the same diameter, as another stem originating from the same union; often the piths are connected in the union. Codominant stems are equal in size and relative importance.

Conk: The fruiting body of a fungus. Fruiting bodies on trees indicate advanced decay.

Critical Root Zone: The area of soil around a tree where the minimum amount of roots considered critical to the structural stability and health of the tree is located.

Crown: Portions of the tree above the main stem or trunk; including the branches, twigs and leaves.

D

Decurrent: A major tree form resulting from weak apical control. Trees with this form have several to many lateral branches that compete with the central stem for dominance resulting in a spherical or globose crown. Most hardwood trees have decurrent forms.

Defect: A visible sign that a tree or part of a tree is failing or has the potential to fail. Any structural weakness or deformity in the tree's branches stem or root system.

Drip Line: The outer edge of a tree's canopy, where water drips to the ground when the canopy is wet. Often used to approximate the extent of the root system.

E

Epicormic Branches: Also called water sprouts: Stems arising from interior branches, often grow upright and vigorously, often as a result of stress such as over-pruning, drought, or root damage.

Excurrent: A major tree form resulting from strong apical control. Trees with this form have a strong central stem. Lateral branches rarely compete for dominance.

F

Failure: Breakage of stems or branches or loss of mechanical support in the root system. Trees can fail due to defects or during severe storms.

G

Green Belt: A designated area of open land earmarked for planting forest trees to maintain the natural environment, provide recreational areas, and prevent urban sprawl.

H

Hazardous Tree: Any defective tree or tree part that poses a high risk upon failure or fracture to cause injury to people or property damage.

Heading Cut: A type of pruning cut that prunes a shoot no more than 2 years old back to a bud; cutting an older stem back to a lateral branch less than 1⁄3 the diameter of the cut stem; cutting a stem to an indiscriminate length.

Heritage Tree: A tree designated as having historic or cultural significance, often protected by local ordinances.

I

Improper Pruning: When removing branches, cutting into the branch collar, cutting flush to the stem, leaving long branch stubs or removing too many branches at one time.

Included Bark: Layers of bark that have formed inside the tree at a branch union or fork between codominant stems. These ingrown layers of bark make a union weak.

L

Leaf Area Index: The ratio of the total upper leaf surface of vegetation divided by the surface area of the land on which the vegetation grows.

Live Crown Ratio: The ratio of the top portion of the tree bearing live foliage to the cleared lower portion, which includes the trunk, without live foliage.

M

Mature Trees: Trees that have reached at least 75 per cent of their final height and spread.

N

Natural Tree Form: The form that develops in the tree's native habitat without disturbance from human activities.

Neglected Tree: A poorly formed tree that has not been pruned for some time, or that has never been structurally pruned.

Node: The point on a stem where a leaf and bud emerge. Branches emerge from nodes.

O

Over-mature Trees: Trees that have reached their final height and spread that are declining in vigour.

P

Parent Branch (or parent stem): A main branch or stem from which smaller lateral branches arise.

Permanent Branches (permanent limbs): Those that will remain on the tree for many years, perhaps until maturity.

Pollarding: The specialized training technique used to maintain a tree at a specified height with regular heading to the same position; not the same as topping.

Poor Structure (form): Branch and trunk architecture resulting in a canopy form that could lead to premature failure of a tree part.

Pruning Dose: The amount of live tissue removed at one pruning; can be used in a whole-tree sense, or on one stem only.

Pruning Types: Includes clean, thin, reduce, raise, balance, risk reduction, restore, directional prune, vista, root prune, eradicate and structural pruning.

R

Reduction Cut: Reduces the length of a branch or stem back to a live lateral branch large enough to assume apical dominance—this is typically at least one-third the diameter of the cut stem.

Restore (restoring, restoration): The process of improving the structure of a tree that was previously topped, damaged, vandalized, or over-thinned.

Root Pruning: Removes circling and girdling roots around trunk base; a technique of cutting many roots on a tree growing in a field nursery or landscape to prepare it for digging; cutting roots regularly to help keep a plant small.

S

Sacred Tree: A tree that holds religious, spiritual, or cultural significance to a community.

Scaffold Limb: A branch that is among the largest in diameter on the tree.

Scaffolding Branch: A main structural branch that forms part of the main framework of the tree crown.

Senescent Tree: A tree in the final stage of its life cycle characterized by declining vigour, reduced growth rate, and increased susceptibility to disease and decay.

Snag Tree: A dead, usually hollow or limbless, tree that is left on the site for wildlife habitat purposes.

Stem Bark Ridge: Raised bark in the union of two stems.

Structural Pruning: Pruning influences the orientation, spacing, growth rate, strength of attachment, and ultimate size of branches and stems resulting in a strong tree.

Sunscald: A flattened, dried, or sunken area of the bark resulting from overexposure to the sun.

T

Target: A person, vehicle, building, picnic table, tent spot, etc. that could be hit if a nearby tree or branch failed.

Temporary Branch: A branch that will remain on the tree for only a short period; not a permanent limb.

Thin (thinning): Removes lateral branches from the edge of the canopy; increases light and air penetration, or reduces weight by removing branches primarily from the outer edge of the canopy.

Tipping: Removal of branch tips, usually to decrease the tree's width.

Topiary: A training system that creates an animal, column, ball, or other shape with regular heading or shearing.

Topping: Removal of the top portion of a tree's live crown, usually to decrease the tree's height.

Tree Architecture: Natural growth habit or branching pattern that is characteristic of each tree species.

Tree Cover: The area covered by tree canopies within a defined space, often expressed as a percentage of the total area.

Tree Maintenance: Activities performed to maintain tree health, structure, and safety, including pruning, fertilization, pest management, and other care procedures.

Tree Pruning: The selective removal of plant parts to meet specific goals and objectives.

Trunk: The main woody part of a tree begins at the ground and extends up into the canopy from which primary branches grow.

U

Utility Tree Care: Tree practices near overhead wires and other potentially hazardous structures.

V

Veteran Tree: An ancient tree that has cultural, historical or ecological significance, often with features like hollowing, deadwood and other habitat characteristics.

Vista Pruning: A combination of pruning types including thinning, raising, and others designed to enhance a view.

W

Wind Throw: When a tree falls over due to a strong wind.