GUIDELINES ON URBAN AND PERI-URBAN FORESTRY IN JAMAICA

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City Adapt
RECONNECTING CITIES WITH NATURE
LATINAMERICA AND THE CARIBBEAN

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Forestry Department
Protecting our Forests; Sustaining Lives

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1.0 INTRODUCTION

This document is prepared as a guide to inform users about Urban and Peri Urban Forestry in Jamaica, outlining how tree cover can be established and maintained in the urban context. It is elaborated in the framework of CityAdapt's project goals, contributing to a specific target of climate change adaptation in urban areas, by improving tree cover in urban areas, which will in turn create benefits to include the reduction in stormwater runoff, increased infiltration, and enhanced urban resilience against extreme weather events.

In close collaboration with the Forestry Department and the project's National Coordinating Team this manual presents comprehensive guidelines for sustainable development and management of Urban and Peri Urban Forestry, considering the unique characteristics of Jamaican urban spaces. Research and discussions were conducted with local authorities and key stakeholders. Recently implemented projects were reviewed and are documented as examples of urban forest intervention (The Nature Conservancy, 2023).

The findings are presented in a graphically user-friendly format targeted to the Forestry Department's implementation portfolio but are also available for general use by parties interested in similar projects.

1.1 Nature Based Solutions (NbS) and the Importance of Sustainable Urban and Peri Urban Forestry

By utilizing Nature-based Solutions in the establishment and maintenance of tree cover and green spaces in the urban setting, especially as it relates to minimizing the traditional structural elements, has many benefits towards reducing the impacts of climate change. Some of these benefits include the replanting of coastal mangroves which protect the island against storm surges and bioengineering landscape interventions, such as the replanting of slopes which protect against soil erosion.

NbS generally adopt an ecologically friendly approach to the generation of greenery by working with local materials and adapting the planting to the environment. Matching the appropriate plant species with its natural environment can enable successful plant growth and survival. Consequently, this may reduce its susceptibility to pests and diseases and enhances resilience to climatic risks.

Another important benefit of NbS is the lower costs of establishment and maintenance of the Urban and Peri Urban forests. When local materials and labor are sourced, the result is lower labor and utility costs and an advantage for the plant material to quickly establish itself within the ideal ecological space. Additionally, greater tree cover reduces the temperature of buildings, sidewalks, and roads, resulting in more mobility, less dependence on motor vehicles, and reduced energy consumption.

1.2 Purpose and Scope of the Guidelines

Kingston, Jamaica is already facing climate change impacts (UNEP 27/05/2022). As development continues rapidly over the last decade, green spaces have been reduced and replaced with concrete in the form of high-rise complexes, widened roadways, highways and spans of commercial/industrial buildings. In the face of the rising temperatures, more intense periods of drought and rainfall there needs to be a balance. The purpose of these guidelines is to provide options for government agencies as well as private

developers to make their contribution to adapting and mitigating against the impacts of climate change and to creating a more comfortable and sustainable balance between development and the environment.

1.3 CityAdapt Background

The 'Building Climate Resilience of Urban Systems through Ecosystem-Based Adaptation (EBA) in Latin America and the Caribbean' or CityAdapt, is being undertaken by the United Nations Environment Programme (UNEP) through funding from the Global Environment Facility (GEF) Special Climate Change Fund (SCCF). The goal of City Adapt is to increase the capacity of urban and peri-urban areas to adapt to the effects of climate change. It includes:

- Streamline urban ecosystem-based adaptation (EbA) into medium and long-term urban development planning.
- Implement demonstrative EbA interventions to reduce the vulnerability of local urban communities.
- Build the knowledge and capacity of key stakeholders and raise awareness of EbA in urban areas.

Jamaica is among the three countries in Latin America and the Caribbean who were participants of the initiative being implemented. The others are El Salvador and Mexico.

The programme is being executed by the UNEP Office for Latin America and the Caribbean, together with the Climate Change Division of the Ministry of Economic Growth and Job Creation, who is the national authority with responsibility for environment and climate change in Jamaica. The City Adapt project comprises several tree planting activities executed in Kingston and St. Andrew by the Forestry Department. It includes the planting of 800 trees in the upper part of the Hope River Watershed Management Unit, 2ha of wetland rehabilitated with the University of the West Indies (UWI) in the Palisadoes Port Royal Protected Area and 1400 trees planted in lower income communities.

One of the communities that participated in CityAdapt's programme was Rockfort. This project targeted an open space next to the community centre to be planted primarily with fruit trees. Through the community leader, the 4H-Club conducted a training programme, the site was prepared, and the trees planted. The challenges seen included the repetitive drought conditions, and the severe drought recorded in Summer 2023, resulted in a scarcity of water. A rainwater harvesting system was completed with the installation of a tank and guttering to store water. It was seen at the community centre during our site visit. Although this was not installed under the project, it demonstrates a great conservation effort and will provide a watering source for the needs of the community. Other challenges arose in maintenance where stray animals, primarily goats were eating the seedlings and/or destroying the protective barriers. The residents were creative in utilising wooden pallets as protective barriers and allowing the correlata vine to grow around the pallets. The correlata vine which is toxic to the goats created a unique tree guard for the seedlings, giving them a better chance to attain sizeable growth.

a) Project Sign

b) Planted seedlings with protective barrier

c) Tank for Rainwater Harvesting

Figure 1: CityAdapt Rockfort Community Garden Project
(Nov. 27th, 2023)

2.0 UNDERSTANDING SUSTAINABLE URBAN AND PERI URBAN FORESTRY

Ecosystem-based Adaptation (EbA) in urban areas is an approach that uses provisioning, regulating, and supporting ecosystem services as part of a holistic adaptation strategy in urban settings. One of the central aims of the EbA approach is to help vulnerable urban communities cope with extreme weather events and other climate change impacts while simultaneously supporting ecosystems to keep generating regulatory, carrier, production services that provide a range of benefits crucial for human well-being in cities and towns.

2.1 Definition and Principles of Sustainable Urban and Peri urban Forestry

The concept of the urban and peri-urban forest is defined in United Nations Economic Commission for Europe's Policy Brief published 2021, as "the sum of all woody and associated vegetation in and around urban areas" (UNECE, 2023). The focus is on empowering the ecosystems in developing cities and towns utilizing an interdisciplinary approach. In terms of policy, practice, research, and education, the idea has grown rapidly in recent times.

Urban and peri-urban forestry separates itself from the other urban green space concepts by "its focus on forests and trees as key components. Urban and peri-urban forestry can be a Nature based Solution, and is integrative, linking tree dominated components of urban and peri-urban green structures and spaces" (UNECE, 2023)

Urban and peri-urban forestry is associated with green infrastructure planning which assesses green and blue networks in a city or the urban context. This brings into focus the opportunities of a well-functioning ecosystem through a well-connected network (green or blue spaces) rather than the individual space. Urban areas function as ecosystems, or socio-ecological systems, and through the presence of trees and other vegetation they can become more resilient to the impacts of climate change.

2.2 Benefits of Sustainable Urban Forestry in Jamaica

The benefits of Sustainable Urban Forestry in Jamaica will help to create a balance for rapid urban expansion and mitigate against the effects now being experienced with the rise in temperatures and extreme and more frequent weather events due to climate change. The city of Kingston is now experiencing climate departure as predicted by the climate models of the Climate Studies Group, UWI, Mona. After Manokwari in Indonesia, studies "stated that Kingston, Jamaica is on track to be the second city in the world to reach its climate departure by 2023 and this is one race Kingston does not want to win." Climate departure is seen when old temperatures are impacted by climate change to the point that they are no longer experienced. This means the high temperature records are continuously being broken with "the average temperature of its coolest year from then on is projected to be warmer than the average temperature of its hottest year" (Washington Post, 2013).
The Meteorological Service of Jamaica office recorded its hottest meteorological summer from June to August in 2023 with an average temperature of 30.6°C (World Data.Info, 2024). This coupled with extreme drought conditions in many of Jamaica's parishes including the 'breadbasket' of St. Elizabeth and the non-traditional parish of Portland (that usually experiences high rainfall), supports the theory that climate departure has begun as predicted.

A more balanced ecosystem around and within the city will mean more trees, more shaded spaces to tolerate the rising temperatures, less air-pollution, more groundwater infiltration reducing flooding, less heat island effect, more greenery, less greenhouse gas emissions (as they will be filtered), more biodiversity, and a generally healthier community. The ecosystem will not only improve the quality of life for humans but in turn for the flora and fauna that function interdependently as part of the same system.

3.0 IDENTIFYING PRIORITY AREAS FOR SUSTAINABLE URBAN FORESTRY

The first step in identifying priority areas for sustainable urban forestry is to have a wholistic review of a macro level of the area to be assessed.

The watershed approach is an important one in managing the impact of climate change. By controlling the climate change impacts from sections of the watershed, the lower areas where the cities are located become less vulnerable to extreme stormwater events and erosion. The review would analyze the data relating to frequency of floods, drought, landslides, erosion, health issues, rainfall, temperatures, and wind. The reports would include the human impact (high instances of health issues and diseases that are related to dust or water settlement) along with the impact on the flora and fauna. Examples are signs of fish kill in aquatic systems. Monitoring can identify the effect on bird population or if there is an increase in the number of pests.

The Climate and Ocean Risk Vulnerability Index (CORVI) Risk Assessment of January 2020 rated Kingston's ecological risk profile as medium-high risk in the categories of ecosystems, fisheries and climate.

CORVI Category Scores: **Low Risk** 0 - 2.5 **Medium Risk** 2.51 - 5 **Medium-High Risk** 5.01 - 7.5 **High Risk** 7.51 - 10

Ecological Risk		Financial Risk		Political Risk	
Ecosystems	5.78	Economics	5.85	Social/Demographics	5.46
Climate	5.33	Infrastructure	5.14	Governance	5.38
Fisheries	5.16	Major Industries	4.55	Stability	4.43
Geology/Water	4.48				

Figure 2: CORVI Risk Assessment for Kingston
(Rouleau, Stuart, & Yozell, 2020)

The report further recommends: "building resilience in the city's watersheds and marine ecosystems, creating a disaster response planning program that integrates the social issues relating to the vulnerable, and most importantly improving urban city planning." [1] While efforts have been implemented towards improving Jamaica's watersheds and marine ecosystems, a more proactive approach is needed towards updating the disaster response program and urban city plan to facilitate the more frequent occurrences of extreme events and the manifestations of climate change.

3.1 Assessment of Urban Vulnerabilities to Climate Change

How can the communities respond or adjust to the challenges they face? When the events of climate change such as floods, landslides or dust pollution create losses for individuals' investments and assets, cut off movement from place to place, or subject individuals to respiratory illness then the impact is not restricted to the environment only but also to the economic potential and social well-being of the community.

Climate risk assessments using a variety of climate change scenarios are important assessment tools. The Ministry of Local Government and Rural Development has developed a Comprehensive Disaster Risk Management Policy and Strategy 2020-2040 document for Jamaica. The goal is to create a safe and resilient Jamaica using results-based assessments tools to measure performance and identify areas for improvement. Some impact indicators and targets include amongst others: - loss of life as a result of disasters; number of persons directly affected; direct economic losses (US$); impact on agricultural and tourism sector. 2016 was used as the baseline with 3-year targets for the period 2021 to 2039. Another document created as part of the assessment process is the National Mangrove and Swamp Forest Management Plan 2023-2033 (the Forestry Department 2023). The document focuses on the policy and management guidelines to protect this vulnerable and important area considering its value to reduce flooding and extreme coastal climate change events.

A results matrix was developed by Jamaica 4-H Clubs monitoring and evaluation products using a variety of measurement indicators. For implementation, areas (hectares reforested) relative to the quantitative and qualitative impact measured by the reduction in energy emissions in vegetated areas, changes in forest cover, survival rate of newly planted species, changes in soil quality, forest areas (ha) under sustainable forest management plans and population numbers affected by heavy rainfall and flooding. These indicators of measurement conform to the global standards of monitoring. The matrix can be found in the appendices.

In Kingston, seven gullies enter from the hills into Kingston harbour causing the lower lying area to be vulnerable to flooding. Only one gully, the Sandy Gully, has the capacity to weather extreme conditions. Pollution, mainly garbage including plastics, enter Kingston harbour via these gullies. This garbage pollution puts a strain on the mangroves, sea grasses and marine life. The degradation of the marine system in turn affects the fish catch or livelihoods of fisherfolk. When the mangroves and coastal vegetation are damaged or wiped out, they lose their ability to function adequately by filtering the pollutants before entering the harbour, and to protect the coastline from coastal erosion.

3.2 Identifying Areas with the Greatest Potential for EbA and NbS

The areas with the greatest level of impact from climate change will in turn offer the greatest potential for the effectiveness of Nature-based Solutions. The high-risk areas that are already recording the attributes of climate change such as the heat island effect, landslides, flooding, and storm surges with increased frequency should be earmarked for EbA and Nbs interventions. Theoretically an area in downtown Kingston with high density, adjacent to a gully or waterway and with little or no green space would be a good candidate.

These scenarios will offer the potential for the creation of green spaces via container planting or the most appropriate solution to decrease the carbon footprint. The tree coverage will provide some shading for the community and at the same time increase the connectivity for the ecosystem cycle. The three main components of the cycle are the water cycle, the carbon cycle and the nitrogen cycle. There is a complex interdependence of exchange with water bodies, humans, animals, trees and the air. The birds will have a place to nest in the trees, bees can pollinate and the plants themselves can assist in cleaning and filtering the air – both from noise and dust or pollutants.

The flood plains which are the green areas adjacent to the seven gullies, were designed for seasonal flooding, and are areas that can benefit from vegetative barriers to retain the embankment and aid in directing the waterways on their intended courses. The planting or green buffer will assist also in slowing down the damaging effects of the speed of a stormwater deluge. Jamaica's gully banks have the potential of becoming lovely functional green corridors.

Green spaces (including green walls and green roofs), within high density communities are another area with great potential for EbA interventions. The loss of green space to intense development can use EbA and NbS to establish community and regional park spaces along with tree lined sidewalks to offer ecological connectivity.

Most importantly the green space has value to the health of the community by offering a recreational space whether it is passive or active. A passive recreational space can be used for formal and informal gatherings, a space for meditation and reflection (mental health benefits), and a space for community to enjoy the healing benefits of nature's air and sunshine. An active recreational space offers the user the opportunity to run, walk or jog; to play volleyball, cricket, football, or netball as well as enjoy other low impact sports such as board games dominoes, drafts etc.

Tree planting in green spaces is an opportunity to capitalize on food security. Within the urban housing developments fruiting trees can be selected for planting in specially allocated areas or mixed within the landscaped recreational areas. Community gardens with herb beds, leafy vegetables and small crops are ways of guaranteeing nutrition. Vegetable garden plots are now being formalized in some schools where the harvest supplements the canteens offerings to feed the students. Farm to table and organic farm supply market are growing in demand as they appeal to health enthusiasts looking for chemical free and fresh nutritional options. Squatter areas along gully banks that are unsuitable for housing and require people to relocate could be rehabilitated as green space with food banks or community farms. This social intervention presents possibilities not only for food security but also healthier and more economically viable communities.

The establishment of green spaces must be all inclusive spaces, accessible by all and recognize safety. Sight lines and lighting are important for the safety of all and are a few of the elements in design of public spaces utilized to reduce gender-based violence (GBV). Universal accessibility for the elderly, persons with disabilities, women with children and the youths must be accommodated with elements such as level surfaces, ramps and appropriate facilities. All users should feel secure and comfortable to equally enjoy the benefits of nature.

Finally, another area with the greatest potential for EbA or NbS is along the city's major roadways especially where they have been widened recently as along Constant Spring Road, Hagley Park Road, Marcus Garvey Drive. While interventions were made in the past with the upgrading of the Palisadoes strip, Windward Road, South Camp Road and the establishment of the Norman Manley Boulevard, it is important that the effort be valued beyond tree planting and the intervention be recognized and maintained for its ecological value.

4.0 ECOSYSTEM-BASED ADAPTATION (EbA) AND NATURE-BASED SOLUTIONS (NbS)

Ecosystem-based Adaptation and Nature-based Solutions are the buzz words associated with climate change adaptation. Let us explore what each option has to offer and what is the difference between them.

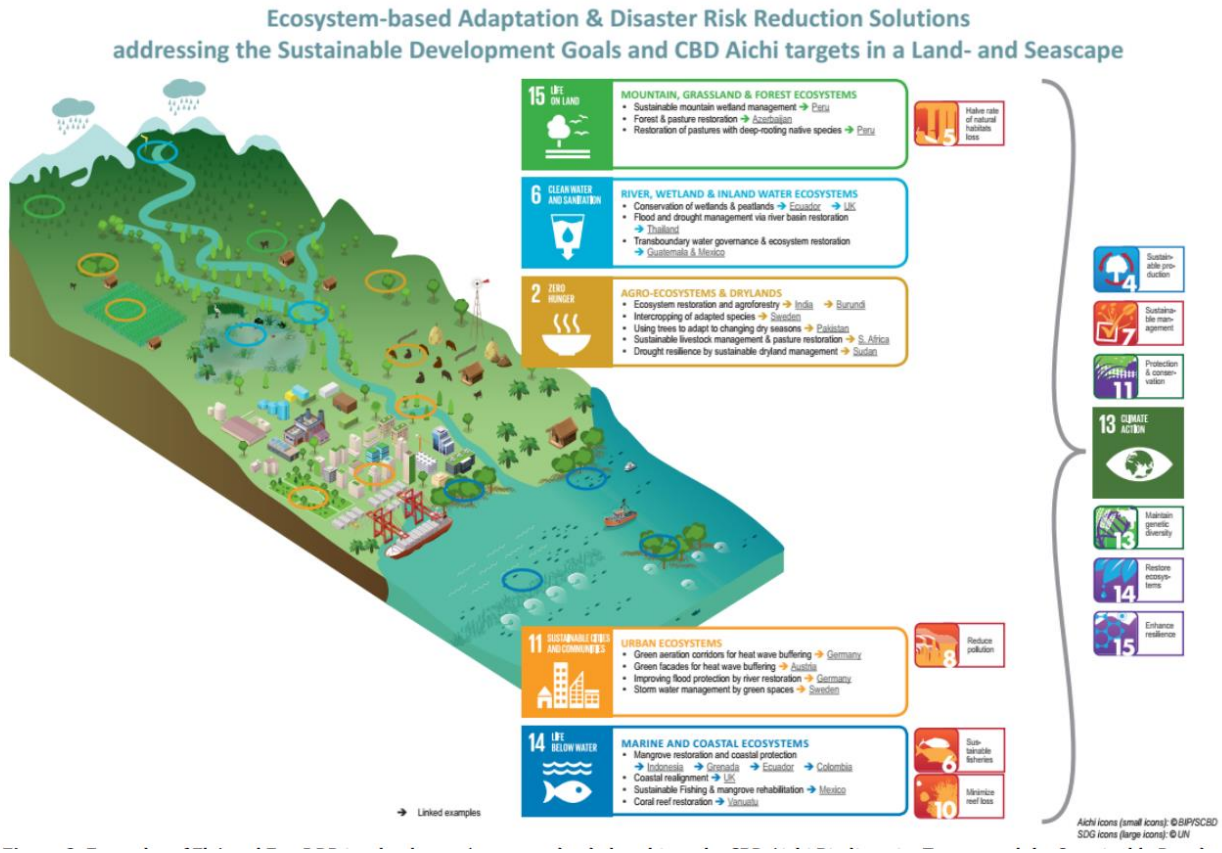


Figure 3: Examples of EbA and Eco-DRR in a landscape / seascape that help achieve the CBD Aichi Biodiversity Targets and the Sustainable Development Goals (The Nature Conservancy, 2023)

The above diagram shows the relationship of the environmental and development impacts from land to sea.

4.1 Definition and Concept of EbA and NbS

For this document, the following definitions are used for EbA and NbS.

EBA -ECOSYSTEM BASED ADAPTAPTION is defined as "overall strategy that integrates the use of biodiversity and ecosystem services to help people adapt to the adverse impacts of climate change. It includes the sustainable management, conservation and restoration of ecosystems to provide services that help people adapt to both current climate variability, and climate change." (FAO/UNDP, 2024)

NbS NATURE BASED SOLUTION is defined "as actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems and calls for more collaboration and resources." UNEA 5.2

(UNEP, 2022)

Both definitions reference the social and physical environment and seek a solution to create a natural balance in the face of the effects of climate change, rapid urbanization, and development. Therefore, Nature-based Solutions offers options to realize Ecosystem-based Adaptation.

The International Union for Conservation of Nature, (IUCN) Global standard for Nature-based Solutions has identified 8 criteria and 28 Indicators for NbS. The eight criteria are referenced as IUCN8 and outlined as follows:-

1) Societal challenges that are identified through the process of inclusive and effective consultation are addressed.
2) Its design recognizes scale that is not limited to the geographic perspective but includes the economy, society and ecosystems.
3) Results impacts positively on biodiversity and ecosystem health and integrity.
4) It is economically viable and offers long term sustainability.
5) Inclusive and participatory governance processes that recognize the rights of Indigenous groups are included.
6) Trade-offs are equitably balanced between providing multiple co-benefits and achievement of goals.
7) It is evidence based and managed adaptively.
8) It is mainstreamed within an applicable jurisdictional context.
(IUCN Global Standard for Nature-based Solutions, IUCN 2020)

4.2 Key Components in Urban Forestry

The key components in Urban Forestry include green infrastructure development, urban tree planting, establishment and maintenance of greenways, urban wetlands, and stormwater management.

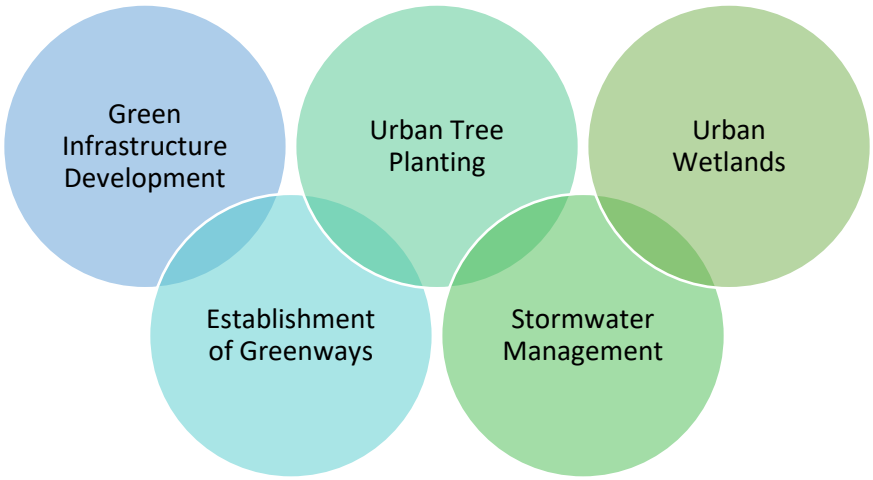


Figure 4: Key Components in Urban Forestry

4.2.1 Green Infrastructure Development

Green Infrastructure Development is defined as a "Strategically planned network of high-quality natural and semi-natural areas with environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings" (European Commission, 2013)

Figure 5: Green Infrastructure at Emancipation Park, New Kingston- Permeable paving and *Bauhinia* Trees
(Dec 17,2023)

Traditionally grey infrastructure is used extensively in the development process creating impermeable pavement and concrete box culverts to carry water runoff ultimately to the sea. Green Infrastructure development focuses on creating a more sensitive approach to the ecosystem and the environment with the creation of permeable surfaces, grass swales, rain gardens, rainwater harvesting, planters, greenways, and roof gardens as some examples. Permeable surfaces allow for groundwater infiltration to replenish the water table. It also reduces the potential for erosion by slowing down the energy movement of water over a wider surface rather than in a concentrated sheet flow.

4.2.2 Urban Tree Planting, Greenways and Maintenance

One of the most impactful methods of Green Infrastructure is Urban Tree Planting. Within the urban context, trees are mostly planted in clusters or defined elements within a development site or park setting. Along roadways, walkways, or waterways, where space is limited to verges, trees are planted in a linear fashion. All plantings contribute to the creation of greenways or green linkages that improve the ecology of the space.

Figure 3: Street tree planting along South Camp Road (Dec 17, 2023)

In Kingston Jamaica, there are a few examples of the establishment of Urban Tree Planting. In the 1980s, there was an extensive drive to landscape roadside verges and establish public green spaces. Of note in that time, are the creation of St William Grant Park, Orange Park and the Kingston Waterfront Park in Downtown Kingston. Along the corridors of Tom Redcam Drive, South Camp Road, Norman Manley Boulevard are a few of the areas that had benefited from extensive landscape tree planting exercises by the Urban Development Corporation. However, aside from the development of Emancipation Park in 2002, there are very few remaining examples of urban tree planting in Kingston and its environs that are impactful and visible. This is mostly due to inadequate maintenance.

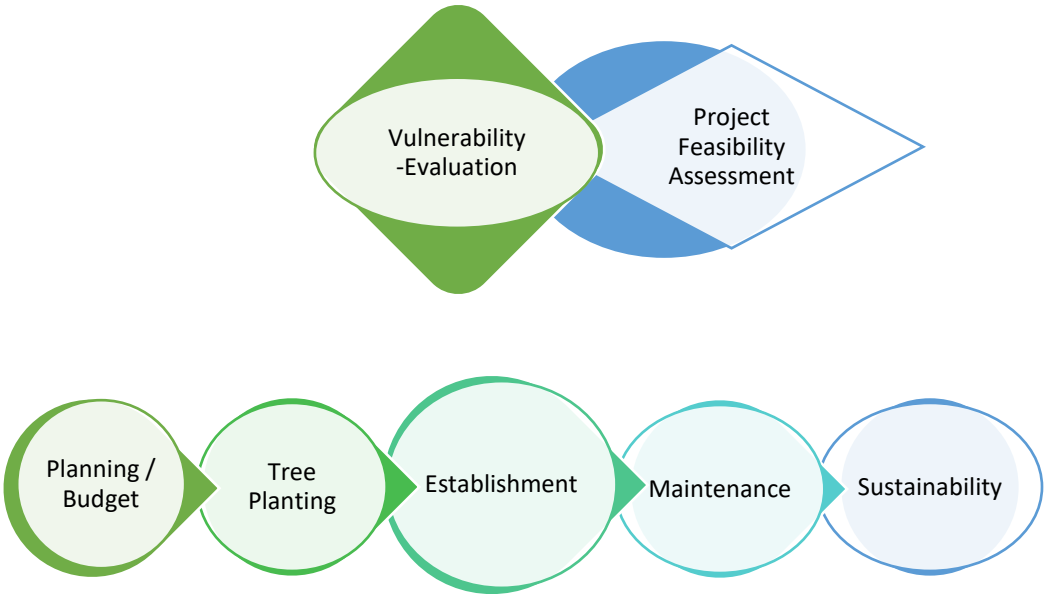


Figure 4: Suggested Requirements and Sequence for Urban Tree Planting

Maintenance beyond the establishment or initial planting exercise of the Urban Forest is key. The budget for the management or maintenance of Urban Forests is usually dismissed as negligible. This budget must be well planned and adequate allowance at the very least to match the amount reserved for establishment. Over time with a well-managed forest the activities will refocus, and the budget may be somewhat lower, but the maintenance tasks and costs will not disappear. The National Housing Trust (NHT) has become one of the most recognized financial and business models that can be used as a base to calculate the requirements for a sustainable maintenance budget.

4.2.3 Urban Wetlands and Stormwater Management

Urban Wetlands can be used as a means of stormwater management. By capturing the stormwater in a manmade pond or contoured basin a detention pond is created to slow down the movement of water. A retention pond is like a detention pond but is designed to permanently hold water. Both, however, control the movement of stormwater and therefore are useful ways of redirecting this natural resource back into the ecosystem by recharging and filtering pollutants before reentering the aquifers or the sea. If the area is planted with trees or shrubs, then there are additional benefits that act in the same manner as the natural wetland forest.

Another area ideal for Urban Wetland planting lies along the reserves of our gullies. These areas, though heavily squatted, are flood plains designed to accommodate the overflowing of stormwater from the gullies. They are not ideal for housing and with climate change, nature will reclaim these spaces as flood plains.

The species selected for the urban wetland must be able to tolerate periods of seasonal flooding. The native species *Conocarpus erectus, Rhizophora mangle, Laguncularia racemose*, *Roystonea princeps, Sabal jamaicensis* along with the *Avicennia germinans*. Other salt tolerant species, some have localized along Jamaica's coastline are *Bucida buceras* , *Thespesia populnea, Guaiacum officinale* and the *Barringtonia asisatica* are also suitable for urban wetlands.

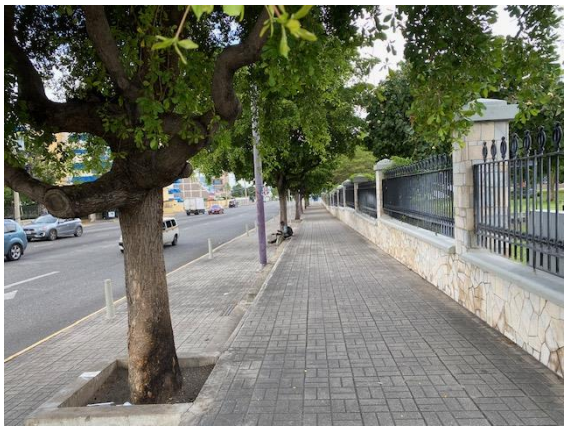
4.3 Examples of Potential or Existing Urban and Peri-Urban Forests in Jamaica

The most successful Urban Forest in Kingston and St. Andrew is undoubtedly Emancipation Park. Some pictures represent good design and planting within the urban setting.

a)

b)

c)



d)

e)

f)

Figure 5 (a-f): Examples of green infrastructure in Emancipation Park
(December 17, 2023)

Along the perimeter of the park, the tree lined walkway provides shade, along with a pleasing aesthetic appeal for the space. Most importantly the avenue of trees acts as a buffer for street noises and a filter from traffic pollution. The green space within the park is well balanced with permeable interlocking paving surface and grass lawns covered with a variety of trees, palms and shrubs. Many of the trees and palms planted were endemic or native to the area. This urban space provides a safe space for humans to rest, exercise and relax in the offerings of greenery. The park also offers a gathering space for emergency assembly which is of growing importance with the frequency of natural emergencies such as earthquakes, bomb threats and fire.

Within the city, Kingston still offers several potential spaces for Urban Tree Forests. The Downtown Waterfront, Greenwich Fishing Village, St. William Grant Park and National Heroes Park are a few of the larger spaces that can be impactful. Some of the areas selected for the CityAdapt programme in conjunction with the Forestry Department and Jamaica 4H Clubs include Up Park Camp, Denham Town Primary, Vauxhall High School and the Rockfort Community Center.

The Urban Forest planting at Up Park Camp is the most successful example of the programme so far. It is a true reflection of the use of a permeable surface (gravel walkway); grass drainage swales to control storm water and allow for groundwater recharge. Poui (*Tabebuia sp.)* and Wild Orchid trees *(Bauhinia sp.)* are planted in an allée which is supported by grey water. Container planting of Silver Buttonwood (*Conocarpus erectus*) trees are planted in tyres to retain the embankment and control erosion.

Figure 8-9 illustrates a pervious gravel walkway that allows for rainwater percolation to recharge the aquifer. Adjacent to the walkway are the Poui Trees and beyond it is an earth drain or grass swale. A grass swale is a nature-based solution to control stormwater runoff as it also allows for permeability.

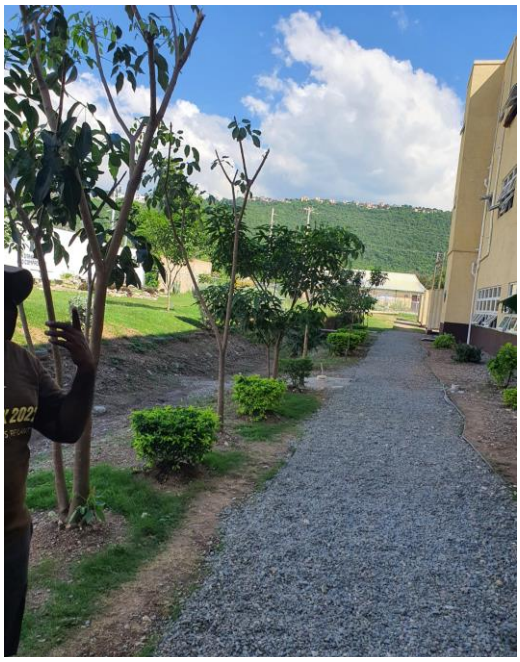


Figure 6: Example of Pervious Gravel Walkway (Nov 27, 2023)

Figure 7: Examples of Urban tree planting at Up Park Camp, Kingston, Jamaica (Nov 27th 2023)

The above images are examples of green infrastructure supporting urban tree planting. The tyres have been recycled and used to help retain the soil in which the Silver Buttonwood trees are planted just at the edge of the swale. The tree growth is encouraging over the one-year period as the trees are now showing a defined canopy of approximately three to four (3-4m) diameters. Wider spacing would allow the trees to be more efficient in their natural growth patterns. They would grow faster to their natural form rather than competing for light and nutrients and they would be stronger and better able to fight diseases and withstand stress. On the other hand, there are instances where in the urban setting the tree growth is better maintained (pruned) at a manageable level to avoid conflicts with the built environment.

4.4 Use of Endemic plants in Urban Forestry

The island of Jamaica is rich in biodiversity. Terrestrial endemism as rated by the United Nations Environment Programme is high. Several of the plants and animals present are indigenous (originating and living or occurring naturally in an area or environment) while a large number are endemic (found nowhere else in the world). Some endemic or native trees to Jamaica include the national tree Blue Mahoe, the National flower Lignum Vitae, the Jamaican Dogwood and the Jamaican Ebony. A look through Forests of Jamaica by C.B. Adams will give the details of the species, its original location and its natural occurrence. In addition, the Forestry Department through the Trees for Tomorrow Project (supported by the Canadian International Development Agency) published a book "Manual of Dendrology Jamaica" in 2003. It provides a reference to several of the endemic, indigenous and introduced tree species to be found in Jamaica. If we can replenish these species within the area of their natural ecology, they will climatize more easily within the Urban Forest and in turn contribute ecological value to the other systems (flora and fauna) that depend on their existence.

a) Jamaican Ebony Tree *(Brya ebenus)*

b) Jamaican Bullhead Thatch Palm *(Sabal maritima)*

c) Blue Mahoe Tree *(Hibiscus elatus)*

Figure 8 (a-c): Endemic tree species in Emancipation Park, Kingston, Jamaica
(Dec.17, 2023)

Figure 9: Lignum Vitae *(Guaiacum officinale)* Trees on Seymour Lands in Liguanea, Kingston, Jamaica
(Dec 17, 2023)

For example the native species (Lignum Vitae, Blue Mahoe and Bullhead thatch), seen in the images above at Emancipation Park, will strive more than the exotic non-native species like the hybrid rose garden which was attempted in the park but did not prove to be successful.

5.0 POLICY AND REGULATORY FRAMEWORK

The three main agencies that govern the regulatory framework for forests in Jamaica are the Forestry Department, National Environmental Planning Agency (NEPA), and Kingston and St. Andrew Municipal Corporation (KSAMC). Each has their own act and governing policies referencing forests which will be reviewed.

The primary legislation that governs the management of forests in Jamaica is the **Forest Act 1996**. This law establishes the Forestry Department as the lead government entity responsible for the management of forests located on crown lands. The Forest Act is intended to enhance Jamaica's tree cover through the implementation of its conservation policy and the management of the islands' ecosystem, and to increase Jamaica's ability to cope with the effects of climate change. The goal of the agency is to *"Manage and conserve the forest resources of Jamaica for the benefit of present and future generations".* The law mandates the agency to establish rules on directing and controlling the exploitation of forest resources, promote reforestation, conduct research, develop and implement public education and awareness programmes, and develop recreational initiatives in forests. The **Forest Policy for Jamaica 2017** mandates the primary responsibility of the management and conservation of Jamaica's forest cover to the Forestry Department. The vision and goals of the policy aim to ensure that …. *''By 2062, Jamaica's forests and its biodiversity are sufficiently restored and sustainably managed, so once again the island can adequately be described as **'the land of wood and water'**, capable of meeting the social, economic and ecological needs of current and future generations."*

The road map towards achieving this vision is supported by several plans such as **Vision 2030: National Development Plan, National Forest Management and Conservation Plan 2016-2026 (NFMCP)** and the **Strategic Forest Management Plan 2021 – 2026 (SFMP).**

The National Mangrove and Swamp Forest Management Plan (NMSFMP) 2023-2033 is another policy document produced by the Forestry Department. It provides the guidelines to protect and conserve Jamaica's coastal forests, which are influenced by the proposals for resort development to support the Tourism Industry and for the valued real estate coastline. The NMSFMP was produced with funding from the European Union.

5.1 Review of Existing Jamaican Policies Related to Urban Forestry and Climate Change Adaptation

The Forest Act 1996 of Jamaica encompasses several agencies with each having different responsibilities regarding urban forestry and climate change adaptation. The table below lists each agency and their primary role in the Forest Policy 2017.

Table 1: List of agencies and their responsibilities

RESPONSIBILITY	EXECUTING MINISTRY OR AGENCY	SUPPORTING AGENCY COLLABORATION
Protection & Sustainable use of Tress of National Significance	Forestry Department	JNHT, RADA, NSWMA Institute of Jamaica Parish Councils
Research, Advanced Education, and Training for the Forestry Sector	Forestry Department	Scientific Research Council Institute of Jamaica, NEPA RADA, Academic Institutions
Improve Management of Protected Areas	Min with responsibility for the Environment-Protected Areas Committee	Forestry Department Institute of Jamaica NEPA, JNHT, Fisheries Division
Climate Change, REDD+, and Carbon Credit Trading	Forestry Department Min with responsibility for climate change	Min for the Environment Min for Energy, NEPA, Entity for UNFCCC Focal Point
Fuel Wood Yam Stick Production and Charcoal	Min with responsibility for Agriculture Min with responsibility for Energy	Forestry Department, RADA, PCJ, STATIN, NEPA, Local Universities Min for the Environment
Scaffolding and Building	Min. with responsibility Planning or Works, Town & Country Planning Auth Parish Councils	Forestry Department NEPA, Parish Councils Bureau of Standards Jamaica Engineering & Architecture Boards
Mining and Quarrying	Min. with responsibility Mining & Quarrying Min. with responsibility for the Environment	Forestry Department Mines& Geology Division Jamaica Bauxite Institute
Land Use Planning, Development Orders and the National Spatial Plan	Physical Planning Land NEPA Parish Councils & Local Government`	Forestry Department Planning Institute of Jamaica Min for Agriculture Mining, Urban Development Corporation
Protection of Water Sources and Watershed Management	NEPA Water Resources Authority	Forestry Department National Eater Commission Min for Housing, Min for Land
Agro-Forestry	Min. with responsibility for Agriculture	Forestry Department, RADA
Replanting Mangrove Forests	NEPA	Forestry Department Fisheries Division Academic Institutes
Tourism	Min. with responsibility for Tourism	Forestry Department Tourism Product Dev Co.
Urban Forests	Min. with responsibility for Local Government Forestry Department Local Authorities	NEPA, NSWMA, Min for Tourism Urban Development Corporation Tourism Product Dev Co.

5.2 Recommendations for Policy Enhancements

The table above shows that there are numerous agencies involved in the governance of Forests and Forest related policy. As the impact of climate change becomes more dire, there must be more empowerment of the governing agency, the Forestry Department to have more monitoring control to manage and maintain the existing and growing forest reserves. Perhaps another department or agency can take on the role of a comprehensive master plan for new forests with defined goals to achieve the tree cover whether on public or private property. Regardless of the owner, for the mandate to be achieved there is the need for greater interagency collaboration between all parties for the "vision" to be achieved and sustained. Perhaps a consolidation of priority tasks with high impact potential should be solely controlled by a maximum of three Executing departments, Ministry, or agencies to ensure efficiency. This will eliminate the deflection of responsibility from one agency to another by having am single agency with the authority to implement the policy effectively.

5.3 Integration of Sustainable Urban Forestry into Municipal Planning

The integration of sustainable urban forestry is an important aspect of urban planning and development that is often overlooked. Development is being driven mainly by the socio-economic needs of our society as opposed to the whispering warnings of the environment, that are now turning into the more vibrant outbursts of global warming and climate change events.

A wholistic review of the Town and Country Planning Act 1958 for designated areas is required and should be approached as a matter of urgency. At present our reviews seem to be reactionary and may appear in instances to be responsive to the needs of each development proposed rather than having a clear vision for each city. An updated physical plan should assess and identify each city's capacity for housing based on the physical constraints of the space and its infrastructure requirements. Calculations are needed to establish the thresholds for each area's plan within the context of the existing green spaces and the options available through EbA interventions to create the balance needed by establishing urban forests. For example, high rise developments should be required to replace the same amount of green space removed by requiring the developer to build elements such as vertical gardens, green roofs, or establishing and maintaining a nearby green space as a conservation forest or park.

If the Forest Act or Policy proffered a bold move such as this in favour of the environment, then a positive result would very quickly be realized in the reversal of some of the island heat effects, and soon thereafter the city would benefit from positive mitigation against the effects of climate change.

6.0 HOW-TO GUIDELINES FOR ESTABLISHMENT AND MANAGEMENT

The first step in the establishment and Management of the Urban and Peri Urban Forest is to have a plan. The plan must look at the issues from a macro level and then the micro level. The macro level looks at the selecting the site for climate change impact effectiveness and value both in the short term and long term. The most suitable solution for space is important to its sustainability. Formulating and projecting the right budget and management in the long term is also key to the success of the project. The work goes on beyond the implementation. Where a community is involved, it is critical that the community is

involved from the start. They must understand that the project is theirs, for their benefit and for their community. A sense of ownership must come from the community to ensure sustainability.

The success of urban forestry programs depends on the support and involvement of the community. The community must be engaged in the planning, implementation, and maintenance of urban forestry projects to ensure their long-term success. Community involvement can contribute to the development of urban forestry programs, increase awareness of the benefits of trees, and foster a sense of ownership and pride in the community. *(USDA Forest Service Southern Region 1993)*

Health and Safety standards must be adjusted in response to climate change. As the summer temperatures are now at a dangerous level that can affect health, protocols must be established to safeguard workers. This includes monitoring individuals and ensuring they wear appropriate clothing, take regular cooling breaks and are properly hydrated. Some physical provisions should be established through temporary shading and the addition of cooling areas with misters. It is also necessary to restrict or limit outdoor activities during the peak periods of heat wave.

6.1 Site Selection, Analysis, Constraints (infrastructure, plant size, wind tunnels, seasonal waterways)

Selecting the site is the first step in the planning design process followed by the analysis of the site. The site selection is usually predetermined based on the needs of the client or regulatory agency and based on the priorities of each. The site is analyzed to identify its microclimate alongside other physical constraints.
There are three general categories for the Kingston region: the alluvial plain; the dry limestone forest and the coastal wetlands. This will determine to some extent the climatic constraints that will affect the viability of the plant species to be chosen.
Some characteristics typical to each category that would affect the planting are as follows:

Table 2: Primary Ecosystems of Kingston

Ecosystem	Main Characteristics	Recommended species
Alluvial Plain	Silty Soil, Prone to flooding,	Hardy, drought tolerant plants
Dry Limestone Forest	Rock outcrops, Windy, Dry	Xeriscape, Wind tolerant species
Coastal wetlands	High water table, high salinity	Highly salt tolerant species, Mangroves or coastal species

6.2 Planting Guidelines

Planting guidelines are important to establishing correct standards for compliance in order to implement the urban forest project in an efficient manner. The guidelines look at the components to achieve this in a step-by-step approach, by first looking at the options, constraints, plant selection, implementation and finally maintenance.

6.2.1 Planters

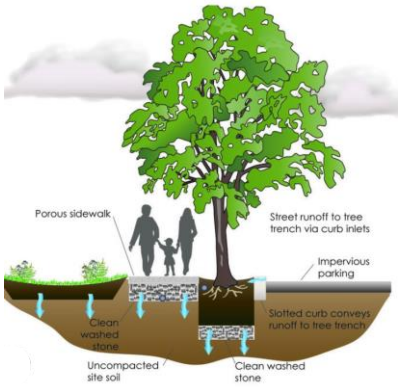
The urban fabric is synonymous with the term “concrete jungle’. This translates in many instances to an impervious surface whether at the street level or within the high-rise development. There are a few options for planters amongst which two are shown below:

Inground Planters

Inground planters have the base of the tree at the same level as the ground surface with the roots below the surrounding surface level. Ideally the surface below should be permeable to at least 1.2M to allow for tree growth of a medium sized tree.

a) Inground Planter in pavement

b) Inground Planter with tree grate



c) Detail profile of inground planter

Figure 10 (a-c): Example in-ground planters
(a&b Engineeeringdiscoveries.com; c Melioradesign.net 2024)

The advantages of this option are that it allows for free movement over the tree roots and so pedesturians can walk over it. It easily allows stormwater to penetrate the tree roots. The main negative is that in urban development projects, without proper preparation the ground is backfilled and compacted with marl or the ground surface may be impervious with rock. These impediments will result in the tree having a stunted growth due to the extension of the rootball into infertile soil or undesirable growing medium.

Raised Planters

Raised Planter are constructed above ground level. They should be designed and sized to accommodate the root ball for the specimen selected. The design should include outlets for drainage along with inlets to accommodate irrigation which could be sourced from rainfall using a variety of options. Raised planter beds can accommodate seating on the edges also.

a) Raised planter with a metal edge b) A concrete seat planter c) An elevated timber boxed planter

Figure 11: Examples of raised planters
(a. Furnitubes.com, 2024 b. pwpla Instagram 2022 c. Arlau.com 2024)

The material for the raised planter can vary from metal, to concrete to timber or other creative options to include cut or dry packed stones. The best option is dependent on the individual site, the availability, and the sustainability of the raw material within that environment.

Vertical Gardens

Vertical Gardens are gardens designed along the vertical surfaces of buildings. This design allows for an increase in the square area coverage for green space to mitigate against the loss of green space relative to the new construction. It is a very viable solution to combat urban sprawl and the scarcity of land while allowing for the socio-economic demands for development which favors high rise construction.

a) Vertical Gardens on a high-rise building b) Balconies designed for Vertical Farming on a high-rise development

Figure 12: Examples of Vertical Gardens
(a. paisajismourbano.com,2024; b. idea.club, barnhaus, 2024)

Haus Von Eden Urban Living magazine promotes the image on the right as vertical farming. Vertical gardens in any form require more technological solutions inclusive of water supply, the right growing medium and adequate lighting. and Hydroponics and artificial lighting are some of the options used to promote sustainability. And the correct species to be used within the site is also key.

Rooftop Planting

The Green Roof Company defines a green roof as "a roof of a building that is partially or completely covered with vegetation and soil, or a growing medium, planted over a waterproofing membrane… It may also include additional layers such as a root barrier and drainage and irrigation systems" (Green Roof Company, 2021).

The images show a partially covered roof with raised container planting, which is typical of what is found in some of the recently established high rise developments in Kingston. The other image shows the total roof covered with vegetation. The ideal vegetation for sustainability is low growing groundcover, sedums or grasses which have very shallow roots and a tendency for horizontal branching. This is ideal as the planting bed is usually shallow as design limitations will be restrictive in consideration of the weight of the soil or planting medium.

a) Container Plants on a green roof

b) A variety of sedums planted on a green roof

Figure 13 (a-b): Examples of Green Roofs
(a. Vo Trong Nghia Architects, Vietnam Sept 2017; b. Zinco-Greenroof UK, 2024)

Container Planting

Planting in containers like raised planters fulfills the needs of extended growing space for trees where the existing surfaces are impervious or rocky. The containers used can vary from concrete pots to recycled materials such as old tyres or drums. The latter is used extensively in community planting projects in Jamaica and has proven to be effective. Other creative options have been upcycled as containers to include old bathtubs, fridges and old canoes.

Figure 14: Examples of Container Planting
(a. Vdberk nurseries, 2024; b. P.Orosco, Pinterest, 2024; c. Medinilla,Vina. Magazine Agriculture, Nov 2020)

6.3 Plant Selection

Selecting the correct plant species must be matched to where the plant will be placed. First, it must match the ecology of space, e.g. coastal wetland or beach, dry limestone forest or alluvial plain. For example, planting a Yellow Poui Tree along the waterfront with its breezy saline harsh environment is not ideal. That environment will need a highly salt and wind tolerant species to survive e.g. Jerusalem Thorn, Cordia, Lignum Vitae or Seaside Mahoe.

The characteristics that are important to plant selection include root structure, its canopy at maturity, and its general form. All are important in the context of the space within which it is to be planted. Other aspects to consider are whether the plant is an irritant (touch or smell), whether it is brittle along with the texture of the stem and leaves. Table 3 in the appendices outline examples of suitable trees for urban planting in Jamaica, with the recommended planting specifications.

Plant toxicity is an issue that is often overlooked. Many plants that are commonly used are highly toxic to the touch and if ingested can cause serious health problems. Some examples are the Oleander tree, Cane Draceana, Mango (for allergies) and Candlestick Cactus. Usually, a white milky sap indicates the potential for toxicity. However, the use of toxic plants such as Oleander, Allamanda, Bignonia can be beneficial for streetscaping where stray animals (especially goats) are a nuisance. These toxic plants would be inappropriate for schools where children may be exposed to the harmful effects of the toxins.

In schools and specialist institutions, care must be taken in specifying plants that don't have allergens. Again, the designer must be mindful of the sensitivity of the users of the space to the allergens and plant placement is important. Plants that are irritants to humans or pets, within commercial spaces, institutions and homes are better kept along the boundary away from contact.

6.4 Site Preparation (Soil / Planting Medium: - Depth, Drainage, Type, Nutrition)

Preparing the site for tree planting involves earthworks or a growing medium, accommodation for water supply and drainage or extraction of excess water. The space would need to be evaluated for water movement. If rainwater or stormwater cannot be captured naturally via drainage swales, runnels, or drainage channels then the area to be planted must allow water in and out. Watering can be done by hand, but in most instances, it is tedious and tends to be ineffective. Several irrigation options are available and should be explored for the most suitable for the tree planting site.

The soil of the planting medium to be used should be healthy and congruent to the species selected. Most species require a sand-loam mix, while others require a sandier and fast draining mix. Ideally material found close to the site such as the excavated soil is ideal especially the top layer or topsoil. The less rich soil can be enhanced with river sand and organic fertilizers to create an ideal planting medium. For high rises planting, roof gardens and balconies a synthetic lightweight planting mix may be required due to the loading capacity of the buildings.

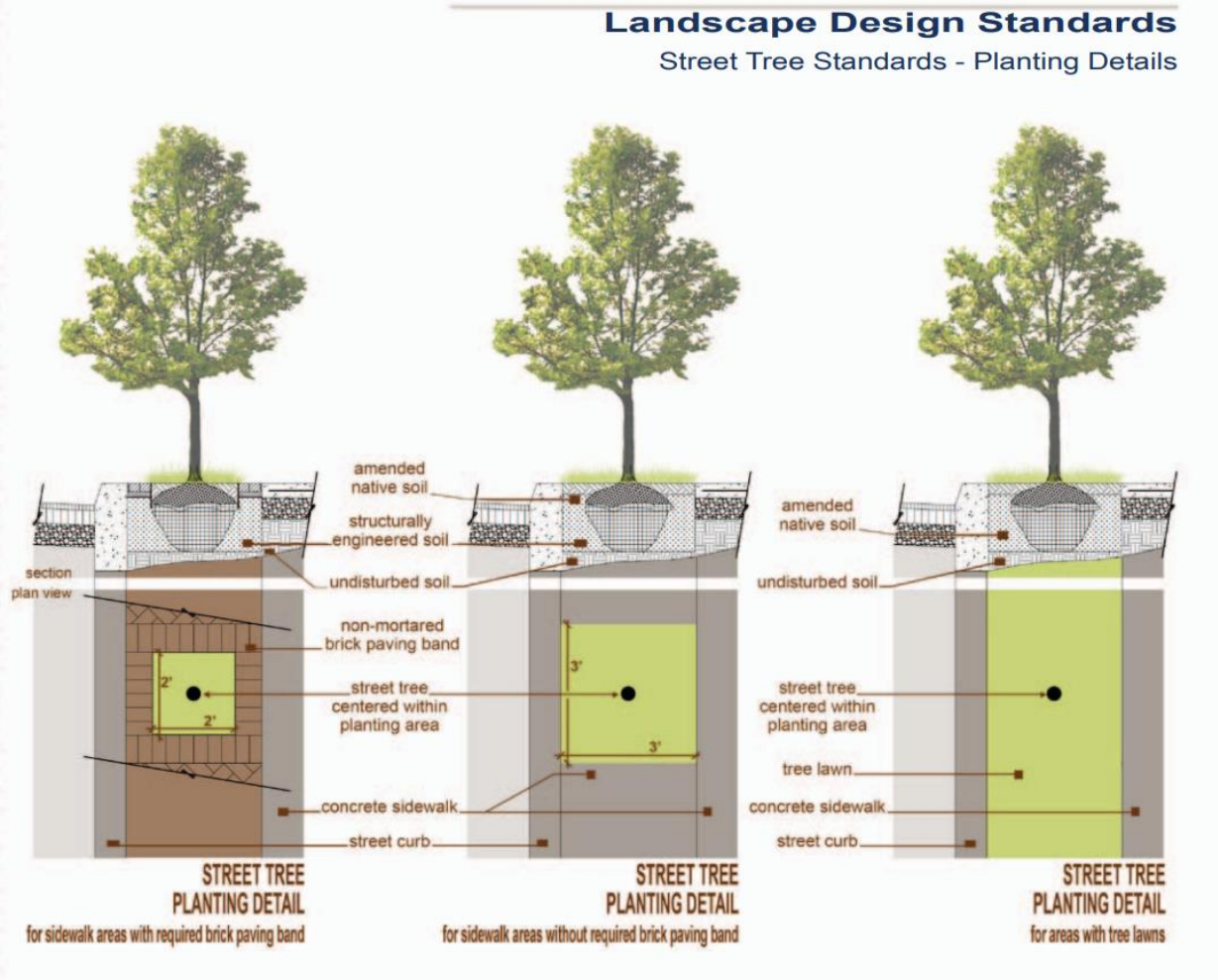


Figure 15: Street tree planting details
(TCA General Standards, Lititizborough, Pennsylvania, 2019)

Each species requires a different depth of planting dependent on the root system. Plants with a more aggressive root system should not be planted adjacent to the building services as the roots would ideally be fed along sewer or stormwater lines and can clog the system and cause major structural damage. On average the planting depth for small trees to medium trees is approximately 1.2 meters with a diameter of 1.0 m. The base of the planting hole (approximately 100 mm min) should be filled with stone to facilitate drainage so that the water will not remain stagnant on the tree roots. The base should also permit excess water to either filter freely into the ground or to drain into a stormwater system. Where planters are raised, weepholes can allow for the natural drainage over the surface or into a designed system.

6.5 Placement and Implementation

The placement of the plant is important in the numerous limitations of the urban setting. The root system of the tree as well as the form of the tree's canopy must be assessed to allow for the best fist.
The area available for the mature form of the tree should be included in the selection evaluation process. Below are some examples of the many different tree forms.

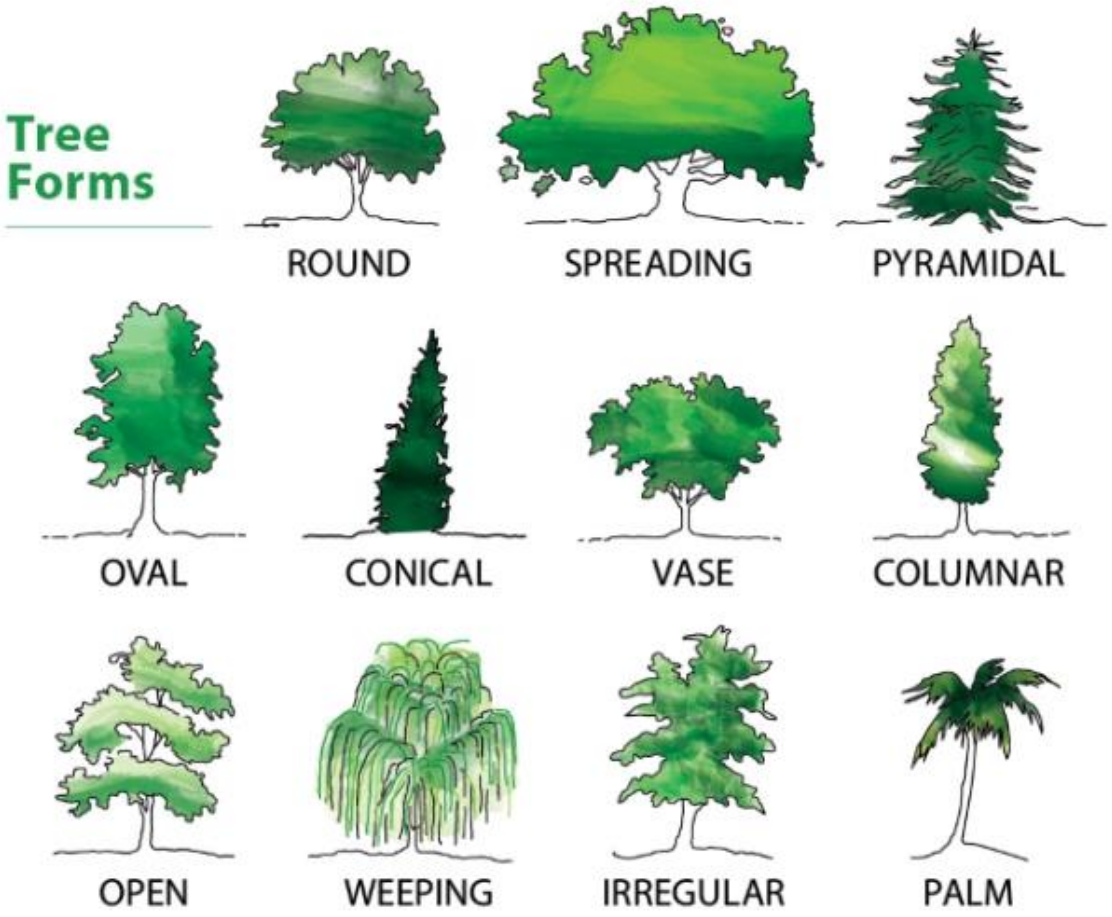


Figure 19: Tree Forms
(North Sydney Council, Planting Trees Guide, 2024)

Where space is limited with structures a tree with a columnar form is the more suitable option. It is also said that the spread of the tree canopy is matched by the spread of the root system, therefore the root system of a tree can be controlled by pruning the tree canopy (Rickman, 2024). The detail below shows the proper methodology for tree planting.

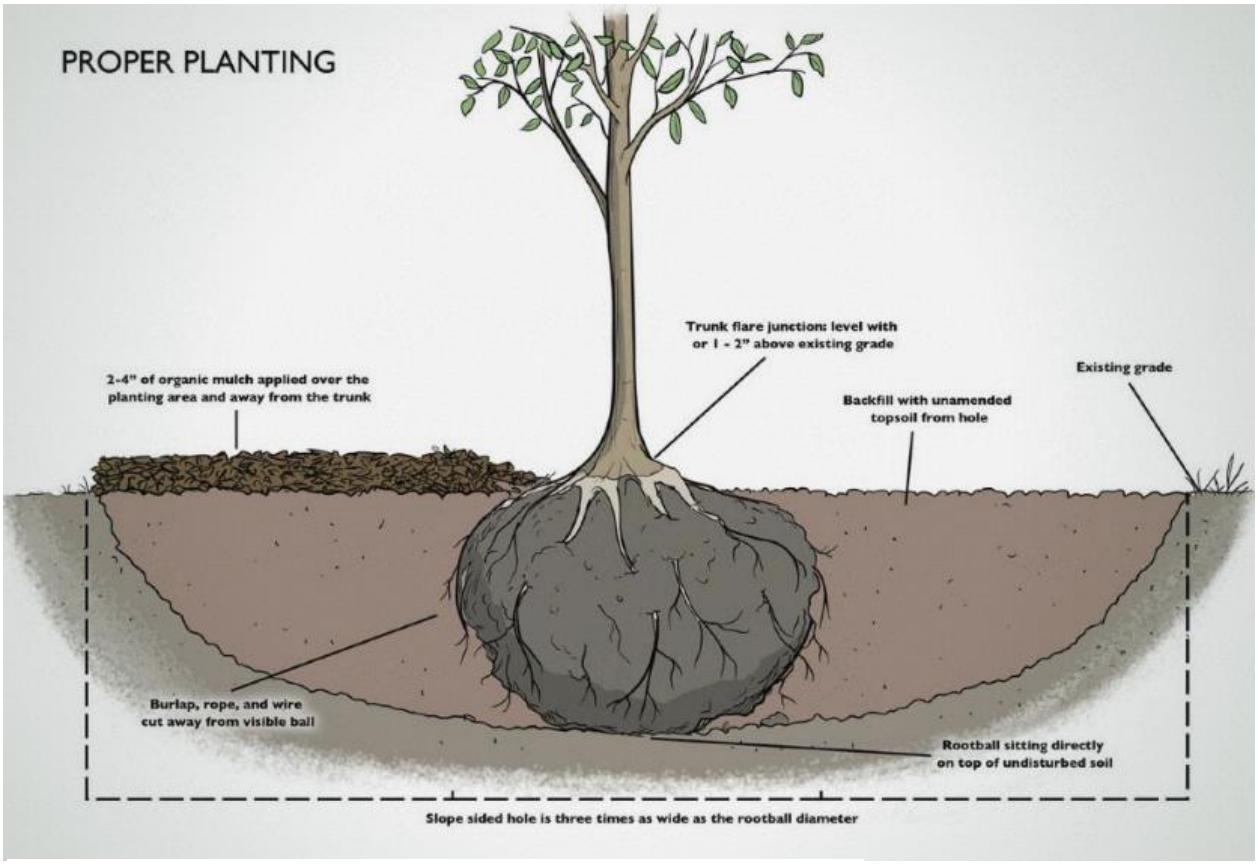
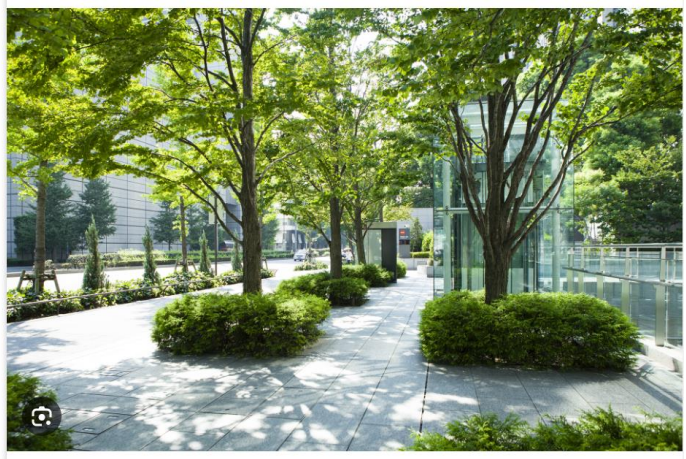


Figure 16: Tree planting detail
(The Morton Arboretum, 2024)

Adequate allowance should be made for root growth when planting trees or shrubs. Ideally the spacing of the tree is dependent on the growth habits and characteristics of the species and tree variety. The space between small tree planting holes ranges from 2.4m to 3.0m. The space between the planting hole and a structure such as a concrete wall or fence should equal approximately half the space between planting holes. For small trees the general rule would be a minimum of 1.2m to allow for sufficient root growth. For medium-sized and larger trees a minimum setback of 1.8m is best.

Urban tree planting must create a comfortable and user-friendly environment. The interface of pedestrian and vehicular traffic is an important safety consideration. Trees are often planted adjacent to the street to create a buffer and increase safety for the pedestrian traffic on the adjacent sidewalk. The impact of the tree's growth habit (form and size) relative to the height of the surrounding buildings and the placement of utility posts, lines and monuments is important. A professionally developed plan will contribute to an attractive urban environment, enhanced pedestrian walkability, building energy efficiency, improved air quality and desirable property values. Figure 21 is an example of the value of a planned approach to tree planting in the urban area.

a) Planners guide to trees in the urban landscape (www.tdag.org.uk)



b) Tree allée in an urban plaza (EcoInventos Pinterest 2024)`

Figure 17 (a-b): Examples of tree planting in urban landscapes

The implementation process can be efficient with proper planning. The tree should be ideally of a suitable size for the urban setting, that is the clear trunk ideally should be approximately 2.4 meter minimum. This will allow for clear movement of traffic within or generally adjacent to the space. If urban density is a factor, then a slightly smaller tree can be used especially within a confined green space. The challenge there though may be the susceptibility to damage by animals. The higher the branches are the less likely they will be attractive or accessible as feed.


Figure 18-23: Examples of tree guard and tree barrier
(Blurain Waterscape, Indiamart, Haryana, 2024; EU Science Hub, 18 January 2024)

Tree barriers or fencing should be planned for where animals and people are vulnerable. Some creative options have been used locally to include chicken mesh and old crates. In the Jamaican context though any barrier used can be seen as valuable and will easily disappear as they are valued more economically than for the protection of the tree.

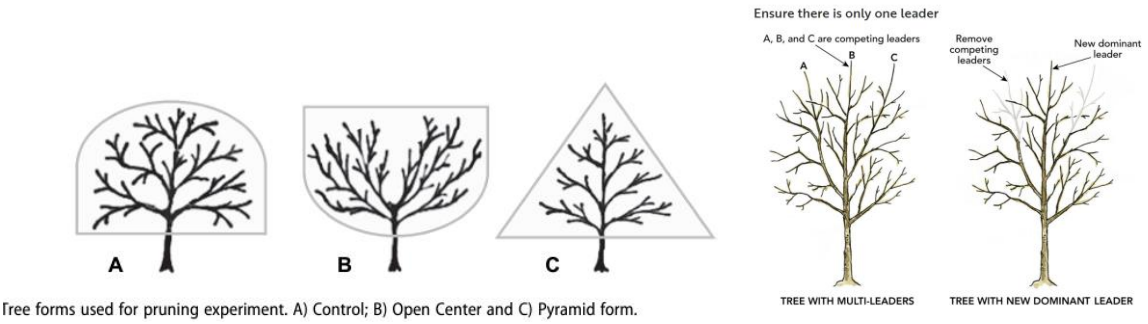
It is important that the community sees, participates, and values the project as their own. Traditionally the Jamaican culture tends to see value in fruit trees only, possibly for their economic potential or food. In common spaces crops and fruit tree planting must be partnered with a structured form of management. Otherwise, the result will be conflict with ownership.

6.6 Maintenance, Monitoring and Evaluation

Maintenance of the urban forest requires as much if not more attention than the planting both physically and economically. A management or maintenance plan must be in place to water, weed, protect from disease, and control growth to allow the plant its highest potential in form and value. Our biggest faux pas is poor pruning and that requires a manual and training on its own. An arborist is specially trained in this regard.

During the early stages of growth and depending on the species the tree must be groomed or pruned to a standard form or a single trunk. That means if there is heavy branching below the upper third of the tree, the branching should be removed to encourage the standard form. After the tree is near maturity or

mature, the tendency is to have many small branching known as gormandizers. To reveal the beauty of the tree branching these should be removed.



a) Tree forms used for pruning experiment b) Guide to proper pruning

Figure 19: Tree pruning guidelines
(a. Int'l Journal of Fruit Science, 2021; b. Dr. Andy Pulte, Fine Gardening Issue 199)

Pruning is usually done for three main reasons: health of the plant, public safety or for aesthetics. Unfortunately, there are often many more examples of poor pruning than good pruning. The tendency however, is to behead the tree and lollipop it in form, keeping it stunted like a shrub and limiting its growth to somewhere between 3 to 4 metres. That tree pruning can be matched to the height the pruner can access using a ladder. The tree cannot function as it should if it is not allowed to mature in its natural form or close to its natural form.

Figure 2520: Example of Tree Topping
(Marc Doyle Treework, Nov. 8, 2022)

Figure 26: Why a tree should not be topped
(Marc Doyle Treework, Nov. 8, 2022)

Another popular pruning technique that was first developed for agricultural purposes is called pollarding. It is an ancient horticultural technique where the plant branches are cut back to the same point every year, resulting in the growth of long, thin, rapidly growing branches. Over time, the cut ends heal forming large, knobby stumps. The practice was originally done to produce fodder for livestock, wood for fuel or other utilitarian purposes.

In the modern landscape, it is done purely for style or personal taste (DC Tropics, 2015). In Jamaica, this technique is the most straightforward method to control the tree growth within arm's reach of the pruners, while using the commonly available tools of a ladder with a pruning saw or machete. The outcome is unattractive and far from ideal.

a) New growth

b) Pollarded trees

Figure 21: Examples of pollarding
(a. DWTreeCare, Arboricultural Specialist, 2024; b. John Keates, Sept. 2014))

Another pruning technique of note is creating a 'standard' tree form where the lower branches are removed for a minimum of 1.8 metres from the ground to the lowest branch for mature trees.

Figure 228: Example of full tree standards
Source: (Paramount Plants & Gardens, 2020)

Within the management plan there should be documentation to monitor the growth and health of the urban forest project. A monitoring plan can provide better control of the sustainability of the forest as it will highlight possible deficiencies and caution for possible disease or other hazards.

An evaluation of the project over a five-year or ten-year period will provide both standards and procedures to be evaluated for success, and incidents to be observed as lessons learned. In addition, succession planning is essential as the urban forest has a limited life cycle and are affected periodically by natural disasters. These events will impact the mortality of some species.

6.7 Management and Training

Planting and landscaping are often seen as beautification and an element that is optional to development. This mentality needs to change quickly as we are now experiencing heat waves and floods manifested as impacts of climate change. Experts like physical urban planners, park designers, arborists, bio engineers, landscape architects, drainage engineers and food security professionals must be sought out to add value to the process of establishing and maintaining the urban forest.

Where the expertise is required and non-existent, agencies should look to identify suitable candidates and sponsor their training to eventually upgrade the skill sets within the organization and become relevant to the global changes and standards.

7.0 CONCLUSION

Jamaica's Urban and Peri Urban centers are rapidly growing in response to the pressures of the economic upturn and the development of hotels, high rises, industries, and commercial enterprise. The result is a scarcity of land or green space the value of which is often overlooked until the personal impacts of negative health or loss of physical assets due to natural events are felt. The global issue of climate change impacts now evident in Kingston Jamaica, its environs and by extension most of Jamaica can no longer be overlooked. The use of NbS in adapting to climate change effects of sea level rise, warmer temperatures and more frequent and severe weather events can be proven through the establishment of urban and peri urban forests.

7.1 Recap of the Importance of Sustainable Urban Forestry

Urban Forestry is critical now more than ever to allowing our cities or development centers literally air to breathe and allow for infiltration to reduce flooding. The higher density demands from development result in less green space, more traffic, more greenhouse gas emissions, more stormwater resulting in more potential flooding events, more instances of drought (less rainfall), high carbon footprints and less healthy communities of both people and animals. The ecology of a space looks at the relationship or interdependence of all living things: plants, animals, insects and humans. As humans, we are dependent on trees and plants to clean our air, and whether directly or indirectly provide us with food for our nutrition. Likewise, the bees are dependent on trees to produce honey which we consume. The butterfly is dependent on the Lignum Vitae tree for its survival. And some trees are dependent on pollination by birds or insects to produce fruit. All life is intertwined.

In this light, when trees are eliminated in the name of development, the result will be polluted air and waterways as well as higher energy consumption needed for more cooling with the heat island effect of more concrete. This emphasizes the need for creating a balance by not only establishing urban forests but creating sustainable urban forests.

Sustainable Urban forests are best established through Ecosystem-based Adaptation and Nature-based Solutions. This is looking at and listening to nature and adapting the recommendations and examples of efficient sustainability. When nature's guidelines are followed by the planting of trees and greening of the urban centers, maintenance requires less energy and the establishment of green roofs, parks, green ways, streetscapes and vertical gardens become more sustainable (The Ecological Society of America, 2024)

Figure 23: Butterflies on Cactus and Lignum Vitae Tree

7.2 Call to Action

Every Jamaican now has his or her part to play in realising the dream of seeing our island return to its glory days for whit it was named. Land of Wood and Water. When as individuals there is awareness of the threats of climate change which was felt especially throughout this year 2023 with the uncomfortable heat, loss of assets or economic income due to flooding events or rising medical costs due to increasing respiratory conditions and the need for urgent medical attention when the forest fires rage or the Sahara dust blankets the island. After awareness is recognized, action must not only be taken at the national level by our government but also as individuals. Globally there are calls by agencies such as UNDP and many environmental NGOs to reclaim our forests, establish more parks and green spaces, rid our oceans of pollution, and reduce or carbon emissions by introducing more energy efficient modes for mass transit or planning or cities to eliminate the need for long commutes.

Kingston has been active in taking the first step. Collaborations with the Forestry Department and agencies such as the Kingston and St Andrew Municipal Corporation have resulted in some a streetscape planting along Church Street in the vicinity of their offices. This along with other projects headed by the Forestry Department include plantings along the highways and the collaboration with City Adapt to bring awareness to schools and community centers and establish green spaces in each.

Figure 24: Tree planting along Church Street in front of the KSAMC office
(Dec. 17,2023)

Some recommendations to improve on the programme includes the following: -

- Establish a master plan in collaboration with the Town and Planning Department at NEPA for the city of Kingston. This would create more efficiency in identifying and being able to create ecological linkages through green corridors and a more vibrant solution to the tree planting efforts.
- The planting of seedlings is not ideal for establishing trees in public spaces due to the many environmental threats within the busy logistics and physical scales of the urban context. This means that a seedling is more fragile and has a low chance of mortality by its sheer size and exposure to inadequate water (rainfall or otherwise); a greater chance of being eaten or vandalized by animals and will require more attention and expense from monitoring and maintenance to reach turgidity and grow into a tree.

- For a successful urban forest, it is recommended that a tree (defined by most nurseries and universal standards) be a minimum of 1.8 meters in height with a DBH (diameter of the caliper at breast height or 1.55M) of at least 50 mililimeters. This can be achieved by allowing the seedling to grow in nurseries to the required height. As space may be limited a faster option would be to establish the tree size either by grafting or circumposing from larger trees. This method is widely used by commercial nurseries after utilizing a set of healthy stock plants for that purpose. Agencies such as NWA or even JPS need to limit the growth of trees for various reasons of maintenance and security. The branches from these trees could be targeted as a source for circumposing and creating a viable source for tree stock suitable for urban forest planting projects.
- Ensure a watering programme is in place to supplement the plants' nutrition at the start of the project. If the tree planting exercise starts a few weeks before the rainy season, allow for at least eight weeks of water supply to cover the initial growth of the tree. With the severe droughts now being experienced, planting trees in the urban areas will require some form of irrigation until the tree is mature enough to sustain itself. NbS options like stormwater collection for distribution through rainwater harvesting or the creation of runnels can be explored. The design can utilize stormwater from public spaces via retention ponds. NWC and Underground Water Authority are two agencies worth collaborating with to provide grey water (treated to suitable standards) or well water whichever may be feasible for each project.
- The Forestry Department has a programme in place promoting apartment gardens and encouraging individuals to plant trees. They provide free seedlings to homeowners, groups and individuals on tree planting day. Also, they provide resources to individuals and businesses to educate and encourage tree planting along verges and within their properties. More promotion and education at the individual level to move to action will help to achieve the vision of urban and peri urban forestry to create a more balanced and sustainable ecosystem. Perhaps community tree planting competition or tree planting tax incentives are some options available to assist in achieving this goal.
- Projects should be planned for implementation in the period just before the rainy season but not include the hot summer period. This year record temperatures were recorded globally and in Jamaica in the first week of August. All outdoor activities including planting should be limited during the peak of summer. Health and Safety guidelines for workers outdoors will need some revision within both the private and public sector. The Forestry department could lead the charge. Some options that would assist in wellness and better performance would be earlier shifts ending with indoor activities in the early afternoon. Creating shelter stations with humidity spritzers and/or misters. Building out a microclimate of trees or shading devices with these misters, especially a portable system would greatly enhance site working conditions and safety. With temperatures rising to dangerous levels, this must become a standard requirement similar to other health and safety requirements such as protective site hoarding. Uniform clothing generally needs to be looked at and revised where needed for appropriateness, safety and health in reducing the risk of heat related exposure and illness.

7.3 Role of Sustainable Urban Forestry in Jamaica

Jamaica presently has several initiatives towards creating a sustainable urban forest. There are also a few programmes being implemented by private sector organisations, other governmental agencies, and non-governmental agencies. The Forestry Department is the ideal repository for data and monitoring these programmes and initiatives as part of their existing mandate.

However, a comprehensive national plan would be a better driver for the various parish authorities to use as a guide for the review of all development/building plan applications for landscape plans, parks, agroforests, or any green initiative. The Parish Councils and the Town and Planning department (NEPA), who are presently the primary approval agencies for development must be equipped and staffed with the professional experts able to collaborate and prepare such a plan with the requisite standards. A comprehensive, urban greening mission and plan, grounded in a strong sustainable policy, would result in a more efficient journey to the goal and vision of preserving Jamaica's asset and resource in being the 'land of wood and water".

8.0 GLOSSARY OF TERMS

Acid Soil	A soil with a pH level below 6.6. Determined by a soil test
Arborist	A professional who possesses the technical competence through experience and related training to provide for or supervise the management of trees and other woody plants in the residential, commercial and public landscape
Aquifer	Water-bearing geologic formations that can provide usable amounts of water.
Backfill	Soil used to fill in the excavated area around the roots of a newly planted tree or shrub. May be native soil or a mixture or native soil and amendments such as compost
Balled and Burlap (B&B)	Shrubs and trees dug from fields with a ball of dirt around the roots; the ball is wrapped in burlap and set in a wire basket to hold it together. Usually dug from late fall to early spring, during the dormant season
Bare Root (BR)	Trees and shrubs dug from the field without soil around the roots. Plants are dug while they are dormant and stored in very humid, cold storage lockers until spring
Basal area	The cross-sectional area of a tree trunk at 4½' above ground. Commonly measured in square inches or square feet
Bedrock	Unbroken solid rock, overlain in most places by soil or rock fragments
Bioretention	On-lot retention of stormwater through the use of vegetated depressions engineered to collect, store, and filter runoff
Botanical variety	A group of individual plants that have noticeable differences from the species and retain those differences when reproducing in nature from seed
Buffer	A vegetated zone adjacent to a stream, wetland, or shoreline where development is restricted or controlled to minimize the effects of development
Caliper	Diameter of a young tree measured at 6" (for trees up to and including 4" caliper) or 12" (for trees over 4" caliper) above the groundline
Canopy	The upper level of a tree and/or forest, consisting of branches and leaves of taller trees
Carbon sequestration	Processes that remove carbon from the atmosphere
Clinometer	An instrument used to estimate the height of a tree using a vertical angle and a distance determined by taping or pacing
Clone	A plant group derived from a single individual plant through vegetative reproduction. Example: A clone of many aspen trees may sprout from the roots of a single aspen tree
Community	A collection of living organisms functioning together in an organized system through which energy, nutrients and water cycle

Community Forestry	Addresses the social benefits of the urban forest: community pride, community planting and care projects, reduction of violent crimes and a sense of safety
Conservation	Use, management, and protection of natural resources that insures use and enjoyment for future generations
Containerized (potted)	A tree or shrub placed in a container by the nursery. Quality containerized plants grow in the container long enough that the roots and soil ball hold their shape and stay together when removed from the container, but not so long that the roots fully circle around inside the pot, leading to girdling
Crown	The point where the tree trunk meets the roots of a tree. Commonly, it refers to the leaves and branches in the uppermost part of a tree
Crown cleaning	The removal of dead, dying, diseased, crowded, weakly attached, low-vigor branches and water sprouts from a tree's crown
Crown height	The vertical height measured from the ground to the first (lowest) branch of the tree
Crown thinning	The selective removal of tree branches to increase light penetration, air movement and reduce weight
Cut	The wood exposed on a tree when a branch is removed
Cutting back	Pruning designed to make the size of a tree or a branch smaller. A branch is cut back to a side branch that is at least one-third the diameter of the removed branch. Also called heading back, cutting back, natural pruning, lateral pruning or directional side pruning. It is not topping
Circumposing	A method of propagating new trees and shrubs from stems still attached to the parent plant. The stem is wrapped with damp moss to encourage roots to form.
Container gardening	Plants that are grown in containers such as pots rather than in the ground. Container gardening is often used in urban areas where actual garden space is limited. It is a space-efficient option that is portable, so it offers the gardener flexibility in placement or arrangement.
Detention Pond	The temporary storage of stormwater to control discharge rates, allow for infiltration, and improve water quality
Diameter, breast height (DBH)	The diameter of a tree at 4½ feet above ground level
Dormant	A state of inactivity
Dripline	A ring around the tree canopy on the ground level that receives most of the rainwater shed from the canopy
Drop-crotch pruning	Pruning designed to make the size of a tree or a branch smaller. A branch is cut back to a side branch that is at least one-third the diameter of the removed branch. Also called heading back, cutting back, natural pruning, lateral pruning or directional side pruning. It is not topping

Ecology	The study of the relationships and interactions between living organisms, including humans, and their physical environment; it seeks to understand the vital connections between plants and animals and the world around them.
Ecosystem	An interacting system of living organisms, soil and climatic factors. Forests and wetlands are examples of ecosystems.
Ecosystem-based adaptation (EBS)	A strategy for adapting to climate change that harnesses nature-based solutions and ecosystem services.
Endemic species	Species that are found only in a limited, restricted, and defined area or habitat, with no traces of its populations in any other part of the world.
Environment	The prevailing conditions which reflect the combined influence of climate, soil, topography and biology (other plants and animals) present in an area.
Erosion	The wearing away of the land surface by water, wind, ice or other geologic agents, and by such processes as gravitational creep
Espalier	A combination of cutting and training branches which are oriented in one plane, formally or informally arranged, and usually tied to a wall, fence or trellis.
Evergreen	A plant which retains living leaves or needles throughout the year or longer or until new ones appear
Exotic	(Non-native) A species that due to direct or indirect human activity occurs in locations beyond its known historical or potential natural range. Refers to species from another continent, region, ecosystem, or habitat
Fertility of Soil	(Soil fertility) The quality that enables a soil to provide nutrients, in adequate amounts and in proper balance, for the growth of specified plants. Light, moisture, temperature, tilth and other growth factors are favorable
Fertilizer	Substance added to a plant or the surrounding soil to supplement the supply of essential elements needed for growth
Foliage	Leaves and other above-ground plant organs specialized for photosynthesis, respiration, transpiration, and guttation
Glysophate	A type of systemic herbicide (eg. Roundup for land, or Rodeo for wetlands or near water)
Grafting	A horticultural technique whereby tissues of plants are joined so as to continue their growth together.
Green Infrastructure	An interconnected network of waterways, wetlands, woodlands, greenways, parks, forests, and other open spaces that support native species, maintain natural ecological processes, sustain air and water resources and contribute to health and quality of life. Includes parks, parkways, riparian buffers, residential landscaping, street trees, rain gardens, green roofs, and window boxes.

Green roof	A specially designed roof that incorporates plants. Depending on the structural capacity of the building, depth and type of soil, and desired maintenance, green roofs can be planted with anything from sedums to trees. Benefits include stormwater management, energy cost savings, and reduction of urban heat island effect
Greenspace	Any vegetated land or water within an urban area that serves as recreation or open space. This includes neighborhood and regional parks, gardens, cemeteries, playing fields, bike and walking paths, and urban landscaping
Green wall	A vertical built structure intentionally covered by vegetation. Green walls include a vertically applied growth medium such as soil, .
Greenways	A corridor composed of natural vegetation. Greenways can be used to create connected networks of open space that include traditional parks and natural areas.
Greywater	This describes wastewater from non-toilet plumbing systems such as hand basins, washing machines, showers and baths. It also includes untreated water from rivers, streams or wells. With proper handling, greywater can be safely reused for irrigating gardens and landscaping.
Grey infrastructure	Human engineered systems to manage stormwater and sewers through pipes. It refers to traditional stormwater infrastructure in the built environment such as gutters, drains, pipes, and retention basins.
Groundwater	Water stored underground in natural pore spaces between soil particles or rock fractures
Groundcover barriers	Usually, a geotextile fabric used in landscaping to block the growth of weeds.
Groundcover planting	Low growing plants that cover the ground
Habitat	Food, water, shelter and space that supports plant or animal life
Hardiness	The ability of a plant to withstand cold temperatures without death of woody tissues and/or flower buds
Hardscape	Landscape elements like decks, walls, fences, fountains, walkways and other structures that are not plants.
Heading	Cutting a currently growing or one-year-old shoot back to a bud, or cutting an older branch or stem back to a stub or lateral branch not sufficiently large enough to become the leader. Heading should rarely be used on mature trees
Heat Island effect	A phenomenon where air temperatures in urban areas are 2-10°F hotter than surrounding rural areas due to the high concentrations of buildings and pavement in urban areas
Hydrology	The study of the waters of the earth, their distribution on the surface and underground, and the cycle involving evaporation, precipitation, flow, etc.

Impervious surface	A hard surface (such as a parking lot or rooftop) that prevents infiltration of water into the ground, causing water to run off the surface
Infiltration	The downward movement of water from the land surface into the soil
Infrastructure	The system of roads, bridges, canals, wires, pipes etc., that provide public services.
Invasive	Species that grow and spread rapidly, establishing over large areas, and displacing native species
Landscape Architecture	A profession that combines art and science to research, plan, design, and manage the natural and built environment. Landscape architects often create parks, gardens, plazas, and streetscapes
Limb	Large, primary branch of a tree. Often the term is used colloquially for pruning or removing a large branch or branches of a tree.
Loam	A classification of soil texture based on a certain ratio of sand, silt, and clay. Considered ideal for plant growth.
Native Trees	A species that naturally occurs in a particular region, ecosystem and habitat. Species native to North America are generally recognized as those occurring on the continent prior to European settlement
Nature Based Solution (NbS)	The sustainable management and use of natural features and processes to tackle socio-environmental issues. Some examples of these issues are climate change (mitigation and adaptation), water security, food security, preservation of biodiversity, and disaster risk reduction.
Nomenclature	The naming and qualifying of plants. Most trees have two names, a scientific and common name
Non-native	A species that, due to direct or indirect human activity occurs in locations beyond its known historical or potential natural range. Refers to species from another continent, region, ecosystem, or habitat
Nutrient	Any element taken in by a plant that is essential to its growth. Plant nutrients are obtained from the soil, air and water
Open space	Land set aside for public or private use that is not built upon
Ornamental tree	A tree that is used for its ornamental qualities, such as: flowers, leaves, scent, fruit, stem, bark or other attractive characteristics
Park	A large public garden or area of land used for passive or active recreation
Particulate matter	Tiny particles of solid or liquid suspended in a gas. Sources of particulate matter often can be pollutants and become the cause of toxicity or allergic reactions
Percolation	The downward movement of water through the soil.
Permeable	Having pores or openings that allow water to pass through
Pervious surface	A surface (such as soil or vegetation) that allows water to infiltrate into the ground

Peri-urban Area, Peri-urban Forestry	The transition zone, or interaction zone, where urban and rural activities are juxtaposed, and landscape features are subject to rapid modifications, induced by anthropogenic activity. These critical areas of land cover change, lead to transformations in the hydrological, ecological, geomorphological and socio-economic systems. Examples of peri urban areas include Papine, Stony Hill and Bullbay. All are considered gateways into Kingsons Urban center.
Pest	Plant or animal or other organism considered harmful
Phosphorous	Element naturally present in the soil and absorbed by the roots. Without adequate phosphorus, the cell structure can weaken making the plant more susceptible to pathogens. Phosphorus is one of the major components of fertilizer, along with nitrogen and potassium
Photosynthesis	A process by which plants make food. Process uses the pigment chlorophyll, light energy from the sun, carbon dioxide from the air and water. This process produces sugar and gives off oxygen
Pollarding	A training system used on some large maturing deciduous trees. From the time they are young the trees are severely headed every year or two to the same point (pollard head) from which they produce new sprouts. There are few examples of good pollarding. Pollarding is not the same as topping.
Pollution	Substances introduced into the environment by human actions that contaminate the environment
Preservation	As it relates to trees and urban ecology, the maintenance of natural resources in an unchanged condition
Pruning	Removing branches (or occasionally roots) from a tree or other plant using approved practices, to achieve a specified objective (e.g., visual appearance, clearance for pedestrians, strength of the tree in maturity, etc.)
Rain Gardens	A form of bioretention for use in courtyards, small residential lots, and parking lots. Strategic placement next to hard, impervious surfaces helps a rain garden effectively collect runoff
Rainwater Harvesting	The collection and storage of rainwater runoff from roofs in tanks, barrels, or drums to be utilized for watering of gardens and the landscape
Recharging area	A land area in which surface water infiltrates the soil and reaches the zone of saturation or groundwater table
Restoration	The process of bringing back into existence, or reestablishing, the condition of a degraded environment
Retention Pond	A stormwater management pond designed to detain urban runoff and always contain water.
Riparian area	Vegetated ecosystems along a waterbody through which energy, materials, and water pass. Riparian areas characteristically have a high-water table and may be subject to periodic flooding

Road verge	A strip of groundcover consisting of grass or garden plants, and sometimes also shrubs and trees, located between a roadway and a sidewalk.
Root ball	Soil containing all (e.g., containerized) or a portion (e.g., B&B) of the roots that are moved with a tree or other plant when it is transplanted
Root protection zone	Surface area where there is a concentration of tree roots to be protected from construction damage which is usually soil compaction damage. Protection is best achieved by fencing off the entire root protection zone.
Root pruning	In transplanting, the process of pre-digging a root ball to increase the density of root development within the final root ball. In tree conservation and preservation, the process of pre-cutting roots behind the line of a planned excavation to prevent tearing and splintering of remaining roots. In tree disease management, severing tree roots to prevent disease transmission through root grafts
Runoff	Water from rain, melted snow, or irrigation that flows over the land surface
Scale	The ratio or relationship between a distance or area on a map and the corresponding distance or area on the ground.
Seedling	A small, young tree, less than 3-years old
Shade tree	Any tree grown specifically for its shade. This term usually applies to large trees with spreading canopies. Some of the most popular shade trees are Poincianas, Guango and Black Olive.
Shrub	A woody plant which is smaller than a tree and has several main stems arising at or near the ground
Site analysis	The evaluation of conditions, restrictions, and environment of a planting site. Also, the evaluation of a construction site requiring a tree conservation or preservation plan
Site considerations	Factors taken into account when assessing a site for planting, tree conservation, or preservation
Slope	An inclined surface. A slope may be concave, straight, convex expressed in percent or degrees
Soil amendment	Material that is mixed into the soil to add organic matter, improve drainage and/or improve aeration
Soil composition or soil texture	The relative proportions of sand, silt and clay particles in a mass of soil. Important in choosing the right tree species to plant
Species	A category of living things that ranks below a genus, is made up of related individuals able to produce fertile offspring, and is identified by a two-part scientific name
Storm drain	Constructed opening in a road system through which runoff from the road surface flows into an underground system and ultimately to larger bodies of water

Stormwater management	Management of stormwater runoff, often using water retention facilities, to provide controlled release into receiving streams
Stormwater runoff	Precipitation that falls on impervious surfaces (such as roofs and roads). Because it is not absorbed by soil and vegetation, it flows into storm drains
Swale	An open drainage channel designed to detain or infiltrate stormwater runoff
Symbiotic relationship	When two or more organisms benefit from each other's functions
Systemic herbicide	An herbicide that is absorbed by a plant and carried throughout the tissues
Thinning	In pruning, the selective removal of live branches to provide light or air penetration through the tree or to lighten the weight of the remaining branches. Recommended during winter/dormant period
Topiary	Trees sheared or pruned carefully in a formal shape. Commonly done on ornamental hedges such as duranta gold and Texas sage.
Topography	The shape or configuration of the land, represented on a map by contour lines and relief shading
Topping	Cutting off branches to stubs. Cuts made without consideration of the location of side branches. Topping is no longer an acceptable practice in arboriculture. Sometimes called tipping, round over, heading, shaping capping or pollarding
Topsoil	The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter
Tree	A woody perennial plant, typically having a single stem or trunk growing to a considerable height and bearing lateral branches at some distance from the ground
Tree planters	Rectangular openings that are usually regularly spaced found in the sidewalk that provide the growing space for street trees. Sometimes called a tree pit
Tree canopy	A tree's leaves and branches extending out in all directions from the trunk to the dripline
Urban ecology	The study of natural systems and human constructed environments in urban areas. This study includes identifying and addressing problems related to water and air quality, wildlife and plant conservation, human life quality and other related topics
Urban ecosystem	The community of living organisms and non-living elements that make up the whole landscape of an urban environment. This includes people and their domesticated animals, wildlife, plant life, water, geology, etc.
Urban forest	An urban forest includes all of the natural resources in an urban area: plants, soil, water, and animals. This includes humans.
Urban forestry	The management of the urban forest to maximize benefits to people without compromising the health and condition of the forest

Urban heat island effect	A phenomenon where air temperatures in urban areas are 2-10°F hotter than surrounding rural areas due to the high concentrations of buildings and pavement in urban areas
Urban Planning	Profession that guides the development and redevelopment of communities by planning for land use, housing, transportation, and economic development. Urban planners often work for cities, regional and state governments, or design firm
Urban sprawl	Patterns of urban growth that include large acreage of low-density residential development, rigid separation between residential and commercial uses, residential and commercial development in rural areas away from urban centers, minimal support for nonmotorized transportation methods, and a lack of integrated transportation and land use planning
Utility	An entity that delivers a public service such as electricity or tele communication lines
Verge	a strip of groundcover consisting of grass or garden plants, and sometimes also shrubs and trees, located between a roadway and a sidewalk.
Watering	Essential to help young trees overcome transplant shock; newly planted trees require approximately a 2-year watering commitment, one or two times per week of 5-10 gallons if it hasn't rained at least an inch that week
Wound	An opening that is created any time the tree's protective bark is damaged, cut or removed. Pruning a live branch creates a wound, even when the cut is properly made
Zoning	Regulations or requirements that govern the use, placement, spacing, and size of land and buildings within a specific area

Source: (Casey Trees, 2007)

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10.0 APPENDICES

10.1 RECOMMENDED SPECIES FOR URBAN TREE PLANTING WITH SPECIFICATIONS

The following table identifies trees recommended by a group of landscape architects as requested by the Forestry Department to be planted in the urban areas in Jamaica. The table categorizes the plant as large, medium, small tree as well as a shrub. Specifications of mature size and hazards are presented along with the recommended spacing for each species. The suitability is matched to the ideal location such as streetscape, park, or large open space.

Table 3: Suitable Trees and Plants for Urban and Peri-Urban Forests (Source: APAC, 2023)

LARGE TREE						
BOTANICAL NAME	**COMMON NAME**	**MATURE SIZE- height x width ft(m)**	**SPACING ft(m)**	**HAZARD**	**SUITABLE FOREST TYPE**	**REMARKS**
Tabebuia rosea	Pink Poui	25-30 x 40 (7.5-10 x12)	8-10 (2.4-3)	AGGRESSIVE ROOTS.	Parks, Large Open Spaces	Pink papery flowers.
Delonix regia	Poinciana / Flamboyant	10-12 x 15-20 (3-3.6 x 4.5-6)	12+ (3.6+)	BRITTLE BRANCHES.	Parks, Large Open Spaces	Red, yellow or orange flowers and large hanging pods. Prone to termites.
Peltaphorum pterocarpum	Yellow Poinciana	15-20 x 10-15 (4.5-6 x 3-4.5)	10 (3)		Parks, median, streetscape	Upright yellow flowers.
Swietenia mahagoni	West Indian Mahogany	20-25 x 15-20 (6-7.5 x 4.5-6)	10 (3)		Parks, median, streetscape	NATIVE. Attractive brown pods.
Terminalia catappa	Almond	25-30 x 12-15 (7.5-10 x 3.6-4.5)	12 (3.6)	AGGRESSIVE ROOTS. INVASIVE.	Coastal Areas, Farm Gardens	Salt tolerant, Edible Fruit.
Samanea saman	Guango	20-25 x 25-30 (6-7.5 x 7.5-10)	12+ (3.6+)		Parks, Large Open Spaces	
Cordia gerascanthus	Spanish Elm	20-25 (6-7.5)	10 (3)		Median, Verges, Parks	NATIVE. White flowers.
Bombax ceiba	Bombax	20-25 x 20 (6.7-8 x 6.7)	12+ (3.6+)		Specimen Gardens, Parks	Red flowers.
Barringtonia asiatica	Barringtonia	30-40 x 25 (10-13 x 8)	8-10 (2.4-3)	AGGRESSIVE ROOTS.	Large Open Spaces, Coastal Areas	Salt tolerant.
Guazuma ulmifolia	Bastard Cedar / West Indian Elm	25-30 x 35 (8-10 x 11.5)	8-10 (2.4-3)	TOXIC.	Large Open Spaces	
Grevillia robusta	Silky Oak	25 x 35 (8 x 11.5)	8-10 (2.4-3)		Park,Coastal Areas	
Ceiba pentandra	Silk Cotton	50 x 35 (16.5 x 11.5)	12+ (3.6+)			NATIVE. Culturally significant.
Lagerstroemia speciosa	Queen Flower / Queen's Crape Myrtle	20 x 30 (6.7 x 10)	8-10 (2.4-3)		Specimen Parks Verges	Pink, purple or white flowers.
Triplaris cumingiana	Long John	15-20 x 60 (5-6.7 x 20)	8-10 (2.4-3)		Verges Parks Screens	Red flowers. Attractive to ants.

MEDIUM TREE						
BOTANICAL NAME	**COMMON NAME**	**MATURE SIZE- height x width ft ft (m)**	**SPACING (m)**	**HAZARD**	**SUITABLE FOREST TYPE**	**REMARKS**
Erythrina poeppigiana	Mountain Immortelle	20-25 x 25 (6.7-7 x 8)	6-8		Park, Median, Large Open Space	Orange-red flowers.
Bucida buceras	Black Olive	12-15 x 15 (3.6-4.5 x 4.5)	6-8	Stain tannin	Median, Verge Shade Tree, Coastal Planting	NATIVE. Salt tolerant.
Azidirachta indica	Neem	25-30 x 25 (6.7-7 x 8)	6-8		Hardy, Verge, Median, Companion for crops	Insecticidal.
Cassia spp	Pink Cassia	25-30 x 20 (6.7-7 x 6)	6-8		Park, Median, Verge Specimen	Upright pink flowers (Cassia javanica) or hanging pink flowers (Cassia nodosa).
Cassia fistula	Golden Shower Tree	15-18 x 8-10 (4.5-5.4 x 2.4-3)	6-8		Park, Median, Verge Specimen	Attractive hanging yellow flowers.
Cassia siamea	Yellow Cassia	15-18 x 8-10 (4.5-5.4 x 2.4-3)	6-8		Park, Median, Verge	Upright yellow flowers.
Thespesia populnea	Seaside Mahoe	10-12 x 6-8 (3-3.6 x 1.8-2.4)	6-8	Messy	Coastal Tree Screen Hedge	Salt & drought tolerant.
Hibiscus tiliaceus	Variegated Mahoe	10-12 x 12 (3-3.6 x 3.6)	6-8			Salt tolerant.
Hibiscus elatus	Blue Mahoe	15-18 x 18-20 (4.5-5.4 x 5.4-6)	6-8	Dense canopy	Park Open Space	NATIONAL TREE. Red flower gets darker with age.
Guaicum officinale	Lignum Vitae	20-30 x20-30 (6-10 x 6-10)	8-10		Park, Verge Open space Coastal Tree	NATIONAL FLOWER. Blue or white flowers.
Bursera simaruba	Red Birch / Gumbo Limbo	18 x 10 (5.4 x3)	6-8	Bark is and Irritant	Verge, Cluster Planting, Hardy in dry limestone areas	Attractive copper-red flaky bark.
Jacaranda mimosifolia	Jacaranda	15-25 x 25 (4.5-8 x 8)	6-8		Specimen, Park, Open Space	Blue flowers. Useful as windbreaks.

SMALL-MEDIUM TREE						
BOTANICAL NAME	**COMMON NAME**	**MATURE SIZE- height x width ft (m)**	**SPACING (m)**	**HAZARD**	**SUITABLE FOREST TYPE**	**REMARKS**
Callistemon viminalis	Bottlebrush	8-12 x 8-12 (2.4-3.6 x 2.4-3.6)	5-7		Park, Verge Open Space Median Specimen Accent	Weeping habit (Callistemon viminalis) or upright habit (Callistemon citrinus)
Tabebuia serratifolia	Yellow Poui	15-20 x 20-25 (4.5-6.6 x 6.6-8)	5-7		Park, Verge Open Space Median Specimen Accent	Yellow papery flowers.
Cordia sebestena	Geiger Tree	25 x20 (8 x 6.7)	5-7		Verge, Median Open Space Coastal Area	Salt tolerant. Orange flowers.
Bauhinia spp	Poorman's Orchid	20 x25 (8 x 6.7)	5-7		Park, Median Verge, Specimen	Purple, pink or white flowers.
Parkinsonia aculeata	Jerusalem Thorn	20 x 25 (8 x 6.7)	5-7	THORNS Poisonous	Coastal Area, Security Fence	Salt & drought tolerant. Yellow flowers.
Plumeria spp.	Frangipani	15 x 10 (4.5 x 3)	5-7	Irritant	Median, Verge Specimen Streetscape	Salt tolerant. Host to caterpillars. Numerous varieties.
Thevetia peruviana	Lucky Nut	15 x 20 (4.5 x 3)	5-7	TOXIC	Median, Verge Coastal Plant	Salt & drought tolerant. Yellow flowers.
Coccoloba uvifera	Sea Grape	15 x 20-25	5-7		Coastal Plant	Salt tolerant.
Brya ebenus	Ebony / Jamaican Rain Tree	6-10 x 3-5 (1.6-3 x 1-1.5)	5-7		Accent, medians, xerophytic landscape	NATIVE. Attracts bees. Salt & drought tolerant.
Conocarpus erectus 'Sericeus'	Silver Buttonwood	15 x 20 (4.5 x 3)	5-7		Park, Median, Verge, Coastal Area, Screen	Salt tolerant. Silver foliage reverts to green at high elevations.
Conocarpus erectus	Buttonwood	15 x 20 (4.5 x 3)	5-7		Park, Median, Verge, Coastal Area, Screen	NATIVE. Salt tolerant.
Piscidia piscipula	Jamaican Dogwood	25 x 15 (8 x 4.5)	5-7		Median, Verge	Hardy, Endemic
Gliricidia sepium	Quick Stick	15-20 x 15-20 (4.5-6.7 x 4.5-6.7)	5-7		Median, Verge Fence Screen	Useful as fence posts or bioengineering. Pink flowers.

SHRUB						
BOTANICAL NAME	**COMMON NAME**	**MATURE SIZE- height x width ft (m)**	**SPACING ft (m)**	**HAZARD**	**SUITABLE FOREST TYPE**	**REMARKS**
Nerium oleander	Oleander	6-10 x 6 (1.8-3 x 1.8)	3-5 (1.0-1.5)	TOXIC	Median, Verge, Fence Screen	Salt tolerant. Red, pink or white flowers.
Lagerstroemia indica	June Rose / Crape Myrtle	3-6 x 3-6 (1.0-1.8 x 1.0-1.8)	3-5 (1.0-1.5)		Specimen, Park, Median	Red, white, pink or purple flowers.
Hibiscus rosa-sinensis	Hibiscus	3-6 x 3-6 (1.0-1.8 x 1.0-1.8)	3-5 (1.0-1.5)		Park, Median, Planters, Landscape Hedge	Numerous varieties and hybrids.
Caesalpinia pulcherrima	Pride of Barbados	8-12 x 6 (2.4-3.6 x 1.8)	2-3 (0.6-1.0)		Security fence, Verge	Salt tolerant.
Plumeria pudica	Bridal Bouquet	8-12 x 8 (2.4-3.6 x 2.4)	2-3 (0.6-1.0)		Streetscape, Median, Verge	Salt tolerant. White flowers.
Tecoma capensis	Cape Honeysuckle	8 x 6 (2.4 x 1.8)	2-3 (0.6-1.0)		Fenceline Drought Tolerant	Orange-red flowers.
Tecoma stans	Tecoma / Yellow Elder	10-12 x 4-6 (3.0-3.6 x 1.2-1.8)	2-3 (0.6-1.0)		Fenceline Drought Tolerant	Yellow flowers.
Mussaenda erythrophylla	Mussaenda / Ashanti Blood	10-12 x 4-6 (3.0-3.6 x 1.2-1.8)	2-3 (0.6-1.0)		Streetscape, Median, Verge, Fence	Standard form as tree. Red, white, or pink bracts
Tibouchina urvilleana	Tibouchina / Glory Bush	6-8 x 3-6 (1.8-2.4 x1.0-1.8)	2-3 (0.6-1.0)		Streetscape, Park,	Standard form as tree. Blue flowers. Best in higher elevations.

10.2 RESULTS MATRIX FOR GUIDELINES ON URBAN AND PERI-URBAN FORESTRY IN JAMAICA

The following matrix was developed by 4H Club in Jamaica as a standard of measurement for urban tree planting. The level of impact, outcome and output are measured against indicators defined for each. Targets are established and the protocols established for data collection, frequency with the responsible agency. Each result will target a framework policy for Alignment Monitoring, Evaluation and Learning (MEL)System Sustainability. The goal is to have a viable data base and standards of measurement and review towards efficient urban tree planting.

Table 4: Monitoring, Evaluation and Learning Matrix for EbA Intervention

Results Level	Indicator	Target	Data Collection Method	Data Source	Frequency	Responsible MDA	Framework /Policy /Strategy/Plan/Alignment Monitoring, Evaluation and Learning (MEL) System Sustainability
Impact	% Reduction in Energy Sector Emissions (NDC) in vegetated areas	*7.8% by 2030 (against BAU)*	Document Review	National Determined Contributions Communication- Global Stocktake; MSET Energy Report card	Annual	Ministry of Science, Energy & Technology (MSET)	Update of Nationally Determined Contribution (NDC) of Jamaica (October 20220)
	Change in status of forest cover	*10-year target*	Document Review	*Land Use Assessment (FY 2024/2025)*	Periodic *(3-year cycle)*	Forestry Department	National Forest Management and Conservation Plan 2016 – 2026 **Impact**: Jamaica's forests are sustainably managed, protected, healthy, economically viable and socially beneficial to all
	Estimated Affected Population Due to Heavy Rainfall and Flooding	TBC as per meteorological event	Document Review	*As reported to the ODPEM's NEOC*	Annual	Office of Disaster Preparedness and Emergency Management (ODPEM)/National Wor ks Agency	

Results Level	Indicator	Target	Data Collection Method	Data Source	Frequency	Responsible MDA	Framework /Policy /Strategy/Plan/Alignment Monitoring, Evaluation and Learning (MEL) System Sustainability
	Change in Soil Quality	*10-year target*	Document Review	*Soils and land cover/land use surveys*	Periodic *(3-year cycle)*	Agricultural Land Management Division (ALMD)	Land use monitoring and management (subdivision and quarry assessments), Ministry of Agriculture, Fisheries and Mining- Agricultural Land Management Division
Outcome	Survival rate of newly planted tree species	10-year target	Document Review	NFMCP Performance Monitoring, Evaluation and Reporting (PMER) system.	Annual *(85% baseline maintained and Forest Operations will continue to track survival.)*	Forestry Department	**National Forest Management and Conservation Plan 2016 – 2026 Outcome 2.2:** Sustainable harvesting and use of timber products from forests.
	Area (ha) of forest under sustainable forest management plans.	**10-year target**: (*All targeted areas under SFM have supporting management plans.)*	Document Review	NFMCP Performance Monitoring, Evaluation and Reporting (PMER) system.	Annual	Forestry Department	**National Forest Management and Conservation Plan 2016 – 2026 Outcome 3.1: Improved** participatory planning to manage, protect and conserve Jamaica's forests.
Output	Area (hectares) reforested	600 ha for 2016-2021 planted; 526 ha maintained.	Document Review	NFMCP Performance Monitoring, Evaluation and Reporting (PMER) system.	Annual	Forestry Department	**National Forest Management and Conservation Plan 2016 – 2026 Output 3.1.1:** Reforestation programme for forest estates developed. *(Suggested Reword: Reforestation in targeted forest estates)*

Results Level	Indicator	Target	Data Collection Method	Data Source	Frequency	Responsible MDA	Framework /Policy /Strategy/Plan/Alignment Monitoring, Evaluation and Learning (MEL) System Sustainability
	Number of seedlings produced and cost per seedling.	120,000. Costing info baseline established.	Document Review	NFMCP Performance Monitoring, Evaluation and Reporting (PMER) system.	Annual	Forestry Department	**National Forest Management and Conservation Plan 2016 – 2026 Output 3.1.4:** Nursery programme implemented and evaluated.
	(Yes/No) Guidelines developed for the establishment and maintenance of trees in urban settings and for use in culture, aesthetics and shade purposes.	Guidelines Completed	Document Review	NFMCP Performance Monitoring, Evaluation and Reporting (PMER) system.	Annual	Forestry Department	**National Forest Management and Conservation Plan 2016 – 2026 Output 3.1.7:** Appropriate guidelines developed for the establishment and maintenance of trees in urban settings; for cultural, aesthetics and shade purposes
	Number of public education/awareness sessions and school awareness programmes delivered (by type and stakeholder).	1400 schools in 14 parishes visited and 25 communities reached.	Document Review	NFMCP Performance Monitoring, Evaluation and Reporting (PMER) system.	Annual	Forestry Department	**National Forest Management and Conservation Plan 2016 – 2026 Output 4.1.1:** Education programme developed to strengthen the public's understanding on the benefits of forests and its resources, the importance of sustainable forest management and conservation practices.

Source: Product No.3 - Monitoring and Evaluation sections included in the 2 EbA guidelines developed by Jamaica 4-H Clubs.

11.0 ADDITIONAL READING

The following are recommended reading/resource areas to aid the planning process of building a sustainable urban landscape. Some of the reading outlines the historical environment that can assist in the planning process for the rapidly developing urban and peri-urban centres.

Adams, C. D. (1971). *The blue mahoe & other bush : an introduction to plant life in Jamaica*.

Adams, C. D. (1972). *Flowering Plants of Jamaica*. University of the West Indies.

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Bauer, T. (2022). "Adjustments in Indigenous Peoples' Forest Use and Management in the Context of Climate Change: A Global Systematic Literature Review". *International Forestry Review*.

Campbell, K. C. S. E., & Institute of Jamaica. (2010). *Endemic trees of Jamaica*. Institute of Jamaica.

FAO, & OAA. (2013). *Climate change guidelines for forest managers*. Food and Agriculture Organization of the United Nations FAO.

Higman, B. W. (1990). *Jamaica surveyed: plantation maps and plans of the eighteenth and nineteenth centuries.*

Parker, T. (2003). *Manual of dendrology : Jamaica*. Forestry Dept.

Salbitano, F., Borelli, S., Conigliaro, M., Chen, Y., & Food and Agriculture Organization of the United Nations. (2016). *Guidelines on urban and peri-urban forestry.* Food and Agriculture Organization of the United Nations.

Schiechtl, H. M. (1973*). Sicherungsarbeiten im Landschaftsbau.*

Steele, J. G., Vernon, K. C., & Hewitt, C. W. (1954). *A capability grouping of the soils of Jamaica, B.W.I.*

Tortello, R. (2007). *Pieces of the past : a stroll down Jamaica's memory lane.* Ian Randle Publishers.