North Oakville Urban Forest Strategic Management Plan

September 14, 2012

OAKVILLE

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DILLON
CONSULTING

Table of Contents

Executive Summary

North Oakville, planned to be an urban, compact community, presents many strategic planning challenges to the Town of Oakville, in pursuit of a long-term vision to meet the 40 percent tree canopy cover target. North Oakville Urban Forest Strategic Management Plan (NOUFSMP) is a document prepared to provide the Town of Oakville with high-level strategy and planning recommendations for achieving a sustainable, healthy urban forest. North Oakville is comprised of the lands roughly bounded by Dundas Street to the south, Ninth Line to the east, Highway 407 and Lower Base Line to the north and Tremaine Road to the west.

This Plan complements and builds upon the recommendations presented in the town's Urban Forest Strategic Management Plan, 2008, which provided direction regarding the effective management and stewardship of the town's 'green infrastructure' within the built context, south of Dundas Street.

An investigation of the Town of Oakville's 4,000 hectares of land north of Dundas Street determined the study area's existing and potential urban forest canopies: 1,603 hectares of the total land area will be needed to achieve the 40 percent tree canopy cover target[1]. The Natural Heritage System (NHS), defined as native forests, cultural woodlands (regenerating), shrublands (cultural or native shrub thicket wetlands) and agricultural hedgerows[2], accounts for 901 hectares of north Oakville's land area and is a critical to achieving the targeted urban forest cover. Currently, there are 473 hectares of shrub thicket and forest communities within the NHS and an additional 310 hectares that are identified for future urban forests. The NHS does not include lands north of Highway 407; existing forests and wooded hedgerows in this area are referred to in this document as the natural lands north of Highway 407 and include 294 hectares of existing and an additional 13 hectares of future urban forest. Collectively the NHS and natural lands north of Highway 407 currently have 767 hectares of canopy cover and are planned to contribute 1,087 hectares or approximately 67 percent of the 1603 hectares of canopy cover needed to achieve the 40 percent urban forest target.

Of North Oakville's total land base, 1,625 hectares (40 percent) land base is developable (i.e., residential, employment/industrial, institutional and commercial) and has the potential to contribute 312 hectares (approximately 20 percent) towards the urban forest canopy cover. Other areas, including transitional areas, cemeteries, transit ways, roads and stormwater management facilities, make up the remaining 1,045 hectares of the north Oakville lands, contributing approximately 124 hectares (approximately 8 percent) towards the town's tree canopy cover target.

Parks provide an excellent opportunity to contribute to a potential canopy cover, if planted to their fullest capacity. A study of three demonstration park types reveals the ability to achieve high canopy cover percentages: village square at 77 percent coverage, neighbourhood park at 57 percent coverage, and community park at 66 percent coverage. The maximum canopy cover of the tree park types contributes 82 hectares (approximately 5 percent) to the overall urban forest cover in north Oakville.

Many factors contribute to tree health and tree mortality, including soil compaction, inadequate soil volumes and tree species selection. Fundamentally, land-use and design practices affect the growth and health of urban trees. The use of engineered soils (e.g., CU-Structural Soil ™ and Silva Cell ™) on paved sites such as parking lots, low use access roads and urban plaza areas in places such as the Trafalgar Core area and along downtown streetscapes can improve tree habitat conditions. Engineered soils also contribute towards stormwater management. Other considerations to achieving a healthy urban forest are the use of native species, and addressing the decline of Oak forests and threat of Emerald Ash Borer.

To ensure prosperous growth and health of urban trees, UFORE soil volume recommendations (15 cubic metres for small stature trees, 30 cubic metres for medium stature trees and 45 cubic metres for large stature trees) were acknowledged and then adapted to meet conditions specific to north Oakville. The required soil volume for the NOUFSMP is 30 cubic metres per tree. This Plan strives to achieve the greatest volumes and soil quality possible (refer to Appendix C) in all locations.

Capital costs for implementing the recommendations are primarily related to soil depth and volume for tree planting. A 750 millimetre to 200 millimetre topsoil depth range is based on the planting conditions, such as in parks, private lands and public right-of-ways. The cost also increases if engineered soils are used for hard landscape locations, such as parking lots and boulevards. These costs can be mitigated by maximizing on most suitable planting locations and species to minimize mortality and ongoing cost of tree replacement.

1 Refer to Table 5 on page 20.
2 Definition from North Oakville Creeks Subwatershed Study, 2006.

Implementation of the urban forest canopy cover target in north Oakville will require the use of a variety of planning tools, including the zoning by-law, the subdivision approval process, North Oakville Sustainable Development Checklist and User Guide, and green parking lot design guidelines. Successful implementation will also require training for town staff in order to effectively implement the recommendations into the site approval process.

To achieve a 40 percent canopy cover target requires the Town of Oakville's leadership in the transitional process of both establishing policy and its implementation. The long-term benefits will be the sustained ecological health of the urban forest. Below are recommendations for meeting the 40 percent canopy cover target in north Oakville:

1. Amend the Development Review Process to check for compliance with the canopy cover targets as shown below, including: reflecting the canopy cover target in the design plans; updating Site Plan Approval and Subdivision Approval Requirements; and updating Landscape Standards for Landscape Plan Submissions.

Land Use	Proposed Standard
The NHS & Natural Lands North of 407	90%
Agricultural Lands North of 407	0%
Residential (all types)	20%
Employment/Industrial	20%
Parkland	50%
Arterial + Avenue Roads	34%
Cemetery	34%
Commercial/Mixed Use	15%
SWM	15%
Transit Ways	34%
Public Use (schools)	20%
Transitional Area	15%
Institutional	25%

2. Implement new landscape standards.

3. Adopt new Tree Planting Standard Details to reflect an increase in soil volume to the full potential of each planting location with 30 cubic metres per tree and soil depth in continuous tree planting trenches to 750 millimetre depth (Appendix B).

4. Revise the spacing for street trees on landscape plans to reflect the optimal growth opportunity of the site.

5. Implement design guidelines for 'greening parking lots'.

6. Amend the zoning by-law to include one (1) tree for five (5) parking spaces in surface parking lots.

7. Review to incorporate the tree planting details, landscape standards, and green parking lot landscape standards outlined in the NOUFSMP into the development standards south of Dundas Street.

8. Provide staff training in landscape architecture, planning, urban design and forestry for the implementation of the new requirements and standards. This may require new resources.

9. Establish incentives or support voluntary stewardship activities (e.g., tree give-away for residential landowners) to enhance tree canopy on low and medium density residential lots (e.g., 10,000 lots with medium stature trees at 78.5 square metres per tree provides 78.5 hectares canopy cover, or 10,000 lots with small stature trees at 7.05 square metres per tree provides 7.05 hectares canopy cover).

10. Recognize that tree planting requirements in the Natural Heritage System (NHS) are distinct from those in urban areas. Trees planted in the NHS should be 100% native and conform to best management practices in natural areas.

11. Consider partnering with a university (e.g., University of Toronto, Faculty of Forestry) to conduct performance testing on mycorrhiza fungi products with the intent of generating a peer-reviewed article in a forestry journal.

12. Work with Conservation Halton so that agricultural fields not assigned a management prescription in the Glenorchy Conservation Area draft Master Plan be considered for future forest cover.

13. Conduct periodic site reviews during construction, and regular inspections to monitor tree health.

14. Review maintenance securities such as 'maintenance holdback' to ensure that ongoing care is provided to support growth.

15. Monitor oak dominated forests and provide silvicultural treatment if oak savannas, woodlands and forests area are to be maintained in north Oakville.

16. Form partnerships with Non-Government Organizations whose grass-roots greening initiatives include planting events, parkland stewardship and green-space planning.

Figure 1: North Oakville, Town of Oakville

1.0 Introduction

The Town of Oakville retained Natural Resource Solutions (NRSI) and Dillon Consulting (previously ENVision – The Hough Group) as a team to prepare North Oakville's Urban Forest Strategic Management Plan (NOUFSMP). This Plan follows on one of the recommendations of the Urban Forest Strategic Management Plan, Town of Oakville: 2008 – 2027[3] (UFSMP), which was to develop a separate Urban Forest Strategic Management Plan for the lands north of Dundas Street. The study area covered in the NOUFSMP is defined by Dundas Street to the south, Ninth Line to the east, Highway 407 and Lower Base Line to the north, and Tremaine Road to the west (see Figure 1).

The purpose of this Plan is to provide high-level strategy and planning recommendations for achieving a sustainable, healthy urban forest within the study area and to build on the findings of the town's UFSMP. In total, the UFSMP made 66 recommendations designed to make more effective the management and stewardship of the town's 'green infrastructure'. While the intent of that plan was to provide direction for the town as a whole, the focus was primarily on the built-up portion of the town which encompassed all lands south of Dundas Street. The study area covered by this Plan is predominantly agricultural; however, the lands south of Highway 407 will be developed. The lands south of Highway 407 have been the focus of much study from a subwatershed and secondary planning perspective. The lands north of Highway 407 are outside the Urban Area and are situated within the Greenbelt and Parkway Belt West Plan. According to the Town of Oakville's Official Plan, municipal servicing will not be extended north of Highway 407; it is anticipated that this area will remain largely agricultural.

The UFSMP is the foundation for this Plan; the recommendations made in this Plan are meant to compliment and build on those of the UFSMP.

3 Urban Forest Innovations Inc. and Kenney, A., 2008.

2.0 Review of Background Information

North Oakville Urban Forest Strategic Management Plan (NOUFSMP) builds on the substantial body of work and research completed to-date by the Town of Oakville, as well as relevant material from other jurisdictions. Rather than repeat material already published, the NOUFSMP is focused specifically on presenting realistic, practical strategies and providing planning recommendations towards achieving the Mayor's challenge – 40 percent canopy coverage by 2057 - for the Town of Oakville. This target is also presented as one of the general town-wide objectives for sustainability in the new official plan – The Livable Oakville Plan.

2.1 Relevant Planning, Policy and Research Documents

2.1.1 Greenbelt Plan

The Greenbelt Plan is a provincial policy document that defines where growth should occur within the Greater Golden Horseshoe and what lands should be protected from development. This plan is a result of the *Greenbelt Act (2005)*. This act covers some of the north Oakville lands north of Highway 407.

2.1.2 Provincial Acts

Ontario's *Places to Grow Act (2006)* also includes policies to protect natural systems. In addition, the provincial *Forestry Act* and the *Municipal Act* give municipalities authority to pass tree-cutting and tree protection by-laws. See further discussion of the 2008 Private Tree Protection By-law, Section 2.1.11.

2.1.3 Parkway Belt West Plan

The Parkway Belt West Plan was implemented in 1978 to establish a multi-purpose utility corridor, urban separator and linked open-space system. Part of the Parkway Belt West Plan overlaps with the Greenbelt Plan in north Oakville, north of Highway 407. A portion of the lands south of Highway 407 are also subject to this Plan.

2.1.4 Urban Forest Strategic Management Plan

The Urban Forest Strategic Management Plan (UFSMP) provided the starting point for the NOUFSMP. The UFSMP suggested that a combination of voluntary (carrot) and mandatory (stick) policy measures would be necessary to protect existing canopy trees or ensure the installation and sustainability of proposed canopy trees, on private lands. *Oakville's Environmental Strategic Plan (2005) Action 1.1: 'To protect and enhance our natural habitats, including Oakville's urban forest'* is also mentioned in the UFSMP.

Along with Recommendation Number 2 – *'The town should develop a separate Urban Forest Strategic Management Plan for the lands north of Dundas Street consistent with the principles outlined in this document'*, the following additional recommendations are most relevant to the NOUFSMP:

6. The town should consider incorporating an assessment of potential leaf area by land use type into the 2009 UFORE [Urban Forest Effects Model] Study.

22. The town's Interdepartmental/Interagency Technical Advisory Committee (IITAC) should collaborate in a review of Tree Habitat Design Guidelines, and the potential role of zoning by-laws in reserving sufficient good tree habitat to support the canopy/leaf area targets identified for each Land Use Type.

24. The town's IITAC should establish canopy cover targets for parking lots and should develop design and implementation guidelines to achieve these targets.

25. The town's IITAC should collaborate on the development of guidelines for the protection of tree habitat during the maintenance and upgrading of grey infrastructure.

27. The town should develop a set of engineering road cross-sections using root zone modifications for implementation in difficult sites.

32. The town should develop a Prime Site strategy which will identify priority sites to amend the soil quantity and quality in accordance with the Town of Oakville's Our Solution to Our Pollution.

34. The town should outline the creation of a pro-active under planting program in those communities at risk of decreasing urban forest canopy cover due to aging trees.

36. The town's Parks and Open Space Department will identify opportunities for Parks Naturalization that contribute to the forest canopy (and prepare capital budget costs).

54. The town should develop a private urban forest stewardship education program.

61. The town should consider an amendment to the Zoning By-law for

Employment, Commercial, and Industrial land use types to regulate the planting area for trees.

62. The town should undertake a study to assess the impact on the town-wide canopy cover of implementing a "Planting Area for Trees" policy on all land uses which are subject to site plan approval.

Recommendation 62 was based on demonstration landscape plans for two different land use types: Commercial Plazas and Corporate Centres. This exercise generated several key findings that are relevant to this Plan, and because north Oakville south of Highway 407 is not yet built-out, town staff is in a position to apply these lessons during the site planning process for north Oakville lands.

- *The current site plan approval process could be effective in achieving between 25 percent and 30 percent canopy cover of the development site if the trees grow to maturity.*

- *This amount of tree canopy on commercial and employment sites is significantly higher than what currently exists for this general land use category across the municipality.*

- *Many trees on many sites across the town will not achieve their potential mature size because they are planted in areas where there is deficient habitat or where the level of maintenance is not adequate to sustain the trees.*

- *The trees actually planted on the sites in accordance with the approved Landscape Plans are spaced too close together for each individual tree canopy to optimize their contribution to the total canopy area. When the mature canopies are plotted on the plan, it is seen that there is often a very large amount of overlap. If the same number of trees were planted in accordance with the optimal spacing guidelines for their tree size, the canopy cover on the site would increase significantly. For these two sites, if there were no overlapping effect, the number of trees planted would achieve approximately 38 percent canopy cover on the small commercial site and 48 percent canopy cover on the office site.*

- *The number of trees planted on a site may not be the most important issue in achieving the desired canopy cover. The provision of appropriate planting area for trees is more critical, since it allows for optimal spacing and ensures the long-term health and growth of the tree.*

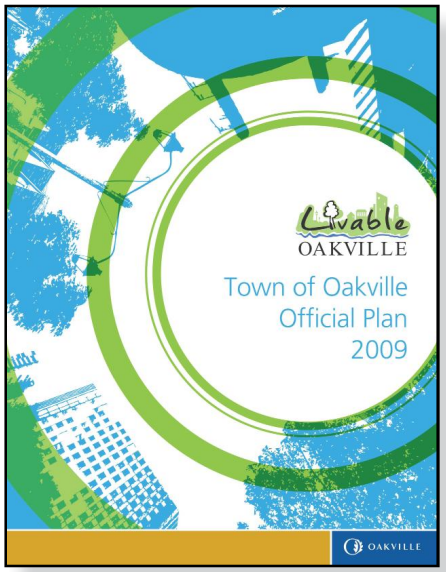
- *A policy to achieve 40 percent canopy cover in the land use types represented in these two studies appears to be feasible in the long-term. The actual number of trees to be planted does not increase significantly. The impact on the parking spaces is minimal given the predominance of smaller cars. The functioning of the site in terms of building area, parking area, number of parking spaces, and circulation routes is not affected. However, it is recognized this can only be achieved with the use of enhanced rooting environment techniques and a commitment to long-term tree care, both of which will increase the overall costs of landscape establishment and maintenance*[4].

2.1.5 North Oakville Creeks Subwatershed Study

Between 2002 and 2006, the study area south of Highway 407 was subject to the North Oakville Creeks Subwatershed Study (NOCSS). Key outcomes of that process are a defined Natural Heritage System, and the layout of developable lands. The long-term vision / management of the lands within the Natural Heritage System were determined in the NOCSS; these management prescriptions have been adhered to in this Plan. For example, areas that were known to support ecological functions associated with early successional habitats and were prescribed to be maintained as open country habitats have been assumed to be maintained as permanently open, and not eligible for tree planting or forest regeneration.

2.1.6 Official Plan, 2006 and The Livable Oakville Plan, 2009

The town's Official Plan (2006) sets clear goals for Oakville's urban forest, its management, planning and policy directions, as well as other town policies that have potential impacts on the quantity and quality of tree habitat, as a consequence of zoning by-laws and engineering cross-sections. The Livable Oakville Plan, 2009, the town's new official plan, sets the general sustainability objectives to maintain the existing urban forest and to progressively increase the urban forest canopy cover to 40



4 Urban Forest Innovations Inc. and Kenney, A., 2008, p. 91.

percent[5]. Lands north of Dundas Street are not subject to the policies of the Livable Oakville Plan, but the development of these lands would be subject to the town's overall sustainability vision and policy direction.

2.1.7 Oakville Transportation Master Plan

The Oakville Transportation Master Plan study provided guidance to Council, staff and stakeholders regarding transportation requirements in the town to 2021. The Master Plan established transportation policies, guidelines and infrastructure development plans that encompassed all modes of transportation. The Master Plan provided a comprehensive update of previous transportation studies and expanded on the Oakville Transit Operational Review and provided input to the town's Official Plan and Development Charges by-law.

2.1.8 North Oakville East Secondary Plan (NOESP)

The NOESP reflects the official plan policies for North Oakville East area. Site plans are reviewed in relation to the North Oakville Urban Design and Open Space Guidelines. The town requires some classes of development to be subject to site plan control as per the town's site plan by-law. In addition, the town has approved a new zoning framework for both NOESP and NOWSP areas.

2.1.9 North Oakville West Secondary Plan (NOWSP)

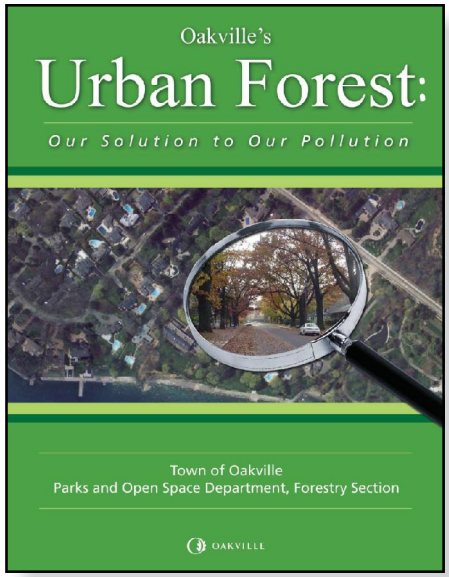
The NOWSP follows the same subwatershed and planning approaches as the NOESP. This plan was adopted by Council in May 2009 and is proceeding to a hearing at the Ontario Municipal Board.

2.1.10 Oakville's Urban Forest: Our Solution to Our Pollution (2006)

Canadian towns and cities have begun to measure and predict the utility of urban forests. Using an established model of Urban Forest Effects (UFORE), developed through the United States Department of Agriculture's (USDA) Forest Service, they now have a scientific picture of structure, function and economic value of their urban forests, including the forests' role in greenhouse gas mitigation.

The City of Calgary was the first Canadian city to participate, in 1998, and three more Canadian cities have completed UFORE studies: Kelowna, BC; Toronto, ON; and the Town of Oakville. Halifax, NS and Fredericton, NB have UFORE studies in progress.

Oakville's Urban Forest: Our Solution to Our Pollution[6], produced by the town's Parks and Open Space Department (Forestry Section), provided an overview of the benefits of urban forests, the state of south Oakville's urban forest (as assessed through UFORE), as well as tools for building the urban forest canopy.



With this document, the town demonstrated that municipalities can take a scientific approach towards assessing the ecological benefits provided by urban forests, and provided a number of conclusions, recommendations and action items relevant to the NOUFSMP:

Action Item 8
The town should investigate the feasibility of an incentive program for private large-stature trees (in order to maximize filtration of criteria pollutants and greenhouse gasses).

Action Item 10
The Parks and Open Space Department should identify opportunities for Parks Naturalization that contribute to the forest canopy and prepare capital budget costs.

Action Item 11
The Forestry Section should Chair an Interdepartmental/ Interagency Technical Advisory Committee to recommend:

- Urban forest canopy targets for Oakville; and,
- How key town Departments can contribute to achieving these targets.

Action Item 15
The Tree Habitat Design Guidelines for Oakville should be reviewed with the Interdepartmental Technical Advisory Committee identified in Action Item 11 – to incorporate the guidelines into the town's urban design standards of key town Departments.

5 Town of Oakville, 2009, Part C.
6 Town of Oakville, 2006a.

Action Item 17
The Interdepartmental Technical Advisory Committee, identified in Action Item 11, should investigate the potential role of zoning by-laws to reserve the land which supports the tree.

Action Item 20
The Parks and Open Space Department (should) establish a 'soil restoration program' as part of its 'Prime Site' management program.

Action Item 22
The town to review the Site Plan design guidelines for parking lot design with respect to tree habitat and establish targets for urban forest canopy cover attainment linked to Action Item 11.

One point *Oakville's Urban Forest: Our Solution to Our Pollution* makes clear is that '*trees have long been fit into spaces left over after everything else is written into the design.*' If urban design reflects a true balance of both the "grey" and "green" infrastructure interests, in accordance with formal policy and design standards spanning departments, if the right site is provided for the right tree, and if that tree is sourced and planted to best practises, then the odds are much improved that the tree will live long enough to contribute to their carbon storage and sequestration potential.

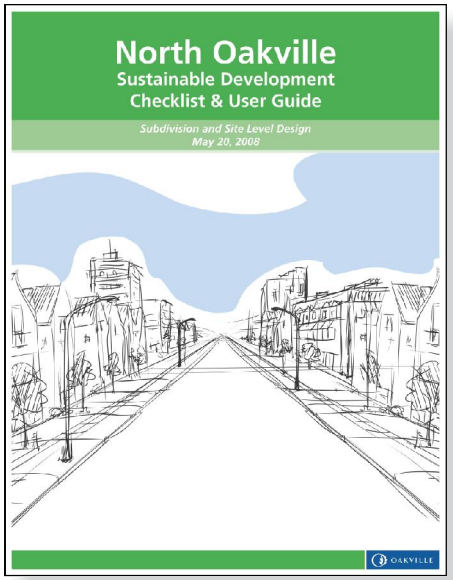
Oakville's Urban Forest: Our Solution to Our Pollution[7] suggested:

> *'A paradigm shift in landscape design is (also) required. When sites are over planted with trees, after 10 to 20 years the trees have outgrown the location and start to decline in health… An alternative landscape design which optimizes ecological services would be to plant fewer large-stature trees. Over time, this will attain the optimum carbon storage and sequestration potential, assuming suitable tree maintenance."*

2.1.11 Private Tree Protection By-Law (2008-156)

The town has a Private Tree Protection By-Law (2008-156), enacted in October 2008 (similar to protection by-laws enacted in Mississauga and Aurora), which prohibits the injury or destruction of any tree classified as endangered, threatened or at risk, or five (5) or more trees greater than 20 centimetres diameter-at-breast-height (dbh) and less than 76 centimetres dbh (without first obtaining a permit) on private property within one calendar year, although there are a number of exceptions. Penalty fees are also imposed (starting at $200 per tree at the fifth tree). When permits for the destruction of a tree(s) is issued, conditions such as replacing trees or payments for trees not replanted, may be applied. The Private Tree Protection By-law applies town-wide, including lands in north Oakville. However, there is clause, s. 6(m), which gives discretion to the Director of Development Engineering to exempt projects going through EIR/FSS processes due to the comprehensive nature of the EIR/FSS.

2.1.12 North Oakville Sustainable Development Checklist and User Guide



The North Oakville Sustainable Development Checklist and User Guide (2008) is a tool used by staff to assess the sustainable features of subdivision and site level design development applications. Its intent is to encourage sustainable development practices although the required components actually reflect requirements as contained in the North Oakville Secondary Plans (NOSP).

The checklist employs a 'points' system. The lowest level, Level 1, indicates that a minimal level of conformance to the NOSP has been achieved. Currently the checklist does not specifically reference canopy coverage. Landscape-based items refer to '*bioswales (and) appropriately sized landscape islands*' for surface parking lots, '*low maintenance and drought resistant*' planting palettes, and the maintenance of '*existing on-site trees that are 30 centimetres or more diameter-at-breast-height (dbh)*'[8].

2.1.13 Town of Oakville Site Plan Review Process

Through the Site Plan Review process, applicable town-wide on the majority of sites, development proposals incorporating tree preservation, tree removals and/or tree plantings are assessed and either modified or deemed satisfactory by staff representing several town Departments and external Agencies. In all

7 Town of Oakville, 2006a, page 30.

8 Town of Oakville, 2008b, page 10.

instances, assessments and recommendations by staff are specific to the desired outcomes on the subject site, on abutting town lands (boulevard and/or open space) and on mitigating possible impacts on abutting and adjacent private properties resulting from the proposed development activity.

During the mandatory pre-application meeting, staff provide the applicant with general feedback on the proposal and outline the submission requirements; materials typically include landscape plans and plant list details, tree preservation plans, arborist report or declaration letter (verifying no vegetation on the site). Upon receipt of the site plan application, the above-mentioned materials are circulated to and reviewed by town staff in Planning Services and Development Engineering. When applicable, the materials are circulated to and reviewed by Parks and Open Space, and Engineering and Construction departments and by external agency staff at the Region of Halton and Conservation Halton or Credit Valley Conservation.

Planning staff continually update and refine the submission requirements on the pre-application materials checklist and the site plan application forms. Planning staff are in the process of creating a Site Plan Standards Manual which will outline the expectations for site development and detail the type and contents of the materials to be submitted. The Manual will include a 'landscape standards' chapter that will incorporate the standards presented in this document.

2.1.14 Conservation Halton Guidelines

Conservation Halton Guidelines for Stormwater Management Pond and Creek Realignment Planting Plans and Tree Preservation Plans (2005) contain policies regarding the preservation and enhancement of vegetation in natural heritage systems within its jurisdiction, specifying planting design techniques, appropriate native tree, shrub, ground cover, floodplain and aquatic plant species, planting guidelines regarding topsoil, stabilization, monitoring and maintenance and specific criteria and preferred densities, for planting in stormwater management and watercourse areas. These guidelines are currently being reviewed and updated.

Development applicants may be required to prepare a tree preservation plan in order to ensure there is no impact to existing trees during the development process. The plans are required to consist of the following:

- location of site, project name, address, applicant and owner's name, file number;
- existing and proposed grades;
- drip line (as staked by Conservation Halton in conjunction with municipal staff);
- tree inventory (botanical names for all species), size and health;
- tree protection measures;
- construction access routes;
- location of topsoil stockpiles; and,
- opportunities for salvage/transplant in those areas impacted by development.

In some instances, a revegetation/landscape plan may be required. Conservation Halton (CH) requires only species native to the Region for vegetation proposed within or near a natural feature. Invasive species, such as Norway maple (*Acer platanoides*) and its cultivars, are not permitted. A net gain principle will be applied when providing comments on revegetation/rehabilitation plans to ensure a net environmental benefit for the proposal.

- location of site, project name, address, applicant and owner's name, file number;
- scientific names and quantities for all species;
- native species adjacent to natural areas;
- non-invasive species;
- ground cover species list including botanical names and percent composition;
- nursery crop species – if required due to timing;
- minimum caliper for tree is 60 millimetres;
- minimum height for conifer tree is 150 centimetres;
- minimum height for shrub is 60 centimetres;
- location of existing vegetation;
- top soil details – depth and composition;
- rodent protection details;
- extent of disturbed area; and
- existing watercourses.

Conservation Halton is also a commenting agency, providing input and review for land-use planning applications submitted to the upper and lower tier municipalities under the Planning Act. Comments by CH regarding planting plans and tree preservation plans may be included as a condition of site plan approval or subdivision agreement, but in areas not regulated by CH, comments regarding planting plans are for advice only. Should the municipality agree with CH's recommendations, CH will review the detailed plans for conformity. The municipality is responsible for ensuring appropriate planting plans are implemented by the proponent/developer.

2.2 Oakville's Natural Heritage System

The town's Natural Heritage System (NHS) - to be conveyed into public stewardship as development occurs - is a mix of terrestrial (i.e., woodlots, wetlands and open fields) and aquatic systems (i.e., watercourses and valleys), as shown in Figure 2. It will run through the four new communities of Oakville: 407 West, Sixteen Hollow, Glenorchy and Joshua's Meadows.

The NHS is a total of 900 hectares - approximately 600 hectares east of Sixteen Mile Creek and 300 hectares west of Sixteen Mile Creek[9] and is bounded by Dundas Street West to the south and Highway 407 to the north. This area is comprised of eleven core natural areas, stream corridors and linkages. A part of the NHS includes the portions of the Ontario Realty Corporation lands which are being managed as part of the Glenorchy Conservation Area (Glenorchy CA) by Conservation Halton. Specifically, Glenorchy CA overlaps all of Core #2 and part of Core #3.

Lands outside of the NHS will be developed but will include neighbourhood parks, village squares, community centres and community parks.

9 Town of Oakville, 2009c.

Figure 2: North Oakville's Natural Heritage System, Town of Oakville

Everything within the NHS will be preserved. Its protection will be reflected within the Draft Plans of Subdivision and their implementing zoning by-law.

North of Highway 407 the landscape is largely agricultural and as such is comprised of agricultural fields with scattered woodlots and wetlands. Sixteen Mile Creek is the major natural feature and is associated with extensive riparian forests, the majority of which will be managed by Conservation Halton as part of the Glenorchy Conservation Area. For the purpose of this document all treed or otherwise natural areas north of Highway 407, either within existing woodlots, well established hedgerows and Glenorchy CA, will be referred to as the Natural Lands north of Highway 407.

2.3 How Canopy Cover is Measured for this Study

Canopy cover is a widely-used measure of the extent of our urban forests because it is relatively easy to estimate by using remote sensing, aerial photographs or from the ground. The approach involves an estimate of the proportion of the ground area that is covered by tree (and shrub) crowns resulting in a value expressed as a percentage of canopy cover. While a percentage of cover such as 20 percent is quantitatively informative, the distribution of the canopy cover is the most useful for determining the health and viability of the urban forest.

Current canopy cover calculations represent the existing urban forest but do not measure what the potential canopy cover may be if the trees are able to achieve a mature size. Dr. Andy Kenney, a Senior Lecturer teaching courses in urban forestry at the University of Toronto, was a contributor to the Town of Oakville UFSMP (south of Dundas Street). He has helped several municipalities enhance the relationship between urban design and urban forest structure, and is particularly interested in strategic planning in urban forestry and the involvement of stakeholder groups in managing urban forests. Dr. Kenney has identified some problems with the use and definition of the term "canopy cover" and how it is measured. Specifically, he has noted that canopy cover and the way it is usually measured is an aggregate of all trees and shrubs and much depends on how the resources are being managed[10]. In some instances, forest or woodlands are managed as a stand or woodland unit, while in others trees are intensively managed as landscape specimens.

Dr. Kenney also noted that canopy cover is calculated two dimensionally and doesn't consider the crown depth of trees, nor does it consider the health of the crowns or the quality of the ecological contribution to the natural heritage system

10 Interview between Dr. Kenney and town staff.

in the community. The Urban Forest Effects Model (UFORE) model estimates among other things, the proportion of some air pollutants that are sequestered by the urban forest. These models are primarily derived from estimates of the leaf area of the urban forest. Leaf area estimates are derived from sample plots across the various land use types, based on actual tree measurements, taking into account tree size (crown width and length), species and condition. Put very simply, these measurements are used to describe the town's urban forest and it is these measurements that contribute to the estimation of the benefits derived from the forest. While there should be a relationship between canopy cover and leaf area, it does not represent a simple conversion.

2.4 Canopy Cover in the Greater Toronto Area

The Town of Oakville is in pursuit of a high-level strategy to increase its urban forest canopy cover from 29 percent to 40 percent in the next 50 years. This is increasingly becoming a high priority strategy for many neighbouring municipalities. City of Toronto established a framework to increase its urban forest canopy cover from approximately 20 percent to 35 percent, and the City of Brampton is in pursuit to increase its urban forest canopy cover from 7 percent to 20 percent.

Other municipalities' existing urban forest canopy cover ranges between 15 to 29 percent; Mississauga is at 15 percent, Ajax is at 18 percent, Caledon East at 29 percent and Bolton at 17 percent[11].

2.5 Lessons from Other Jurisdictions

Measuring, evaluating, protecting and enhancing urban forest cover/canopy has become a pressing concern globally. Based on satellite images of 40 US cities, American Forests reported in 2003 that "*urban areas have 21 percent less tree canopy today than they did 10 years earlier*." Tree canopy covers only 12 percent of Buffalo and Lackawanna, New York. Trees shelter less than 20 percent of metropolitan San Diego. At the other end of the spectrum, one of the lushest cities is Savannah, Georgia, where trees shelter more than 60 percent of the land and buildings.

The Town of Oakville's urban forest canopy cover is at 29.1 percent with a vision to increase its urban forest canopy cover to 40 percent by 2057[12], as cited in Mayor's "Canopy Cover Challenge", reflected in the direction of the town's official plan – The Livable Oakville Plan, and deemed feasible in the canopy cover study for the town' UFORE. The town's vision is consistent with the recommendations given by the American Forests (formerly known as the American Forestry Association) for an average 40 percent tree canopy in metropolitan areas east of the Mississippi and in the Pacific Northwest.

To achieve a 40 percent canopy cover target requires the Town of Oakville's leadership in the transitional process of both establishing policy and its implementation. This section of the Plan establishes a comprehensive understanding of the subject matter and lessons learned from other jurisdictions.

2.5.1 Urban Forest as Green Infrastructure

Until only a few years ago, much planning policy regarding trees focused on the protection of existing single mature specimens, regulating tree planting to maintain desirable views or sight lines and/or using plant material to reduce energy consumption, heating and cooling costs. Some jurisdictions have begun to look at urban forests as green infrastructure, and have only recently undertaken UFORE analyses of their own. Consequently background material, findings, lessons and especially successes based on implementing canopy targets are limited.

UFORE is the most comprehensive urban forestry analysis tool currently available and provides the most accurate and detailed data results that are useful for management decisions or for developing a comprehensive urban forest master plan. Results are representative of the local climate. UFORE does not take into consideration management costs.

Most recently, Oakville joined hundreds of North American cities that have performed some kind of urban forest assessment with *Oakville's Urban Forest: Our Solution to Our Pollution* (2006). This was followed by the town's *Urban Forest Strategic Management Plan, 2008 to 2027* in 2008 for the lands south of Dundas Street West.

2.5.2 Urban Forest Cost-Benefit Analyses

Cost-benefit analyses of urban forest investments show that communities receive tremendous pay back for dollars spent. An urban forest canopy provides savings in cooling-energy requirements during the summer as a result of shading and reduction in solar heat retention, and the potential reduction in winter heating needs due to wind sheltering effects. For example, a study conducted by Akbari, Pomerantz & Taha[13] has shown that trees can provide a seasonal cooling-energy

11 City of Toronto & TRCA. Unknown.

12 29.1% canopy cover (urban forest) is the existing cover on Oakville lands south of Dundas Avenue (Town of Oakville, 2006).

13 Akbari H. et al. 2001.

savings of up to 30 percent. During the winter, heating-energy savings on the order of 10 to 15 percent were estimated by Akbari and Taha[14]. An urban forest canopy also provides an additional benefit due to the reduction in greenhouse gas (GHG) emissions associated with the reduction in energy use. Fossil fuel based power generation and building comfort heating all contribute to GHG emissions in Ontario.

One of the concerns with achieving and maintaining urban forest targets is that most cities and towns have tree planting programs but, unfortunately, most are planting fewer trees annually than are being removed as dead or dying.

2.5.3 Urban Forest Management in Other Jurisdictions

A body of research relevant to Town of Oakville's urban forest strategic management is provided by numerous North American studies and projects (refer to Appendix A), and is summarized in following sections of the Plan.

Baltimore, Maryland
In 2006, the City of Baltimore created a new target to double its existing urban forest canopy under its urban forest management plan, with an objective to integrate the urban forest protection and enhancement framework into its current standards of practice. Other objectives included in the management plan were: to maximize volume and quality of tree habitat in urban infrastructure; to develop tree compaction prevention specifications for street rights-of-way and high density development; to develop a tree species list; to protect existing trees from construction practices; and to provide incentives and stewardship programs.

Toronto, Ontario
City of Toronto has completed the UFORE (2000), and adopted Design Guidelines for Greening Surface Parking Lots that implement policies and strategies set in the Official Plan and the Toronto Green Development Standards. The Green Surface Parking Lot guidelines include: consolidation of landscaped areas to enhance tree and plant material growing conditions; protection of existing trees; enhanced rooting zones techniques (engineered cells, planting trenches and/or permeable paving); providing one (1) planted tree for every five (5) parking spaces; and providing minimum growing environment of 30 cubic metres of good quality soil per tree (see Figure 3).

Markham, Ontario
Town of Markham is working on the UFORE study to determine its current and target urban forest canopy coverage. The Town has established a streetscape manual that focuses on site plan, subdivision and boulevard tree planting practices, with specifications and details for successful tree planting. In understanding a tree's growth requirements, current spatial limitations and streetscape framework, the Town developed a requirement of 30 cubic metres of soil for large trees and 15 cubic metres of soil for small trees or trees with consolidated tree planting areas.

Chicago, Illinois
City of Chicago assigns a monetary value to trees, based on their diameter. Departments, such as Transportation, have to pay for the tree loss to the Bureau of Forestry if a tree is removed for street widening or other projects. The policy discourages unnecessary tree removals.

Milwaukee, Wisconsin
Financing and Managing the Urban Forest - This forestry program is considered as one of the most successful in the United States[15]. It has its own municipal nursery and forestry maintenance shop offering operational support and structure for innovative management. The Forestry Section is within the city's Public Works department and is responsible for reviewing all work conducted by other departments that may have an impact on city trees, including sidewalk construction, building development or transportation projects.

The program is funded by the City based on the Forestry Sector's budget proposal supporting a mortality rate of a particular percent (rather than framing the costs of maintaining, planting and removing trees), as well as by the State and Federal sources.

Other interesting aspects of this program include: a comprehensive employee training program; having year-round arborists; collaboration with University of Wisconsin-Stevens Point and offering undergraduate and graduate internships; establishment of a non-profit organization with an objective to increase tree planting and proper maintenance on private property; providing tree planting incentives; and development of city's 160 acre management units for maintenance.

14 Akbari H. & Taha H. 1992.

15 Bell, R. & Wheeler, J. 2006.

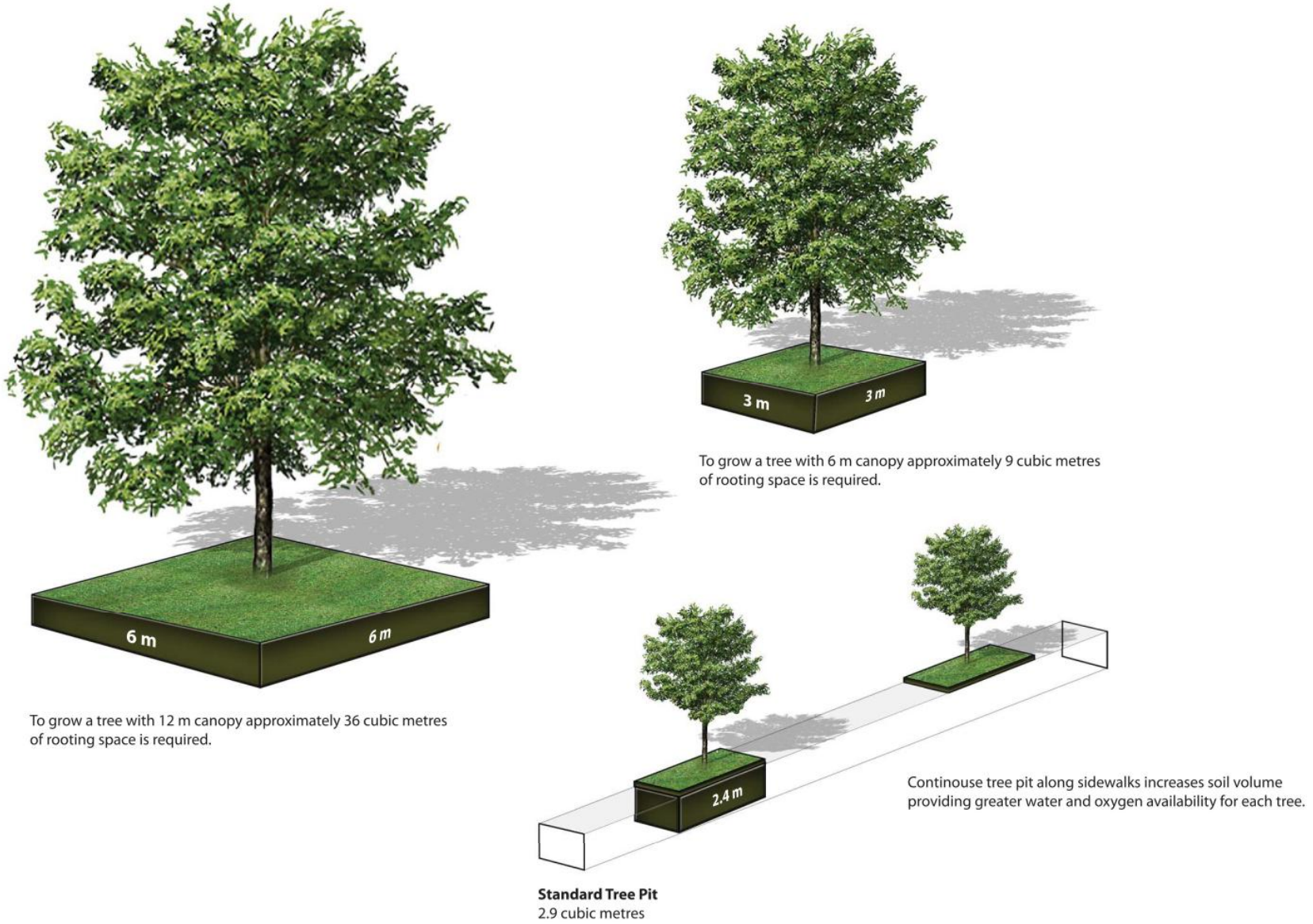


Figure 3: The Relationship Between Tree Size and Soil Volume
(reproduced from City of Toronto Detail TGI-2, Urban Forestry Services (Dec. 2000)

St. Paul, Minnesota
Minnesota Shade Tree Advisory Committee (established in 1974) and Tree Trust (private non-profit corporation founded in 1976) created a Field Guide in 2002 that presents a voluntary step-by-step resource guide to assist developers and builders protect, preserve and replant trees during land development and construction, as well as a list of technical resources on woodland management and restoration, and transplanting native trees and shrubs.

*Fort Collins, Colorad*o
Fort Collins's Forestry Division justifies its $1 million budget by calculating the economic benefit produced by their trees. Its strategies are more proactive, such as "graduated rotation cycle" that addresses the tree's needs at the critical time during its lifetime (i.e., pruning cycle based on tree stature). The Division also implemented an educational public program for planting and protecting drought-resistant trees in its arid climate.

A unique aspect of Fort Collins's urban forestry program is that it is integrated into the city's Climate Protection Plan – reduction of emissions, as well as increasing its health, stability and diversity by increasing or maintaining the stocking level, raising the average mortality age and planting in strategic energy-saving locations.

3.0 Current Planting and Management Practices

James Urban, a landscape architect and urban arborist and principal of Urban Trees and Soils in Annapolis, Maryland, has extensive experience in planting trees in difficult urban sites. He has collaborated with many leading arborists, horticulturalists, and researchers to test new urban tree systems, innovative soil and planting concepts, and develop new approaches to landscape architectural design, details and specifications[16].

Urban believes the most critical factors for healthy urban trees are how much soil is provided, whether it drains properly, and whether it is loose enough, i.e., not hardened through compaction. Of these three, soil volume has the greatest impact;

> '*The size of the tree's available soil volume that is open to the sky has a direct linear relationship to tree health… By increasing soil volumes the need in the long term for additional water would be eliminated because the soil should be balanced to the water needs of the tree*[17].'

For decades it has been common to plant street trees in "tree pits." If these excavations are too small, the root system cannot support the tree for more than a few years. The lack of room for roots stunts the tree's growth, and soon the tree begins to die. The Urban Horticulture Institute at Cornell has found that two cubic feet of soil is needed for every square foot of crown projection (the anticipated area under the drip line of the tree at expected maturity) and Urban suggests a thousand cubic feet (28.3 cubic metres) of soil is required for trees to reach their mature canopy targets. A tree can achieve an 8 inch (20 centimetres) caliper with 400 cubic feet (11.3 cubic metres) of soil, providing other prime conditions such as soil quality, little compaction and drainage are met.

3.1 Enhanced Rooting Environment Techniques

3.1.1 Continuous Soil Trench

Innovative means of promoting tree root growth are referred to as enhanced rooting environment techniques. One form of enhanced rooting environments technique recommended by Urban is a "continuous soil trench," which runs beneath sidewalks or other pavement, linking the soil area of two or more trees together. A continuous soil trench gives each tree more room for root growth

16 Urban, J. 2004.
17 Urban, J. 2004.

and offers an alternative to small, isolated tree pits. Most trees do not send their roots deeper than three feet (approximately 0.9 metres), so the soil trench usually need not be deeper than that.

3.1.2 Engineered Soils – CU-Structural Soil™

Macropores are large diameter (more than 50 nm) conduits in the soil, created by agents such as plant roots, soil cracks, or soil fauna. These play a major role in tree health, increasing the hydraulic conductivity of the soil, allowing air and water to infiltrate faster and reach tree roots. Ongoing construction, including sidewalk and road repair, disturbs and compacts soil, crushing macropores. Loss of macropores has three negative consequences: restricted aeration, diminished water drainage, and creates a dense soil that is difficult for roots to penetrate[18]. When roots encounter dense soil, they change direction, stop growing, or adapt abnormally by remaining close to the surface. This superficial rooting makes urban trees more vulnerable to drought and can cause pavement heaving. Conversely, if a dense soil is waterlogged, tree roots can rot. CU-Structural Soil™ is a planting medium consisting of 80 percent crushed limestone and 20 percent soil and has been designed for use in areas that need to or will be compacted. Because of the size of the aggregate, engineered soil always provides large soil pore space which is good for tree roots and allows for ready water drainage.

18 Urban Horticulture Institute, 2005.

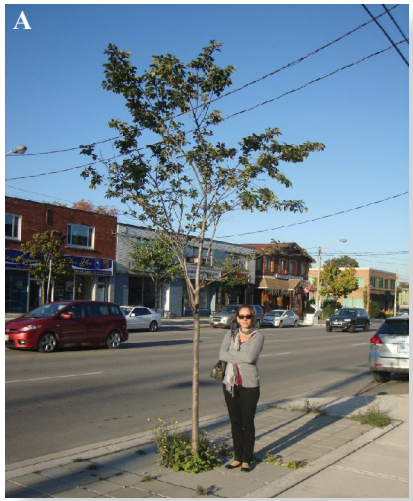


Figure 4: Traditional Street Tree Planting (A) and Street Tree Planting Using SilvaCell System (B), The Queensway, Toronto

CU-Structural Soil™ is intended for paved sites such as sidewalks, parking lots, and low-use access roads comprised of a rigid stone "lattice" (to meet engineering requirements for a load-bearing soil), and a quantity of soil (a mix of water and clay mixed with organic matter to ensure nutrient and water holding capacity while encouraging beneficial microbial activity) to ensure the greatest amount of porosity. With carefully chosen uniformly-graded stone and the proper stone to soil ratio, a healthy medium for root growth is created that also can be compacted to meet engineers' load-bearing specifications.

Engineered soil can also be used with conventional planting techniques. If possible, pavement openings should be expandable (via removable pavers or using a mulched area) for the sake of the anticipated buttress roots of maturing trees. Engineered soils can be used right up to the surface grade down to a minimum of one metre depth. One problem that has been attributed to engineered soil is that it lacks real soil volume to sustain tree growth over an expected life span because it is 20 percent soil and 80 percent crushed limestone by volume[19]. However, engineered soil is also an option for creating break-out zones under pavement for trees in narrow tree lawns to allow roots to travel to adjacent soft landscapes. Anecdotal evidence suggests that coarse aggregate used as backfill around utility trenches or subdrains functions similarly to engineered soil in that it provides a rooting environment or allows roots to travel to other soil volumes. For these reasons, it would be appropriate to use under sidewalks to create a break-out zone for boulevard trees to access soil volumes in front yard areas.

3.1.3 Engineered Soils – e.g. SilvaCell™

In partnership with DeepRoot, James Urban has devised a gridded 'caged' superstructure made of an ultra high-strength compound of glass and polypropylene called SilvaCell. It is designed to secure adequate tree habitat, support sidewalks and other hard surface treatments and provide on-site stormwater management. A 1,200 cubic foot volume (34 cubic metres) of SilvaCells can be designed for 0 percent runoff from a 3,000 square foot (279 square metres) Type II rain event)[20]. SilvaCell systems are installed below grade, back-filled with topsoil and are capped with a hard surface. For example, a sidewalk becomes, in effect, a floating roof over the rooting space (technical specifications and drawings are provided in the Appendix B).

The modular framework provides uncompacted soil volumes for large tree growth and (potentially) unlimited access to healthy soil - a critical component of tree growth in urban environments - allowing them to manage stormwater,

19 Urban, J. 2004.
20 Deep Root, unknown.

reduce heat-island effect, and improve air quality (see Figure 4). Of all the methods currently available for improving tree habitat in intensely urban environments, SilvaCell appears to be promising but also the most expensive. In some situations "caged/PVC" structures (like Silva Cell) use may be prescribed for use only under sidewalks or driveways, as a bridge or link for tree roots to grow into 'breakout' areas with greater soil volumes such as lawns or other soft surface areas.

3.2 Soil Quality and Tree Health

Soil quality is primarily a function of how much the soil has been graded or disturbed and how much the soil has been compacted. Developers sometimes scrape the topsoil off, leaving sterile 'dirt' with little feeding value for trees. Sites designated for tree planting should be evaluated to predict what the condition of the soil will be after construction is completed. Providing enough nutrient rich soil to support the proposed tree canopy is almost as important as providing enough soil volume (see Appendix C), and should also be accounted for in the early phases of site design. Urban suggests that a town such as Oakville should have at least five or six different soil-based standard tree planting details to respond to a variety of land use types and tree habitats (see Appendix B).

In addition to soil quality, various soil biotic considerations can have profound impacts on tree health. Typically, numerous species of fungi are found in healthy soils. Mycorrhiza is the symbiotic association of the mycelium of a fungus with the roots of most vascular plants, in which the hyphae form a closely woven mass around the rootlets or penetrate the cells of the root. The result is that trees and other plants growing in soils with healthy populations of mycorrhiza fungi are healthier and grow faster. They are also better able to withstand drought periods and recover from root injuries, including transplanting. Soil compaction, fertilizers, fungicides and other chemical products have resulted in significantly lower populations of these beneficial fungi in urban soils. Little research has yet been done to determine the potential of inoculating urban soils with native mycorrhiza fungi; however, intuitively it may be a means to increase tree health in urban settings. Several commercial suppliers sell different mycorrhiza fungi products.

Other tree habitat factors will have an effect on tree health, such as extremes of very sandy, silty or clayey soil textures or unusual soil profiles. Site work and site history can also have a significant impact on the opportunities for root growth. A minimum level of maintenance should be prescribed on a long term basis - regular pruning, watering during the initial transplant period, and some ongoing insect and disease control. Less maintenance will require more site modification to grow similarly sized trees while more maintenance, particularly irrigation and fertilization, will allow for slightly less site modification.

Other issues that contribute to tree death:

Containerization
Tree planters, usually above ground, are modular and come in a variety of materials and sizes and sometimes have an open bottom to allow roots to extend below the planter. Planters have problems with freeze-thaw cycles, and with constricted growing areas stunt tree growth.

Compaction
Trucks and heavy equipment cause soil compaction, which reduces soil pore space thereby reducing precipitation infiltration rates, available oxygen, and makes it difficult for tree roots to penetrate the soil.

Inadequate Drainage
If the soil around and below a planted tree are clay, water is slow to percolate or infiltrate the surrounding soils and the tree can 'drown' in its hole.

Utility Trenches
In new areas, contractors and municipalities use underground trenches to accommodate infrastructure such as cables and pipes. As almost all tree roots are located in the top 0.9 m of soil, trenches frequently sever large portions of tree root systems, causing trees to topple or die within a year or two.

Tree Grates
Many municipalities install decorative metal grates around newly planted trees. As the trunk grows, it may become girdled by the encircling obstacle. Though some tree grates are designed so that the innermost section can be removed as the trunk expands, rarely are these removed promptly enough. The grate girdles the trunk, stopping the flow of water and nutrients between the top and bottom of the tree. If the tree doesn't die first, it may lift the grate and create a hazard for pedestrians. Grates also collect litter that is difficult to remove.

Excessive Paving
Covering the tree pit with bricks or paving stones may injure the growing trunk and roots and may prevent needed water from reaching the roots. Sidewalks become problems when they compact the soil, overly confine the roots, and prevent the tree from receiving enough rainwater.

The use of porous and flexible pavement surfaces that can adapt to the expansion of tree roots is one method that can be employed on sidewalks and in the parking lanes of roadways as an alternative to the use of concrete pavement immediately adjacent to tree planting locations.

Sidewalks normally require excavation to set the face of the sidewalk flush with the lawn surface. This digging severs tree roots. In the city of Surrey, BC, mulch was used as the sidewalk substrate to protect the stand of very large trees that would have been impacted. The mulch protected the tree roots since mulch can be added directly to the lawn surface.

Infrastructure and Utilities
Maturity in street trees is often not achieved because of the problems associated with the streetscape condition and the influence of infrastructure and utilities, both below and above grade, combined with the clearance required to access/ service them. Other public service related features and streetscape elements impose additional restrictions; stop signs and traffic signals require daylight triangles, hydro boxes, streetlights, fire hydrants, cable boxes, driveways and sidewalks all require a certain amount of clearance which need to be considered in calculating available space for tree planting and may impact tree maturity.

3.3 Land Use and Tree Health

It can be argued that the full benefits of mature trees are realized not by the diameter of canopy but by the extent of leaf area density. In her 1999 Master's thesis, *Design Limitations to Potential Leaf Area in Urban Forests*, Natasha Duffy set up sample plots in 10 different land use types in Toronto. Potential leaf area densities (PLAD) were calculated for each under four different buffer area scenarios (surface area required by other features in the landscape): no buffers, minimum buffers, average buffers, and maximum buffers. The feature composition of each of the land use types and the impact of each feature's buffer on the loss of soft surface available for tree habitat was also determined. There were significant differences in PLAD between the ten different land use types and between the four different buffer scenarios. Land use types that had similar potential leaf area densities were Residential Low Density and Exhibition Lands (1,629 to 2,083 square metres per 1,000 square metres); Residential Medium and High Density, Industrial, Institution, and Transportation (648 to 953 square metres per 1,000 square metres); and Low, Medium, and High Intensity Commercial (11 to 26 square metres per 1,000 square metres).

Land use types with the highest amount of soft surface were Residential Low Density, Institutional, and Exhibition Lands (38 to 44 percent of area). Land use types that had the lowest amount of soft surface were Low, Medium, and High Intensity Commercial lands (1 to 8 percent of area).

In '*Street Trees, Overhead Utility Distribution, and Physical Infrastructure: Design Implications, Maintenance Costs and Proposed Alternatives*' produced by the Northeast Center for Urban and Community Forestry, USDA Forest Service, Amherst, MA, David V. Bloniarz (1991) examined the problems associated with street tree plantings as they relate to utility lines and urban infrastructure. While the emphasis in the report is on preventing damage to trees caused by infrastructure, the work is insightful and with recommendations that support tree health. In the study major arterial, minor arterial, collector and local street types, their characteristics, and the design intent of street trees is addressed and the implications of poorly juxtaposed physical infrastructure is demonstrated. Recommendations are suggested for planting locations and tree species. Three key recommendations include:

1. Proper species selection, so that only trees that will not interfere with overhead utility lines, buildings and sidewalks be planted along streets.

2. Setback planting of the street trees to a location where they will be able to grow without interfering with overhead utility lines, buildings and sidewalks (maximum 7 metres from the curb line).

3. Planting trees in locations within the right-of-way other than directly below the utility lines and include, where possible, the construction of new planting islands along the street edge (interspersed with curb side parking in bump outs).

In summary, a comprehensive review of the current planting and management practices led to a wide knowledge base on the approaches that are applicable and could be refined for the study site in north Oakville. Those include, but are not limited to: enhanced rooting environment techniques, such as continuous soil trench and engineered soils; soil quality and volumes for maintaining good tree health; and effects of land use types on tree health.

4.0 The Natural Heritage System and Natural Lands North of Highway 407

The management goals and objectives for the Natural Heritage System (NHS) were determined through the North Oakville Creeks Subwatershed Study (NOCSS), 2006. This study delineated the features to be retained as the NHS as well as the developable lands. The NHS is comprised of core areas, stream corridors and linkages. Management recommendations were developed as a part of the subwatershed study and are recognized in this plan in terms of calculations of potential urban forest. Areas that were identified for regeneration in NOCSS are assumed to be potential urban forest. Conversely, areas that were identified to be managed as open country habitats are assumed to not be eligible as future urban forest. Open country habitat enables different ecological functions than do the habitats that make up urban forest. For example, certain open country habitats provide for deer bedding, others are associated with riparian habitat requirements for redside dace (*Clinostomus elongates*). The subwatershed study looked not only at what other jurisdictions were doing to determine both the natural heritage system and its management, but also the best available science. For further information please refer to the NOCSS.

The Natural Lands north of Highway 407 are comprised of scattered woodlots, hedgerows and part of Glenorchy Conservation Area (Glenorchy CA). Glenorchy CA is comprised of land parcels south of Highway 407 within the NHS, and north of Highway 407 within the Natural Lands north of Highway 407. Conservation Halton has completed a Parks Master Plan for Glenorchy CA (GCAMP). For the area north of Highway 407, GCAMP has identified two blocks of agricultural lands for restoration to forest. South of the Highway 407 the proposed restoration includes reforestation and the establishment of large grassland areas and marsh. The areas of reforestation are intended to bulk up the 16 Mile Creek Valley (Core #3, NOCSS) forests to maximize interior forest habitat. All management prescriptions identified by the subwatershed study (NOCSS) for the NHS or GCAMP for Glenorchy CA have been carried forward by this plan.

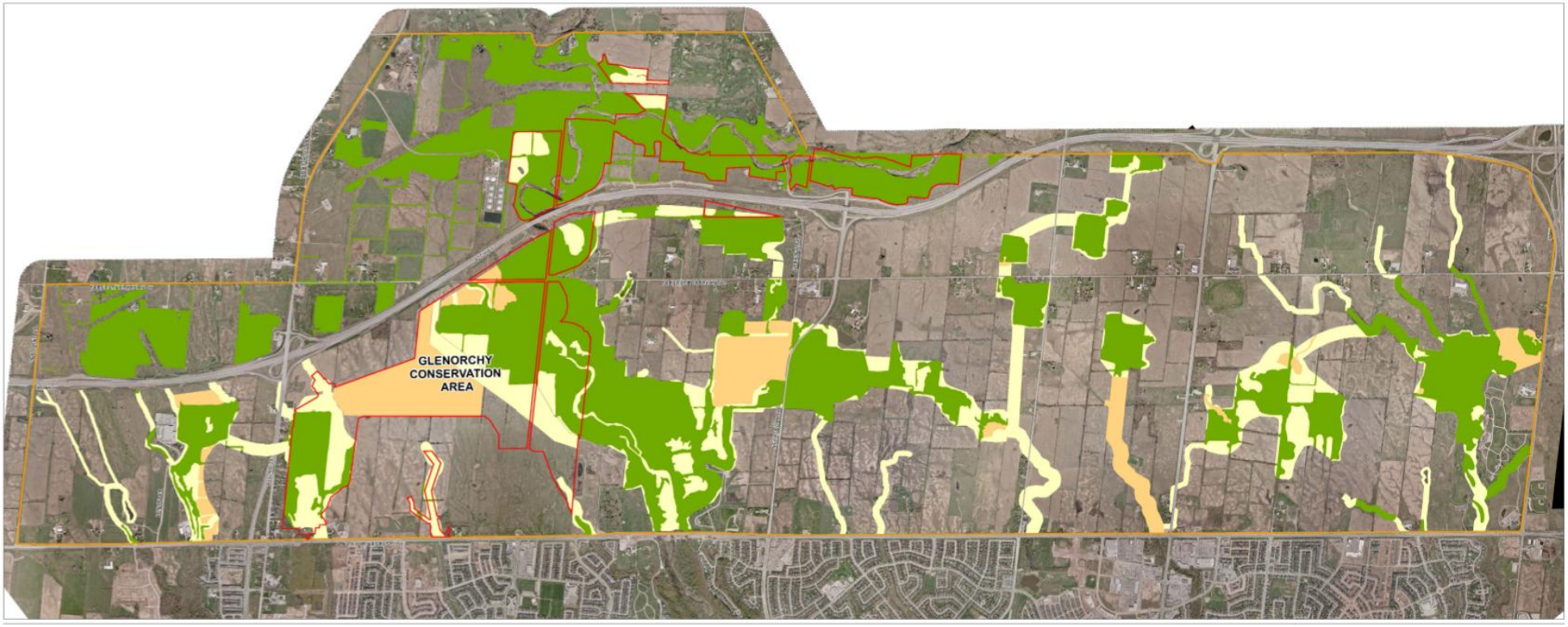
4.1 Canopy Cover Calculations

Digital aerial photographs were provided by the Town of Oakville from spring 2008 with the trees in leaf-off condition. The photos were captured by First Base Solutions and are in MrSID format. Geographical Information Systems (GIS) software (ArcGIS 9.3) was used to analyze the photos. Digital information was obtained from AECOM (Kitchener) for the Subwatershed Study, from the town and from Conservation Halton. Specific layers included the Core boundaries 2007, Linkages, Stream Corridors, Ecological Land Classification (ELC), Natural Heritage System (NHS) September 2007, NHS January 2009, Wetlands, Glenorchy CA, and Forests.

4.1.1 Natural Heritage System

After the study area was delineated, polygons were digitized within the eleven cores, the linkages, and stream corridors to be retained (determined by NOCSS as either high or medium constraints) to determine existing and potential canopy cover within the NHS. Adhering to the definition used in the Urban Forest Strategic Management Plan (UFSMP), 2008, urban forest is lands with tree or shrub cover. As such, the urban forest canopy cover within the natural heritage system includes forested areas, plantations, woodlands, hedgerows, cultural thickets and swamp thickets as determined by the Ecological Land Classification in the NOCSS (2006). Potential urban forest was calculated by delineating all non-urban forest lands as either potential or permanent open country habitats. These determinations were made by looking first at existing cover and deciding if through the natural processes of succession it is likely that the area would become treed or shrub dominated. For the most part, open areas will become naturally covered by trees and shrubs, notable exceptions include gravel and point bars along Sixteen Mile Creek, marsh communities and private lands within the NHS that are maintained as lawn. The final consideration before determining whether an area was potential urban forest was to refer to the long-term management prescriptions from the NOCSS, Implementation Report (2006). This report prescribed that certain areas within the NHS should be maintained as open country habitats to support specific ecological functions that depend on early successional habitats. The end result is a map that defines the study area and a series of polygons that designate lands within the NHS and Natural Lands north of Highway 407 as either existing urban forest, potential urban forest or open country habitats (see Figure 5).

NOCSS designated every reach of all watercourses within the study area as high, medium or low constraint. The corridor for each stream reach was determined based on a number of fluvial, hydrologic and ecological factors. High constraint stream reach corridors are to be retained in situ and are all part of the NHS. As such, existing canopy within high constraint stream reach corridors was determined and included in the assessment of existing and future forest cover. Medium constraint stream reach corridors are part of the NHS and are to be retained but can be moved. As such, existing forest cover associated with these stream corridors may not be retained. However, existing forest cover associated with these stream corridors was assumed to be included in



Legend

- Study Area Boundary
- Glenorchy Conservation Area
- Existing Urban Forest
- Open Country Habitat
- Permanent Open Country Habitat

250 0 250 500 750 1,000 Meters

Figure 5:
Existing and Potential Urban Forest, North Oakville

NAD83 - UTM Zone 17
Scale: 1:7,500 (34x68")
Airphoto: Spring 2008

Project: NRSI-901
August 25, 2009

Natural Resource Solutions Inc.
Aquatic, Terrestrial and Wetland Biologists

OAKVILLE

DILLON CONSULTING

Table 1. Breakdown of Existing Canopy Cover in the NHS and Natural Lands North of Highway 407*

Existing Land Cover and Management Prescriptions	Trees	Shrubs	Open Habitats to be Wooded to be Wooded (potential additional canopy)**	Open Habitats to Remain	Combined Total
NHS Cores					
#1. 14 Mile Cr. (Main)	18	1	10	9	38
#2. 14 Mile Cr. (East)	15	8	22	0	45
#3. 16 Mile Cr. Valley	187	4	50	0	241
#4. Hwy 407 East of 16 Mile Cr.	19	0	4	0	23
#5. Neyagawa Woodlot	55	6	21	32	114
#6. NW of Burnamthorpe and 6th Ln.	5	0	1	0	6
#7. SW of Burnamthorpe and 6th Ln.	11	0	1	0	12
#8. Earth Science Woodlot	15	0	6	0	21
#9. Trafalgar Woodlot	13	1	3	0	17
#10. Buttonbush	30	4	31	2	67
#11. Joshua's Cr.	27	14	4	8	53
Cores Total:	**395**	**38**	**153**	**51**	**637**
Stream Corridors	8	11	67	1	87
Linkages	8	6	48	18	80
Glenorchy CA south of 407 outside Cores 2 & 3	7	0	42	48	97
Sub-totals	**418**	**55**	**310**	**118**	**901**
Natural Lands North of 407					
Glenorchy CA, forest blocks outside of Glenorchy & hedgerows	294	0	13	0	307
Study Area Totals:	**712**	**55**	**323**	**118**	**1,208**
Total Existing Urban Forest (Tree & Shrub Cover)(ha):	**767**				

* These numbers are approximate.
* * Based on NOCSS recommendations in Implementation Report (2006) and GCAMP (2010).

the assessment of existing and future forest cover. Low constraint reaches are assumed to be removed and were not included in the NHS. Therefore, any forest cover associated with the low constraint steam reaches was not included in existing or future forest cover.

4.1.2 Natural Lands North of Highway 407

Existing canopy cover for the Natural Lands north of Highway 407 is the sum of existing forest area and hedgerows. The forest area data was provided by the town; hedgerow areas were digitized.

4.1.3 Glenorchy CA Lands South of Highway 407 outside the Core NHS Areas

Existing canopy cover for the hedgerows and small wooded area (greater than 2 hectares) situated within Glenorchy CA south of Highway 407 and outside of Core NHS areas was calculated by summing the areas of the digitized polygons.

4.2 Existing Canopy Cover in the Natural Heritage System and Natural Lands North of Highway 407

Currently, the study area is relatively undeveloped and the existing urban forest cover is comprised of native forests, cultural woodlands (regenerating), shrublands (cultural or native shrub thicket wetlands) and agricultural hedgerows. In total there are 767 hectares of urban forest within this matrix of lands (see Table 1).

5.0 Opportunities for Additional Urban Forest

The study area south of provincial Highway 407 is comprised of the Natural Heritage System (NHS) as determined by North Oakville Creeks Subwatershed Study (NOCSS), developable lands and Glenorchy Conservation Area (Glenorchy CA). North of provincial Highway 407 the study area is a mix of farms, rural residences, a golf course and the remainder of Glenorchy CA.

5.1 Natural Heritage System

The NHS is comprised of eleven core areas, medium and high constraint stream corridors, linkages, and Glenorchy CA lands south of Highway 407. In total there are approximately 473 hectares of existing urban forest within this matrix (see Table 1 and 2). Within these same lands there are an additional 310 hectares of open country habitats that have been identified in NOCSS or GCAMP for future tree or shrub canopy cover.

5.2 Natural Lands North of Highway 407

The natural lands north of Highway 407 are comprised of treed or otherwise natural areas either within existing woodlots, well established hedgerows or Glenorchy CA lands north of Highway 407. In total there are approximately 294 hectares of existing urban forest within this matrix (see Table 1 and Table 2). On these same lands are an additional 13 hectares of open country habitats that have been identified by GCAMP for future tree or shrub canopy cover.

Table 2. Potential Urban Forest in the NHS and Natural Lands North of Highway 407*

Existing Urban Forest in the NHS (ha)	473
Existing Urban Forest in the NHS and Natural Lands North of 407 (ha)	767
Study Area (ha)	4,000
Existing Urban Forest (%)	19
Potential Urban Forest in NHS incl. Glenorchy south of 407 (ha)	310
Potential Urban Forest in NHS (%)	8
Potential Urban Forest in the Natural Lands North of 407 (ha)	13
Potential Urban Forest in the Natural Lands North of 407 (%)	0
Existing plus Potential Urban Forest within NHS and Natural Lands North of 407 (%)	27

*These numbers are approximate

5.3 Developable Lands

The total study area is approximately 4,000[21] hectares. If the town is to achieve a 40 percent tree canopy cover target, this will require approximately 1,600 hectares of total area. The following table identifies the approximate land base area by land use.

Table 3. Estimate of Land Areas by Land Use (ha)

The NHS & Natural Lands North of 407	1,208	30%
Agricultural Lands North of 407	600	15%
Residential (all types)	665	17%
Employment/Industrial	630	16%
Commercial/ Mixed Use	290	7%
Arterial + Avenue Roads	190	4.5%
Parkland	160	4%
SWM	80	2%
Cemetery	67	1.5%
Institutional	40	1.0%
Transitional Area	40	1.0%
Public Use (schools)	35	0.9%
Transit Ways	30	0.8%

The NHS and Natural Lands north of 407 represent approximately 30 percent of the total land base. Developable lands include residential, employment/ industrial and commercial areas that represent approximately 40 percent of the land base. The balance of the lands include arterial and avenue roads, parkland, SWM facilities, cemeteries, school sites and transit corridors and account for approximately 15 percent of the total area north Oakville lands. The balance of the lands are those north of Highway 407 that are not herein considered natural (primarily agricultural).

5.4 Canopy Cover Calculations Using Current Standards and Practices

In order to maximize tree canopy cover, it is important to use all of the available planning tools to ensure that the lands outside the NHS and Natural Lands north of Highway 407, particularly residential, employment and commercial areas maximize the potential for tree canopy cover.

Table 4 illustrates the potential canopy cover if current practices are extended to the north Oakville lands.

Table 4. Canopy Cover Estimates Using Current Standards and Practices

Land Use	Current Standards (ha)	Total Area	Canopy Cover Estimate (ha)
The NHS & Natural Lands North of 407	63%	1,208	767
Agricultural Lands North of 407*	0%	600	0
Residential (all types)	15%	665	100
Employment/Industrial	10%	630	63
Parkland	34%	160	54
Arterial + Avenue Roads	25%	190	48
Cemetery	34%	65	22
Commercial/Mixed Use	6%	290	17
SWM	10%	80	8
Transit Ways	25%	30	7
Public Use (schools)	15%	35	5
Transitional Area	6%	40	2
Institutional	15%	40	1
			1,094 ha

Approximately 28 percent of total north Oakville area.

The estimate for canopy cover in the NHS and Natural Lands north of Highway 407 reflects that the area is a mosaic of habitats and anticipates that some of Glenorchy CA will be eligible for additional future canopy cover.

The low density and medium to high density residential areas have been combined into a single land category because the North Oakville Master Plan does not distinguish these areas, although the plan does estimate roughly a 50/50 split. It is estimated that the residential areas could achieve 20 percent canopy coverage. This estimate is based on an evaluation of similar residential areas in locations such as Cornell and Markham. Some additional contribution to the tree canopy will occur from landscaping on private lands in the residential areas. The amount of additional area will be modest because of the relatively small private amenity areas. The estimate is approximately 1 percent to 2 percent, or 6 to 12 hectares of additional canopy cover may be achieved from primarily small stature trees in the front and rear yards of the homes.

21 3100 hectares south of Hwy 407 and 900 hectares north of Hwy 407.

Estimates for the potential for canopy cover in employment/industrial land uses are based on the level of canopy cover that is being achieved using current zoning, site plan guidelines and land use policy.

The estimate of canopy cover that can be achieved in parkland is based on the illustrated plans in the *North Oakville Urban Design Guidelines* that result in an average of 34 percent canopy cover. Cemeteries were considered to have the same canopy cover as parks for this study. They contain many of the same natural heritage characteristics and are similar in size to some neighbourhood and community parks.

Estimates for canopy cover for Arterial Roads (major and minor), Avenues and Transit Ways are based on cross-sections presented in the *North Oakville Urban Design Guidelines* using medium stature trees. Only Major Arterial roads have planted medians (3 rows of trees per corridor). Local road corridors are included in the surrounding land use designations (i.e., residential and employment).

Commercial area canopy cover is based on intensely developed nodes (excluding the public road right-of-way) with a high percentage of paved surfaces. Commercial and Transitional areas described in the North Oakville East Secondary Plan are similar in use and scale and are, therefore, assigned the same canopy cover percentage as the Commercial land use designations.

Estimates for SWM facilities, Public Schools and Institutional uses are based on existing development in Oakville.

5.4.1 Canopy Cover Targets Using Updated Standards and Practises

In addition to current planning tools, updated policies, guidelines and standards can be implemented to increase the percentage of canopy cover in order to achieve the town's 40 percent target, as identified in Oakville's Mayor "Canopy Cover Challenge" and reflected in the official plan- The Livable Oakville Plan. The following table (Table 5) demonstrates the potential increase in tree canopy areas that can be achieved by updating the zoning by-law to increase landscape strips and buffer, require tree planting in parking lots and update the site plan requirements, landscape standards and tree details to support healthy growth of medium and large stature trees.

Table 5. Canopy Cover Targets Using Updated Standards

Land Use Area	Maximize Canopy	Total Area (ha)	Canopy Estimate (ha)
The NHS & Natural Lands North of 407	90%	1,208	1,087
Agricultural Lands North of 407	0%	600	0
Employment/Industrial *	20%	630	126
Residential (all types)**	20%	665	133
Parkland***	50%	160	80
Arterial + Avenue Roads^	34%	190	65
Commercial/Mixed Use^^	15%	290	43
Cemetery^^^	34%	65	22
SWM ^{o}	15%	80	12
Transit Way ^{oo}	34%	35	12
Public Use (schools) ^{ooo}	20%	35	7
Transitional Area +	15%	40	6
Institutional ++	25%	40	10
			1,603 ha

Approximately 40 percent of total north Oakville area.

*Based on UFSMP estimates pg. 91 – adjusted to reflect intensified planning in North Oakville.
** Based on Town's estimate of 17,000 to 20,000 dwellings in North Oakville and planting 1 medium stature tree per dwelling.
*** Estimated by Dillon based on parkland demonstration plans.
^Based on 12 metre tree spacing and BMP for adequate soil quantities.
^^Estimated by Dillon based on urban design guidelines including parking lot greening.
^^^Based on existing precedents.
^{o} Estimated by Dillon based on applying BMP and meeting CA and MOE guidelines.
^{oo} Based on medium stature trees on both sides of the corridor space at 12 metres.
^{ooo} Enhanced based on demonstration plans.
+Estimated by Dillon based on similarities with Commercial areas and applying green parking lot standards.
++ Based on hospital demonstration plan.

5.4.2 Basis for Calculations

Canopy cover estimates for employment, institutional, and commercial land uses are based on meeting zoning by-law requirements (minimum number of trees in parking lots), 'green parking lot' landscape standards and optimizing the layout of soft landscape areas (to provide the opportunity for additional tree canopy).

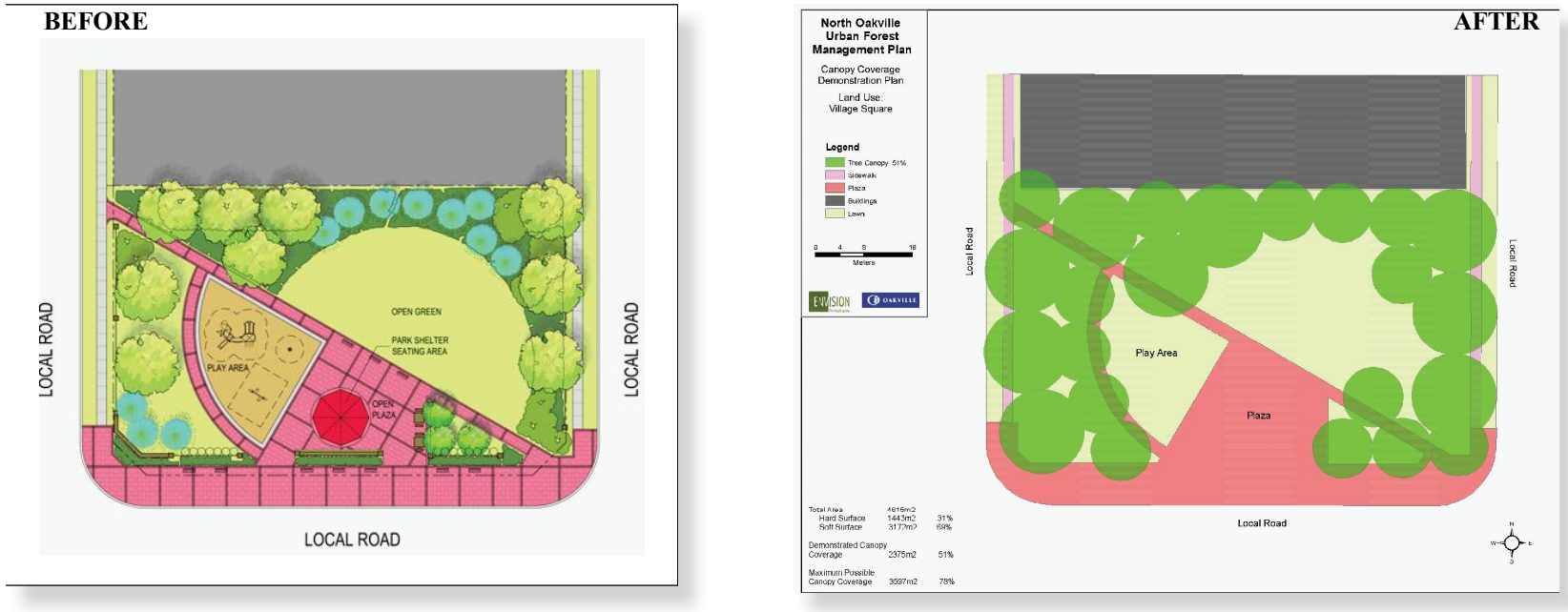


Figure 6: Village Squares: Planned and Potential Urban Forest Cover (Source: Town of Oakville, prepared by Cosburn Giberson)

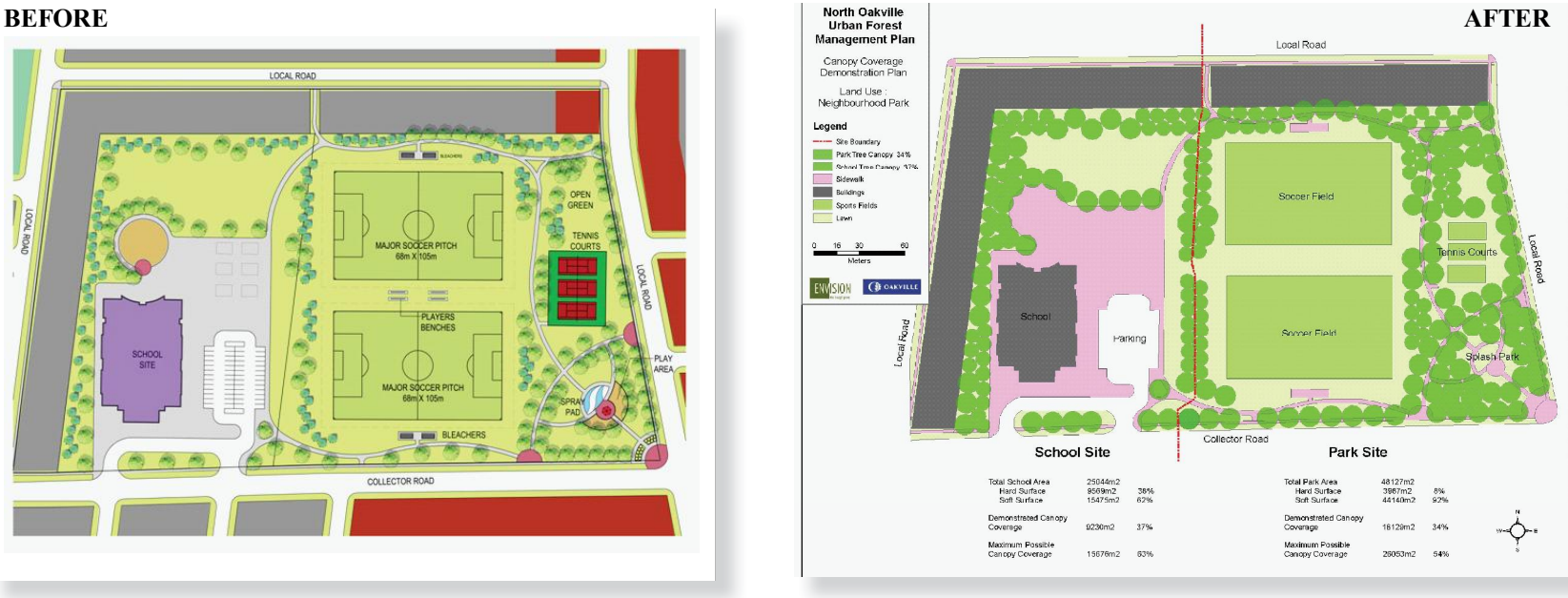


Figure 7: Neighbourhood Parks: Planned and Potential Urban Forest Cover (Source: Town of Oakville, prepared by Cosburn Giberson)

Landscape standards requiring increased soil volumes, optimized tree spacing, and the selection of appropriate species needed to ensure that they can achieve medium or large stature status have been applied to all these land use areas. In addition, the town's own demonstration plans for Village Squares, Neighbourhood and Community Parks, and one campus style institutional site plan were assessed and amended with sensitivity to the intensified urban context and establishing maximum canopy coverage.

The methodology for calculating areas involved importing park plans prepared for the *North Oakville Master Plan* into ArcView 9.3 GIS software. These were then geo-referenced to ensure that the scale was accurate. Once the images were in the program, their individual elements – buildings, plazas, sidewalks, etc. – were traced as polygons using features built into the GIS software. Medium and large trees were drawn to reflect their maximum potential canopy size according to *Oakville's Urban Forest: Our Solution to Our Pollution* (2006). The total number of trees within the park remained the same; however, the spacing of the trees was adjusted to maximize the amount of canopy cover.

Figure 8: Community Parks: Planned and Potential Urban Forest Cover (Source: Town of Oakville, prepared by Cosburn Giberson)

Polygons drawn within ArcView automatically have their areas calculated by the software. This number was divided by the total area of the park to give a potential percentage of canopy cover for the park. Additionally, a possible canopy cover was calculated based on the amount of lawn area that could possibly be covered by canopy – this excludes hard landscape features, parking areas, buildings, and sports fields. The resulting calculations are as follows:

Village Square (see Figure 6)

Total Park Area	4,423 m^2	
Canopy Cover	2,375 m^2	(54%)
Possible Canopy Cover	3,387 m^2	(77%)

Thirty-three (33) Village Squares will result in 7.84 hectares of urban forest, but could result in 11.18 hectares..

Neighbourhood Park (see Figure 7)

Total Park Area	72,791 m^2	
Canopy Cover	25,329 m^2	(32%)
Possible Canopy Cover	41,729 m^2	(57%)

Ten (10) Neighbourhood Parks will result in 25.33 hectares of urban forest, but could result in 41.73 hectares.

Community Park (see Figure 8)

Total Park Area	258,649 m^2	
Canopy Cover	67,759 m^2	(26%)
Possible Canopy Cover	170,487 m^2	(66%)

Three (3) Community Parks will result in 20.33 hectares of urban forest, but could result in 51.15 hectares.

BEFORE **AFTER**

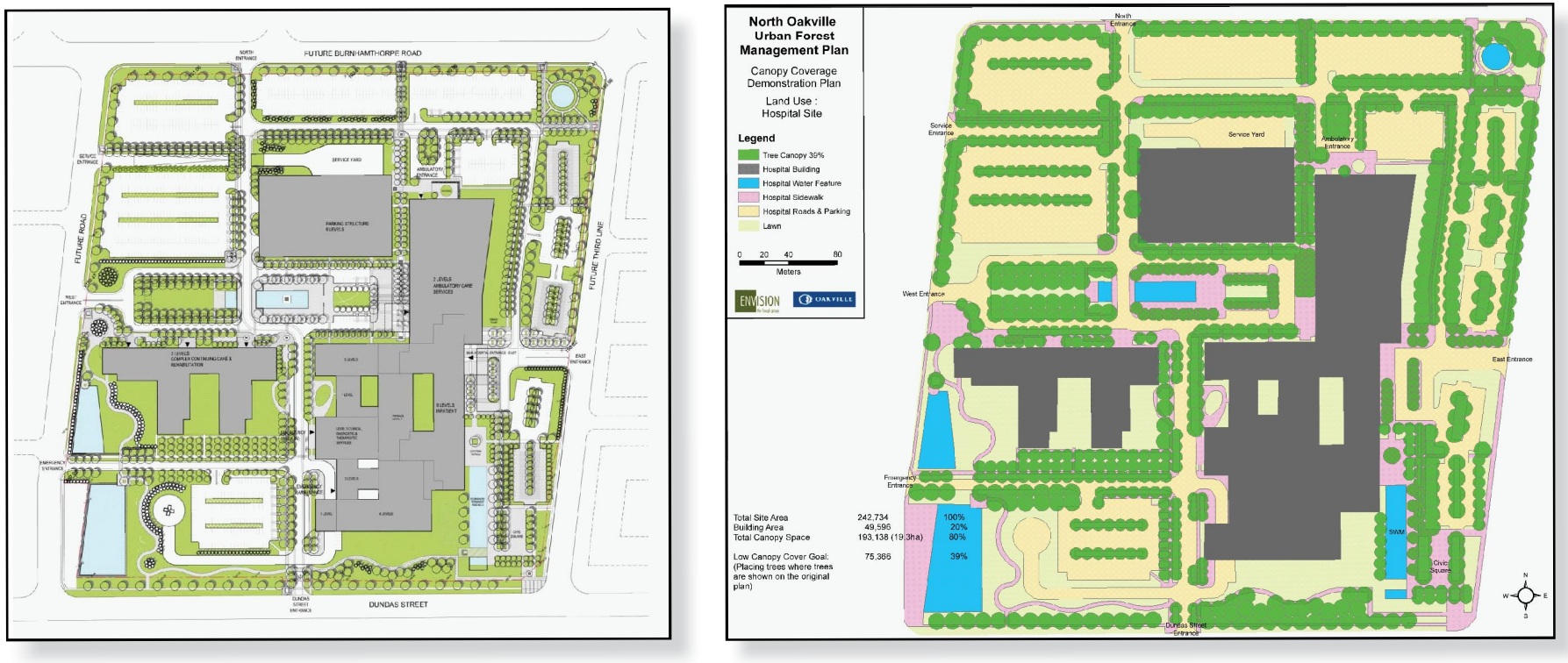


Figure 9: Institutional Campus Demonstration Plan: Planned and Potential Urban Forest Cover (Source: Town of Oakville, prepared by Cosburn Giberson)

In combination, the three park types will generate a total of 53.50 hectares of urban forest, or an additional 1.34 percent. However, there is a potential on these lands to generate as much as 104.06 hectares of urban forest or 2.6 percent.

Optimizing canopy cover in parks could lead to an average of 40 percent canopy cover across north Oakville. The demonstration plans depict that canopy coverage can be maximized to achieve 77 percent in a village square; 57 percent in a neighbourhood park; and 66 percent in a community park. A more realistic average of 50 percent was used for estimating purposes recognizing that site specific characteristics such as underground utilities, walkways and plaza space and other factors will reduce the plantable area available for supporting medium and large stature trees.

5.4.3 Margin of Error

There are a number of possible sources of error in the calculations because the estimates are based on PDF images of the North Oakville East Land Use Plan. This data was saved as a JPEG and imported into GIS where it was then geo-referenced to scale. The geo-referencing involved matching the PDF's scale bar to one drawn in the GIS program at the same scale. This then served as the base from which to insert the North Oakville West Land Use Plan and the North Oakville Master Plan. Once these JPEGs were in place, the land uses were "traced" using drawing software in ArcMap v. 9.3. These newly created polygon shape files were used to calculate areas using functions built into the GIS program. Because these polygons were traced over top of the Land Use Plan JPEG, any inaccuracies in the geo-referencing of this document would lead to inaccurate area calculations for the various land use types.

The other source of error could be the way in which the polygons were drawn. Once the Land Use Plan JPEG is imported into GIS, it becomes enlarged to accurately reflect the scale. This leads to the image becoming pixelated and blurred. While tracing land use areas using the GIS software, small inaccuracies can result from unclear edges.

5.5 Summary of Existing and Known Potential for Urban Forest

The existing urban forest has only been calculated for lands within the NHS and Natural lands north of Highway 407. In total there are 767 hectares of existing urban forest which will be retained during development. This is roughly equal to a 19 percent urban forest canopy cover. There is potential for an additional 310 hectares from the cores, stream corridors and linkages which will add 8 percent to the urban forest, resulting in a total of roughly 27 percent (please note that these numbers have been rounded).

From the developable lands, it is estimated that the parks will contribute 55 hectares or 1.34 percent, which will take the total to 28.34 percent. However, there is a potential, too, for as much as 29.60 percent if the parks were to be planted to their full capacity.

6.0 Other Considerations

6.1 Non-native Species

Non-native species pose a serious threat to the integrity of natural areas. Invasive non-native or alien species are harmful species whose introduction or spread threatens the environment, the economy and society, including human health. Many of the early introductions of non-native species were deliberate; however, with increased international trade many arrive in ballast water, landscape nursery stock or cargo containers, and have severe economic consequences.

Emerald Ash Borer

Possibly the most significant threat facing forests in southern Ontario today is Emerald Ash Borer (*Agrilus planipennis*)(EAB). The Canadian Food Inspection Agency reports that millions of ash trees (*Fraxinus spp.*) have been killed in southern Ontario and adjacent United States. Federal Ministerial Orders prohibit the movement of any ash material including lumber, firewood and yard waste from specific areas of Ontario and Quebec, including the Regional Municipality of Halton. The purpose of these orders is to slow the spread; currently there is no known means of eliminating this pest although research into biological controls is underway in the United States. Biological controls have proven effective in controlling purple loosestrife (*Lythrum salicaria*), an invasive plant.

EAB has been confirmed at a number of locations within the town including the Town Hall property. There are approximately 1.9 million trees in the Town of which 9.3 percent or roughly 175,000 are ash. According to *Oakville's Urban Forest: Our Solution to Our Pollution* (2006), it was estimated that EAB could result in up to $86.1 million in structural damages.

Other Species

There are numerous other pest species that pose varying threats to the town's urban forest including Asian Long-horned Beetle (*Anoplophora glabripennis*), Gypsy Moth (*Lymantria dispar*) and Dutch elm disease (*Ophiostoma ulmi*), a fungal disease that is spread by the European Bark Beetle (*Scolytus multistriatus*). The reader is referred to *Oakville's Urban Forest: Our Solution to Our Pollution* (2006) for more information on these species.

Invasive plant species are also an issue; of greatest concern is when invasive species threaten the integrity of natural areas. Species such as Norway maple (*Acer platanoides*) are increasingly abundant in natural areas in southern Ontario. Once established they alter forest structure and species composition by casting deep shade that prevents the survival of most native plants, including wildflowers, shrubs and tree saplings. Other species such as garlic mustard (*Alliaria petiolata*), an invasive woodland wildflower, also have the ability to alter forest structure and species composition. According to the *Control Methods for the Invasive Plant Garlic Mustard (Alliaria petiolata) within Ontario Natural Areas* (2007):

> *"Recent studies have suggested that Garlic Mustard, by inhibiting arbusccular mycorrhizal fungi (AMF) activity in native plants, has great potential to substantially alter the structure and function of mature deciduous forests. Over three quarters of all native vascular plant species have associations with mycorrhizal fungi that increase the availability of a wide variety of soil resources. Either through root exudates, leaf litter, or damaged root tissue, Garlic Mustard releases phytochemicals into soils that reduce AMF colonization of plant roots (Roberts and Anderson 1998, Stinson 2006), and reduce plant growth (Stinson et al. 2006). The strength of dependency on AMF varies across plants (Klironomos 2003), and accordingly there is variation in growth reductions of native species in contact with Garlic Mustard (Stinson et al. 2006). In 2006, Stinson and colleagues reported that species with coarse roots (typically slow growing woody plants – e.g., Sugar Maple, Black Cherry, Red Maple) tend to have the highest AMF dependency and suffer the highest reductions (i.e.,' 50 to 75 percent) in growth in association with Garlic Mustard."*

6.2 Oak Decline

Oak decline is known to be a problem in both urban and forest situations throughout the range of the different oak species and groups. Initially, trees are weakened by environmental stresses such as drought or defoliating insects. These weakened trees are then susceptible to attack from two key pests: a root disease called armillaria (*Armillaria mellea*) and the two-lined chestnut borer beetle (*Agrilus bilineatus*).

Armillaria is a common forest fungus that typically lives on stumps and roots of dead trees but will also attack the roots of stressed oaks. It produces a root-like structure, called a rhizomorph, which grows through the soil and over the surface of tree roots. When a tree is stressed, chemical changes occur in the root system which allows the fungus to infect them. The result is girdling of the

buttress roots and root collar which in turn kills the tree. Dead trees are a food source for the fungus; in the fall it will often fruit and produce honey-coloured mushrooms at the base of infected trees[22].

Two-lined chestnut borer beetle attacks the crown and stems of weakened trees. Larvae bore into the inner bark to feed and form meandering galleries. The larvae molt three times, getting larger each time. As they grow, the feeding galleries block the transport of nutrients and water between the roots and canopy eventually girdling the tree[23]. Tree death is often brought about by both amillaria and the two-lined chestnut borer beetle attacking the tree at the same time.

A characteristic of oak decline is that it may develop suddenly on many trees in an area affected by initial stressors such as drought or defoliating insects (e.g., fall cankerworm (*Alsophila pometaria*)). In the Town of Oakville, Iroquois Shoreline Woods Park was severely affected by oak decline with the death of several hundred oak trees in the early 2000s. Currently, there are roughly 95 hectares of oak dominated forests in north Oakville as indicated by the Ecological Land Classification completed for the subwatershed study.

Another issue affecting oak dominated communities in southern Ontario is invasion and ultimately replacement by closed canopy adapted species, particularly sugar maple (*Acer saccharum)*. Historically, many of the native oak communities were maintained by fire. First Nation's use of fire to clear land or lightning strikes resulted in open community structures that favoured oaks. Many of the oak species are fire resistant in comparison to maples, ashes, and beech. Without recent fire, many oak communities are not regenerating. In recognition of this problem, Ontario's Stewardship Network, which is comprised of 42 community-based councils affiliated with the Ministry of Natural Resources, has in many areas been conducting prescribed burns. The town has undertaken four successful prescribed burns at Iroquois Shoreline Woods Park to regenerate oak. The town should continue with such oak community management practices and introduce new oak plantings with the intent to establish an early successional oak savanna structure.

Another possibility for ensuring the continued existence of oak communities in the study area is to dedicate suitable open areas to oak plantings. Ideally, any such areas would be larger and regular in size (not a linear strip) and/or proximal to existing oak woodlands.

22 Wargo et al., 1983.
23 Wargo et al., 1983.

7.0 Urban Forest Vision for North Oakville

7.1 Background

Targets and guidelines for urban forest, forest or natural cover have been established by various agencies for other jurisdictions in southwestern Ontario. The following are examples that can be considered relative to north Oakville's existing and potential urban forest, as well as the Mayor's challenge of 40 percent for the town:

- Environment Canada, How Much Habitat is Enough? (Environment Canada, 2004)

  Guideline: 30 percent forest cover in Great Lakes Areas of Concern

- Toronto and Region Conservation Authority, Rouge River Watershed Plan (TRCA, 2007a)

  Target: 31 percent natural cover within the Rouge River watershed

- Toronto and Region Conservation Authority, Toronto Natural Heritage System Strategy (TRCA, 2007b)

  Target: 30 percent natural cover within the TRCA jurisdiction

- Regional Municipality of York Official Plan (Region of York, 2005)

  Target: 25 percent forest cover within the region

There are meaningful differences between some of these targets and guidelines in terms of what they are prescribing. Forest cover, natural cover and urban forests are different entities. Forest cover refers to natural and cultural forests (plantations) which typically have canopy closure of greater than 60 percent. These communities have structural layers: canopy, sub-canopy and groundcover, and provide a suite of ecological functions that include wildlife habitat, habitat for flora, groundwater infiltration, migratory stopover habitat for passerines and raptors (birds), carbon sequestration, etc. Natural cover includes forests but also other natural and cultural communities such as shrublands, savannas, meadows and marshes. Each of these communities provides different ecological functions. Meadows or open country habitats are often dismissed as not being natural (typically eligible for development) but provide habitat for flora and fauna that does not exist in communities with woody plant cover. For example, grassland birds have demonstrated more significant and widespread population declines than any other group of North American birds.

Urban forest is arguably the 'loosest' term in that it applies to any lands with tree or shrub cover. It is a useful and necessary number for developed areas but should be used in conjunction with numbers for both forest cover and natural cover. True forest cover will provide more ecological benefits than street trees; however, street trees may provide more social benefits to a community than a forested area some distance away.

In that light, the Town of Oakville should be commended for its work to establish its Natural Heritage System in advance of development of the north Oakville lands. In most jurisdictions natural heritage systems are being developed after the fact or in a piecemeal approach. Through the north Oakville Creeks Subwatershed Study (NOCSS) the town included 900 hectares of lands within the NHS. The subwatershed study only applied to north Oakville lands south of Highway 407 or approximately 3100 hectares of the study area. This means that roughly 29 percent of the NOCSS area will be natural lands in perpetuity. Of this, 418 hectares or 13 percent are trees, predominantly as large naturally forested blocks (cores), but also as hedgerows and tree areas along stream corridors. Shrublands account for an additional 55 hectares or 2 percent. Open country habitats include 428 hectares or 14 percent.

In this light, the Town of Oakville has already achieved the very significant amount of having 29 percent natural cover within the NOCSS area. Within the NHS, it is anticipated that natural forest cover will increase from 12 percent to as much as 20 percent.

7.2 Canopy Coverage on Developable Lands - Planning and Design Context

The Town of Oakville recognizes that the opportunities for urban forest habitat, canopy target contributions, ecological value, reforestation and tree planting standards in the developable lands in north Oakville are not as robust beyond the Natural Heritage System (NHS). Urban forest opportunities within the developable lands of north Oakville are also different from south Oakville in that the long-term vision for north Oakville is driven by the principles of New Urbanism, i.e., the creation of a community designed to be dense, compact and transit-supportive.

In recognition of Oakville's community planning tools, including higher densities, a more urban built-form, narrower street cross-sections and reduced building setbacks, it is possible that all trees outside the NHS may not reach their full genetic potential. However, all components to the public realm, such as parks, stormwater management blocks, and street trees, should contribute to achieving the tree canopy target.

Street tree survival is a particular challenge for most municipalities. Street trees rarely reach maturity. Trees in high density areas have the capacity to make positive ecological and aesthetic contributions to the environment and to quality of life as Oakville's own Urban Forest Effects Model (UFORE) and Urban Forest Management Plan studies on the subject make clear. This is in spite of habitat, budgetary, maintenance and management challenges.

Oakville's *Environmental Strategic Management Plan* (ESP) established an environmental vision for the town in 2005:

> *'In Oakville, we recognize that our quality of life rests on the quality of our environment and we respect our natural and cultural heritage. We strive to be a model community by taking individual and collective action to protect and enhance our ecological environment, while maintaining a vibrant social and economic base.'*

The ESP's stated goals are:

1. *To sustain and enhance our natural resources: airsheds, watersheds, shorelines, landscapes, flora and fauna;*
2. *To reduce consumption and increase efficiency in resource and material use;*
3. *To establish an environmentally friendly transportation system that improves mobility;*
4. *To maintain and improve the health, cleanliness, safety and vitality of our neighborhoods;*
5. *To foster an educated, aware and engaged community acting as responsible stewards of the environment; and*
6. *To lead in creating, adapting and applying best environmental and risk minimization practices.*

In order to meet these goals and to build on the *Urban Forest Strategic Management Plan* and *Oakville's Urban Forest: Our Solution to Our Pollution*, and to ensure the expectations of the *North Oakville East Secondary Plan*, the *North Oakville West Secondary Plan*, and that the *North Oakville Urban Design Guidelines* are achievable as conceptualized, it will be necessary to adopt policy changes, update landscape standards and apply cutting edge management practices with regards to tree planting.

Figure 10: Town of Oakville Community Illustrated with Old Standards (5 metre canopy trees) and New Standards (10 metre canopy trees)

7.3 Contributions of Canopy Coverage in Urban Areas

As described in Section 5.3 - developable lands (those outside of parkland and cemeteries) could yield canopy coverage estimates ranging from a low of 6 percent in commercial areas to a high of 25 percent along avenues under current standards, and from 15 percent to 34 percent if practices are updated to reflect the latest thinking and technology.

Great gains can be made by providing sufficient soil volumes and applying innovative planting and management techniques. Updating and strengthening the policy framework to communicate and reflect the town's canopy goals ensures a strong set of standards for the development community to follow.

The town should conduct periodic site reviews during construction, and regular inspections to monitor tree health during the first five years of growth. This will serve to identify factors impacting the tree's development and ability to provide its full range of ecological services.

7.4 Implementation of Green Guidelines for Surface Parking Lots and Canopy Cover Targets

7.4.1 Zoning By-law

The town's *Urban Forest Strategic Management Plan* (UFSMP) provided suggested policy reforms with regard to zoning by-laws and site plan control. These reforms would only apply land use classes that typically have extensive hard surface areas (for parking and driveways, etc.) and that, therefore, do not typically achieve significant tree cover:

> *'(T)he Zoning By-law should have a regulation for "planting area for trees". This would be similar to other regulations such as a landscape area, parking space, and building area that are currently required in the by-law.'*

> *'To minimize the impact of this provision on the viability of sites from a development perspective, it is recommended that the "planting area for trees" also permit uses that typically would not be expected to co-exist with trees. For example, with the use of engineered soils / rooting environments, trees could be planted in parking lots and adjacent to driveways.'*

The Town of Oakville's urban built form and patterns have a significant amount of impervious surface parking lots which result in increases to stormwater peak-flow volumes and function as heat islands. Stormwater management practices and tree cover can greatly minimize the negative effects of surface parking lots.

With respect to surface parking lots, rather than a focus specifically on urban forest canopy coverage per se, many municipalities, particularly in drier climates, have adopted by-laws that require set amounts of tree planting or shading in parking lots to reduce excessive heat build-up and improve local microclimate and air quality. Some other communities require parking lots to be landscaped so that 50 percent of the total paved area is shaded 15 years after development.

Similar to Section 4.2 *Parking for the Physically Disabled* in the North Oakville Draft Zoning By-law, a new section under Parking and Loading Regulations could require a minimum number of trees be planted per number of parking spaces. For north Oakville, we recommend that one (1) shade tree per five (5) parking spaces be required instead of the provision of "planting area for trees" as recommended in the *Urban Forest Strategic Management Plan*. This recommendation could apply to any land use allowing for surface parking and subject to site plan approval.

7.4.1.1 Surface Parking

The Town of Oakville's zoning requirements for surface parking lots have been prepared to support the town's objectives regarding canopy coverage and direction on how and where trees should be planted, as follows:

- Minimum one (1) 60 millimetre caliper deciduous tree planting for every five (5) parking spaces.
- Minimum two (2) trees per parking lot island.
- All required trees must be in or within 5.0 metres of surface parking area in parking lot with 76 or more parking spaces.
- All parking spaces shall be no more than 30 metres from a tree.

Landscape Strips

- Provide a minimum 3.0 metre wide landscape buffer from inside the property line, between the parking lot and the municipal right-of-way.

- Provide for a minimum 3.0 metre wide landscape strip not abutting a street in 5 to 75 space parking lot.
- Provide for a minimum 4.5 metre wide landscape strip not abutting a street in parking lot with 76 or more parking spaces.
- Provide a minimum 4.5 metre soft landscape area as setback when abutting a residential zone. If other zoning setbacks apply, the greater setback shall be required.

7.4.1.2 Development Subject to Site Plan Approval

The Town of Oakville's zoning requirements for development subject to site plan have been prepared to support the town's objectives regarding canopy coverage and direction on how and where trees should be planted, as follows:

- Provide a minimum 10 percent landscape area.
- Landscape area to be designed to be permeable and a minimum dimension of 3.0 metres by 3.0 metres (suitable for small stature trees).

7.4.1.3 Parks

The Town of Oakville's zoning requirements for park design have been prepared to support the town's objectives regarding canopy coverage and direction on how and where trees should be planted, as follows:

- Landscape design should meet the town's urban tree canopy objectives of maximizing tree canopy targets.

7.4.2 Review of the Draft North Oakville Zoning By-law and Recommendations

Since the zoning by-law is a planning tool that prohibits and regulates uses, the review of the by-law has been undertaken with the objective of amending it to prohibit the creation of 'landscape strips' and 'landscape areas' that will not support planting areas for large and medium stature trees (the logic is backwards, but works with the nature of the planning tool).

Language provided in Section 3.25 Landscape Strip Regulations could be revised to include use of the phrase 'plantable areas for trees'. In addition, buffer strips around large parking lots could be increased to a minimum of 4.5 metres.

7.4.3 Landscape Standards for Development Approval Applications

The site plan approval and development approval processes will be an effective tool in implementing the urban forest canopy targets and tree planting requirements across various land uses in north Oakville. For site development proposals, the 'Site Plan Standards Manual' will outline the terms of reference for the required submission materials and provide an overview of how staff will assess the proposals. The 'Site Plan Standards Manual' will include and expand upon the landscape standards contained within this document, and as outlined below.

7.4.3.1 Canopy Coverage Objectives

- Site design should meet the town's urban tree canopy objectives of maximizing tree canopy targets.
- The town's official plan, '*The Livable Oakville Plan'*, seeks to progressively increase the urban forest to achieve a canopy cover of 40 percent town-wide.

7.4.3.2 Canopy Coverage Requirements

Provide Canopy Coverage Plan to determine compliance with canopy coverage targets. The plan shall provide the following:

- Dimension tree spacing for all required trees.
- Plans shall demonstrate compliance with canopy cover targets outlined in the 'Area Design Plans' (Table 5, page 20).
- Trees shall be drawn and dimensioned to scale at the size indicated on the canopy coverage chart submitted, as described below.

The Canopy Coverage Plan shall comply with, but is not limited to, the following guidelines:

- Canopy coverage bonus area of 1.5 times the existing canopy, can be credited for preserved existing trees on the subject site.
- Show total projected canopy coverage, as following:
    - 1 small tree (3 metre spread) = 7 square metres

    shown as 3 metre diameter circle

    - 1 medium tree (10 metre spread) = 78.5 square metres

    shown as 10 metre diameter circle

• 1 large tree (14 metre spread) = 154 square metres

s*hown as 14 metre diameter circle*

- Where canopies merge or overlap, the combined area contributes to the coverage requirement, as opposed to including the canopy area of each overlapping tree. Overlapping canopy does not count twice. For example, for every ¼ of overlap the credit to the overlapped tree is reduced by 25 percent.
- Full canopy of proposed trees overhanging adjacent properties can be included as contributing to the required canopy coverage calculation.
- Only the portion of the existing canopy overhanging the subject site from a tree on an adjacent property can be included in the required canopy coverage calculation.

Tabulations in chart form to determine compliance with these requirements shall be provided, noting the tree, tree spread, crown area, total canopy area, and percent of site canopy coverage (required and proposed).

7.4.3.3 Soil Volume Requirements

The following outlines the soil volume requirements for new tree plantings:

- 30 cubic metres of good quality topsoil with a minimum depth of 750 millimetres;
- If 30 cubic metres cannot be realized in the planting bed then a 300 millimetre break-out zone will be constructed to allow the roots to access additional soil.
- Soil quality shall be per Town of Oakville's requirements (Appendix C).
- Soil shall be placed in maximum 150 millimetre lifts and compressed to between 80 to 85 percent Standard Proctor Density (SPD).

7.4.3.4 Planting

Landscape planting areas shall generally consist of evergreen and deciduous trees, woody shrubs, ground covers, perennials, and sod.

Self sustaining, low maintenance landscapes are preferred.

Provide minimum 3.0 metre wide landscape strip / space for all proposed tree plantings. Landscape strips shall be located entirely within the subject site, and be unimpeded by any structure, wall, fence, utility, or paving, unless enhance rooting techniques are employed.
Provide a diversity of plant species that are chosen for their ecological compatibility, appropriate for the site conditions, and provides seasonal variety, drought tolerance, and salt tolerance. Acceptable species mix is as follows:

- Provide a mix of tree types (species or cultivars) if more than ten trees are required.
- If 20 to 40 trees are required, no more than 50 percent of the trees may be of the same type.
- If more than 40 trees are required, then no more than 25 percent of the trees may be of the same type.
- 30 percent of the tree selection for a site should be native tree species.

All plant material shall conform to the Canadian Nursery Landscape Association specifications and standards.

Minimum acceptable sizes for plant material are:

- Deciduous Trees – 60 millimetre caliper, 3 to 3.5 metre height
- Coniferous Trees – 1.5 metre height
- Shrubs – 60 centimetre height

Where landscape area is over an underground garage roof slab, the following minimum depth of cover shall be provided:

- 900 millimetres for tree plantings
- 600 millimetres for shrub plantings
- 400 millimetres for sodded areas

All shrubs are to be planted in continuous planting beds.
Place mulch on all planting beds and maintain planting beds weed free.

All sod is to conform to the Nursery Sod Growers Association of Ontario specifications.
Artificial plants or trees shall not be used.

Planting areas, including backfill, shall be free of aggregate base (or other materials or construction debris detrimental to optimal plant growth).

Parking lot lighting and other utilities above and below ground should not conflict with required shade tree locations or growth.

Figure 11: Street tree planting in Uptown, Town of Oakville.

Where possible, plant trees at least 1.5 metres from curbs, sidewalks, etc, to buffer trees from stress and damage caused by salt, snow piling / removal, vehicle overhang, etc.

The typical tree planting detail shall depict a tree pit diameter three times (3x) the root ball diameter. The root habitat preservation zone shall be maintained at a minimum 2 metre radius beyond the edge of the backfill, possessing loosened soil with a compaction rating between 80 to 85 percent Standard Proctor Density (SPD).

Where the landscape buffer strip is adjacent to a property line, ensure that the tree pit, at three times (3x) the diameter of the root ball, does not encroach onto neighbouring properties.

7.4.3.5 Street Trees

7.4.3.5.1 Boulevard Street Trees—Within Residential and Employment Areas

750 millimetres depth of growing medium within town boulevard.

Conform to town's tree planting details and topsoil depth/ volume requirements.

Planting areas, including backfill, shall be free of aggregate base (or other materials or construction debris detrimental to optimal plant growth).

Use enhanced rooting environment techniques where required due to physical limitations.

The soil surface shall be covered with understory planting, such as shrubs, perennials, ornamental grasses and groundcover.

Street lighting and other utilities above and below ground should not conflict with required shade tree locations or growth.

Continuous tree pits to have minimum 2.25 metres to 2.5 metres wide planting trench at 750 millimetres depth.

Provide engineered soil systems for tree planting in paved areas to conform to the town's tree planting details.

Utilize engineered soil systems in 'break out' areas below hard surfaces.

Provide appropriate drainage system connected to storm sewer and grade excavated area to effectively utilize available/ provided drainage system.

Refer to applicable Landscape Standards.

Provide medium and large stature trees to support urban tree canopy targets.

Provide 30 cubic metres of good quality topsoil with a minimum depth of 750 millimetres; and

- Where 30 cubic metres cannot be realized as per above, then the depth will be a minimum of 750 millimetres and a 300 millimetre tree root break-out zone will be required under the sidewalk adjacent to the tree. The break-out zone will consist of 19 millimetres to 38 millimetres of unwashed crushed non-recycled aggregate (see Appendix B).

7.4.3.6 Subdivision Approval Process

The subdivision plan approval process will be a very effective tool in implementing the urban forest canopy targets and tree planting requirements on larger development proposals. The landscape standards for Subdivision Plan Approval have been prepared to support the town's objectives regarding canopy coverage and direction on how and where trees should be planted, as follows:

- Developers plant street trees in accordance with an approved utility co-ordination plan.
- For low and medium density residential land use, provide one (1) shade tree per lot. If dense urban context does not permit such provision and at the town's discretion, the owner shall:
    - Plant a medium or small stature street tree in the space available and compensate for canopy coverage by:
        - Optimize tree spacing with remainder of trees planted elsewhere on site, such as side yard, adjacent boulevard space or park areas.
        - Where feasible and necessary accommodate street trees on private front yards
        - Contribute funds for trees to be planted south of Dundas Street in parkland areas identified for naturalization to augment town's urban forest canopy cover.

7.4.3.7 Surface Parking Lots

7.4.3.7.1 Tree Planting Requirements

Minimum one (1) 60 millimetre caliper deciduous tree planting for every five (5) parking spaces.

Minimum two (2) trees per parking lot island.

All required trees must be in or within 5.0 metres of surface parking area in parking lot with 76 or more parking spaces.

Distribute shade tree planting such that no parking space is no more than 30 metres from a tree.

When necessary, small-statured trees (3 metre spread and less) will be accepted to meet these requirements.

7.4.3.7.2 Landscape Buffer Strip Requirement

Provide a minimum 3.0 metre wide landscape buffer from inside the property line, between the parking lot and the municipal right-of-way.

Provide for a minimum 3.0 metre wide landscape strip not abutting a street in 5 to 75 space parking lot.

Provide for a minimum 4.5 metre wide landscape strip not abutting a street in parking lot with 76 or more parking spaces.

Provide a minimum 4.5 metre soft landscape area as setback when abutting a residential zone. If other zoning setbacks apply, the greater setback shall be required.

7.4.3.7.3 Landscape Buffer Strip Planting Requirements

For landscape buffer abutting the municipal right-of-way, the buffer shall include:

- One (1) deciduous tree for every 12 metres of street fronting the parking lot; arrangement of trees in clusters or groupings is encouraged, but in no case shall trees be more than 15 metres apart. Site trees must be sufficiently set back to avoid overlap with any municipal street tree.

- A hedge, berm, wall, low decorative fence, or combination thereof forming a continuous screen at least 75 centimetres in height above the parking area grade, located in the buffer strip to provide maximum screening of the parking lot. Walls and fences to be set back from the property line by 1.2 metres with shrubs planted on the street side of the wall / fence.

For landscape buffer not abutting a street, the buffer shall include:

- Deciduous tree plantings meeting parking lot tree spacing and minimum tree planting requirements.

For landscape buffer abutting a residential zone, the buffer shall include:

- One deciduous or coniferous tree planting for every 7 metres of abutting land. At target of 50 percent of the trees within the buffer strip should be coniferous species. Arrangement of trees in clusters or groupings is encouraged, but in no case shall trees be more than 15 metres apart.
- A hedge, fence, or combination thereof forming a continuous screen at least 1.5 metres in height.

Buffers shall comply with all other 'Landscape Planting Standards' not covered by the above requirements.

7.4.3.7.4 Internal Landscape Area / Parking Lot Islands

Minimum two (2) shade trees per parking lot island.

Provide ground cover planting.

Internal landscape areas shall comply with all other 'Landscape Planting Standards' not covered by the above requirements.

7.4.3.7.5 Parking Lot Tree Spacing Requirements

Small stature tree (3 metre spread) = min 5 metre spacing

Medium stature tree (10 metre spread) = min 10 metre spacing

Large stature tree (14 metre spread and greater) = min 14 metre spacing

7.4.3.7.6 Determining Compliance

Tabulations in chart form to determine compliance with these requirements shall be provided, noting the soil volume of each interior landscape area / island and buffer strip, number of parking stalls, number of required trees, and number of trees proposed to meet requirement.

7.4.4 Soil Requirements

Tree planting of high design quality contributes to the overall health and life-span of a tree. Its ecological functions improve when planting soil volume provide adequate space for the root system. Current soil volume for tree-planting in Town of Oakville are inadequate to sustain tree growth and desired large canopies. This Plan identifies a soil volume requirement of 30 cubic metres for all trees. This standard has been benchmarked against other leading edge municipalities, such as City of Toronto, and is of precedent-setting quality. The UFORE soil volume standards are higher but do not account for conditions specific to north Oakville which will be a compact urbanized area with tight spaces and urban form. Though the NOUFSMP standards do not meet the high UFORE standards, they are realistic and constitute a large improvement over the current practice.

7.4.5 Tree Planting in Residential Land Uses

North Oakville's residential land uses will provide approximately 20 percent of tree canopy cover area, contributing 8 percent of the 40 percent tree canopy cover target. In order to achieve this target, an average of one (1) shade tree per lot must be implemented for all residential land uses.

Lot size will determine the possible number, stature and tree species. If it is demonstrated that it is not possible to provide the soil volumes required due to compact urban context, then at the town's discretion one (1) medium or small stature tree per lot will be planted in the space available and the canopy coverage will be compensated by: optimizing tree spacing with remainder of trees planted elsewhere on site (e.g., side yard or adjacent boulevard); where feasible and necessary accommodating street trees on private frong yards; contributing funds for trees to be planted south of Dundas Street in parkland areas identified for naturalization to augment town's urban forest canopy cover; or contributing funds for trees to be planted south of Dundas Street on boulevards with existing ash (*Fraxinus spp.*) trees that will likely succumb to Emerald Ash Borer. These provisions ensure that trees planted in the compact urban environment have adequate soil volumes to increase their health and chance for survival.

High density residential housing types such as apartment buildings and condominiums must adhere to the tree planting standards, surface parking lots and site plan approval sections outlined in Section 7.4 of this Plan.

7.4.6. Site Plan Approval North Oakville Sustainable Development Checklist and User Guide

The town's Sustainable Development Checklist is a tool to be used in north Oakville to assess the sustainable features of all development applications. Credits are given based on a level of compliance achieved using a checklist of 'points'. The completion of the Checklist is a pre-requisite prior to a pre-consultation meeting with the Planning Services Department. The town's urban forest canopy target, and the functional role of a robust urban forest, has relevance to all four sustainability principles:

- Development Form;
- Air Quality/Energy Efficiency;
- Water Management; and
- Natural Heritage System.

Shade conserves energy use and reduces heat island effects (especially in the summer). Leaf density and soft landscape areas reduce run-off and improve infiltration and air quality, and street/back/front yard trees extend habitat and/or provide migratory corridors for birds and habitat for other species.

Practically, an additional optional checklist item in Site Plan section could be added:

28. Designed to achieve projected canopy coverage percentage specified for class of development.

7.4.7 Green Parking Lot Design Standards

In addition to helping achieve urban forest canopy coverage goals, trees planted in parking lots provide shade and help reduce the excessive heat buildup that can adversely affect local microclimate and air quality. Design standards for surface parking lots have been prepared to advise applicants of the town's objectives regarding canopy coverage and provide direction on to how and where trees should be planted, as presented in Section 7.4.1.1. The following section outlines other green parking lot elements to be considered by the town in addition to the surface parking standards.

7.4.7.1 Best Practices

A review of ordinances and 'green' parking lot design guidelines in other jurisdictions provided guidance on the implementation standards for surface parking lot design.

The specific requirements are presented above, however the design guidance for measures to green parking areas is offered in the following:

- For parking lot edges not adjacent to the public realm, provide soft landscaping with a variety of deciduous and coniferous trees and plantings. Include bio-retention or other stormwater management systems as appropriate.
- Continuous planting islands are encouraged to allow for multiple tree plantings, increased soil volume and surface water runoff treatment measures such as bio-swales (areas required for tree planting can also satisfy the town's requirement to provide on-site treatment of stormwater);
- Irrigation shall be adapted for deep watering.
- Parking lot trees shall be indicated on both the Site Plan and on the Landscape Plan and shown in the same location on each.
- Deciduous canopy trees in parking areas shall meet the town's Landscape Standards; and
- Trees shall be protected from vehicles with curbing or with appropriate setbacks.

Trees growing in parking lots are often stunted because soil compaction and impermeable pavement limits the amount of rootable soil volume available and because temperature and soil moisture regimes in parking lot islands are often unfavorable for tree growth. At the beginning of parking lot construction, topsoil is generally removed. The subgrade is then compacted, followed by layers of crusher run stone, and asphalt or concrete that are spread and also compacted. Most municipal compaction specifications limit soil pore space and in turn available oxygen and moisture resulting in limited root growth. In addition, sometimes soil is treated with chemicals during the construction process (e.g., high amounts of lime) that may render it unfavourable for plant growth.

Parking lot "islands" act as root containers and should be designed with as much soil volume as possible with a minimum two (2) tree requirement, while

providing at minimum 30 cubic metres of soil per tree or per two (2) trees where that soil volume is shared. Ideally, the roots should be able to grow at least to the drip line or crown edge of the tree at maturity.

In the majority of landscape areas, topsoil in large continuous planting beds is the most practical approach to ensuring adequate growing medium for the desired medium and large stature trees. In some locations it may be necessary to expand the growing medium under pavements (streetscapes). In these situations the town should require that enhanced rooting environment techniques, such as engineered soils, are provided to ensure that there are adequate soil volumes to support tree growth.

8.0 Implementation

The opportunity to improve tree canopy cover within the north Oakville lands has been evaluated by reviewing master plan documents and the tree canopy being achieved under the current site plan approval process. This work has demonstrated that it is possible to achieve the town's long term vision to achieve 40 percent urban forest canopy cover, as identified in Mayor' Challenge for the Town of Oakville, the official plan – The Livable Oakville Plan and UFSMP, within the study area. This can be achieved primarily by requiring tree planting in parking lots (using engineered soils where necessary) and improving tree cover in landscape areas, parks and the Natural Heritage System.

This plan demonstrates that a 40 percent urban forest canopy cover is attainable and concludes:

- The natural heritage system is a critical contributor (90 percent) to the urban forest cover and needs to be appropriately managed.
- The current planning approval processes need to be modified to focus on improving the opportunities for tree growth in all land use zones in the North Oakville Plan Area.
- Tree planting standards in Oakville need to be modified in order for trees to achieve their potential mature size including planting in areas with adequate soil and levels of maintenance.
- Planting plans that are prepared for north Oakville need to reflect optimal tree spacing and soil volume to increase canopy cover on a site by site basis.
- The target of 40 percent urban forest canopy cover can be achieved if parking lot standards are updated to require increased soil volumes and the use of enhanced rooting environment products designed to support trees which will increase the overall landscaping costs.

8.1 Zoning By-law

The opportunity to improve tree canopy cover on the developable lands in the North Oakville Planning Area requires that the zoning by-law be amended to require that landscape strips and landscape areas are suitable for tree planting and that tree planting be required in parking lots, as identified in Section 7.4.

It is recommended that this regulation would apply to all land use zones. In north Oakville the best opportunity for enhancing tree canopy cover is to ensure that the parking lots are developed as 'green parking lots' that require minimum of one (1) shade tree for five (5) spaces in parking lots.

It is also recommended that landscape design of parks meet the town's urban tree canopy cover objectives of improving tree canopy targets, and that zoning by-law be amended to require development subject to site plan approval to provide a minimum 10 percent landscape area and that the landscape area to be designed is permeable.

8.2 Site Plan Approval Process

Unlike the zoning by-law which is focused on the regulation of land use, the site plan process is more focused on achieving design standards and suitable urban form feasibility. Therefore, the site plan approval process can be an effective tool in implementing the urban forest canopy objectives outlined in the Official Plan and the regulations established in the zoning by-law. Through this comprehensive review process, the quality of the existing and proposed planting environments are assessed to ensure optimal conditions for healthy trees (i.e., soil volumes, location in proximity to other landscape features, planting details, etc.).

Site Plan Design Standards will advise applicants and their consultants of the town's urban tree canopy cover objectives and tree planting requirements, as identified in Section 7.4 of this Plan.

8.3 Subdivision Approval Process

The town's landscape standards will effectively support the implementation of the urban forest canopy targets and tree planting requirements through the subdivision approval process, as outlined in Section 7.4 of this plan. The review and assessment process will ensure the implementation of the landscape standards towards the optimal conditions for healthy tree growth.

8.4 Cost Implications to Achieving Canopy Cover in Urban Areas

An increase in capital cost for implementing the recommendations of this report are primarily related to the additional soil depth and volume for tree planting, and using engineered soils in locations where it is necessary to install planting medium beneath pavement to achieve the recommended soil volumes.

The town's Standard Tree Planting Details (Appendix B) illustrates a minimum of 750 millimetre depth of topsoil for all tree planting trenches, 300 millimetre of depth of topsoil in parks (all other soft landscape areas excluding specialized sports fields) and 200 millimetre depth of topsoil within public rights-of-way and private lands. Although it is not possible to quantify the cost at this scale of study, future capital cost estimates prepared by town staff, and landscape cost estimates prepared for development applications, need to reflect the increase in additional soil volume from the previous standards.

The other considerable capital cost is related to applications where trees are required in hard landscape locations such as paved boulevards and parking lots. The cost of engineered soil can range from $50 per cubic metre to $200 per cubic metre. The cost of comparable topsoil ranges from $30 to $40 per cubic metre. Although structural cell applications use traditional soils, the cost of the installing cells will add cost in locations where it is necessary to provide additional growing medium and soil volumes in commercial and urban areas.

These costs can be somewhat mitigated by planting trees in locations that are most suitable, i.e., having relatively open and unconstrained sites, spacing the trees to support long-term root growth and selecting suitable species. Having consideration for the long-term growth and habitat of the selected tree will minimize mortality and the cost of ongoing replacement.

Additionally, there will be costs for staff training - specifically for the Planning and Development Engineering staff that review plans and will need to inspect sites to ensure that the updated standards are being implemented. There will also be a need for additional staff to provide arboricultural inspection of the installations. The skill set for the additional Development Engineering reviewers should include landscape architecture, planning, urban design and forestry. Additionally, existing staff currently responsible for building and site inspection will need training on the application and implementation of the new standards.

Again, in the long term, some of these costs may be off-set by a reduction in replacement cost and improvements to water and air quality.

8.5 Recommendations

The approach to achieving the 40 percent canopy cover target requires support from the leadership of the town and all departments. Clearly, there will be challenges transitioning to the updated standards during development review and implementation; however, the long term benefits will be the sustained ecological health of the community.

Recommendations for Meeting the 40 Percent Canopy Cover Target

1. Amend the Development Review Process to check for compliance with the canopy cover targets as shown below, including: reflecting the canopy cover target in the design plans; updating Site Plan Approval and Subdivision Approval Requirements; and updating Landscape Standards for Landscape Plan Submissions.

Land Use	Proposed Standard
The NHS & Natural Lands North of 407	90%
Agricultural Lands North of 407	0%
Residential (all types)	20%
Employment/Industrial	20%
Parkland	50%
Arterial + Avenue Roads	34%
Cemetery	34%
Commercial/Mixed Use	15%
SWM	15%
Transit Ways	34%
Public Use (schools)	20%
Transitional Area	15%
Institutional	25%

2. Implement new landscape standards.

3. Adopt new Tree Planting Standard Detail to reflect an increase in soil volume to 30 cubic metres and soil depth in continuous tree planting trenches to 750 millimetre depth (Appendix B).

4. Revise the spacing for street trees on landscape plans to reflect the optimal growth opportunity of the site.

5. Implement design guidelines for 'greening parking lots'.

6. Amend the zoning by-law to include one (1) shade tree for five (5) parking spaces in surface parking lots.

7. Review to incorporate the tree planting details, landscape standards, and green parking lot landscape standards outline in the NOUFSMP into the development standards south of Dundas Street.

8. Provide staff training in landscape architecture, planning, urban design and forestry for the implementation of the new requirements and standards; this may require new resources.

9. Establish incentives or support voluntary stewardship activities (e.g., tree give-away for residential landowners) to enhance tree canopy on low and medium density residential lots (e.g., 10,000 lots with medium stature trees @ 78.5 square metres per tree provides 78.5 hectares canopy cover, or 10,000 lots with small stature trees @ 7.0 square metres per tree provides 7.0 hectares canopy cover).

10. Recognize that tree planting requirements in the Natural Heritage System are distinct from those in urban areas. Trees planted in the NHS should be 100% native and conform to best management practices in natural areas.

11. Consider partnering with a university (e.g., University of Toronto, Faculty of Forestry) to conduct performance testing on mycorrhiza fungi products with the intent of generating a peer-reviewed article in a forestry journal.

12. Work with Conservation Halton so that agricultural fields not assigned a management prescription in the Glenorchy Conservation Area draft Master Plan be considered for future forest cover.

13. Conduct periodic site reviews during construction, and regular inspections to monitor tree health.

14. Review maintenance securities such as 'maintenance holdback' to ensure that ongoing care is provided to support growth.

15. Monitor oak dominated forests and provide silvicultural treatment if oak savannas, woodlands and forests area are to be maintained in north Oakville.

16. Form partnerships with Non-Government Organizations whose grass-roots greening initiatives include planting events, parkland stewardship and green-space planning.

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APPENDIX A

LESSONS LEARNED FROM OTHER JURISDICTIONS

1.0 Baltimore, Maryland

Baltimore's Forestry Division, Department of Recreation and Parks urban forest management role is limited to managing a public tree program within street rights of way, parks and other public lands, and has limited impact on other issues such as tree protection violations, development practices, or developing comprehensive policies that affect trees throughout the city.

In Baltimore, tree mortality patterns differ with land uses. Invasive, short-lived species dominate transportation corridors and industrial and commercial sites. Medium to low-density residential is the only land use with a higher number of trees in the mature age class reflecting better growing conditions.

The City hired an Arborist as chief officer in 2005 that introduced new standards of practice including:

- No new planting in existing tree pits less than 4 feet X 4 feet (1.2 metres X 1.2 metres) in dimension;
- New pits must be a minimum of 4 feet X 8 feet (1.2 metres X 2.4 metres) dimension; and
- Spacing between canopy trees 30 feet (9.1 metres) minimum, and for understory trees, 15 feet (4.6 metres) apart.

In 2006, the Baltimore Urban Forest Management Plan (BUFMP) adopted the same tree canopy goal, doubling the existing canopy. Similar to Oakville, the Baltimore forest has size class distribution that favors small/young trees. Two thirds of the trees are small/ young, or less than 6 inches (15.2 centimetres) dbh, less than one-third are medium sized or mature and only 5 percent are large or "over mature". Only one-third of trees in Baltimore live longer than 15 years.

The BUFMP provided a number of objectives for the City - potentially key for North Oakville:

Interagency Cooperation to Support the Tree Canopy Goal

- Design an integrated regulatory framework for the protection and enhancement of the urban forest, which reflects current standards of practice.
- Upgrade the regulatory framework to be consistent with professional standards recommended by the USDA Forest Service, the National Urban and Community Forestry Council and the International Society of Arboriculture. Where there is a conflict (with existing City ordinance), the stricter standards will apply.
- Require Arborist approval of all streetscape plans.

Build Tree-Friendly Urban Infrastructure

- Urban infrastructure should be designed and built to maximize the volume and quality of tree habitat while minimizing conflicts with trees (develop policy that ensures city infrastructure incorporates tree standards to the best practices and provides the maximum amount of tree planting opportunities practical).
- Provide compaction prevention specifications for street ROW and high density development.
- Select tree species best suited to the specific growing environment.
- Trees in right of way and high density residential and commercial areas: 2 to 2.5 inches (5.1 centimetres to 6.4 centimetres) cal. min, 3 to 3 ½ inches (7.6 centimetres to 8.9 centimetres) preferred.

Protect Existing Trees from Construction Practices

- Protect designated individual trees and forests on development sites from unnecessary removal and damage.
- Develop a sidewalk repair and tree preservation program consistent with the tree canopy goal—preserving as many large, healthy trees as possible.

- Until a comprehensive program is developed require an arborist sub-consultant on each sidewalk repair contract administered by DOT (Department of Transportation) as well as development projects that involve existing mature trees.
- City Arborist to review all permits for removal or damage to protected trees.
- Arborist shall prescribe and supervise methods where root pruning is required. Follow-up all root pruning with inspections at 18, 40, and 78 months.
- During sidewalk repair, contractor shall improve both the growing environment for trees and increase opportunities for future planting by revising the sidewalk designs to conform to tree canopy infrastructure standards (see infrastructure policy objectives) to the degree possible:
    - Enlarge tree wells
    - Minimize sidewalk width
    - Obtain additional public easement from property owner
    - Sidewalk ramping
    - Flexible sidewalks
    - Use root deflection devices.
    - Create curb bump outs.

Increase Tree Canopy on Private Property through a Variety of Incentive and Stewardship Programs

- For smaller development sites consider a Tree Impact Plan (performance standards for retaining trees, replacement schedule for trees permitted for removal, tree protection provisions during development, performance bond for tree protection, mitigation for tree loss) requiring review by the City Arborist and Department of Planning.
- Implement an on-going bi-annual small tree giveaway of trees in 1 to 2 gallon pots. Residents to pick-up and plant trees at a centralized location.
- Implement a grant program to promote shade trees on private property directed towards public or private institutions or civic organizations such as including 50/50 cost share of larger trees.

Baltimore's Office of Park Conservation and Community Outreach (PCCO) has also developed a Community Forestry Program that:

- Organizes and leads volunteer park tree plantings with friends of parks groups, community associations, churches, businesses and other civic organizations.
- Maintains young park trees for six (6) years after planting.
- Inventories park trees.
- Conducts "tree-based" environmental education lessons.
- Designs tree planting schemes.
- Collaborates with communities on park greening initiatives.

2.0 Toronto, Ontario

Toronto, like Oakville, is researching how it can achieve more canopy through the city planning process, and not just through planting parks and other public lands.

Toronto began a UFORE process in 2000. In a more formal, large-scale study in 2008 data collectors were able to gather information on Toronto's private trees in addition to street and park tree data. Toronto's private tree by-law currently protects trees on private property that are 30 centimetres or more (dbh). That data is currently being analyzed and will assist the City's forest managers as they develop a strategic management plan, but one lesson that has already been learned is urban trees require better quality growing space to reach mature canopy areas and volumes.

In 2004, City Planning, Parks, Forestry and Recreation, Toronto Water and Technical Services Divisions sponsored a staff training session with internationally recognized speakers to share their experiences, challenges and success stories on creating liveable, beautiful city streets with a focus on the role of the tree. The City of Toronto Tree Symposium: Healthy Trees for a Beautiful City was attended by over 180 staff and has led to new approaches to planting street trees.

The approach was to invite in a group of respected experts to discuss the importance of investing in trees, not just to improve the environment, but also for the benefits to the economy and the city's social well being. The intent was to provide convincing interdisciplinary arguments about why trees should be viewed as an asset, part of the City's infrastructure, as are roads and utilities. In many ways, trees are more significant than typical city infrastructure in that they last longer, and become more valuable with age.

At the time there were no regulations in place to ensure adequate space, soil and water for the growth of healthy trees, nor to encourage the use of permeable surfaces. Existing planting and growing practices were either inconsistent or insufficient to provide for proper growing spaces limited by pavement, access to water and quality soil, cold winters and road salt.

Ian Lockwood, a Senior Transportation Engineer and a pioneer and leader in the fields of context-sensitive design and traffic calming addressed the "conventional engineering paradigm" as being associated with inhibiting street trees' potential to contribute to the expansion of the urban forest cover[1].

In November 2007, Toronto presented in draft form 'Design Guidelines for 'Greening' Surface Parking Lots' which implements some Built Environment and Natural Environment policies of the Official Plan as well as provides design options and strategies to implement some of the environmental performance targets of the Toronto Green Development Standard. The draft Design Guidelines were approved for public release and Council also approved a recommendation for City staff to apply and test the draft Guidelines during the design, review and approval of all new developments containing surface parking. A number of guidelines relating to landscaping are relevant to the NOUFSMP:

> 4.4.1 a:
> Retain and protect existing trees, vegetation, natural slopes and native soils and integrate these features into the overall landscape plan.
>
> 4.4.1.c:
> Consolidate soft landscaped areas, particularly in larger parking lots, to enhance tree and plant material growing conditions.
>
> 4.4.1.e:
> Expand rooting zones of landscaped areas under adjacent hard surfaces.
> Note: Techniques may include the use of engineered soils or cells, continuous planting trenches and/or permeable paving.
>
> 4.4.1.g:
> Install a permanent irrigation system in all landscaped areas. Where possible, collect rainwater from rooftops and other surfaces for plant irrigation.

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1 Lockwood, I., 2004.

4.4.1.k:
Coordinate tree planting with the location of light standards and other utilities.
4.4.3.d:
Provide internal shade trees at a minimum ratio of one tree planted for every five parking spaces supplied.

4.4.3.e:
Provide a minimum growing environment of 30 cubic metres (at 0.9 metre depth) of good quality soil (per tree).

Transforming municipal tree-planting will not be inexpensive. By some estimates, it will cost $5,000 to $10,000 per tree for downtown commercial sites (lower for residential areas) to ensure optimal soil, drainage, and pavement design factors.

3.0 Markham, Ontario

Town of Markham is working on the UFORE study to determine its current and target urban forest canopy coverage, although the Regional target is already set to 25% urban canopy. The Town has established a streetscape manual that focuses on site plan, subdivision and boulevard tree planting practices, with specifications and details for successful tree planting. Tree for Tomorrow, Tree Preservation By-law and Urban Design Streetscape Manual are just some of the initiatives that help protect the town's urban forest.

In understanding a tree's growth requirements, current spatial limitations and streetscape framework, the Town developed a requirement of 30 cubic metres of soil for large trees and 15 cubic metres of soil for small trees or trees with consolidated tree planting areas.

4.0 Chicago, Illinois

Chicago allocates $14 million a year to its Bureau of Forestry[2]. In 1990, Chicago had an estimated 430,000 street trees. By 2003, the number grew to an estimated 538,000, many of them planted by private interests responding to the city's investment. Chicago assigns a value to trees, based on their diameter, and requires departments such as Transportation to repay the value if they are removed for street widening or other projects, a policy that discourages unnecessary tree removals.

5.0 Milwaukee, Wisconsin: Financing & Managing the Urban Forest

Milwaukee's urban forestry program is acknowledged as one of the most successful in the United States[3]. A Municipal Nursery and a Forestry Maintenance Shop offer operational support by supplying stock and repairing tools, and a strong operational structure and staff allow for innovative management.

Milwaukee's Forestry Section is located within the City of Milwaukee's Department of Public Works. A department commissioner, who reports to the mayor, is responsible for all operations of the department. He meets with section heads separately and in broader department-wide meetings to ensure that the voice of each section is heard by the mayor and that close connections are maintained between departments. The Forestry Section thus has the advantage of being aware of potential problems that may otherwise have gone unseen. Any work conducted by another department that has an impact on city trees (e.g., road and sidewalk construction, new building development, storm drainage development, transportation issues) must be reviewed by the Forestry Section. This allows the department to minimize damage to trees, maximize tree replacement and planting, and hold contractors responsible for tree damage or loss. This inter-departmental communication and support is essential for proper forest management and care.

In addition to inter-departmental support, the Mayor and Council demonstrate support by allocating appropriate funding. In order to secure funding the Forestry Section must first submit a budget proposal to the Department of Public Works. Forestry directly frames the effect of funding levels on mortality rates by conveying a certain amount of funding as supporting a mortality rate of a particular percent. With any decrease in funding the mortality rate will rise. This type of budget is much easier for city leadership to understand because it does not have to analyze the costs of maintaining, planting, and removing trees. This budget strategy has also proven to be highly successful, since at $11 million ($18.50 per capita) annually, the Forestry Section budget is the highest in the country. In recent years, both the mayor and council have been

2 Langdon, P., 2005.
3 Bell, R. & Wheeler, J. 2006.

reluctant to cut planting budgets. They are more willing to cut tree maintenance budgets in order to retain funds for planting.

In addition to receiving money from the City, the Forestry Section also applies for grants from both State and Federal sources[4]. One grant that they have been awarded was for the replacement of asphalt playgrounds with trees to reduce stormwater runoff and improve school grounds.

Forestry also has a comprehensive employee training program. All entry-level "Urban Forestry Specialists" go through a training program that results in a common work-ethic and set of goals. Arborists are year-round employees, offering many more long-term benefits and contributions than seasonal employees. Arborists are in charge of tree planting and removal, structural pruning, lift truck operation, cable and bolting techniques, and plant health care, and are also trained in landscape gardening techniques such as irrigation installation and repair, planting and maintenance of annuals, perennials, turf, and shrubs. Landscape Gardeners are in turn trained to perform the tasks of Arborists. This cross-trained, flexible, and stable workforce is able to reduce the time necessary to complete an operation. This comprehensive training has greatly increased the efficiency and stability of the Forestry Section and has enabled it to allocate funds more diligently.

In addition, the Forestry Section has partnered with the University of Wisconsin-Stevens Point (UWSP), which has one of the best collegiate Urban Forestry Programs in the U.S., to provide undergraduate and graduate students with internship work experience. These internships not only provide valuable work experience for the students, they also provide the city with employees who have a vested interest in urban forestry in Milwaukee. The partnership with UWSP also allows for research opportunities like maintenance modeling of the city's urban forestry program.

The most significant change was the establishment and funding of a non-profit group, Greening Milwaukee. Council founded the new organization with the primary objective to increase tree planting and encourage proper maintenance of trees on private property (which the City felt it did not have proper access to). This allocation of responsibility enabled the City to more confidently attempt to reach its goal of 40 percent canopy cover.

Greening Milwaukee has been able to increase tree planting on private property through the "Adopt a Tree" program. This program offers homeowners a free tree if they are willing to go through a tree planting, care, and maintenance training session, plant the tree, and maintain it for its lifetime. The organization first evaluates the available space and recommends an appropriate species before they choose a tree. This program enables homeowners to not only have a new tree, but also helps to provide for its proper care.

The Forestry Section is responsible for the care and maintenance of all trees on civic property. The city is broken up into 160 acre management units that are maintained with regular pruning cycles; trees smaller than 12 inches in diameter are pruned every three years and trees larger than 12 inches in diameter are pruned every six years. This proactive management enables the Forestry Section to detect problems early, prevent future problems, and prolong the lifespan of its trees. Milwaukee's proactive management practices pay off with an average street tree age of 62 years – twice the national average.

The continued success of Milwaukee's Forestry Section is dependant on its ability to maintain this level of high quality management. Since Milwaukee's proactive management prolongs the lifespan of trees and increases tree health, the Forestry Section can report higher numbers of benefits to the community. Providing these positive numbers to policy makers secures adequate funding, which will in turn continue to benefit the urban forest. Overall, this encouraging cycle demonstrates that the urban forest is an investment opportunity for cities that will continually appreciate in value over time.

6.0 St. Paul, Minnesota

The Minnesota Shade Tree Advisory Committee was created in 1974. Its mission is to 'advance Minnesota's commitment to the health, care and future of all community forests'.

Tree Trust is a private non-profit corporation founded in 1976 whose mission is 'to provide education and employment experiences that develop individual responsibility and environmental stewardship'.

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4 Such a grant system is not available in Canada as neither the Federal nor Provincial Governments fund urban forestry initiatives at this time.

In partnership these two groups created a Field Guide: A Resource for Builders and Developers to Follow When Preserving, Protecting and Restoring Trees (2002). The Field Guide is a voluntary step-by-step resource guide that assists builders and developers in preserving, protecting and replanting trees during land development and construction. It presents information and provides ideas to follow throughout the course of a project, before, during and after construction:

- Mapping;
- Inventory;
- Planning Components;
- Tree Preservation Plan;
- Design Components:
    - grade changes
    - roads
    - utilities
    - drainage
    - building lots
    - materials storage, clean-out, access routes, parking and fill
    - Protection Components;
    - Restoration and Replanting Components;
    - Restoration and Replanting Map; and
    - Maintenance Considerations.

It also provides a list of technical resources on building and developing among trees, woodland management and restoration, and on transplanting native trees and shrubs.

7.0 Fort Collins, Colorado

Fort Collins's Forestry Division justifies its large annual budget of almost one million dollars by calculating the economic benefit produced by their trees. The budget for Forestry is allocated from the general fund by budgeting for outcomes. This means that the division must appeal for funding by articulating all possible benefits of the urban forest.

In 2003, the Center for Urban Forest Research conducted a study entitled Benefit-Cost Analysis of Fort Collins's Municipal Forest. The study concluded that Fort Collins's relatively large urban forestry budget was fully justified because its net annual benefits total $1.17 million. Total benefits of the urban forest equalled $2.17 million.

This relatively large budget has enabled the Forestry Division to manage its urban forest with more proactive and less reactive strategies, such as a "graduated rotation cycle" that addresses the needs of trees at critical times during their lifetime - small trees are pruned every eight years, medium trees every seven years, and large trees every twelve years.

To address water shortages in its arid climate, the Forestry Division has implemented a program entitled "Save our Shade" to help residents protect existing trees and plant drought-resistant trees. To implement this program, the Forestry Division has teamed up with a coalition of supporting local, non-profit organizations like Trees, Water, and People, The Colorado Tree Coalition and Plant It 2020. The program's objectives are to increase public awareness of the importance of protecting trees during drought,

educate citizens of the benefits of urban trees, and promote responsible and sustainable tree planting and care appropriate to the local dry climate. The Forestry Division has also collaborated with Colorado State University and other local research groups to put together a list of acceptable species to plant. These aspects and many others make Fort Collins's forest management efforts stand out among other programs.

One unique aspect of Fort Collins's urban forestry program is that it is integrated into the city's Climate Protection Plan. Fort Collins embarked on a campaign to reduce emissions by up to thirty percent below worst-case levels predicted for 2010. In order to maximize the reduction of emissions, Fort Collins has included tree planting and maintenance goals in its Municipal Climate Protection Plan written in 2001 by the City's Energy Management Team. The vegetation measures, "strive to increase the health, stability, and diversity of the urban forest" by increasing or at least maintaining the stocking level, raising the average mortality age, and planting in strategic energy-saving locations.

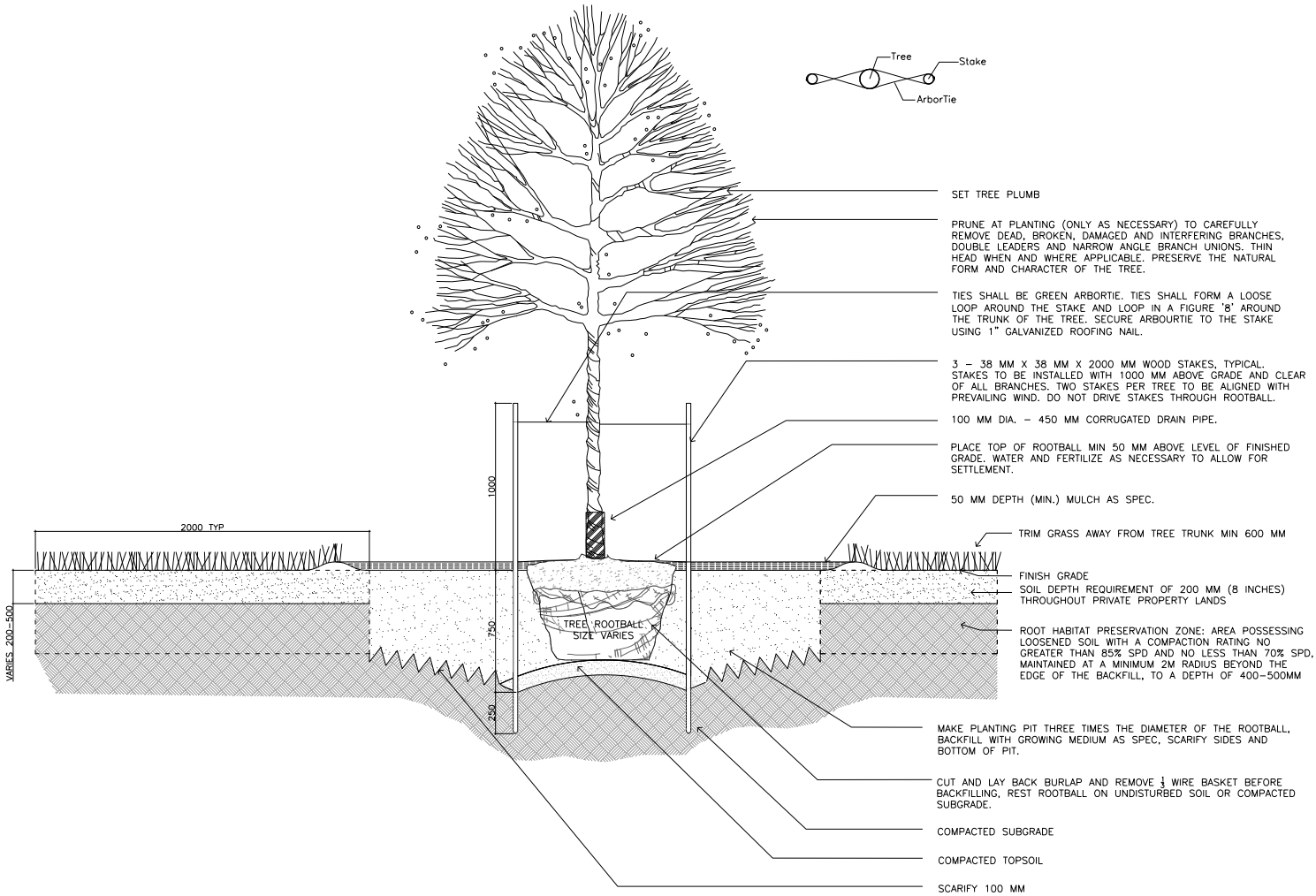
As a part of the Fort Collins Local Action Plan to Reduce Greenhouse Gas Emissions, 1999, two important measures were adopted:

1. The first measure aims to increase tree-plantings city wide so that restocking levels equal tree mortality and removal levels, with carbon dioxide savings estimated at 125 tons for 2010. This goal will be reached by offering matching funds to support non-profit tree planting and/or tree education grant proposals, developing an education campaign to raise awareness of the benefits of trees, compiling a list of the most appropriate species for planting, and conducting a study to determine the percent of canopy cover to improve accuracy of carbon sequestration estimates. This measure also requires that the City plant large canopy trees to maximize energy savings.

2. The second measure seeks to increase the life span of trees on city property. This requires that the majority of new plantings consist of large canopy shade trees that produce the most environmental and energy savings benefits. Under this measure existing trees will be preserved to the maximum extent possible. The measure recommends expanding funding of tree maintenance activities to extend the life of trees, planting in all available sites, and that species requiring less maintenance be planted in appropriate locations.

APPENDIX B

PLANTING DETAILS

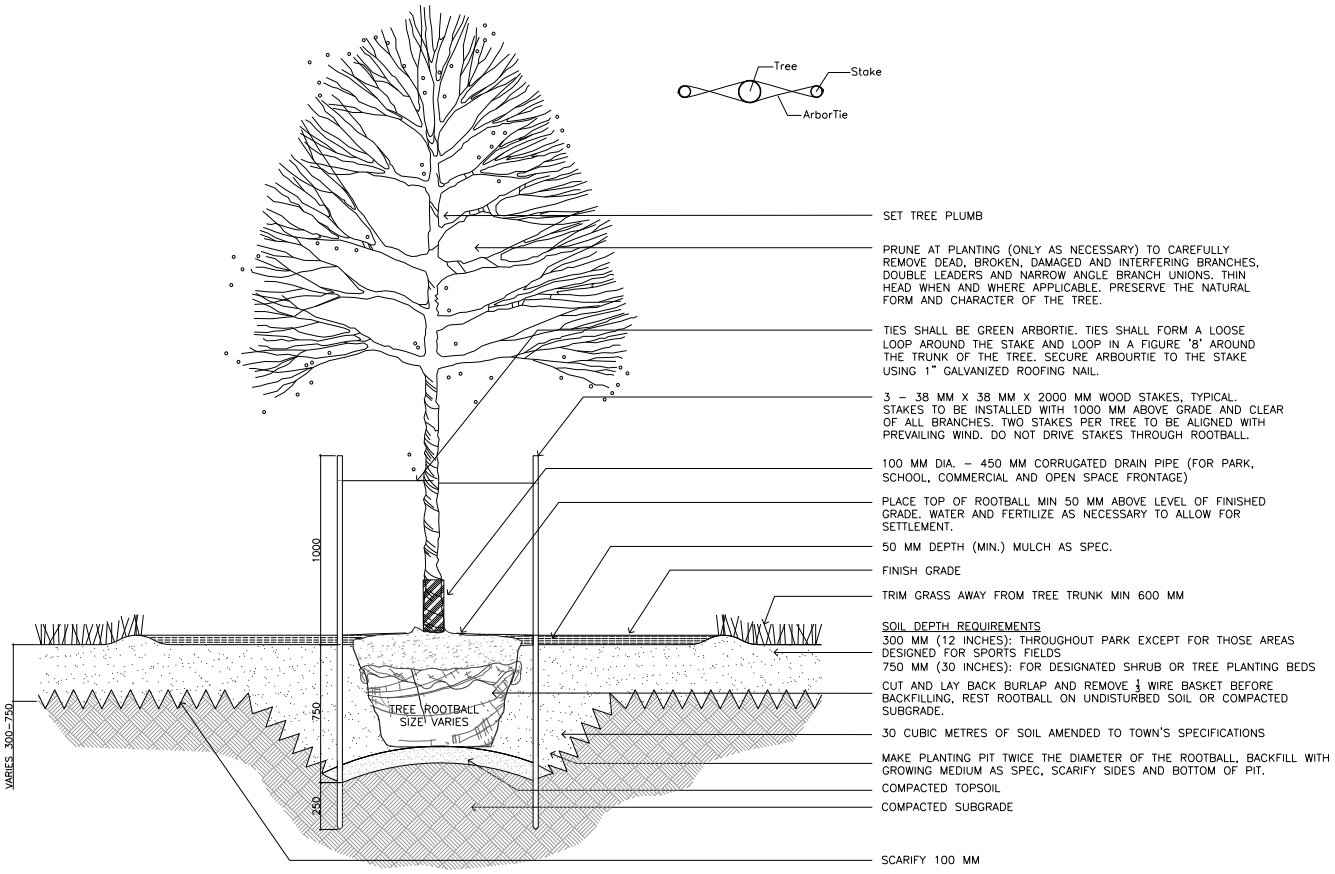


NOTES:

1. TOPSOIL IN PLANTING AREAS SHOULD BE COMPACTED TO 80–85% SPD (MAXIMUM 150MM LIFTS).

1/A TREE PLANTING ON PRIVATE PROPERTY

1:40

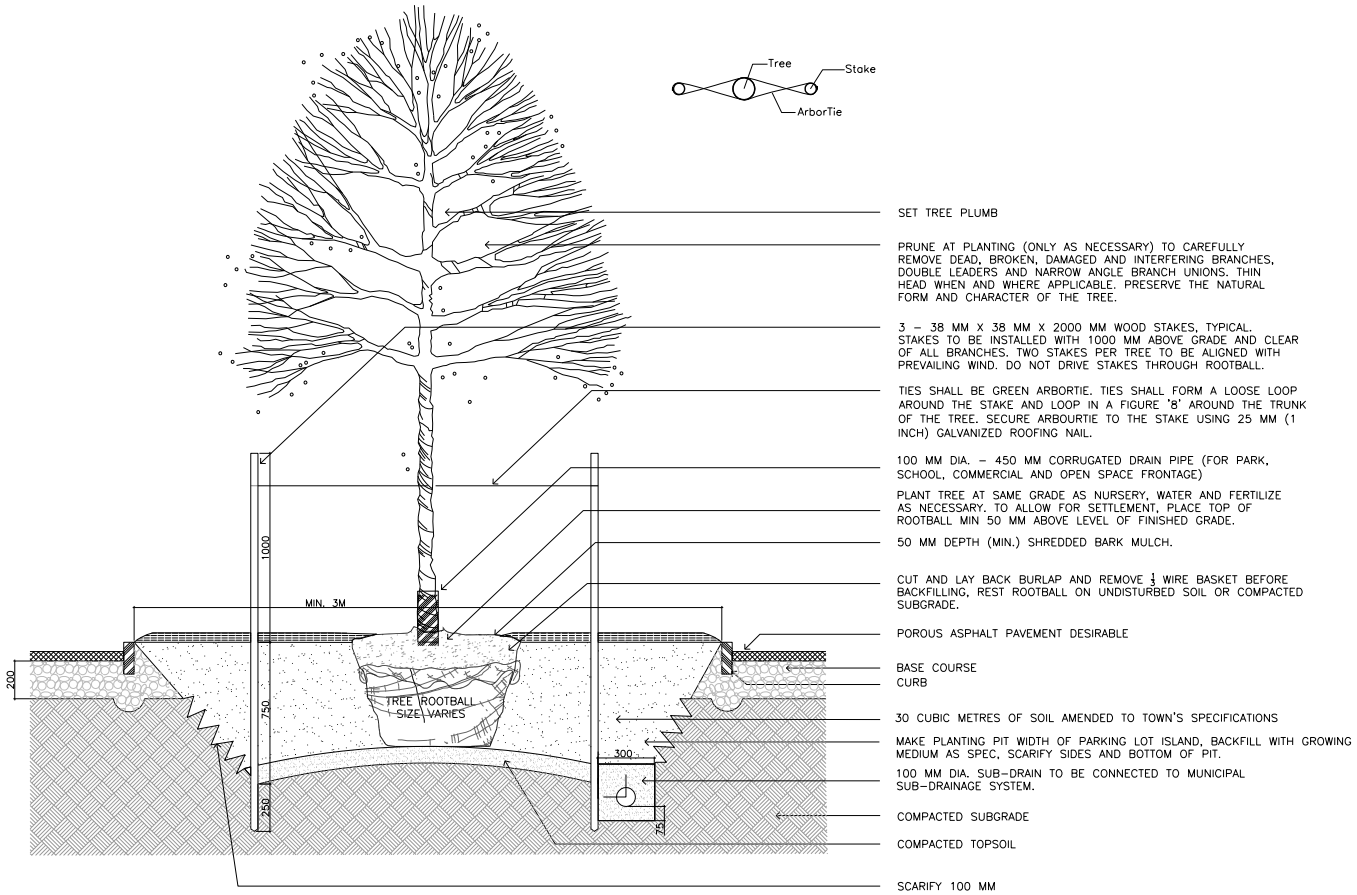


NOTES:

1. TOPSOIL IN PLANTING AREAS SHOULD BE COMPACTED TO 80–85% SPD (MAXIMUM 150MM LIFTS).

2 A TREE PLANTING IN PARKS

1:40

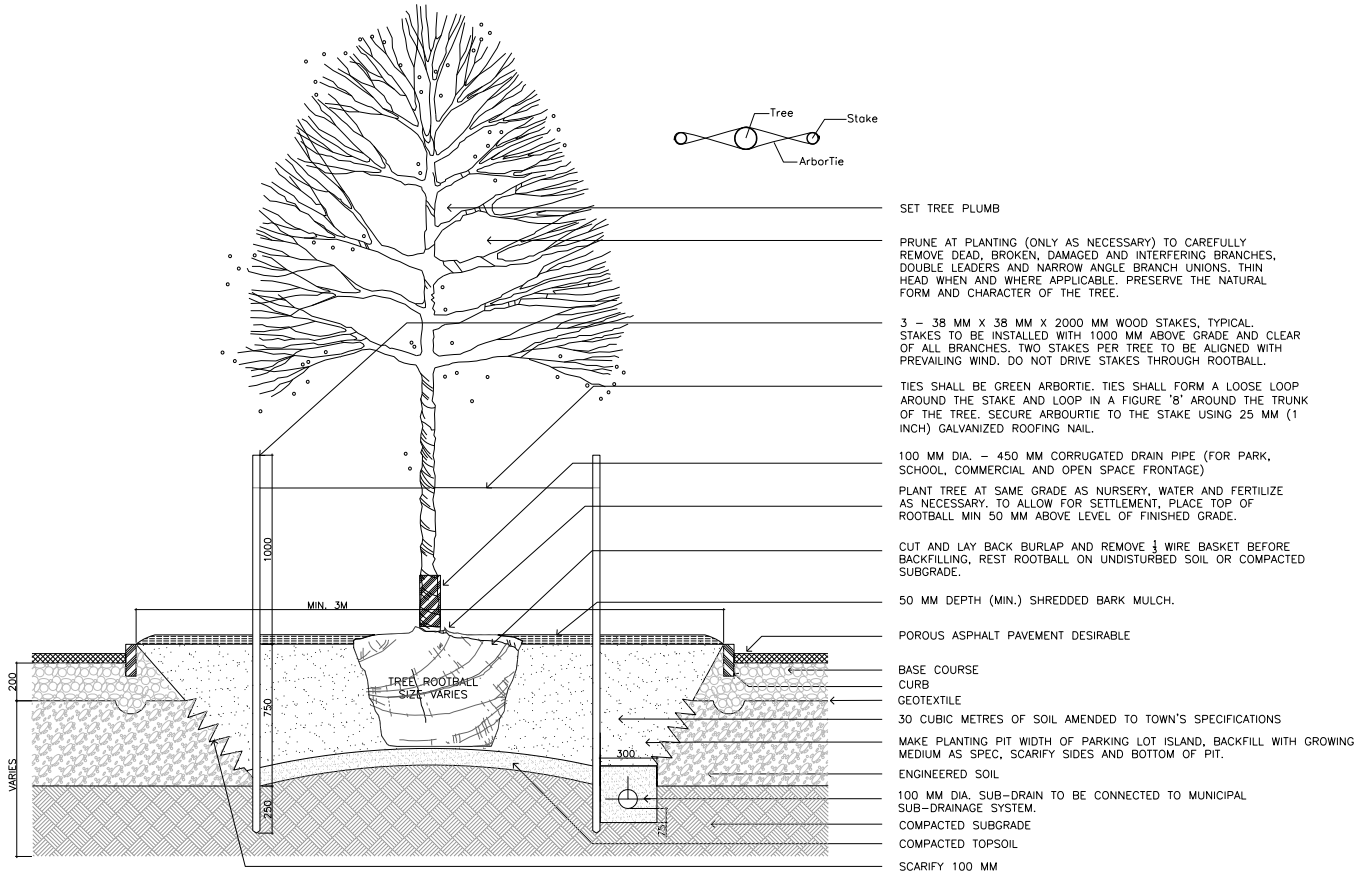


NOTES:

1. TOPSOIL IN PLANTING AREAS SHOULD BE COMPACTED TO 80-85% SPD (MAXIMUM 150MM LIFTS);
2. INSTALLATION TO BE COMPLETED IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS;
3. DO NOT SCALE DRAWINGS;
4. CONTRACTOR'S NOTE: PRODUCT AND COMPANY INFORMATION VISIT www.CADdetails.com/info REFERENCE NUMBER 057-005;
5. ALL TREES REQUIRE A MINIMUM OF 30 CUBIC METRES OF SOIL.

3 A TREE PLANTING IN TYPICAL PARKING LOT ISLAND

1:40



NOTES:

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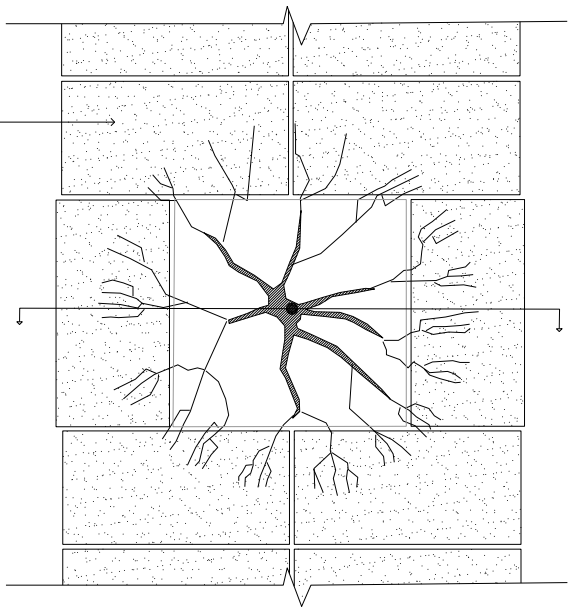
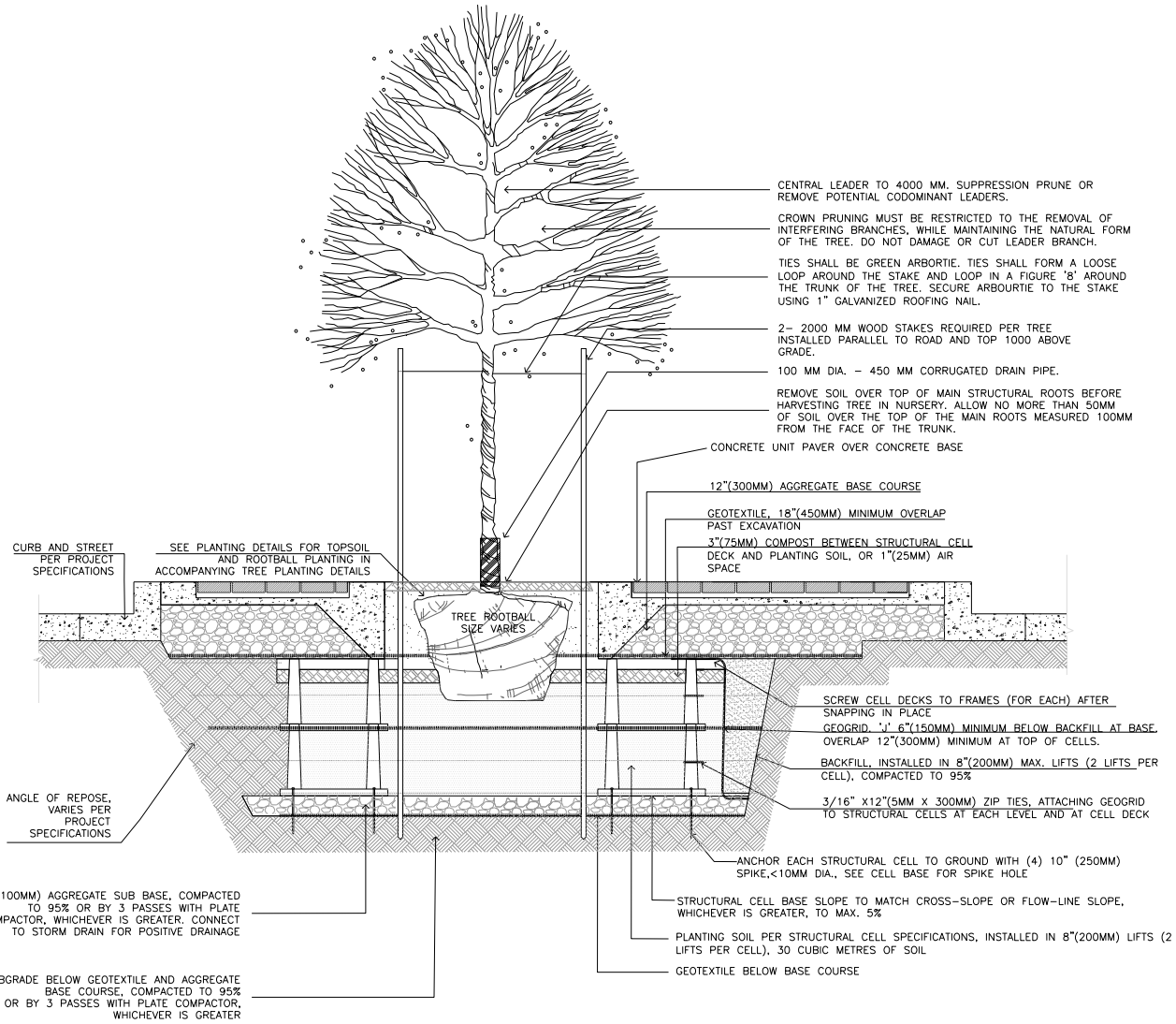
3. DO NOT SCALE DRAWINGS;
4. CONTRACTOR'S NOTE: PRODUCT AND COMPANY INFORMATION VISIT www.CADdetails.com/info REFERENCE NUMBER 057–005;
5. ENGINEERED SOIL IS 20% SOIL BY VOLUME. ALL TREES REQUIRE 30 CUBIC METRES OF SOIL. ANY ENGINEERED SOIL USED MUST BE CALCULATED USING A FACTOR OF 0.2. TREES PLANTED ENTIRELY IN ENGINEERED SOILS REQUIRE 150 CUBIC METRES.

3/B TREE PLANTING IN TYPICAL PARKING LOT ISLAND, USING ENGINEERED SOIL

1:40



PLAN VIEW

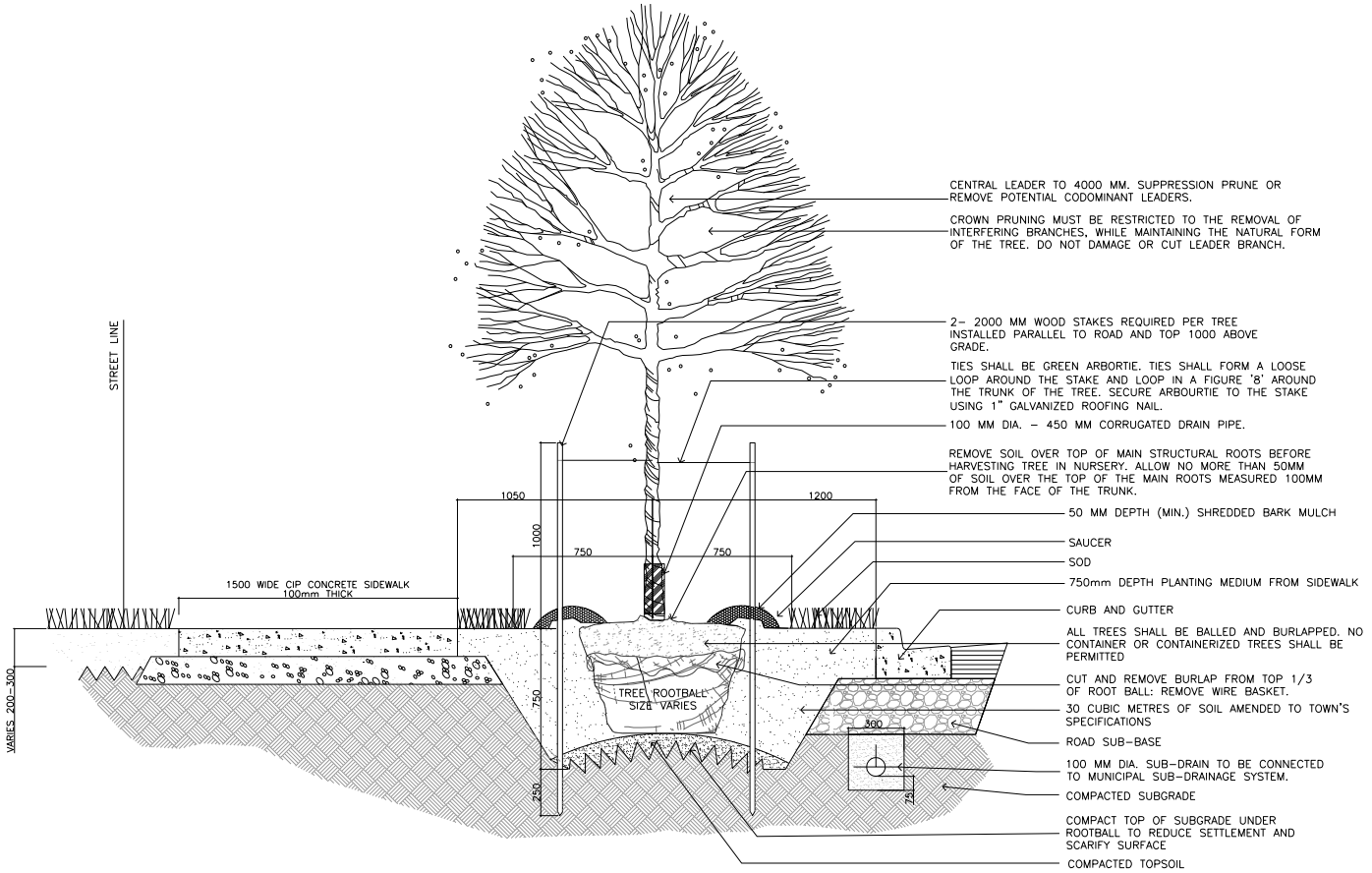


NOTES:

1. TOPSOIL IN PLANTING AREAS SHOULD BE COMPACTED TO 80-85% SPD.

4/A TREE PLANTING IN TYPICAL STREETSCAPE, USING STRUCTURAL CELLS

1:40



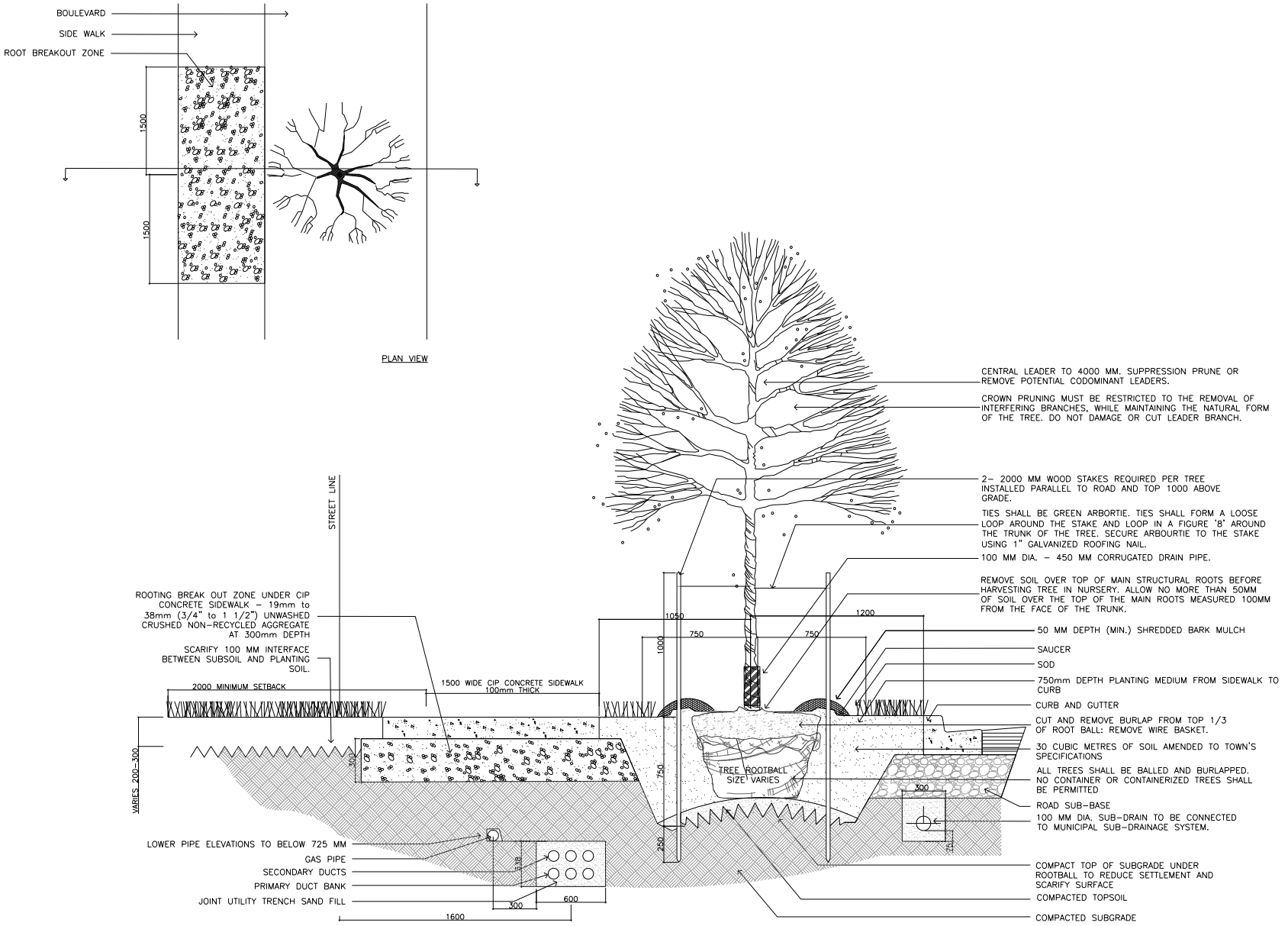
NOTES:

1. TOPSOIL IN PLANTING AREAS SHOULD BE COMPACTED TO 80-85% SPD (MAXIMUM 150MM LIFTS);

5
A

2.25m WIDE PUBLIC BOULEVARD TREE PLANTING DETAIL

1:40

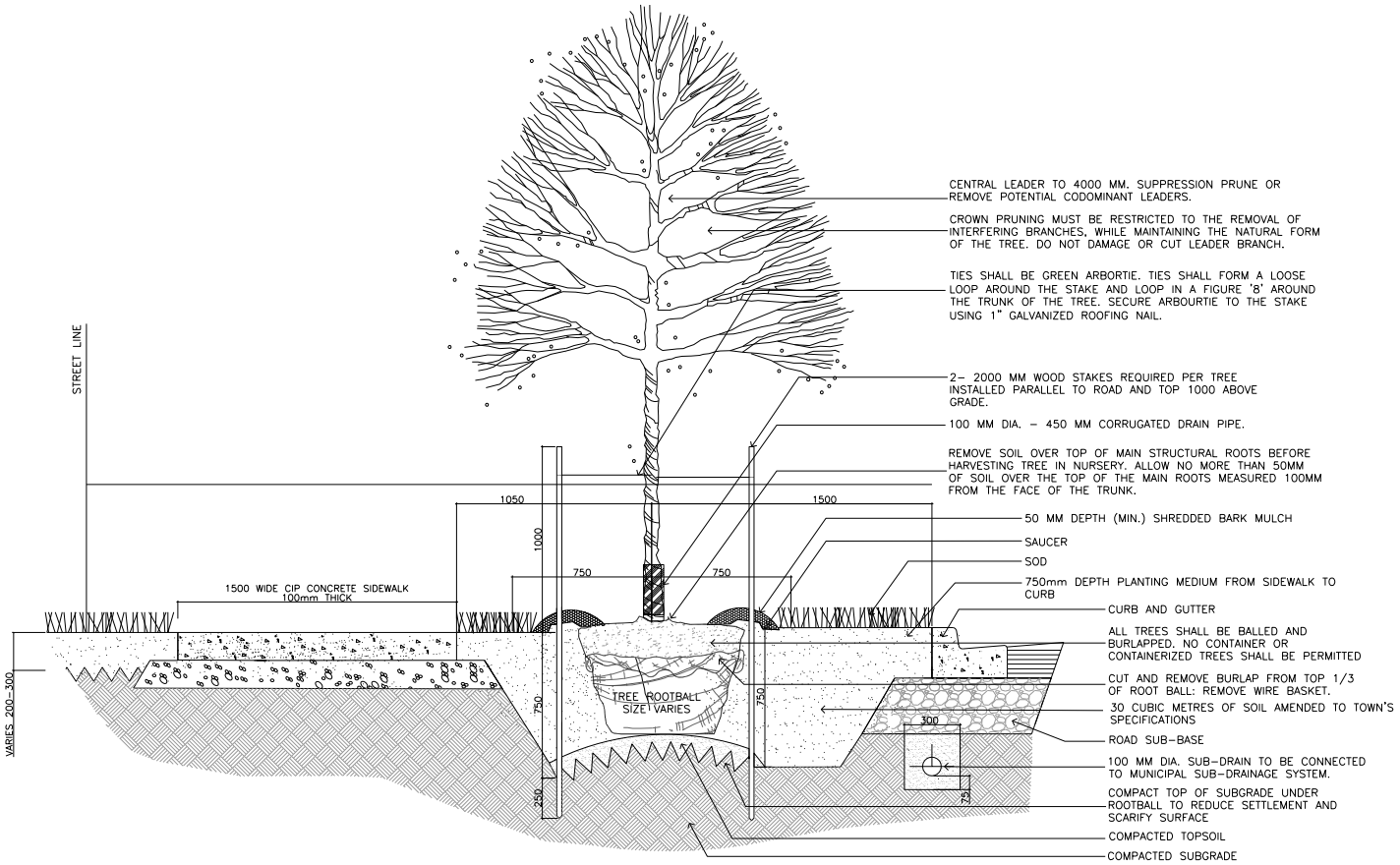


NOTES:

1. TOPSOIL IN PLANTING AREAS SHOULD BE COMPACTED TO 80-85% SPD (MAXIMUM 150MM LIFTS).

5 B 2.25m WIDE PUBLIC BOULEVARD TREE PLANTING DETAIL USING BREAKOUT ZONES

1:40

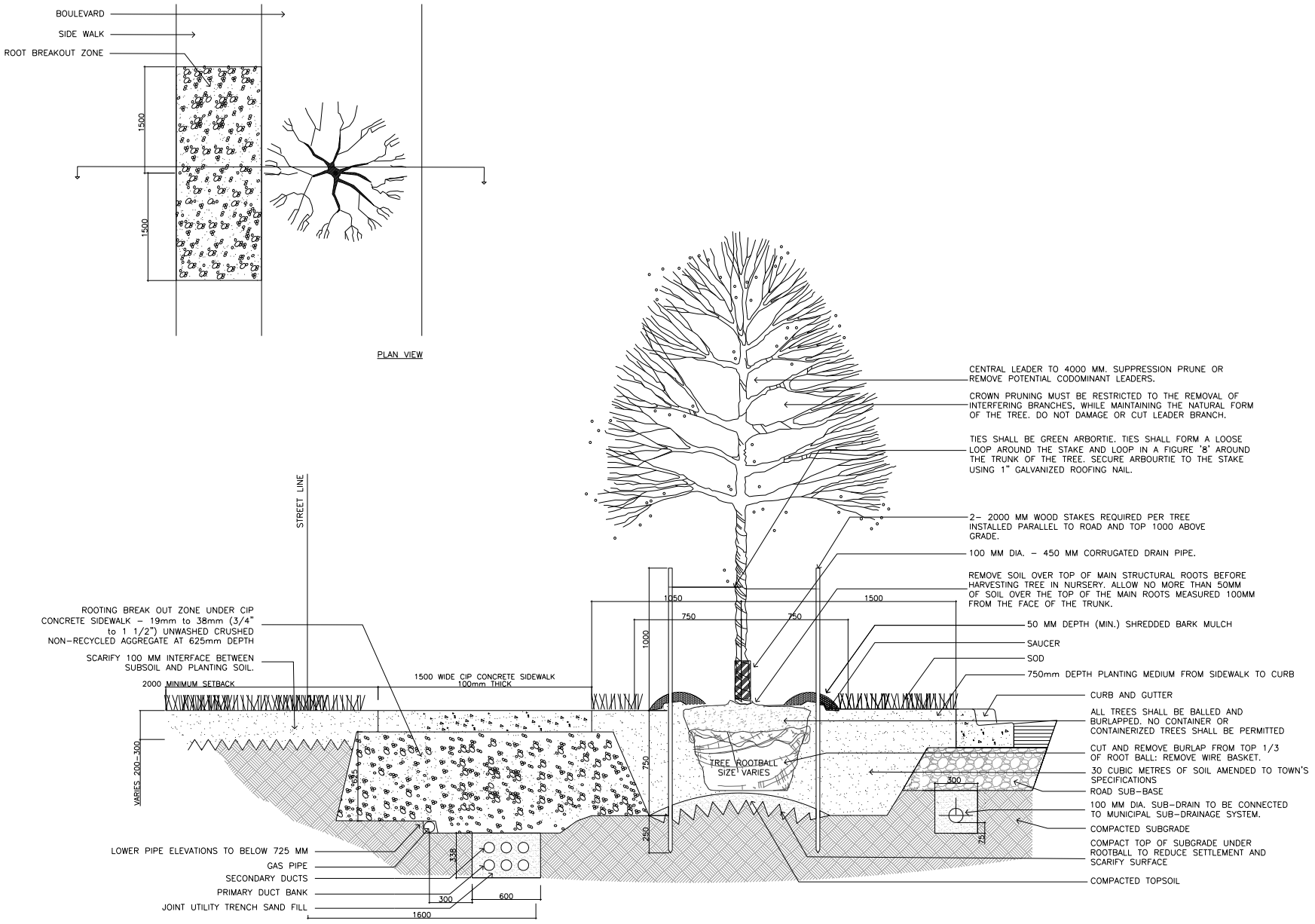


NOTES:

1. TOPSOIL IN PLANTING AREAS SHOULD BE COMPACTED TO 80–85% SDP (MAXIMUM 150MM LIFTS).

5 C 2.55m WIDE PUBLIC BOULEVARD TREE PLANTING DETAIL

1:40



NOTES:

1. TOPSOIL IN PLANTING AREAS SHOULD BE COMPACTED TO 80-85% SPD (MAXIMUM 150MM LIFTS).

5 D 2.55m WIDE PUBLIC BOULEVARD TREE PLANTING DETAIL USING BREAKOUT ZONES

1:40

APPENDIX C

SOIL REQUIREMENTS

Town of Oakville

Topsoil Requirements Matrix

April 30, 2009 (As recommended by CSC at its April 28, 2009 meeting)

APPROVED TOPSOIL REQUIREMENTS

	Private Property Developer via Subdivision Agreement	**Public Boulevards** Developer via Subdivisions Agreement or Town Road Construction Contract	**Parks General** Developer via Subdivisions Agreement or Town Park Development Contract
Depth requirement	▪ 8 inches (200mm) throughout private property lands	▪ 30 inches (750 mm) of growing medium within town boulevard; ▪ Use enhanced rooting environment techniques where required due to soil volume limitations	▪ 12 Inches (300 mm) throughout park except for those areas designed for sports fields ▪ 30 inches (750 mm) for designated shrub or tree planting beds
Topsoil specification	▪ Native stockpile on site as directed by the Town; ▪ Native topsoil mixture screened, fertile, friable, containing 5% minimum organic mater for clay loams and 2% minimum organic matter for sandy loams. ▪ Acidity of topsoil shall range from 6 to 7.5 pH Soil nutrients shall be present in the following rations: Nitrogen (N): 20-40 micrograms of available N/gram of topsoil, Phosphorous (P): 10-20 micrograms of phosphate/gram of topsoil, Potassium (K): 70-120 micrograms of potash/gram of topsoil ▪ Free of subsoil, stones, roots over 1 inch (25 mm) in diameter as well as free foreign objects. ▪ Imported topsoil to match above noted specifications where there is insufficient topsoil on site and shall be tested at source.	▪ Native stockpile on site as directed by the Town; ▪ Native topsoil mixture screened, fertile, friable, containing 5% minimum organic mater for clay loams and 2% minimum organic matter for sandy loams. ▪ Acidity of topsoil shall range from 6 to 7.5 pH Soil nutrients shall be present in the following rations: Nitrogen (N): 20-40 micrograms of available N/gram of topsoil, Phosphorous (P): 10-20 micrograms of phosphate/gram of topsoil, Potassium (K): 70-120 micrograms of potash/gram of topsoil ▪ Free of subsoil, stones, roots over 1 inch (25 mm) in diameter as well as free foreign objects. ▪ Imported topsoil to match above noted specifications where there is insufficient topsoil on site and shall be tested at source. ▪ Drainage for tree trench to be provided as part of tree planting specifications.	▪ Native stockpile on site as directed by the Town; ▪ Native topsoil mixture screened, fertile, friable, containing 5% minimum organic mater for clay loams and 2% minimum organic matter for sandy loams. ▪ Acidity of topsoil shall range from 6 to 7.5 pH Soil nutrients shall be present in the following rations: Nitrogen (N): 20-40 micrograms of available N/gram of topsoil, Phosphorous (P): 10-20 micrograms of phosphate/gram of topsoil, Potassium (K): 70-120 micrograms of potash/gram of topsoil ▪ Free of subsoil, stones, roots over 1 inch (25 mm) in diameter as well as free foreign objects. ▪ Imported topsoil to match above noted specifications where there is insufficient topsoil on site and shall be tested at source.

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April 30, 2009 (As recommended by CSC at its April 28, 2009 meeting)

	Private Property Developer via Subdivision Agreement	**Public Boulevards** Developer via Subdivisions Agreement or Town Road Construction Contract	**Parks General** Developer via Subdivisions Agreement or Town Park Development Contract
Testing requirements for Topsoil	▪ Test topsoil from stockpile source by providing 0.5 kg samples to an approved testing lab (as approved by the Town) and indicate present use, type of subsoil and quality of drainage; ▪ Prepare and ship samples in accordance with Provincial regulations and testing lab requirements; ▪ Testing must identify if the following elements are present in harmful levels: atrazene, salts, pre-emergent herbicides growth inhibitors or soil sterilants and heavy metals; ▪ Should the test results indicate the topsoil is not satisfactory, the report shall include recommendations to improve the soil; ▪ No other topsoil sources shall be used unless approved by the Town; ▪ The Town reserves the right to reject topsoil that does not meet the standard.	▪ Under supervision of Town Consultant or in-house inspectors test topsoil from stockpile source by providing 0.5 kg samples to an approved testing lab (as approved by the Town) and indicate present use, type of subsoil and quality of drainage; ▪ Prepare and ship samples in accordance with Provincial regulations and testing lab requirements; ▪ Testing must identify if the following elements are present in harmful levels: atrazene, salts, pre-emergent herbicides growth inhibitors or soil sterilants and heavy metals; ▪ Should the test results indicate the topsoil is not satisfactory, the report shall include recommendations to improve the soil; ▪ No other topsoil sources shall be used unless approved by the Town; ▪ The Town reserves the right to reject topsoil that does not meet the standard.	▪ Under supervision of Town Consultant or in-house inspectors test topsoil from stockpile source by providing 0.5 kg samples to an approved testing lab (as approved by the Town) and indicate present use, type of subsoil and quality of drainage; ▪ Prepare and ship samples in accordance with Provincial regulations and testing lab requirements; ▪ Testing must identify if the following elements are present in harmful levels: atrazene, salts, pre-emergent herbicides growth inhibitors or soil sterilants and heavy metals; ▪ Should the test results indicate the topsoil is not satisfactory, the report shall include recommendations to improve the soil; ▪ No other topsoil sources shall be used unless approved by the Town; ▪ The Town reserves the right to reject topsoil that does not meet the standard.
Responsibility for installation of Topsoil	▪ Developer, as a condition of Subdivision Agreement	▪ Subdivision Agreement: Developer, as a condition of Subdivision Agreement ▪ Town Tender: Contractor as a requirement of tender documents	▪ Subdivision Agreement: Developer, as a condition of Subdivision Agreement ▪ Town Tender: Contractor as a requirement of tender documents

Town of Oakville

Topsoil Requirements Matrix

April 30, 2009 (As recommended by CSC at its April 28, 2009 meeting)

	Private Property Developer via Subdivision Agreement	**Public Boulevards** Developer via Subdivisions Agreement or Town Road Construction Contract	**Parks General** Developer via Subdivisions Agreement or Town Park Development Contract
Tree Planting soil installation and Tree Planting requirement	▪ Developer responsible for providing at least one (1) shade tree per lot;	▪ Subdivision Agreement: Developer shall be responsible for boulevard tree planting and maintenance; Developer responsible for preparing planting plans to coordinate with utilities and other boulevard features. Planting plans to be approved by Town ▪ Town Tenders: Town contractor responsible for planting trees in Town Construction tender issued by the Town. ▪ Developer or Town contractor to provide warranty	▪ Subdivision Agreement: Developer responsible for planting trees to Town specifications for park development contracts within subdivision agreements; ▪ Town Tenders: Town Contractor responsible for park tree planting in park development contract tendered by the Town. ▪ Developer or Town contractor to provide warranty