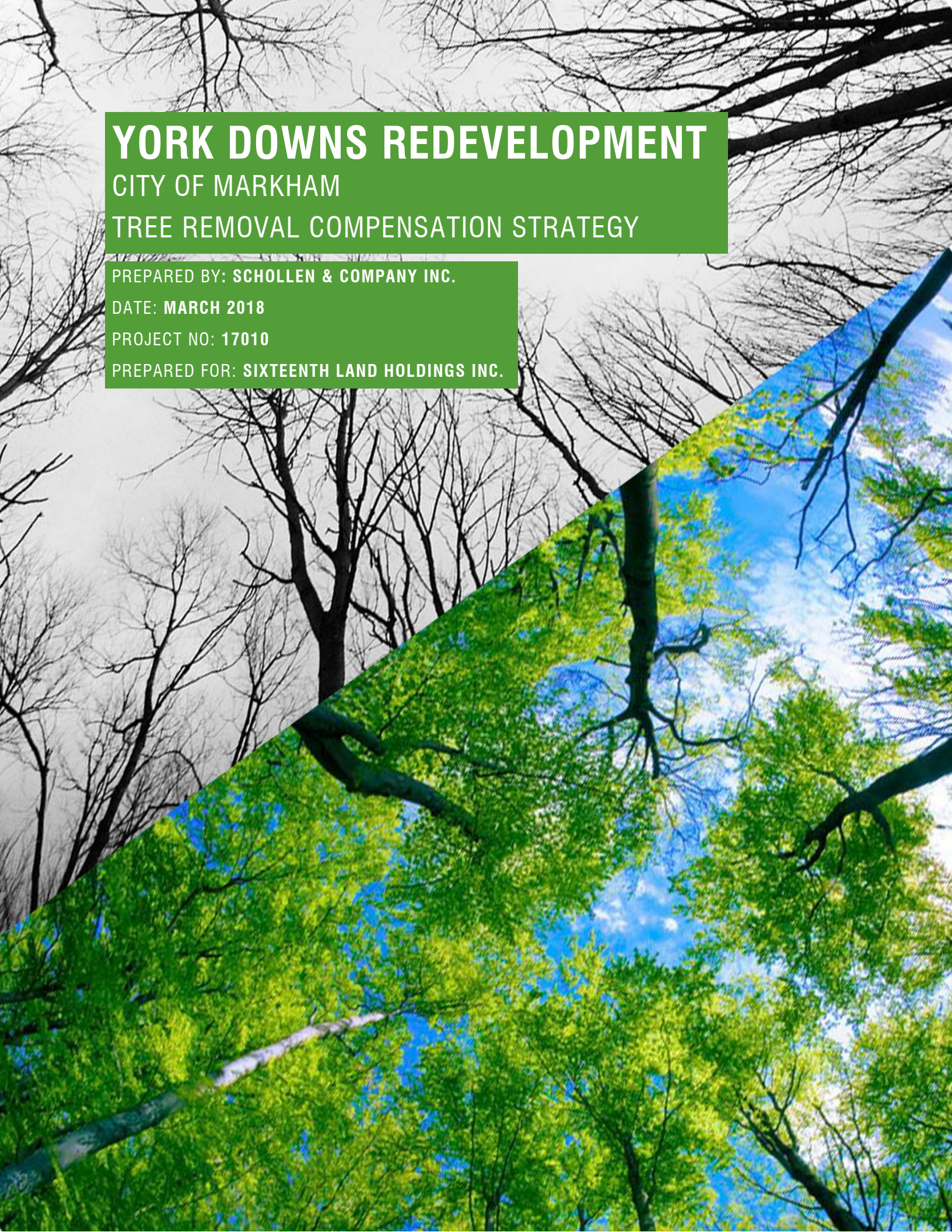

YORK DOWNS REDEVELOPMENT

CITY OF MARKHAM

TREE REMOVAL COMPENSATION STRATEGY

PREPARED BY: **SCHOLLEN & COMPANY INC.**

DATE: **MARCH 2018**

PROJECT NO: **17010**

PREPARED FOR: **SIXTEENTH LAND HOLDINGS INC.**

York Downs Redevelopment

Tree Removal Compensation Strategy

March 2018 – Draft

Schollen & Company Inc.

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SECTION 1.0 – INTRODUCTION

1.1 - BACKGROUND

The City of Markham's current tree compensation protocol is founded on an evaluation methodology that is not appropriate for all applications within the growing city. The existing protocol utilizes an evaluation formula that was developed by the International Society of Arboriculture (ISA) for the insurance industry with the specific purpose of defining a monetary replacement value for an individual tree that has been injured or killed as the result of an accident, weather event or malicious intent. Due to the scale of the York Downs Redevelopment project and the history of the site as a golf course, the York Downs project warrants the application of an alternative strategy to address the removal of existing trees and compensation for their loss.

The redevelopment of the York Downs lands requires that a substantial number of trees be removed to facilitate the implementation of the proposed residential development. The developer, Sixteenth Land Holdings Inc., retained Schollen & Company Inc. to research, test and recommend an appropriate tree removal / compensation strategy for the York Downs Redevelopment project that addresses the unique characteristics of the site and requirements of the project.

The City of Markham recognizes the importance of the natural environment and its role in providing a foundation from which communities can grow. The City is making strides towards more sophisticated regulation to protect these vital foundational elements. Tree canopy cover is one of the many components that supports sustainability. The Council of The City of Markham has endorsed a mandate that is aimed at maintaining and enhancing the extent of tree canopy cover within the City.

1.2 - PURPOSE OF THE DOCUMENT

The purpose of this document is to describe the tree canopy compensation strategy that Schollen & Company Inc. has developed for application to the York Downs Redevelopment project. This proposed strategy is proposed to be used to determine the requirements for appropriate compensation where large numbers of trees are required to be removed. The goal of the tree canopy compensation strategy is to provide a framework that the City of Markham can use to achieve the mandate of "no net loss" to the area of canopy cover within the limits of the City of Markham.

SECTION 2.0 – METHODS

The methodology that was applied to facilitate the generation of the compensation strategy comprises the following tasks:

TASK 1 – BACKGROUND REVIEW

This task included a review of the Tree Inventory Report, Tree Preservation/Removal Plan and Tree Valuation that were prepared by Beacon Environmental Ltd., as well as the proposed community design plan prepared by Gatzios Planning & Development Consultants Inc. and MBTW Group in order to gain an understanding of the scope of the project and establish a benchmark for the evaluation of comparables in the process of undertaking the background research exercise.

TASK 2 – BACKGROUND RESEARCH

A review of Council minutes and City policy was completed to confirm the status of the existing compensation protocol. An exploration of world-wide precedents for tree removal/canopy loss compensation that have been applied to large-scale sites (rather than compensation strategies that were applicable to individual trees) was completed with the objective of identifying potential compensation strategies that could be applied to the York Downs project.

TASK 3 – PRELIMINARY STRATEGY

Based on the findings of Task 2.0, a draft Alternative Compensation Strategy was prepared. This task included the prototypical application and evaluation of various alternative strategies to confirm the outcomes and implications as the basis for the generation of the Preferred Alternative Compensation Strategy.

TASK 4 – CLIENT REVIEW – PREFERRED ALTERNATIVE COMPENSATION STRATEGY

The Preferred Alternative Compensation Strategy and outcomes of the prototypical application exercise were presented to the Client team for review and approval-in-principle.

TASK 5 – TESTING AND VERIFICATION

A variety of possible scenarios for tree removal and compensation were tested utilizing the Preferred Alternative Compensation Strategy in collaboration with Beacon Environmental Ltd., MBTW Group and the client team. Scenarios for compensation were modeled that incorporated variations in tree types, mix of sizes and planting diversity. The testing exercise verified that the Preferred Alternative Compensation Strategy could be applied with consistent outcomes.

TASK 6 – CITY STAFF PRESENTATION

Once the Preferred Alternative Compensation Strategy had been approved by the Client Team, a meeting was arranged with City Staff to present the strategy and outcomes. Comments from City Staff were recorded and addressed through refinements to the strategy.

TASK 7 – FINALIZATION OF ALTERNATIVE COMPENSATION STRATEGY

Once the general support of City Staff was attained, additional research and verification was necessary to address some final comments that were provided by City Staff. The additional research was completed as the strategy was finalized.

SECTION 3.0 – EXISTING POLICY CONTEXT

In 2008, the City of Markham enacted the *Tree Preservation By-law*. The intention of this bylaw was to regulate the destruction or injury of trees on private properties within the City's limits. The removal of any tree with a trunk diameter greater than 20 centimeters at 1.37 meters above the existing grade (Diameter at Breast Height or 'DBH') requires the securement of a tree removal permit by the landowner.

In 2017, the City of Markham made an amendment to the *Tree Preservation By-law.* The amendment was designed to hold individual property owners responsible for destruction or injury to trees located on their property. However, the Tree Preservation By-Law is not intended to be applied to large-scale development or redevelopment projects. For projects of this type, the City applies a process for determining compensation requirements that is set out in the 'Trees for Tomorrow' document.

Table 1 illustrates the compensation practices that developers are compelled to comply with in various situations within the City of Markham. In the case of the York Downs Redevelopment project the 'negotiated amount based on appraisal' approach, under 'Subdivisions, Site Plans, Severances and Heritage Infill' would typically be applied. However, given the large quantity of trees that exist within the York Downs site, the application of this typical compensation approach is problematic and cumbersome, and the outcomes can vary based on specific application protocols. This realization necessitated the generation of an Alternative Compensation Strategy for the York Downs Redevelopment project.

Tree DBH (measured at 1.37m)	Subdivisions, Site Plans, Severances, & Heritage Infill
≥20 cm up to 40 cm	2:1
>40 cm up to 60 cm	Negotiated amount based on Appraisal
>60 cm up to 80 cm	
>80 cm	
Minimum Size for Replanting	6 cm ⌀ deciduous or 300 cm tall conifers
Cash-in-Lieu Rate	$600 per tree

Table 1 – City of Markham Existing Tree Compensation

3.1 – POLICY IMPLICATIONS

The existing *Tree Preservation By-law* was intended to determine tree removal compensation requirements on an individual tree-by-tree basis and is primarily focused on individual private properties. The existing protocol does not directly reflect City Council's direction to maintain, and where possible increase, the extent of urban forest cover within Markham. In the case of the York Downs Redevelopment project, the quantity of trees that will be required to be removed to facilitate the implementation of the proposed new community is extensive and, as a result the, application of the City's standard tree-by-tree based protocol is impractical and unwieldy. Given that the City's typical approach to addressing compensation requirements for 'Subdivision Site Plans, Severances and Heritage Infill' projects is typically 'negotiable' based upon an appraisal, there is sufficient flexibility within the policy to accommodate the application of an alternative compensation strategy for the York Downs Redevelopment project.

3.2 – PROPOSED ALTERNATIVE STRATEGY

Recognizing the complications associated with utilizing the current policy on the proposed York Downs Redevelopment project, City of Markham staff expressed an openness to the concept of applying an alternative tree canopy compensation strategy to this specific project. In response, Sixteenth Land Holdings Inc. retained Schollen & Company Inc. to develop a compensation strategy that is designed to address large-scale developments and achieve the "no net loss" of tree canopy mandate.

SECTION 4.0 – YORK DOWNS SITE DESCRIPTION

The York Downs site is currently a private golf course known as the York Downs Golf and Country Club. The 168.64-hectare golf course is located at 4134 16th Ave, in the village of Unionville, in Markham, Ontario. The site is bordered by Warden Ave, 16th Ave, and Kennedy Rd. and is bounded by residential communities comprising mainly single detached homes, estate homes, semi-detached homes and town homes.

The York Downs site includes the valley lands associated with Bruce Creek. Given that the site is a golf course (rather than agricultural land), existing canopy cover within the areas associated with the fairways is extensive. **Figure 1** illustrates the site and existing conditions as well as the surrounding land use context. Tree cover is concentrated around and along the fairways within the golf course as well as within the Bruce Creek valley corridors.

Figure 1 – York Downs Site

4.1 YORK DOWNS REDEVELOPMENT PROPOSAL

Sixteenth Land Holdings Inc. is proposing to create a new residential community on the existing York Down Golf and Country Club golf course lands. The proposal is designed to create a community that offers a range of diverse housing options with respect to home size and affordability, as well as community amenities. In addition to the approximate 2,421 proposed residential units, the community will comprise parkland, valley land corridors, stormwater management facilities, a woodlot and an elementary school block.

Figure 2 prepared by Gatzios Planning & Development Consultants Inc. and MBTW Group illustrates the proposed layout for the new community.

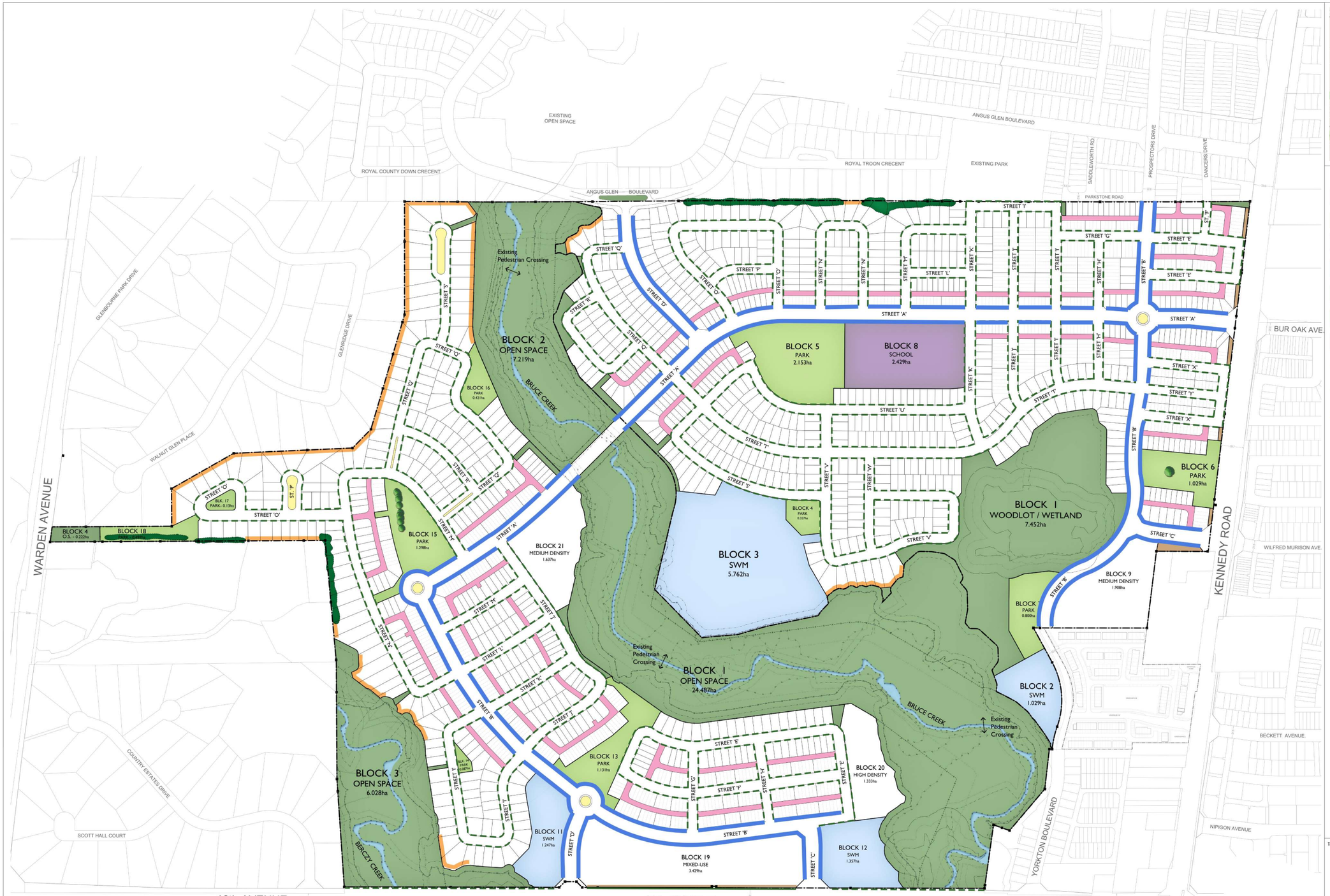
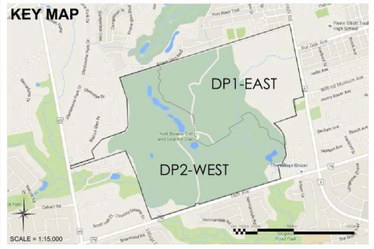


Figure 2 - Proposed Community Design Plan



- Open Space / Greenway
- Park
- Streetscape Elements
- Laneway Enhancements
- School
- Enhanced Bufers
- Storm Water Management Pond
- Double Row of Street Trees
- Single Row of Street Trees
- Rear Yard Larger Transition Trees
- Proposed Tree Preservation Groups
- Proposed Individual Tree Preservation

Title:

TREES COMPENSATION AREAS

Scale:	1:2000 (36 x 54)	Date:	April 6, 2018
Job #:	65MA-1511	Dwg#:	1511-CP1

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SECTION 5.0 – PRECEDENT RESEARCH FINDINGS

Schollen & Company Inc. undertook extensive research that entailed reviewing a variety of papers, journal articles and the policies of various municipalities world-wide, with the objective of identifying precedent methodologies that could be applied to the York Downs project. The precedent research exercise was completed in two stages as described below:

- Firstly, methods and strategies that could be used to measure and quantify the extent of existing tree canopy cover were sourced and evaluated.

- Secondly, methods and strategies that could be applied to determine appropriate compensation for tree canopy cover loss were sourced and reviewed.

The various methods that were sourced and reviewed were assessed for their respective feasibility for application to the York Downs Redevelopment project. The methods that were determined to be feasible were then analyzed and evaluated in comparison to one another. The comparative evaluation is illustrated in Table 2. This table illustrates the findings from the evaluation of the optional methods that could be used to define tree canopy cover, as well as those that relate to compensation for loss of canopy cover. The table also includes the source of each strategy, a description of how the strategy is to be applied and the formulae that are to be used to apply each of the methods. Comments related to the suitability of each method for application to York Downs Redevelopment project are provided.

Table 2 provides a summary of the compensation methodologies that were determined to be most appropriate for the York Downs scenario and were therefore carried forward for further testing and analysis.

York Downs Redevelopment - Tree Removal Compensation Strategy

Table 2 - Precendent Summary Matrix

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Methodology	Source	Method	Formula	Suitability			Compensation Strategy	Formula	Suitability		
				Yes	No	Rational			Yes	No	Rational
Calculation-Based											
Caliper to Canopy	Emory University, Atlanta	Canopy Radius (CR) is assumed to be directly proportional to the caliper or diameter of a tree trunk measured DBH. The canopy is assumed to equal 0.3m - 0.45m (1' to 1.5') per 25mm (1") of trunk.	Deciduous and evergreen trees 6">24"DBH are 1'CR per 1" of DBH. Deciduous and evergreen trees >24"DBH are 1.5'CR per 1" of DBH. Specimen understory trees >10" DBH are 1'CR per 1" of DBH. Immature/Understory trees <6" are replaced with a minimun of 2" caliper tree	✓		Useful or areas with few trees to calculate accurate Tree Canopy Coverage (TCC).	Soft and Hardwoods: 50mm-65mm (2"–2.5") equals 44m2 (471sq.ft.) of replacement canopy, 75mm-100mm (3"-4") equals 88m2 (942sq.ft.) of replacement canopy. Understory 30mm-65mm (1.2"–2.5") equals 9m2 (100sq.ft.) of replacement canopy 75mm-100mm (3"–4") equals 18m2 (200sq.ft.) of replacement canopy.	Example: 30 75mm-100mm (3"-4") caliper Hardwood and/or Softwood trees and 65 75mm-100mm (3"-4") caliper Understory trees (30)(88m2)+(65)(18m2)=3883m2 (41260sq.ft)	✓		Offers predetermined replacment canopy requirments, on a per tree basis, taking into account different types and sized of replacment trees.
Radius Calculation	City of Lake Forest Park, Washington	For existing open-grown trees the radius of the canopy of a tree is measured at its widest and narrowest points and calculate the average canopy radius for the tree. Tree Canopy (TC) (ft2) is calculated using the average canopy radius. For immature trees a predicted size upon age 30 is to be used. For larger grouping of trees, the area is to be measured using an aerial photo or by traversing around perimeter of the canopy.	$TC = \pi r2$ where $\pi = 3.1416$ and r = the canopy radius in feet		✓		The number of replacement trees required is determined by the number of trees that will, at age 30, achieve tree canopy age equal to or greater than the minimum canopy coverage required in the next colomn. Minimun tree replacment sizes: Deciduous trees - 50mm (2") caliper, Coniferous - a minimum of 1.8m (6') tall. 60 month maintainance bond.	Canopy Coverage Goal: Single-family lots >1394m2 (15000Sq.f.) -58% Single-family lots 929m2-394m2 (10000-5000Sq.f.) - 39% Single-family lots < 929m2 (10000Sq.f.) - 28% Multifamily - 15% Commercial - 15%	✓		Offers an age (estimated) at which the replacment trees will equal the set desired canopy coverage goal with the addition of maintainance bond.
Canopy Coverage	City of Oklahoma, Oklahoma	T is the cross-sectional trunk area expressed in meters squared; 0.7854 is a constant; Dt is the trunk diameter in meters measured 1.4m above the ground; F is the canopy footprint in meters squared; Dc1 and Dc2 are the canopy diameters in meters at right angles from each other, S is the surface area in meters squared; 3.1416 is a constant; H is the height of the tree in meters; and V is the canopy volume in meters cubed.	Cross-sectional trunk area: $T = 0.7852D_t^2$ Canopy footprint: $F = 0.7854(D_{c1} + D_{c2})$ Canopy surface area: $S = F + H\ \{3.1416[(D_{c1} + D_{c2})/2]\}$ Canopy volume: $V = F x H$	✓		Possibly for significant trees as it is a more specific calculation.					
Map-Based											
Aerial Photograph (Image analysis method)	N/A	1:6000 aerial photo (decidous forest) is to be used, and converted to grayscale or color image into a black and white image that consists only of canopy (black) and 'not canopy' (white) using image analysis software (ver. 2 alpha, Photoshop graphics software) to make certain image manipulations.	TCC=Black space - White space Result Comparison Example: 20.78% TCC	✓		Time efficient for areas with multiple clusters of trees.					
Aerial Photograph (Dot method)	N/A	1:6000 aerial photo (decidous forest)	Result Comparison Example: 21.4 % TCC		✓	Time consuming.					
Value -Based											
Value-Based Method	City of Melbourne, Australia						Compensation values are based on a series of detailed charts that provide number values to complete the formula. Charts can be found on the City of Melbourne website, search: tree valuation in the City of Melbourne	Value (V) = Basic Value ($) x Species (S) x Aesthetics (A) x Locality (L) x Condition (C)		✓	Offers a well-rounded approch to assesing the trees monetary worth but does not relate specifically to canopy loss or gain. Charts would have to be developed to prioritize tree species for this region.

Value and Ratio-Based Method	Arlington County, Virginia						Compensation is based on three parameters: DBH (inches), Species (1-100% as a decimal), and Condition (condition = 1-100% as a decimal). The outcome of the formula will provide a number, which ever catagory that number falls within is the number of trees required to replant. In situations where the trees may not be replaced they are set a minimun monetary value of $2400 per tree. 1-4.9 = One tree, 5-9.9 = Two trees, 10-14.9 = Three trees, 15-19.9 = Four trees, 20-24.5 = Five trees, 25+ = Six trees	(DBH)(Condition)(Species)	✓		Offers a well-rounded approch to assesing the trees compensation quantities with the option of placing monetary value for off-site compensation. This method would be easy to apply here by simply assigning a % value to different tree species of this region.
Value and Ratio-Based Method	City of Fort Lauderdale, Florida						Compensation is based on three parameters: DBH (inches), Species (1 to 100% as a decimal), and condition (ranked as 1 to 100% as a decimal). The outcome of the formula will provide a number which is the total caliper inches (then converted to cm) of required trees to be planted. If monetary value is needed, take the number of caliper inches to be planted and multiply it by $65. SPECIES NOTE: Class A = 100%, Class B = 80%, Class C = 60%, Class D = 40%, Class E = 20%, Class F (Exotic Invasive)=0%	(DBH)(Condition)(Species)=(caliper inches required to be planted) (for monetary value, X$65)	✓		Simplified version of the above.
Specimen Tree Monetary Value	City of Fort Lauderdale, Florida						Specimen trees are assigned monetary value-based only. Specimen tree values for formula: Class A = $25, Class B = $20, Class C = $15, Class D = $10, Class E = $5, Class F (invasive) =$0	Monetary Tree Value = ($\pi r2$)(Species Classification Dollar Value) NOTE: π = 3.1416 r = DBH/2		✓	Suitable for individual trees only.
Value and Ratio-Based Method	City of Markham Proposed Tree Compensation Strategy	A ratio tree compensation is required for trees >20cm DBH in the case of: Non-Construction Tree Permit, and Infill Tree Permit & Heritage Infill & Minor Variances. An arborist report for any trees over 20cm DBH is required in the case of: Subdivisions, Site Plans & Severances, to assign a size(DBH), condition, species, structure and replacement values, to each tree that is proposed for removal.		✓			For Non-Construction Tree Permit , and Infill Tree Permit & Heritage Infill & Minor Variances, the compensation replacment ratios are: 20-40cm DBH 2:1, 40-60cm DBH 3:1, 60-80 4:1 , >80cm DBH 5:1. When relplacement is not possible: Non-Construction Tree Permit will cost $300 per replacment tree, for Infill Tree Permit & Heritage Infil & Minor Variance will cost $600 per replacement tree. For Subdivisions, Site Plans & Severances trees 20-40cm DBH are to be replaces at a 2:1 ratio. Trees >40cm DBH will use a calculation method based on :size (DBH), condition, species, structure and replacement values, provided by the arborist report. If replacement is not possible $600 compensation per replacement tree is required.	DBH, condition, species, structure and replacement values = Tree Value (a replacment quantity will be assigned based on tree value)	✓		Method provides consistency, fair, transparent, and efficient approch to value trees in any location

Standards-Based											
Age-Based Method	City of Church Falls, Virginia						All lots under going development or redevelopment must provide for 20% Total Canopy Coverage (TCC) after 10 years. TCC is the sum of preserved vegetation and replacement vegetation. As a credit 1.25 is multiplied by existing TCC. If the lot is to remain with 20% TCC no replacment is required. Replacement planting charts indicating predicted TCC after 10 years and other credits are available: http://fallschurchva.gov/documentcenter/view/157	Required TCC = (lot size)(20%) TCC Provided = (# of Trees)(given TCC Value)(Credit % if applicable)		✓	Method does not take into account opportunities and constraints of different land uses. This method does provide incentive to maintain existing trees.
Tree Canopy standard	Forsyth County, Georgia	A chart is provided that assigns a Unit to the tree based on a DBH measument in inches. The Unit multiplied by the number of trees, which determines the existing site density. Charts can be found at (ESD)http://www.forsythco.com/Portals/0/Documents/CommunityDevelopment/TreeOrdinance/Tree_Ordinance.pdf	Ex: 13"DBH = 3.3 18"DBH = 5.4 (3.3)(4 trees)+(5.4)(2 trees)= 24.2	✓		Directly calculates amount of replacment trees required using preset units.	To calculate the required Site Density Factor, (SDF) site size (in acres) is multiplied by a set unit based on zoning: industrial/commercial is 15, commercial/mixed used is 18, and residential is 20. A chart is provided that assigns a unit to the replacement tree based on DBH in inches. The same formula is used to calculate Exiting Density Factor (EDF) however use the replacement tree chart units. Replacement Density Factor (RDF) are based on the required SDF minus the existing SDF.	Required SDF= (site acrage)(15 or 18 or 20) RDF= (required SDF) - (EDF)	✓		Method requires a reasonable quantity of trees based on the TCC goal for the specific land use, while also looking at the existing TCC.
Tree Density Standard	Baton Rouge, Louisiana						Tree Canopy Standard (TCS) which is 17 trees per acre			✓	Method does not take into account opportunities and constraints of different land uses.
Tree Density Standard	Charleston, South Carolina						Tree canopy standard of 406cm (160") DBH of tree per acre			✓	Method does not take into account opportunities and constraints of different land uses.
Tree Density Standard	Marion County, Iowa	TCC area is calculated by the current area within the dripline for existing trees. For newly planted trees, the canopy coverage area is based on a roughly 15-year growth of the tree (700 sq. ft. for overstory trees, 250 sq. ft. for evergreen trees, 175 sq. ft. for understory and multi-stemmed trees)	Incentive to preseve existing trees is provided buy multiplying existing TCC by 1.5	✓		Simple time efficient way of calculating canopy and provides a timeline correlated to estimate canopy size for newly planted trees.	Avarage tree canopy coverage area - 40% Indistrial - 10-15% Commercial - 25% Low density single family - 45% Medium to hight density single family Multfamily development - 45% required open space Special uses - 25-45%		✓		Method requires reasonable quantity of trees based on the TCC goal for the specific land use.

SECTION 6.0 – COMPARISON OF METHODS FOR CALCULATING CANOPY COVER & COMPENSATION

The process of testing and analysis was applied to the short-list of candidate methodologies that were determined to be most well-suited for application to the York Downs project. The most appropriate method was selected based on the following objectives:

- The compensation methodology must address compensation for loss of canopy cover rather than compensation based upon an evaluation of individual trees. The rationale for adopting this objective is three-fold:
    - In consideration of the size of the York Downs site, methodologies that are aimed at compensating for individual tree loss, rather than loss of canopy area are cumbersome to apply.
    - There is a greater potential for error when a formula that is based on the evaluation of individual trees is applied, given the multiplier effect of a potential error in the application single tree formula to large numbers of trees that vary in size, species and health.
    - The application of a 'canopy cover' based formula is consistent with Council's stated mandate that the City should achieve a "no net loss" of canopy cover in the process of approving urban development applications.
- The methodology must be relatively easy to apply with accurate and reliable outcomes using readily available methods, tools and technologies.
- The methodology must be flexible to allow for the exploration of various potential compensation scenarios that involve variations in the sizes and quantities of proposed compensation trees.

SECTION 7.0 – RECOMMENDED ALTERNATIVE CANOPY COVER AND COMPENSATION STRATEGY

Table 3 provides a summary of both the recommended tree canopy cover calculation method and the recommended compensation strategy that were determined to be most appropriate for the York Downs Redevelopment project. The recommended tree canopy cover calculation method and the recommended compensation strategy were applied to determine the required sizes and quantities of replacement trees required to achieve the 'not net loss' objective in the process of implementing the proposed new community within the York Downs site.

Methodology	Source	Method	Formula	Suitability		
				Yes	No	Rational
CALCULATING EXISTING TREE CANOPY COVER						
Aerial Photograph (Image analysis method)	N/A	1:6000 aerial photo (decidous forest) is to be used, and converted to grayscale or color image into a black and white image that consists only of canopy (black) and 'not canopy' (white) using image analysis software (ver. 2 alpha, Photoshop graphics software) to make certain image manipulations.	Total Canopy Cover (TCC) =Black space - White space Result Comparison Example: 20.78% TCC	✓		Time efficient for areas with multiple clusters of trees.
CALCULATING - TREE CANOPY COMPENSATION						
Caliper to Canopy	Emory University Atlanta	Soft and Hardwoods: 50mm-65mm (2"–2.5") equals 44m2 (471sq.ft.) of replacement canopy, 75mm-100mm (3"-4") equals 88m2 (942sq.ft.) of replacement canopy. Understory 30mm-65mm (1.2"–2.5") equals 9m2 (100sq.ft.) of replacement canopy 75mm-100mm (3"–4") equals 18m2 (200sq.ft.) of replacement canopy.	Example: 30 75mm-100mm (3"-4") caliper Hardwood and/or Softwood trees and 65 75mm-100mm (3"-4") caliper Understory trees $(30)(88m^2)+(65)(18m^2)=3883m^2$ (41260sq.ft)	✓		Offers predetermined replacment canopy requirments, on a per tree basis, taking into account different types and sizes of replacment trees.

Table 3 – Preferred Methodologies

The recommended compensation methodology comprises two components:

a) A replicable method using widely available technology to calculate the extent of existing tree canopy cover that exists within the York Downs site as well as the area of existing canopy cover that is expected to be either retained or removed to facilitate the implementation of the proposed development.
b) A tool for determining the appropriate compensation planting strategy that will address the loss of tree canopy cover (calculated as a product of (a) above).

Sections 7.1 and 7.2 describe the recommended methodologies related to (a) and (b), respectively.

7.1 – CALCULATING EXISTING TREE CANOPY COVER

The recommended methodology for calculating the loss of canopy cover is the 'Map-Based Aerial Photograph Image Evaluation Method'. This method involves utilizing a current aerial photograph of the site at (1:6000 scale or less), converting the color or greyscale image to black and white and demarcating areas of 'canopy' versus 'no canopy' using 'Version 2.alpha' Photoshop® graphics software. The positive and negative image is then digitalized into AutoCAD to accurately calculate the area of existing canopy cover and potential canopy loss. This method was determined to be efficient, accurate and reliable.

Figure 3 and Figure 4 illustrate the aerial photographs that were used to determine the quantity of tree canopy cover that exists within the York Downs site as well as the extent of canopy cover that is proposed to be removed to facilitate the redevelopment of the property. Figure 3 is the original full color image and the Figure 4 aerial photograph is the image that has been manipulated in Photoshop® to illustrate existing tree canopy cover in black and white.

Figure 5 illustrates the accurate outline of the area of tree canopy that is proposed to be retained (black hatch and red hatch) as well as the area tree canopy that is proposed to be removed (white area) and for which compensation will be required. Table 4 below summarizes the results that were yielded from the analysis of Figure 5. It was found that existing tree canopy cover comprises 84.31 hectares out of the total 168.63 hectares overall site area. Based upon the proposed development configuration, 42.70 hectares of the tree canopy is proposed to be removed to facilitate the redevelopment of the York Downs lands.

Existing Tree Canopy Cover Calculation - Aerial Photograph (Image Analysis Method)			
Total Site Area	**Tree Canopy to be Removed - Requiring Compensation**		
hectares	(%)	hectares	sq. ft.
168.64	25.32	42.7	4596190

Table 4 – Canopy Cover Calculation

Figure 2 – Color Aerial Photograph Depicting Existing Trees

Figure 3 – Canopy Cover Depicting in Black and White Utilizing Version 2. alpha Photoshop® Software

Sixteenth Land Holdings Inc. - Tree Removal Compensation Strategy

Tree Canopy Cover Map

- Site Limits (total site area 168.64 hectares)
- Tree Preservation Areas (24.68% of total site - 41.15 hectares)
- TCC to be Removed (25.32% of total site - 42.70 hectares)
- Open Area (excluding tree preservation areas)- No Existing Tree Canopy Cover - 128.21 hectares
- Tree Preservation as per Beacon Environmental's Proposal

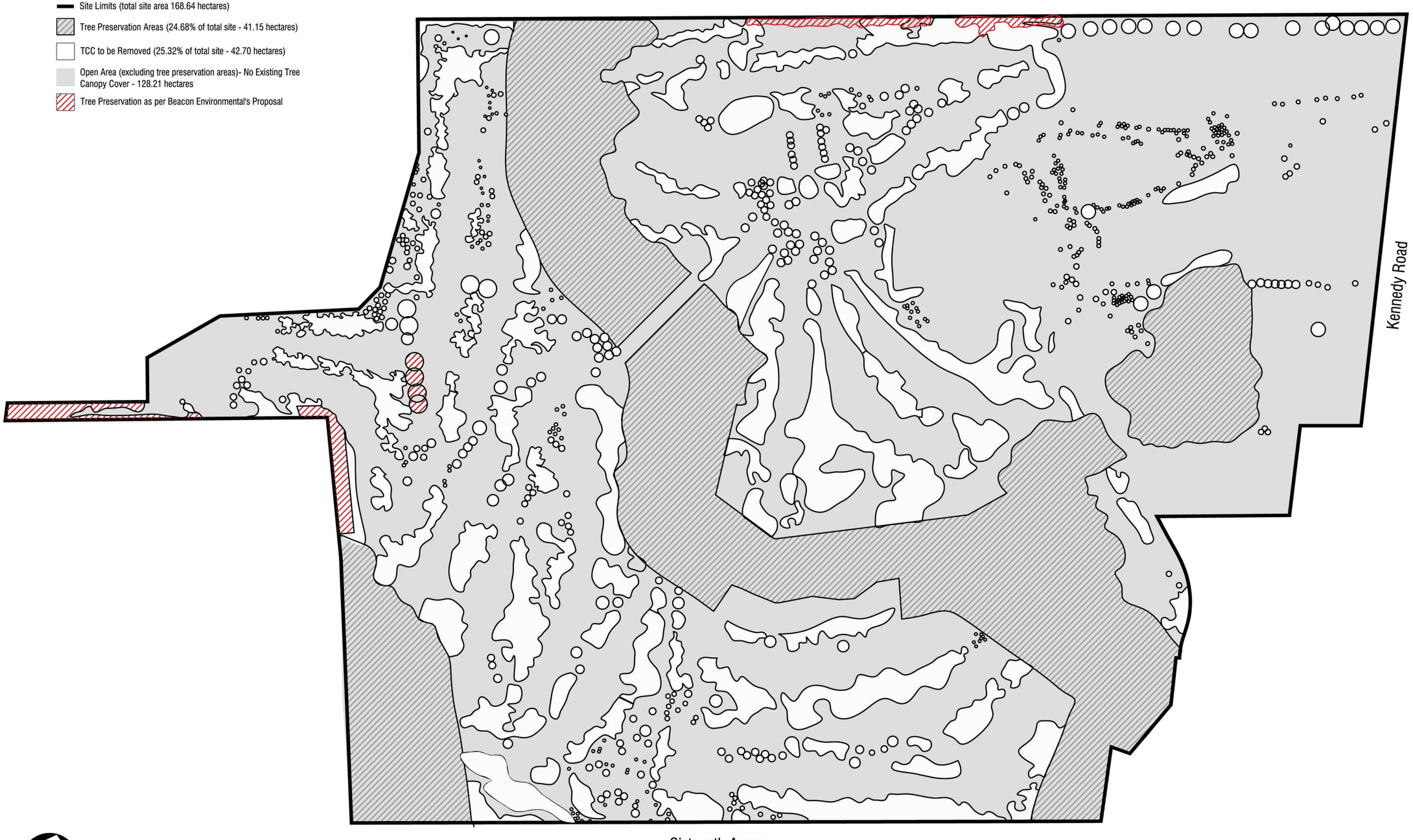

Figure 5 - AutoCAD Translation of Version 2. alpha Photoshop Software Canopy Cover Proposed to be Retained or Removed

7.2 - CALCULATING TREE CANOPY COMPENSATION

Based upon the research and comparative analysis, the 'Caliper to Canopy / Calculation-Based' methodology as developed by Emory University in Atlanta, Georgia, U.S.A., is recommended as the strategy to determine appropriate compensation for the loss of canopy cover. This methodology utilizes a defined ratio of canopy based upon tree caliper (DBH) for different size ranges of trees to determine an area of replacement canopy. This method was tested and was found to yield consistent results that achieved the 'no net loss' of canopy cover mandate in comparison with other compensation methodologies that were evaluated and tested. The recommend methodology has been found to be practical, yielding rationale, fair and replicable results.

Schollen & Company Inc. made some adaptations to the Emory University methodology to allow for the inclusion of several more size-classes of trees in order to better reflect the standard nursery stock sizes that are available locally. These adaptations were made as formula-based mathematical conversions based on the calculations set out in the Emory University methodology. Schollen & Company Inc. then developed a malleable spreadsheet tool that allows for the rapid and accurate exploration of various permutations in the make-up of a potential compensation planting strategy. The tool allows for efficient optimization of the compensation strategy that takes into account all of the potential tree planting scenarios that can be applied to the development proposal.

Table 5 illustrates the breakdown of compensation tree plantings Sixteenth Land Holdings Inc. have proposed to be integrated into the York Downs Redevelopment project. The proposed quantity of trees is then multiplied by the set canopy formula sourced from Emory University methodology. The methodology factors in the caliper size at the time of planting as the base parameter. The mix of quantities and sizes of trees that are proposed to be planted as part of the implementation of the overall York Downs Redevelopment project have been calculated to yield a canopy cover area of 428,259m^2 or 4,609,745 sq. ft. This proposed canopy compensation strategy will result in a slight increase of canopy cover in comparison to the existing canopy cover of 427,000m^2 or 4,596,190 sq. ft. which achieves the City's mandate for 'no net loss' of canopy cover.

Beacon Environmental Tree Proposal / MBTW Canopy Values (Emory University, Atlanta - Replacment Values)				
Proposed Replacement Planting at York Downs Redevelopment				**Required Replacement**
Proposed 1-2 Gallon Whips (canopy value/tree: 9.29m² or 100sq.ft)			Proposed Replacement Canopy Valued in (sq.ft.)	Remaining Required Trees
SWM Pond Trees	629			
Cut/Fill Restoration Trees	1152	(80%)		
Golf Couse Valley Restoration Trees	4849	(80%)		
Proposed 50-65mm Cal. trees (canopy value/tree:43.75m² or 471sq.ft)				
Cut/Fill Restoration Trees	308	(20%)		50-65mm cal. Trees -28.78
Golf Couse Valley Restoration Trees	1137	(20%)		
Proposed 65-75mm Cal. trees (canopy value/tree: 65.63m² or 706.5sq.ft) *			4609745	OR
Meander Belt Trees	133			65-75mm cal. Trees -19.19
Public Realm Trees	190			
Municipal Boulevard Street Trees	2640			
Proposed 75-100mm Cal. trees (canopy value/tree: 87.52m² or 942sq.ft)				OR
Double Row of Collector Street Trees	670			75-100mm cal. Trees -14.39
Replacement Restoration Trees	175			
Rear Yard Transition Trees	400			

Table 5 – Canopy Cover Compensation – Proposed Tree Quantities and Sizes

7.3 – VALIDATION OF CANOPY AREA PARAMETERS

Emory University canopy compensation strategy is based on the formula that assumes a typical 50-65mm caliper tree provides a canopy area of 44m². This canopy area formula is not based on the size of a typical tree upon installation nor does it correspond with the expected mature canopy size. The attributed area value is based on a typical deciduous tree approximately 10 years after planting. To validate this canopy calculation in response to city staff comments, further research was completed.

Using the Emory University strategy in conjunction with an Urban Forestry & Urban Greening study from Yale University. Schollen & Company Inc. was able to conclude that a 50-65mm caliper tree would provide 8.55 to 46.5m² of canopy cover 10 years after planting, depending on tree species, with compact small-crowned species ranging from 8.55 to 28.27m² of canopy while larger-crowned species ranged for 36.26 to 46.57m².

With this confirmation it can be assumed that trees installed at a larger caliper would be proportionately larger at their 10-year mark after installation, so Emory University values for 75-100mm caliper are valid. This being said, different trees have different growth rates and mature canopy sizes. In response, it is recommended that native trees which have relatively fast growth

rates and generate a large mature canopy be given preference when developing a compensation planting plan. It would be feasible to modify the calculation tool to incorporate two 'size classes' of trees; small-crowned and large-crowned trees with canopy area values of 19m^2 and 44m^2 respectively to allow for small-crowned species to be utilized in the compensation calculation.

Table 6 is an adaption of the Yale University data to illustrate the canopy cover area at 10 years after the installation of 50-65mm caliper trees of various species that are commonly planted in the Greater Toronto Area (GTA). The table includes 8 different species to demonstrate the potential canopy area for a wide spectrum of tree canopy sizes ranging from large to small.

Predicted Canopy Size for Trees at 10 Years Growth - Yale University				
Species	**Size of tree when installed (mm)**	**10 year DBH (cm) - averaged from article**	**Crown diameter (m) - averaged from Yale University article**	**Total Crown Coverage (TCC) m2 (=πr2, where π=3.1416 and r= 1/2 Crown diameter)**
Gleditsia triacanthos	50-65	14.8	7.7	46.57
Acer sp.	50-56	19.25	7.2	40.72
Quercus spp.	50-65	18.8	6.7	35.26
Pyrus calleryana	50-65	18.3	6	28.27
Prunus sp.	50-65	21.35	6.65	34.73
Tilia spp.	50-65	16.75	5.45	23.33
Malus sp.	50-65	12.5	4.85	18.47
Syringa reticulata	50-65	10.75	3.3	8.55

Table 6 – Adaption of Yale University Study for Predicted Canopy Size at 10 years Past Installation

SECTION 8.0 – SUMMARY

The Alternative Compensation Strategy that is recommended for application to the York Downs Redevelopment project comprises two components:

- A method for determining the area of 'canopy loss' using a 'map-based' approach.
- A method for calculating the requirements for canopy replacement using a 'caliper to canopy' calculation approach.

Both of these methodologies were tested and verified through application to the York Downs Redevelopment project and were found to yield consistent results in comparison to the range of alternative methods that were researched.

Both methodologies are appropriate to apply to large sites and large-scale projects utilizing widely available software. To enable the efficient application of the caliper-based method to determine possible compensation planting strategies in terms of tree size and quantity make-up, Schollen & Company Inc. developed a tool that allows the user to easily explore different compensation tree planting combinations.

The Alternative Compensation Strategy that is recommended for application to the York Downs project will achieve the mandate of 'no net loss' of canopy cover as directed by the Council of the City of Markham.