Compensation and Enhancement Strategy

4134 16th Avenue, City of Markham

Prepared For:

Sixteenth Land Holdings Inc.

Prepared By:

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Date: *Project:*

April 2018 **215200**

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1. Introduction

This Compensation and Enhancement Strategy has been prepared by Beacon Environmental Limited (Beacon), MBTW Group (MBTW) and Schollen & Company Inc. (Schollen) for the property located at 4134 16th Avenue. This report has been prepared to supplement the Natural Environment Report/Environmental Impact Study and Arborist Report, prepared in November 2017 for overall Master Environmental and Servicing Plan (MESP) in support of an Official Plan Amendment (OPA) application to permit the development of a residential community on the subject property. The purpose of this strategy is to focus on measures proposed by the proponent to address potential impacts and vegetation removal from development.

The property is a total of 168.64 hectares (416.72 acres), and it is located on the north side of 16th Avenue, on the west side of Kennedy Road. It has a small amount of frontage onto the east side of Warden Avenue in the City of Markham, Regional Municipality of York (**Figure 1**). Existing residential development surrounds the property on all sides.

Bruce Creek traverses the property in a roughly north / south direction, bisecting the property into west and east tableland areas. Berczy Creek crosses the southwest corner of the property. These features, and associated woodlots and wetlands, make up the Greenway System.

Sixteenth Land Holdings Inc. proposes to develop the property for a residential community and is submitting an OPA to re-designate the developable portion of the property from “Private Open Space” to appropriate urban residential designations to permit the development of residential uses.

This report provides an overview of the existing conditions within the plan area and provides details as to the proposed restoration, enhancement and compensation for the development.

2. Greenway System

The Natural Environmental Report within the Master Environmental Servicing Plan (MESP) identified Bruce and Berczy Creek valleys, the eastern woodlot (Feature 1), and a Bruce Creek tributary as part of the Greenway System. The purpose of the Greenway System is to:

- Support ecological function;
- Provide access to natural areas; and
- Provide continuous trails linking the City’s Greenway System with the Rouge Park, the Oak Ridges Moraine, and the Don River south of Steeles Avenue.

As shown on the development plan (**Figure 2**), the features on the subject property have been maintained with appropriate buffers in order to ensure their continued function, to promote connections to neighbouring wildlife communities and to allow for safe wildlife passage. Animals will be free to travel safely throughout the development and beyond without being isolated to individual areas. This level of connectivity will ensure their continued ability to migrate throughout the region for the purposes of foraging, breeding, and expanding their habitats.

2.1 Bruce and Berczy Creek Corridors

Both Bruce and Berczy Creeks are considered Significant Valleylands, permanent watercourses and fish habitat. There are riparian woodlots and wetlands associated with these features. Furthermore, both of these watercourses are considered habitat for the endangered Redside Dace.

Development constraints for Bruce and Berczy Creeks were derived from the greater of:

- Staked physical top of slope;
- Long-term stable top of slope;
- Proposed Regional floodline;
- Staked dripline; and
- Limit of Redside Dace habitat (meander belt + 30 m).

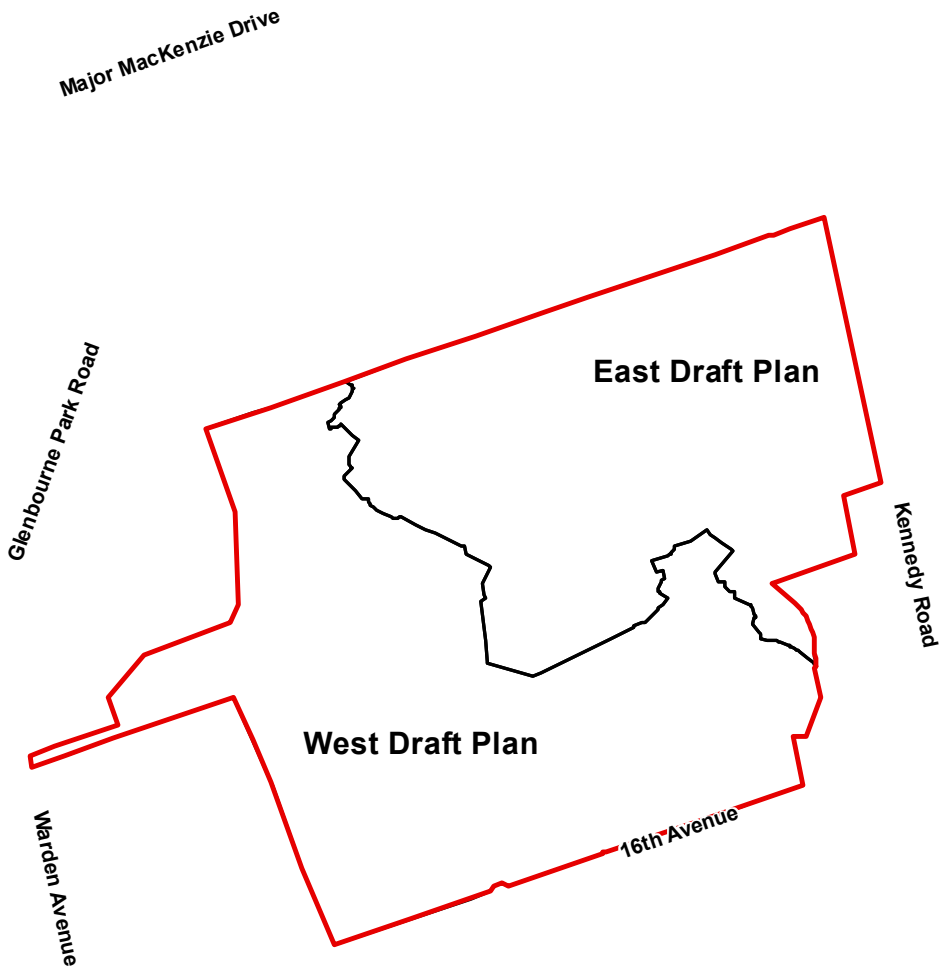
2.2 Feature 1

This feature is approximately 4.3 ha in size and is comprised of cultural woodland, mixed forest, deciduous swamp, and meadow marsh. This area has been disturbed as a result of past agricultural land uses, including tree thinning and grazing as evidenced by sparse mature tree cover, relatively low native species diversity, and an abundance of successional shrubs, notably Buckthorn, apples, and hawthorns. The interior of the feature is less disturbed and supports a mixed cedar hardwood forest community. The wetland in the south end of this feature is higher quality, although Buckthorn is invading. The wetland supports several regionally rare plants including Rough-leaved Goldenrod and Water Horsetail. No breeding amphibians were recorded in the area.

As part of the Hydrogeological Assessment completed by Burnside (2017) two piezometers were installed in Feature 1 – PZ5s/d is in the wetland feature and PZ8s/d is located in the woodlot. Groundwater levels in this feature were below ground surface at the beginning of monitoring and have steadily risen to or above ground surface into the summer of 2017. Data show an upward gradient at PZ5s/d with discharge conditions since April 2017. At PZ8s/d, data show a downward gradient and recharge possibly discharging to the wetland. Burnside has interpreted this data to mean the woodlot/wetland feature is supported by both surface water runoff and groundwater.

The wetland was staked with MNRF and TRCA in September 2016. A 30 m buffer has been applied to the wetland, and a 10 m buffer has been applied to the woodlot. A small portion of Street B, the extension of Yorkton Boulevard, will encroach to within 15 m of the eastern limit of Feature 1. No grading is required within 15 m of the feature and the feature based water balance ensures the hydrology of the wetland post development.

Feature 1 is connected to the Bruce Creek corridor via SDF-C, a permanent tributary receiving groundwater discharge from the upstream wetland unit.



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Subject Property

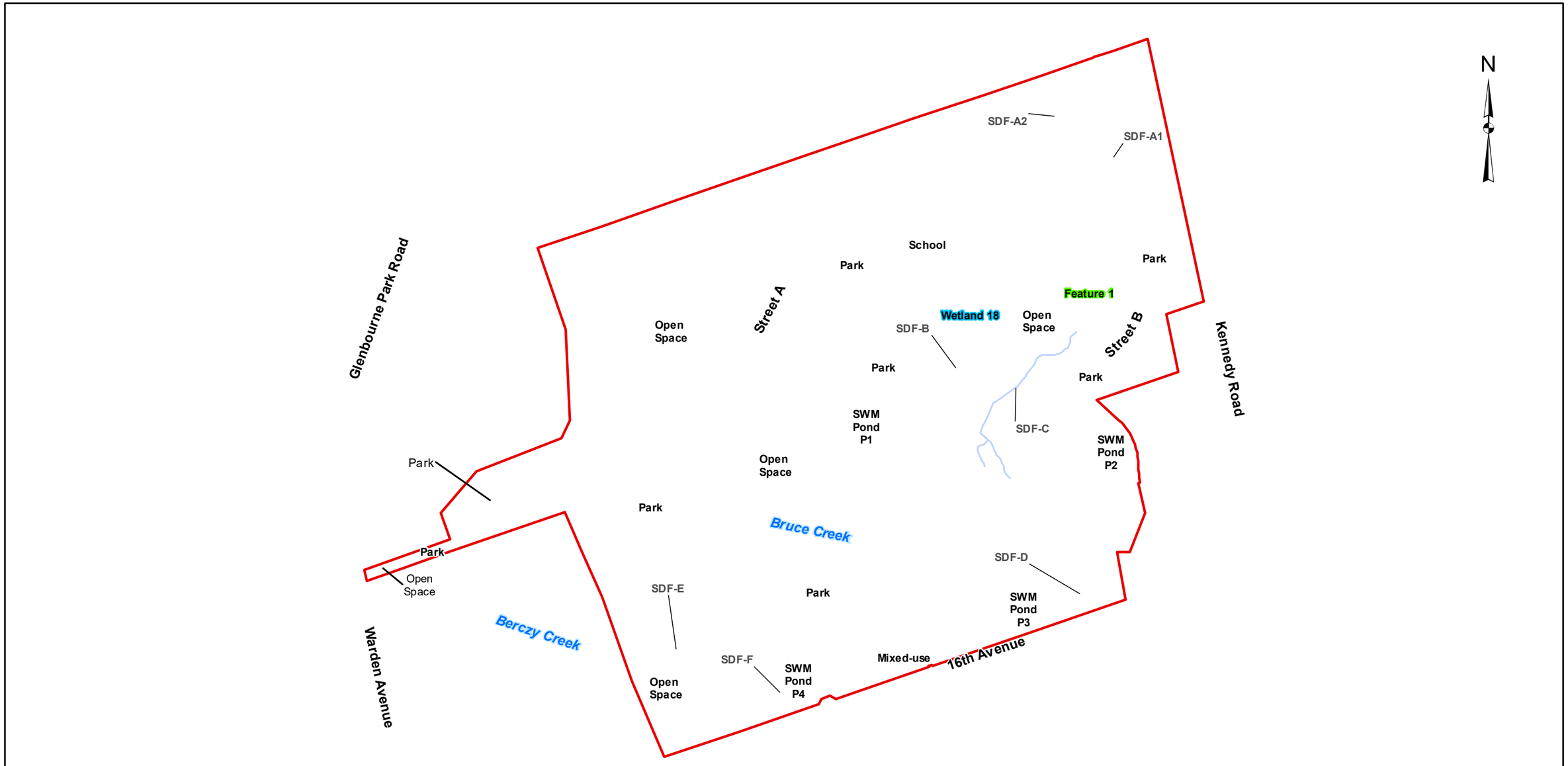
Draft Plan Boundary

Compensation and Enhancement Strategy

FIGURE 1 Site Location

First Base Solutions Web Mapping Service 2015
UTM Zone 17 N, NAD 83

Date: April 2018



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Legend

- Subject Property
- Development Plan
- Greenway System
- Wetland to be Removed
- Wetland to be Constructed
- Ponds to be Removed
- Pond to be Retained
- Watercourse
- Piped Feature
- Surface Flow
- Pond Segment
- Buried/Stone Trench

JD Barnes: Aerial Photograph, 2015.
MBTW: Subject Property, 2015, Development Plan, 2017.
Beacon Environmental, 2017. All other data.

Compensation and Enhancement Strategy

FIGURE 2: Development Plan

UTM Zone 17 N, NAD 83

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2.3 Habitat and Connectivity

The development has been designed to allow connectivity throughout both valleylands, as well as from these valleylands to adjacent woodlots, parks, and ponds.

To maintain connectivity along the Bruce Creek valleyland, the crossing at Street A will be designed with a span large enough to accommodate natural channel migration, provide riparian habitat and have consideration for terrestrial wildlife passage. Sloped walls of the valley will facilitate the movement of animals through this open passageway as opposed to traveling up slope and being put at risk by vehicles by crossing the road. This crossing will be subject to approvals from the MNRF and TRCA, and is currently the subject of a Municipal Class Environmental Assessment.

There are no other road crossings proposed over Bruce or Berczy Creeks, and only three trail crossings have been proposed over Bruce Creek, in existing golf cart path crossing locations. The number of crossings has been minimized so as to limit impacts to the valleyland. Existing golf cart path locations were chosen to capitalize on the areas of disturbance which currently exist within the valleyland.

3. Trees

3.1 Arborist Report

Trees on private property are protected under the City of Markham's Tree Preservation Bylaw, which states that no person shall injure or destroy a tree with a diameter greater than 20 cm without first obtaining a permit. The City of Markham's Trees for Tomorrow Streetscape Manual requires that an appraisal value be determined for trees greater than 40 cm dbh in accordance with the Council of Tree and Landscape Appraisers Guide for Plant Appraisal. Due to the high number of trees present on the property, the City directed that the Arborist Report could be scoped down to provide the following:

1. Groupings of similar species;
2. Endangered Species;
3. Heritage species – individually significant trees 40 cm DBH and greater;
4. Groupings that will potentially occur within the vegetation protection zone of the greenway.

Trees 20-39 cm DBH were inventoried in groups noting species present and the overall health of trees in the group. Trees over 40 cm DBH and condition were assessed based on presence and severity of flaws, damage, evidence of pests or diseases, structural condition, dead or dying branches, or other decline indicators.

A total of 4,260 trees were inventoried and assessed within the subject property. Figures detailing the tree locations were provided in the Tree Inventory and Preservation Plan.

3.2 Preservation

A total of 525 trees have been identified for preservation, primarily within open space blocks and along rear lot lines where grading can be minimized or avoided. Trees adjacent to the subject property on private properties are to be protected as per the City of Markham's requirements and details for tree protection.

3.2.1 Open Space

The majority of the open space areas within the plan are currently used as golf course, including fairways, tee boxes and greens. There are treed areas, including some Significant Woodlands within Bruce and Berczy Creek corridors which have been identified for retention. The remaining landscape within these corridors will be planted. Details of this restoration are provided in Section 5.1.

3.2.2 Rear Yards

Several areas within the plan, adjacent to existing residential yards will be graded so as to retain rear yard trees separating the proposed development from surrounding neighbourhood. In the westernmost portion of the plan, rear yard setbacks were increased to 11.5 m so as to accommodate the row of trees associated with rear yards along Glenburn Avenue. At the northernmost property boundary, rear yard setbacks have been designed to maintain the existing hedgerow, where possible. Additional rear yard "transition" planting has been proposed to fill in gaps and create a consistent vegetated screen in this location (see Section 5.4.2).

3.2.3 Parks

The plan has been designed to retain mature trees within park blocks. Notably, a park (Block 15) has been specifically designed to include a row of Bur Oaks (*Quercus macrocarpa*) which are believed to have lined the laneway to a farmhouse in this location over 75 years ago. Tree Protection Zones of mature trees were identified within all park blocks, in an attempt to preserve the character of the site and specifically mature, native trees over 40 cm DBH within the landscape. To preserve these trees, it was necessary to grade the edges of the parks down to these trees, creating a "bowl-like" landscape. This grading was required to maintain the overall road and lot pattern and associated servicing of the proposed development; however, it is not preferred by the City, as programing these areas becomes more difficult. As a result, all park blocks will be graded and all trees will be removed, with the exception of the row of Bur Oaks on the west, and a single Bur Oak on the east, adjacent to Kennedy Road.

4. Impacts and Removals

4.1 Wetland 18

Wetland 18 is located in the east central portion of the property (**Figure 2**). It is a Reed-canary Grass Mineral Meadow Marsh (MAM2-2), and is located along surface drainage feature SDF-B. It is dominated by Reed Canary Grass (*Phalaris arundinace*), with Spotted Jewelweed (*Impatiens capensis*) and Red-osier Dogwood (*Cornus saricea*) associates. Individual Green Ash (*Fraxinus pennsylvanica*), White Cedar (*Thuja occidentalis*), Willow (*Salix sp*.), and Basswood (*Tilia Americana*) make up a very sparse canopy (<10%). No breeding amphibians were heard calling from this wetland during surveys conducted in 2016. Also, no area sensitive birds or Species at Risk birds were identified during breeding bird surveys conducted in 2015.

The area of the wetland is 4,326 m^2. Adjacent to the wetland are two mixed hardwood forest units (16a and 16b) and a deciduous forest (unit 17), as well as a cultural plantation (unit 1). The total area of these upland communities is approximately 3,800 m^2. The combined area of these units is 8,126 m^2.

A technical memorandum prepared by RJ Burnside and Associates Ltd. details the hydrogeology and hydrology of the wetland and concludes that Wetland 18 is a:

> "…*feature formed in a depressional area that is predominantly fed by surface water (direct runoff to the feature, indirect runoff from tile drainage and direct precipitation on the feature). There is a topographically driven convergence of shallow groundwater flow towards the feature; however, as a result of relatively low hydraulic conductivity surficial silts and clays, the groundwater flow towards the feature is limited in volume. Most of the wetland area has a recharge function, however, there is a small area in the south part of the feature where groundwater seepage is interpreted to occur through a relatively higher permeability sand layer that lies west of the feature and appears to intersect the lowest areas of the feature near the outlet drainage culvert. Groundwater discharge seepage occurs under high water table conditions, but is insufficient in volume to result in outlet flows from the feature*."

This wetland has been proposed for removal and replication, as detailed in Section 5.2. Further details regarding wetland 18 were provided in a submission prepared by Beacon for TRCA, dated August 2017.

4.2 Headwaters

Several small surface drainage features were identified through aerial photo interpretation and were investigated as part of the field program. Assessments of the features were completed on several occasions in 2011, 2016 and 2017. **Figure 2** shows locations of the headwater drainage features.

Surface Drainage Feature A is comprised of small undefined drainage features that appear to originate near Kennedy Road and drain into Pond H in the northeast corner of the property. Pond H, a SWM pond, currently services Upper Unionville, but only temporarily and is proposed for removal from its current location as part of the development. SDF-A terminates in Pond H. SDF-A has been assigned

a management recommendation of "mitigation" using TRCA's Evaluation, Classification and Management of Headwater Drainage Feature Guidelines (Guidelines, 2014). Features may be removed from the landscape, however, overall function must be mitigated using the following management strategies.

- *Replicate or enhance functions through enhanced lot level conveyance measures, such as well vegetated swales (herbaceous, shrub and tree material) to mimic online wet vegetation pockets, or replicate through constructed wetland features connected to downstream;*
- *Replicate onsite flow and outlet flows at the top end of the system to maintain feature functions with vegetated swales, bioswales, etc. If catchment drainage has been previously removed due to diversion of stormwater flows, restore lost functions through enhanced lot level controls (i.e. restore original catchment using clean roof drainage); and,*
- *Replicate functions by lot level conveyance measures (e.g. vegetated swales) connected to the natural heritage system, as feasible and/or LID stormwater options (refer to Conservation Authority Water Management Guidelines for details).*

Surface Drainage Feature B (SDF-B) originates from a pipe that conveys flow from irrigation and rain events across the driving range and discharges at the top of Unit 18. No floodline or top of bank is associated with this feature. SDF-B has generally been assigned a management recommendation of "conservation", meaning the feature may be relocated provided the following management strategies are adhered to.

- *Maintain, relocate, and/or enhance drainage feature and its riparian zone corridor;*
- *If catchment drainage has been previously removed or will be removed due to diversion of stormwater flows, restore lost functions through enhanced lot level controls (i.e. restore original catchment using clean roof drainage), as feasible;*
- *Maintain or replace on-site flows using mitigation measures and/or wetland creation, if necessary;*
- *Maintain or replace external flows;*
- *Use natural channel design techniques to maintain or enhance overall productivity of the reach; and,*
- *Drainage feature must connect to downstream.*

SDF-F is predominately a roadside ditch on the north side of 16th Avenue, and contributes flow to Berczy Creek just upstream of the road crossing. This feature was dry during all site visits. SDF-F has been assigned a management recommendation of "mitigation".

4.3 Bruce Creek Crossings

4.3.1 Street A

One crossing of Bruce Creek is proposed for connectivity, neighborhood structure and traffic flow. The Crossings Guideline for Valley and Stream Corridors prepared by TRCA (2015) was reviewed in relation to the proposed crossing. TRCA outlines objectives for the road crossings in relation to natural hazards and natural heritage functions. These objectives are consistent with TRCA's Living City Policies (2014).

Given Bruce Creek is an occupied reach in this location, the presence of Redside Dace has also been considered.

This crossing is subject to a Municipal Class Environmental Assessment, which is currently underway, and is being led by GHD. Nonetheless, potential impacts and proposed mitigation have been detailed below.

Potential impacts associated with the road crossing of Bruce Creek include:

- Potential for restricted flows and impact to fish passage based on the type and size of structure;
- Reduced light penetration;
- Exacerbated erosion through poor site selection;
- Water quality impairment from construction and surface water runoff from crossing structure; and,
- Removal of riparian vegetation and Redside Dace habitat.

TRCA crossing objectives states that for new crossings, many aspects of natural hazards and natural heritage objectives can be accomplished through proper siting of the infrastructure.

For natural hazards, the objectives pertain to avoidance and mitigation of flood risk, geotechnical risk from slope stability and geomorphic risk that may result from channel migration over time. The proposed crossing must not increase flood risk for storm events up to and including the Regional storm. Further, the crossing structure should span the zone of potential future channel migration as defined by the meander belt, unless alternative designs supported by geomorphic studies have been produced.

For natural heritage function, the objectives relate to terrestrial and aquatic habitat and connectivity functions:

- Terrestrial Objectives
    - Avoid siting infrastructure in locations of existing forests, wetlands, seepage areas, and other sensitive habitats;
    - Minimize footprint impacts of crossings on important terrestrial features and their ecological functions through site selection and design;
    - Maintain terrestrial habitat and wildlife connectivity functions by avoiding the priority areas for habitat and wildlife connectivity or by siting and designing crossings to structurally connect habitat patches and to permit wildlife movement.

- Aquatic Objectives
    - Avoid sensitive aquatic habitat features (e.g. critical spawning areas, important feeding or refuge areas for sensitive/locally rare/indicator species);
    - Avoid channel realignment, hardening, or other modifications;
    - Minimize footprint impacts of crossings on important aquatic features and their ecological functions (e.g. groundwater upwellings and discharge areas, maintaining natural sediment transport) through site selection and design;
    - Maintain aquatic habitat and fish passage functions by avoiding the priority areas or by siting and designing crossings to permit fish passage.

A single road crossing has been selected to minimize the number of stream crossings and still meet the traffic requirements of the proposed development. The proposed crossing location was selected in an area that is relatively narrow and is perpendicular to the valley corridor. This crossing location will not impact any woodlots or wetlands as it is a currently manicured golf course area. There are no observed/known seepage areas in the vicinity of the bridge or unstable slope areas.

The reach of Bruce Creek at the proposed road crossing is fairly consistent with the habitat described in Section 3.4.2. The substrates consist of cobble, silt and gravel with woody debris and aquatic vegetation providing cover. Stream morphology within this reach is mostly riffle/run with some areas of pools associated with the meanders. Canopy cover was low, however there was abundant overhanging vegetation. Pockets of Watercress were observed throughout this reach. Watercress is often an indicator of groundwater discharge. Groundwater seepage contributes to stream base flow and cools water temperatures during the summer resulting in more favourable conditions for coolwater and coldwater fish species.

The bridge is proposed to be a 40 m clear span bridge which avoids any obstructions to fish passage and will permit the movement of wildlife under the bridge. The wide meander belt width in this reach of the valley corridor precludes construction of a complete span of the meander belt. Refer to the Beacon Geomorphic Assessment (2017) for additional studies which support the proposed design. The proposed bridge will be within Redside Dace habitat; however construction of a 40 m span crossing of Bruce Creek within the Angus Glen Village Gate Development just north of the subject property was recently completed and approved by MNRF with a Section 17(2)(c) permit under the ESA (Beacon 2014).

Additional mitigation measures will be implemented to ensure no impact to fish or fish habitat in Bruce Creek, including Redside Dace. These mitigation measures will include, but are not limited to, the following:

- Limit vegetation removal where possible, and stabilize cleared areas to prevent surface water runoff and sedimentation into watercourse;
- Develop and implement an Erosion and Sediment control plan to minimize risk of sedimentation into watercourse, complete regulator inspections of control measures and repair when required;
- Develop a Spill Prevention plan and ensure spill kits are kept on site;
- Restore disturbed areas with native plants; and,
- Adhere to the appropriate timing works if in water works are required.

4.3.2 Pedestrian Trails

A comprehensive trail network is proposed, linking the existing external trail system along 16th Avenue, through the proposed development including Bruce Creek and Berczy Creek Valley systems out to Warden Avenue, Kennedy Road and Angus Glen Boulevard. To minimize overall disturbance within the Greenway System, the trail is proposed primarily along the perimeter areas of the Bruce and Berczy Creek corridors and within areas where grading of the valley corridor is being completed for other purposes. This also minimizes the amount of trail required within Redside Dace habitat. Where possible, the proposed trail has been sited over top of the existing golf course cart paths including through natural heritage features (i.e., woodlots). The proposed trail system also uses the maintenance access roads within the SWM Pond blocks. The only locations where the proposed trail nears the creek bed or banks

is at the existing pedestrian crossing locations. These existing crossings are preferred in order to minimize potential impacts to Redside Dace habitat that would result from new crossings. Should existing crossings require upgrading, all efforts will be made to avoid disturbance of bed and banks of the watercourse at these locations. Existing crossings that are not incorporated into the trail plan will be removed and the area will be re-naturalized (see Section 5.1.3). MNRF, TRCA and the City will continue to be included in trail discussions.

4.4 Trees

The subject property is currently used as a golf course. By design, there are large numbers of mature trees. Trees located within the area of proposed development on the subject site that will be affected by the proposed new buildings, driveways, infrastructure and grading will require removal. There are currently 1,538 trees ≥40 cm DBH and 2,212 trees 20-39 cm DBH proposed for removal under these constraints.

Of the trees ≥40 cm DBH recommended for removal, 129 trees were found to be in a state of decline and have a limited longevity, 41 of which are Ash trees. A total of 56 Ash trees ≥40 cm DBH are located on the subject property, eight of which are in good condition. There is evidence that Emerald Ash Borer is prevalent on the subject property and even those trees that are currently in good condition are likely infected with Emerald Ash Borer and have a limited longevity.

5. Compensation and Enhancement

5.1 Valleylands

The majority of the Greenway System is currently operating as a golf course. Although there are some treed areas and four Significant Woodlands, the landscape is primarily fairways, tee boxes and greens, which provide little functional habitat for wildlife. In many areas, fairways are mowed and fertilized to watercourse edges, which can lead to increased runoff to the watercourses, impacting overall water quality and negatively impacting fish habitat. Several enhancements have been proposed within the valleylands, many of which will provide overall benefit to Redside Dace.

5.1.1 Habitat Creation

It is proposed that the enhancements for the subject lands focus on the Greenway System watercourse corridors. The watercourses are habitat for Redside Dace, which require cool, clear flowing water with riffle-pool morphology and overhanging streamside vegetation. Stream sections flowing through open terrestrial habitats with overhanging vegetation, undercut banks and submerged branches and logs are most suitable. This habitat will be created within the meander belt of both Bruce and Berczy Creek. Nodal plantings of trees will be planted sparsely, within this area. Overall, this will create an open meadow habitat, ideal for Redside Dace, as it provides shading for the creek reducing thermal impacts and provides a much needed food source. This habitat is also ideal for foraging of avian insectivores, such as Barn Swallow. Outside the meander belt, but still within the watercourse corridor, a forest

community is proposed. This habitat will be comprised of a variety of native coniferous and deciduous trees, with associated shrubs and groundcover. Refer to **Figure 3** for a conceptual planting plan of the Greenway System.

Detailed planting plans will be reviewed with MNRF, TRCA and the City.

5.1.2 Online pond removal

Ponds C, D, and E function in series and are used for golf course hazards and irrigation purposes. Pond E discharges to Bruce Creek at its southern end (**Figure 2**). Pond F is also an irrigation and water hazard pond which is located south of the existing driveway crossing. The ponds likely provide habitat for warmwater tolerant fish species, and are known to provide habitat for common breeding amphibians. As these ponds discharge to Bruce Creek, they impact water quality, including thermal regime. They have been proposed for removal and will be filled in.

5.1.3 Removal of Existing Watercourse Crossings

The development plan will require the removal of the existing golf course driveway which crosses Bruce Creek. For the purposes of construction, the crossing will remain in place during earthworks operations. All cart paths and watercourse crossings not incorporated into the trail network will also be removed. Removal of these structures and paved areas will allow for re-naturalization of Bruce Creek through this reach. All appropriate mitigation measures will be implemented during the removal of the existing driveway crossing.

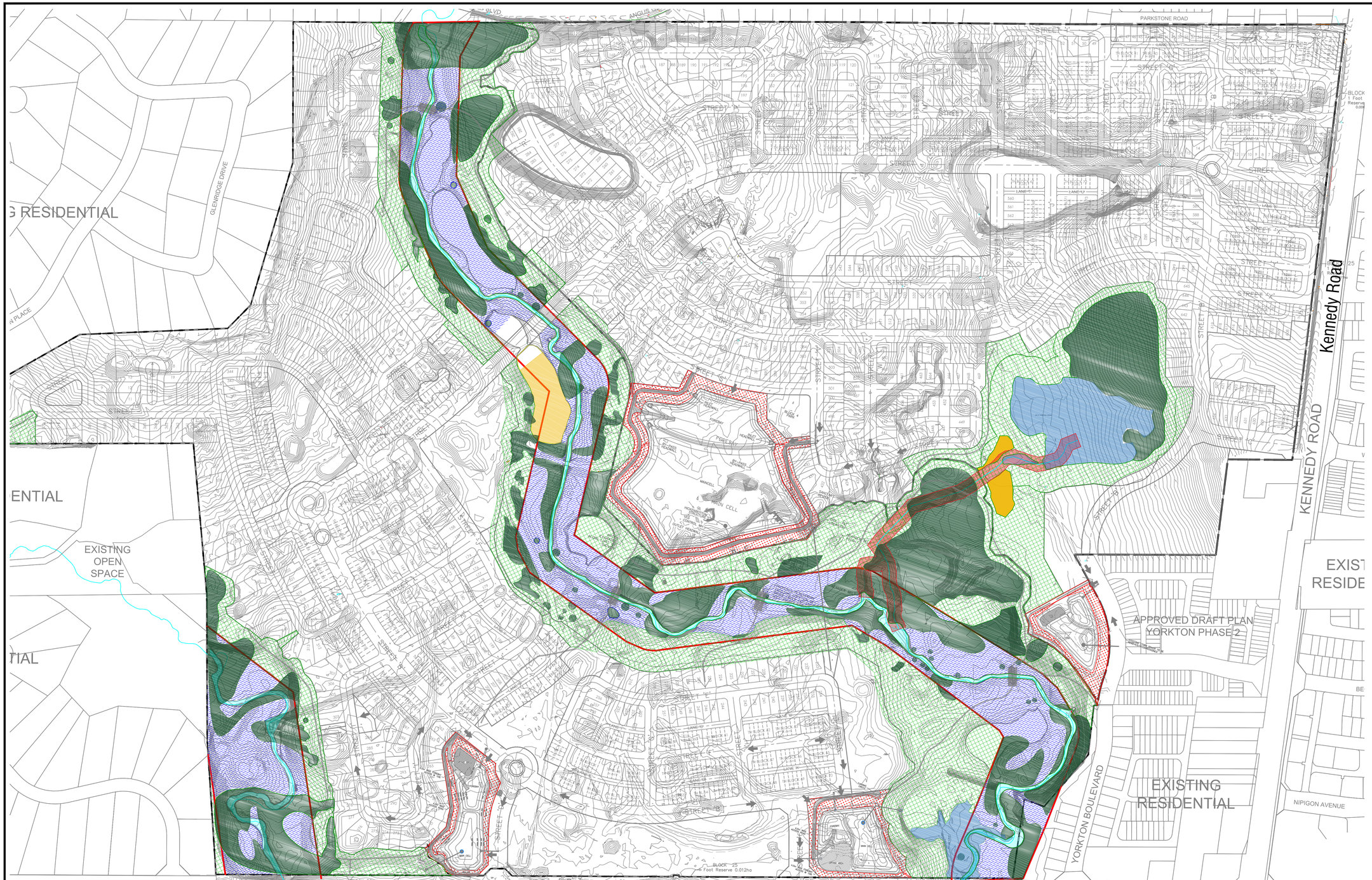
5.2 Wetland Creation

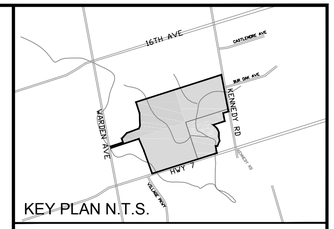
To promote greater ecological function and enhance connectivity, wetland 18 has been proposed for replication between Feature 1 and the Bruce Creek corridor. This provides an increased area of Greenway System around existing features (**Figure 3**).

A wetland feature of at least 4,350 sq. m (equal to the area of wetland 18) will be created between Feature 1 and Bruce Creek valley and will be designed using native wetland species that will be able to respond to changes in drainage patterns. The location of the re-created wetland provides more opportunities for clean roof drainage than the location of the existing wetland and will ultimately improve the quality of water flowing to Bruce Creek. By locating the wetland downstream of Feature 1, the features can be hydrologically connected, providing benefit to overall hydrological function.

An additional 1.6 ha of compensation area over and above the wetland re-creation is proposed within this area. This area will be planted largely with trees, to ultimately enlarge the adjacent forest community. It will provide additional habitat opportunities to those discussed in Section 5.1.2, and increase the function of the Greenway System.

As discussed in Section 5.1.1, one of the irrigation ponds will be converted to a floodplain wetland. This wetland will be “offline” and planted with native emergent plants, leaving some open water area. The wetland will provide for varied habitat within the Bruce Creek corridor, for amphibians, birds and other





LEGEND

- Proposed Nodal Plantings in Meander Belt
- Proposed Tree Plantings
- Proposed Tree Plantings in SWM Blocks
- Trees to Remain
- Existing Wetlands
- Proposed areas for Wetland Creation
- 10 m Buffer from Watercourse
- Meander Belt
- Watercourse

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NORTH ARROW

SEAL

NOT FOR CONSTRUCTION UNLESS SIGNED & DATED

BEACON ENVIRONMENTAL

PROJECT

4134 16th AVENUE

SHEET TITLE

PROPOSED OPEN SPACE COMPENSATION AND ENHANCEMENT STRATEGY

DESIGN BY:	NC	PROJECT N°:	215200
DRAWN BY:	NC	FIGURE N°:	3
CHECKED BY:	CG		
DATE:	10 April 2018		
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wildlife. It is also proposed that foundation drain collectors will outlet to this feature, providing cool, clean water to the valley corridor, and further reducing thermal impacts to the watercourse.

5.3 Headwater Daylighting

The road network has been designed so that Yorkton Boulevard (Street B) does not bisect the connection between Feature 1 and Bruce Creek valley. Rather, the road is east of the feature resulting in re-establishment of connectivity between the two features. The connection between the features is currently interrupted by the golf course. Two sections of SDF-C are currently piped. This headwater feature will be enhanced within a watercourse corridor and the two reaches (approximately 125 m) that are currently piped will be daylighted, which will further improve the size and connectivity of the Greenway System (**Figure 3**).

5.4 Landscaping

Landscaping of the public and private realms is proposed to provide overall tree canopy and provide a pleasing aesthetic to the neighbourhood. Urban landscaping provides habitat for urbanized wildlife, provides shade in parks and yards and reduces water and energy use. Urban landscaping, including streetscapes, private yards and in public areas such as parks, stormwater management ponds and along trails increase the value of the neighbourhood, while providing unique character.

5.4.1 Public Realm

Public realm landscaping will include plantings of various native deciduous and coniferous trees, as well as associate shrubs and groundcover, where appropriate, are proposed within the following locations (refer to **Figure 4**).

- Parks
- Stormwater Ponds
- Laneway Enhancements
- Streetscape Elements
- Enhanced Buffers
- Street Trees

5.4.2 Private Realm

Private realm landscaping will include plantings of various native deciduous and coniferous trees, as well as associate shrubs, where appropriate. This landscaping is proposed along the property boundaries to existing residential lots. These trees will be planted in the rear yards and will act as a vegetated transition and screening for neighbours. These trees will also fill in any gaps between where existing trees have been preserved, and along rear yards which border open space areas. Trees will also be planted in the front yards along Street A and B, where appropriate, providing a second row of street trees along these major collector roads. Refer to **Figure 4** for the locations of these compensatory plantings.

6. Summary of Tree Compensation

Schollen & Company Inc. was retained by Sixteenth Land Holdings Inc. to propose a site wide compensation strategy for tree removal. This strategy is detailed in the Tree Canopy Removal Compensation Strategy, dated April 2018 (**Appendix A**). Extensive research was conducted and the proposed alternative strategy for tree compensation is one that addresses large-scale developments and achieves the "no net loss" of tree canopy, as per City Council's mandate. The methodologies chosen are efficient, adaptable and effective to address tree compensation on a large scale, and the replacement of trees within a naturalized matrix. The habitat creation and landscaping detail above in Sections 5.1 and 5.4 provide the conceptual area where these compensatory trees will be planted. Finer detail to all planting plans, including the quantities of each size of proposed tree, as well as species and spacing, will be addressed during detail design.

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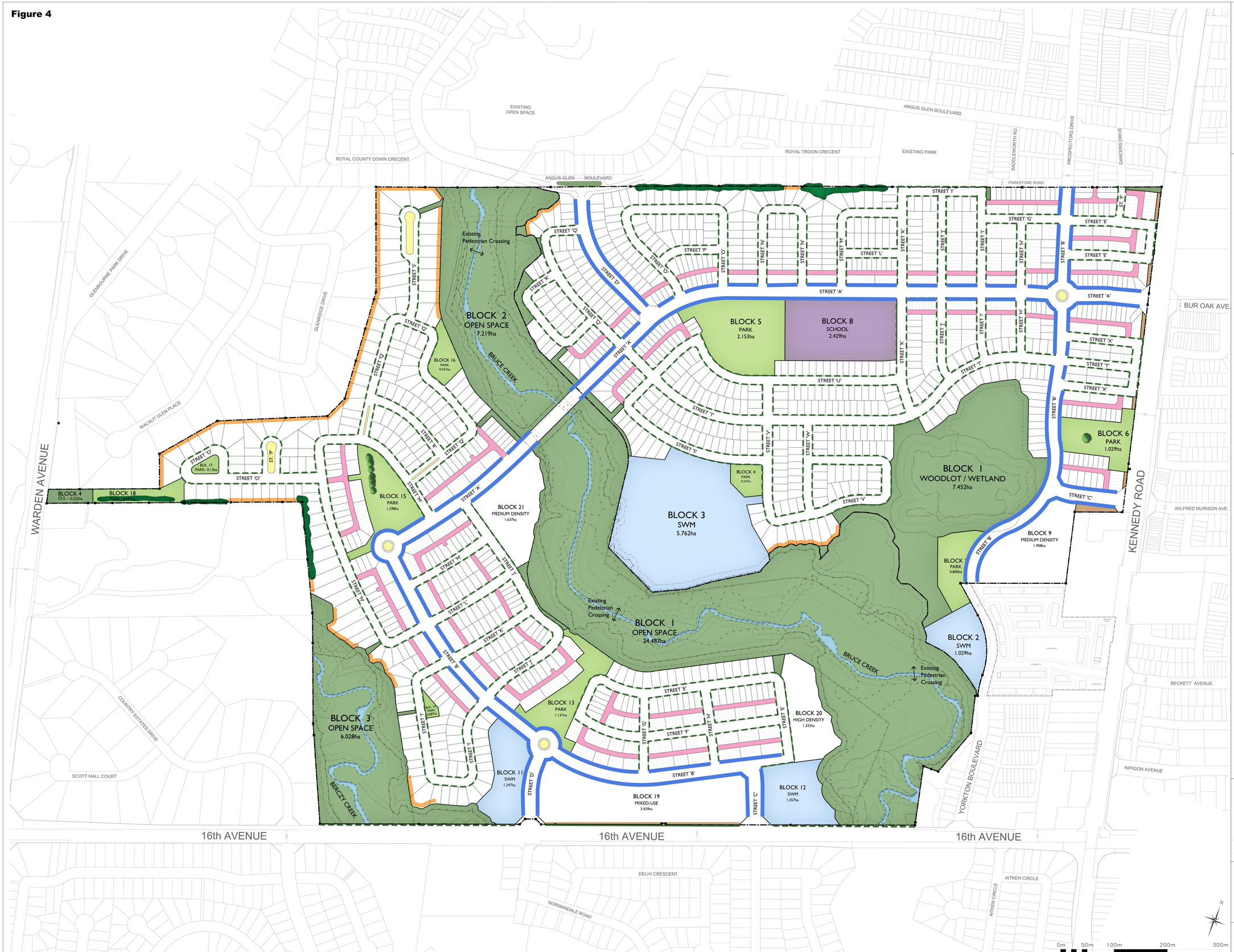
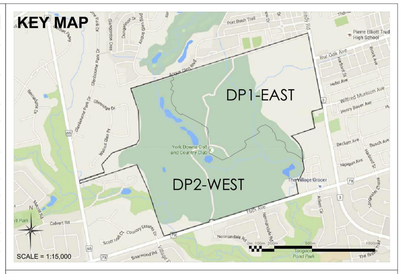
Carolyn Glass, BSc. MES
Ecologist

Report reviewed by:
Beacon Environmental

Jo-Anne Lane, M.Sc.
Principal

Figure 4





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TREES COMPENSATION AREAS

Scale:	1:2000 (36 x 54)	Date:	April 6, 2018
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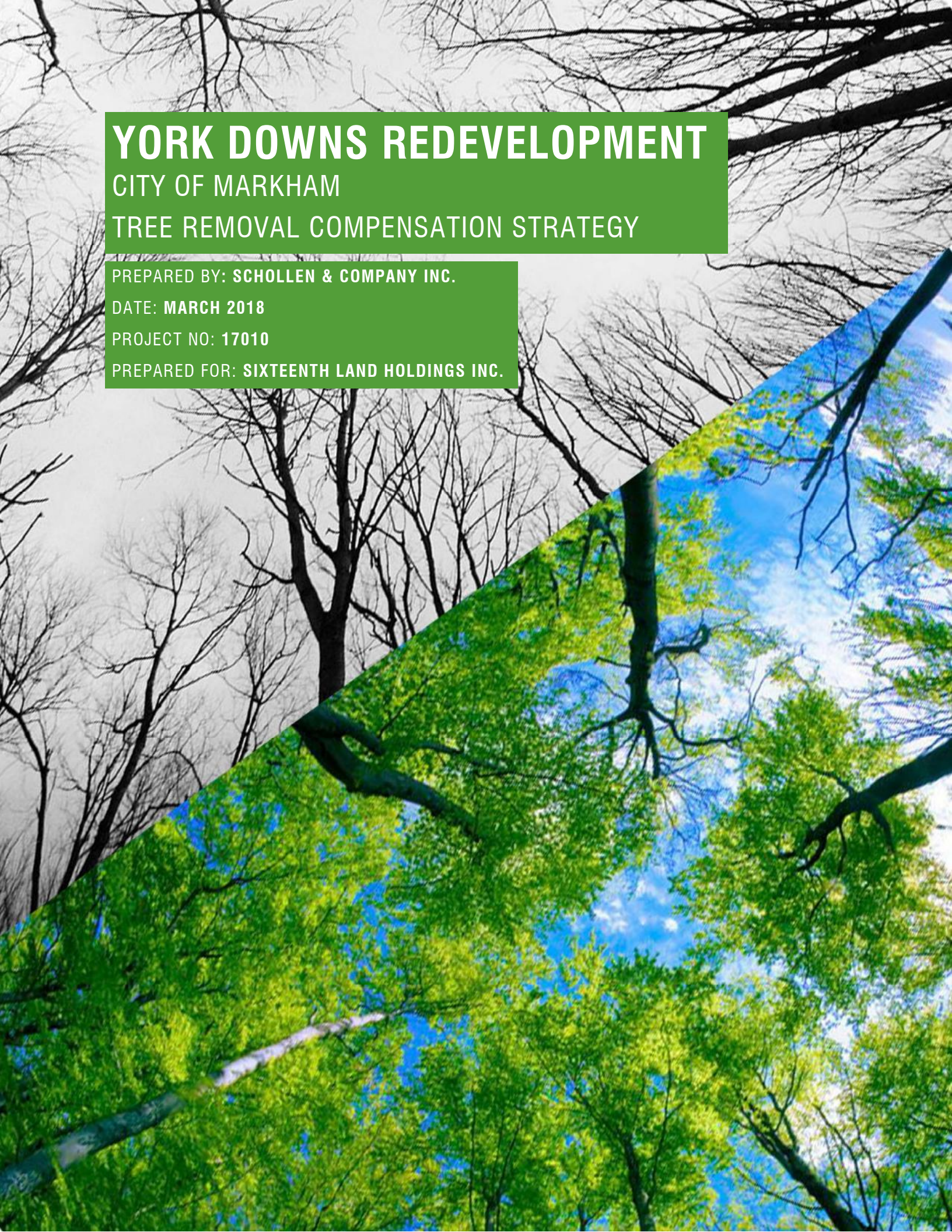
Appendix A

Tree Canopy Removal Compensation Strategy



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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York Downs Redevelopment

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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.

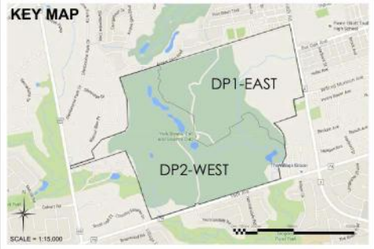
Figure 1 – York Downs Site

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



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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

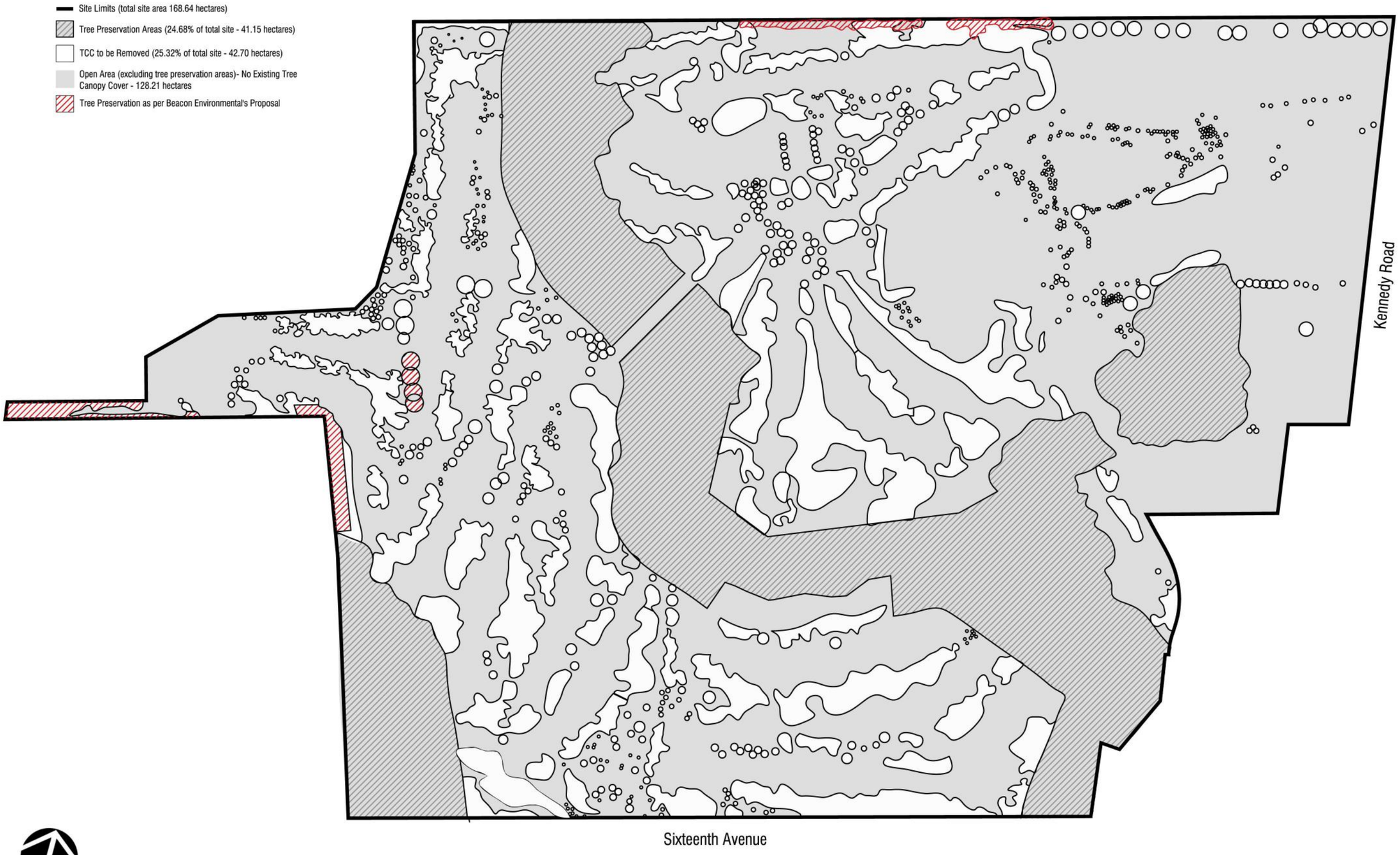

Figure 5 - AutoCAD Translation of Version 2. alpha Photoshop Software Canopy Cover Proposed to be Retained or Removed

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.