Agenda Including Addeds
Environmental and Ecological Planning Advisory Committee

4th Meeting of the Environmental and Ecological Planning Advisory Committee
March 15, 2018, 5:00 PM
Committee Rooms #1 and #2

Next Meeting Date: April 19, 2018

3RD REPORT OF THE
ENVIRONMENTAL AND ECOLOGICAL PLANNING
ADVISORY COMMITTEE

Meeting held on February 15, 2018, commencing at 5:05 PM, in Committee Room #1 & #2, Second Floor, London City Hall.

PRESENT: S. Levin (Chair), E. Arellano, A. Boyer, C. Dyck, P. Ferguson, S. Hall, B. Krichker, C. Kushnir, K. Moser, N. St. Amour, S. Sivakumar, C. Therrien, R. Trudeau and I. Whiteside and H. Lysynski (Secretary).

ABSENT: E. Dusenge, C. Evans and S. Madhavji.

ALSO PRESENT: C. Creighton, J. MacKay, M. McKillop, A. Rameloo, J. Ramsay and A. Sones.

I. CALL TO ORDER

1. Disclosures of Pecuniary Interest

That it BE NOTED that no pecuniary interests were disclosed.

II. SCHEDULED ITEMS

2. Pollution Prevention and Control Plan

That it BE NOTED that the Environmental and Ecological Planning Advisory Committee received the ~~attached~~ presentation from M. McKillop, Environmental Services Engineer, Wastewater and Drainage Engineering Division with respect to the Pollution Prevention and Control Plan.

3. Dingman Creek Subwatershed Environmental Assessment and Low Impact Development Stormwater Controls

That it BE NOTED that the Environmental and Ecological Planning Advisory Committee received the ~~attached~~ presentation from A. Sones, Environmental Services Engineer, Stormwater Engineering Division, with respect to the Dingman Creek Subwatershed Environmental Assessment and Low Impact Development Stormwater Controls and reviewed and received a Notice of Project Commencement for the South London Wastewater Servicing Study, Municipal Class Environmental Assessment Master Plan from K. Oudekerk, Environmental Services Engineer, with respect to this matter.

4. Environmental Impact Study for London's Rapid Transit Project

That a Working Group consisting of S. Levin, B. Krichker, S. Sivakumar and C. Therrien BE ESTABLISHED to review the Environmental Impact Statement for the Rapid Transit Project; it being noted that the Environmental and Ecological Planning Advisory Committee received the ~~attached~~ presentation from J. Ramsay, Project Director, Rapid Transit and E. Fitzpatrick, WSP, with respect to this matter.

III. CONSENT ITEMS

5. 2nd Report of the Environmental and Ecological Planning Advisory Committee

That it BE NOTED that the 2nd Report of the Environmental and Ecological Planning Advisory Committee from its meeting held on January 18, 2018, was received.

6. Municipal Council Resolution - 1st Report of the Environmental and Ecological Planning Advisory Committee

That it BE NOTED that the Municipal Council resolution adopted at its meeting held on January 16, 2018, with respect to the 1st Report of the Environmental and Ecological Planning Advisory Committee, was received.

IV. SUB-COMMITTEES & WORKING GROUPS

7. Issues for Investigation

That the ~~attached~~ Issues for Investigation Working Group comments BE APPROVED and BE INCORPORATED into the 2018 Environmental and Ecological Planning Advisory Committee's (EEPAC) Work Plan; it being noted that the EEPAC received the ~~attached~~ presentation from C. Therrien, with respect to research objectives and methods for pet interference in Environmentally Significant Areas (ESA), particularly the Medway Valley Heritage Forest ESA.

V. ITEMS FOR DISCUSSION

8. Workplan

That the following matters BE INCORPORATED into the 2018 Environmental and Ecological Planning Advisory Committee Work Plan:

- dogs off leash in Environmentally Significant Areas;
- the possible impacts of manufactured surfaces on trails; and,
- the creation of informal trails.

VI. DEFERRED MATTERS/ADDITIONAL BUSINESS

9. (ADDED) Green Standards for Light Pollution and Bird-Friendly Development

That the ~~attached~~ Green Standards for Light Pollution and Bird-Friendly Development brochure BE FORWARDED to Corporate Communications for approval.

VII. ADJOURNMENT

The meeting adjourned at 7:30 PM.

NEXT MEETING DATE: March 15, 2018

Proposed 2018 City Funded ESA Capital Projects

Project Category

Master Plans and Studies

- Meadowlily Woods ESA CMP
- Kilally Meadows ESA – Ecological Restoration Plan

Invasive Species Management / Habitat Restoration:

- All ESAs – Phragmites management/monitoring
- Coves – Buckthorn
- Killaly – Dog Strangling Vine, Buckthorn
- Kains – Buckthorn, Autumn Olive
- Lower Dingman – Buckthorn
- Meadowlily – Buckthorn, Knotweed
- Medway – Goutweed, Knotweed, Buckthorn
- Medway and Killaly – Purple Loosestrife biological control
- Sifton Bog – Buckthorn, Periwinkle
- Warbler Woods – Buckthorn
- Westminster – Buckthorn touch-ups in 4ha restoration area south of Saunders Pond
- All ESAs – Monitor using EDRR approach and touch ups of all 2016/2017 work under operational budget

Trail Improvements

- Warbler Woods – New City owned west ESA lands (post Trails Advisory Group walk to review existing trails)
- Coves - Briscoe Woods woodchip trail loop as per CMP/Local Implementation Committee
- Westminster – Boardwalk lifecycle replacements with AODA upgrades north of tourism building
- Informal Trail closures and restoration with focus on Medway south

Stewardship / Education / Signs

- Additional stay on marked trail signs, way-finding signs, trail closure signs
- Loosestrife Beetle Release Community event(s) in Kilally Meadows/Medway VHF date TBD
- City funding for SAR Reptile Habitat Stewardship with Scott Gillingwater/UTRCA
- Medway Decides program interpretive signs by Friends of Medway Creek installed in north

London CANADA

File: O-8844
Planner: T. Macbeth
Telephone: 519-661-2489 extension 5102
Fax: 519-661-5397
Email: tmacbeth@london.ca
Website: www.london.ca

February 13, 2018

NOTICE OF APPLICATION
TO AMEND THE OFFICIAL PLAN (THE LONDON PLAN)

The Municipal Council for the City of London is considering an amendment to The London Plan (Official Plan) within the lands shown on the map attached. The requested change is described below. We are advising you of this application to invite your comments.

APPLICANT:

City of London

LOCATION:

Lands south of Exeter Road, north of Dingman Drive, east of White Oak Road, and west of Marr Drain (drainage ditch located to the west of the Provincial Ministry buildings) - see attached map.

PURPOSE AND EFFECT:

The purpose and effect of the requested Official Plan Amendment is to initiate a "White Oak/Dingman Secondary Plan". The Secondary Plan is to establish Place Types in *The London Plan* for the "Future Community Growth" lands within this White Oak/Dingman area. Application may also amend the 1989 Official Plan from "Urban Reserve – Community Growth" to other residential and/or commercial land use designations.

POSSIBLE AMENDMENT:

Possible amendment to *The London Plan* to change the Place Type from "Future Community Growth" to other Place Types, including "Neighbourhoods", "Green Space", and/or "Shopping Area". Also possible amendment to the Official Plan (1989) to change the Land Use Designation from "Urban Reserve – Community Growth" to other land use designations including residential, open space, and/or commercial land uses. Council may also consider a special policy to recognize transition between Industrial and non-Industrial land uses within the Secondary Plan area.

HOW TO COMMENT:

Your opinion on this application is important. Please call in, mail, e-mail or fax your comments to The City of London Planning Services, P.O. Box 5035, London, ON, N6A 4L9, Attention Travis Macbeth **by March 5, 2018,** if possible. **Please Note:** Personal information collected and recorded at the Public Participation Meeting, or through written submissions on this subject, is collected under the authority of the Municipal Act, 2001, as amended, and the Planning Act, 1990 R.S.O. 1990, c.P.13 and will be used by Members of Council and City of London staff in their consideration of this matter. The written submissions, including names and contact information and the associated reports arising from the public participation process, will be made available to the public, including publishing on the City's website. Video recordings of the Public Participation Meeting may also be posted to the City of London's website. Questions about this collection should be referred to Cathy Saunders, City Clerk, 519-661-2489 extension 4937. Please ensure you refer to the file number or municipal address of the item on which you are commenting.

If a person or public body does not make oral or written submissions at a public meeting or make written submissions to the City of London before the proposed amendment is adopted, the person or public body may not be entitled to appeal the decision of the Council of the City of London to the Ontario Municipal Board, or may not be added by the Board as a party to the hearing of an appeal unless, in the opinion of the Board, there are reasonable grounds to do so.

A neighbourhood or community association may exist in your area. If it reflects your views on this proposal, you may wish to select a representative of the association to submit comments on your behalf.

Your representative on City Council, Ward 12 Councillor Harold Usher (office phone number 519-661-2489 extension 4012, or e-mail husher@london.ca) would be pleased to discuss any concerns you may have with this application.

PUBLIC MEETING:

The appropriateness of the requested Official Plan amendment will be considered at a future meeting of the Planning & Environment Committee. You will receive another notice inviting you to attend this meeting.

If a person or public body does not make oral or written submissions at a public meeting or make written submissions to the City of London before the proposed amendment is adopted, the person or public body may not be entitled to appeal the decision of the Council of the City of London to the Ontario Municipal Board, or may not be added by the Board as a party to the hearing of an appeal unless, in the opinion of the Board, there are reasonable grounds to do so.

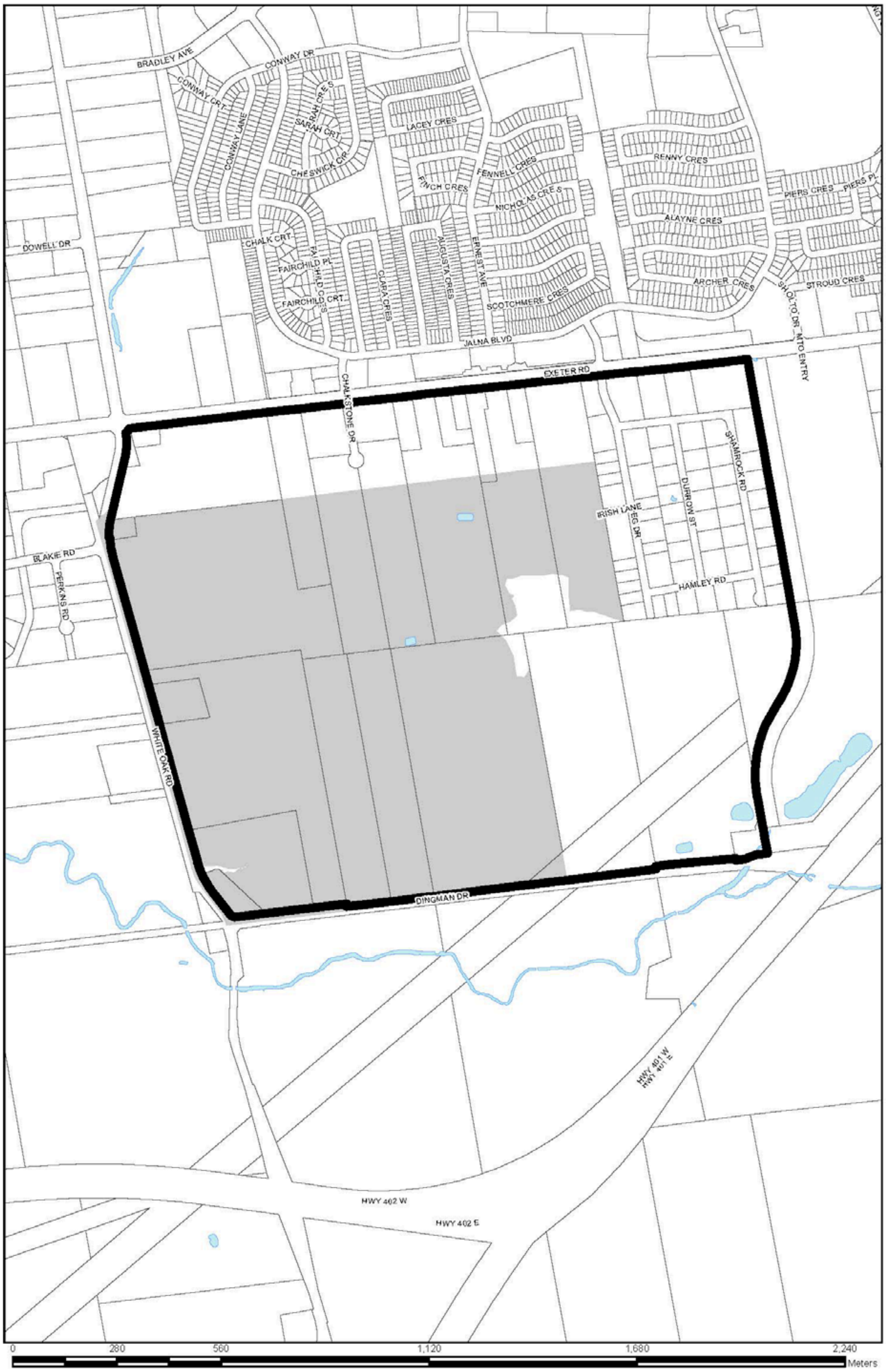
FOR INFORMATION:

If you wish to view additional information or material about the requested Official Plan amendment, it is available to the public for inspection at Planning Services, 206 Dundas St., London, ON, Monday to Friday, 8:30a.m.-4:30p.m.

For more information, please call Travis Macbeth at 519-661-2489 extension 5102, referring to File Number “O-8844”.

TO BE NOTIFIED:

If you wish to be notified of the adoption or refusal of a request to amend the Zoning By-law, you must make a written request to the City Clerk, 300 Dufferin Avenue, P.O. Box 5035, London, ON N6A 4L9. You will also be notified if you address the Planning & Environment Committee at the public meeting about this application and leave your name and address with the Secretary of the Committee.



LOCATION MAP

Subject Site : White Oak/Dingman Area

File Number: O-8844

Planner : Travis Macbeth

Date : 2018/01/30

N W E S

Scale : 1:12,500

Legend

Subject Site

Future Community Growth - London Plan
Urban Reserve Community Growth - 1989 Official Plan

City of London Planning Services
COMMUNITY INFORMATION MEETING

Travis Macbeth
Tel: 519-661-2489 ext. 5102 | Fax: 519-661-5397
Email: tmacbeth@london.ca | Website: www.london.ca

WHAT

This meeting is to start the White Oak-Dingman Secondary Plan process. This is an Official Plan Amendment to the London Plan. The meeting will provide an opportunity for the City to share project information with the community (including "terms of reference" for the project) and to seek input from the community on your goals and visions for the development of the "Future Community Growth" lands within this Secondary Plan area.

WHERE

City Hall – Committee Room #1
300 Dufferin Avenue
Second Floor

WHEN

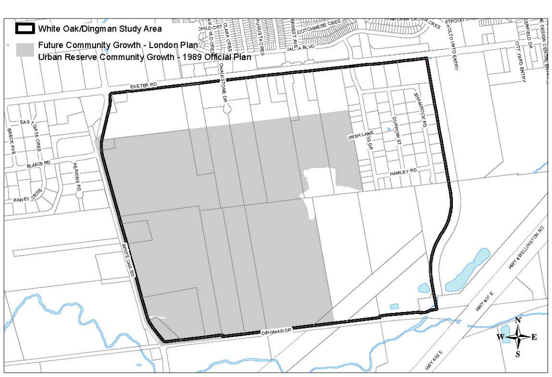
Wednesday, March 7, 2018
From: 7:00 p.m. to 9:00 p.m.

WHO

Everyone – your opinion is important in preparing this Plan. The Plan will develop the vision for the lands, including Future Community Growth lands, in the White Oak-Dingman Area. Representatives from City of London Planning Services are seeking community input on the future growth and development of these lands.

HOW TO GIVE COMMENTS

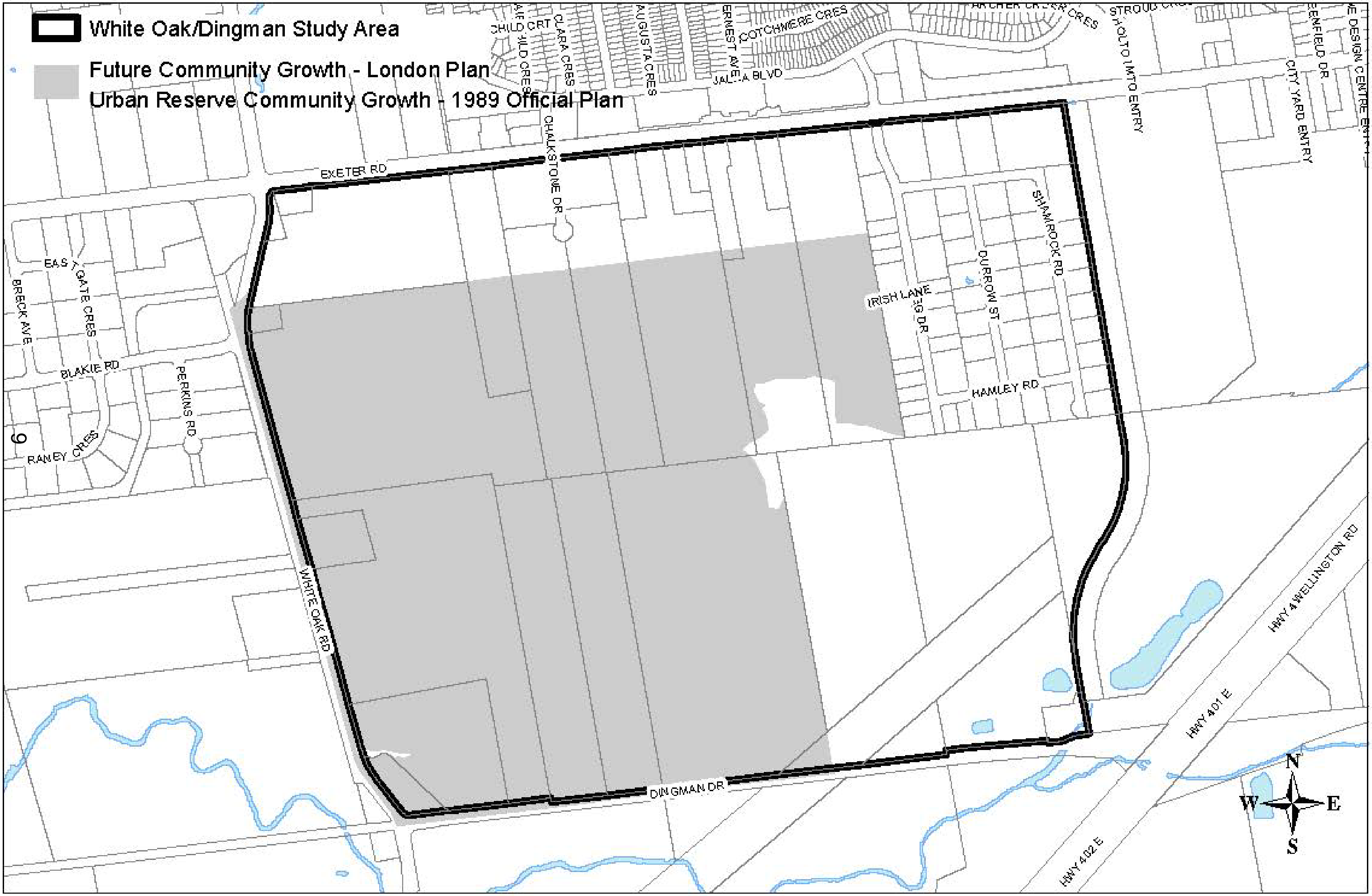
Please call, email, fax, or mail your comments to:
City of London Planning Division
206 Dundas Street, London, ON
N6A 1G7
Attention: Travis Macbeth



(See over for englarged area map)

Please note: This is a community meeting to provide the community with an opportunity to obtain information about the White Oak-Dingman Secondary Plan project. There will be a future public participation meeting required under the Planning Act, held at the Planning and Environment Committee, which will give you an opportunity to comment to City Council on the Secondary Plan.

Personal information collected at this meeting is collected under the authority of the Planning Act, R.S.O. 1990, and may be used for the purpose of informing you of future information meetings and statutory public meetings related to this Secondary Plan.


White Oak/Dingman Study Area
Future Community Growth - London Plan
Urban Reserve Community Growth - 1989 Official Plan
EXETER RD
CHALKSTONE DR
WHITE OAK RD
DINGMAN DR
SHAMROCK RD
DURROW ST
HAMLEY RD
IRISH LANE
BLAKIE RD
PERKINS RD
BRECK AVE
RANEY CRES
EAST GATE CRES
CLARA CRES
CHILD CRT
AUGUSTA CRES
ERNEST AVE
COTCHMERE CRES
CITY YARD ENTRY
SHOLTO IMTO ENTRY
HWY 401 E
HWY 402 E
HWY 4 WELLINGTON RD
N
E
S
W

PICTURE OF GREEN SIGN

You, Your Dog, and Environmentally Significant Areas

What dog doesn't enjoy a nice romp outside? It's fun to take your dog on walks in natural areas. But there are rules: they must stay on a leash and owners must pick up their feces.

WHY? MY DOG ISN"T HURTING ANYTHING!

Actually, there are good reasons for keeping your dog on a leash.

PEOPLE REASONS

While your dog might be friendly, not everyone is comfortable around dogs. Some children and adults are afraid of dogs while others don't want muddy paw prints on their clothes.
Be one of the considerate people and keep your dog on its leash.

Dog waste creates an unclean trail for other users (ever step in it?).

HEALTH OF YOUR DOG

Some dogs interact with other dogs on the trail in an unacceptable manner.

Some plants are toxic to dogs. Milkweed, which is common in many natural areas, contains several toxins throughout the plant, including galitoxin and cardiac glycosides. Other plants like poison ivy and poison oak are also harmful to dogs.

Read more at: https://wagwalking.com/condition/milkweed-poisoning

WILDLIFE REASONS

Dogs are perceived as predators by most wildlife. This elicits an alarm response which is damaging in the long term. Dogs cause the disruption of normal wildlife activity
such as bedding, grooming, or feeding, and can further harass wildlife by chasing and killing it. In particular, pregnant wildlife and newborn animals do not have the energy reserves to repeatedly expend in avoiding dogs. Both types of predation are severely reduced, if dogs remain leashed.

Commented [SM1]: Change to: "Is comfortable with dogs" – less likely to insult

Commented [SM2]: Any info on dog waste being ecologically detrimental?

Commented [SM3]: Poison ivy, poison oak could be added too

In one ESA, a dog cornered a deer against a fence behind a house. The deer got caught up in the fence and the dog began attacking the deer. The police had to be called to put down the deer.

Commented [SM4]: Which?

"Dog walking caused a 41% reduction in numbers of bird individuals detected and a 35% reduction in species richness" –Peter Banks & Jessica Bryant,
University of New South Wales, published in Biology Letters in December 2007

Commented [SM5]: Might be better to tweak the language to be about being off leash rather than vilifying dog walking altogether

There is a rapidly growing body of evidence by ecologists who study predator-prey interactions, suggesting that the most profound effects of carnivores on prey may be through fear rather than mortality. The non-lethal effects of predators can include habitat displacement to safer but less desirable areas (e.g. less food or shelter), increased stress, reduced feeding, and decreased reproduction.
Jennie Miller, Yale School of Forestry and Environmental Studies, published in the Yale Environmental Review, November 2012

Dogs are responsible for some transmission of diseases to wildlife including distemper,
rabies, parvovirus, and parasites.

Dog waste is not natural. Dogs eat a variety of processed foods with many
These chemicals can harm the soil and plants. **(need examples or delete)**

Commented [SM6]: Might need to include concrete examples of harm

SUMMARY

People and their dogs disturb wildlife, and people are not always aware of or willing to acknowledge the significance of their own impacts. ~~People with dogs are much more detrimental to wildlife than people alone; off-leash dogs are worse; and off-trail impacts are the highest~~.

Dogs off leash are significantly more detrimental to the natural environment than when they are on leash. ESAs are areas where we try to protect and enjoy an intact ecosystem so keeping dogs on leash is essential to ESA preservation

GREEN STANDARDS FOR LIGHT POLLUTION & BIRD-FRIENDLY DEVELOPMENT

By – law recommendations for the City of London

Prepared by the Ecological and Environmental Advisory Committee (EEPAC), the Advisory Committee on the Environment (ACE), & the Animal Welfare Advisory Committee (AWAC)

- Fourth Draft -
March 2018

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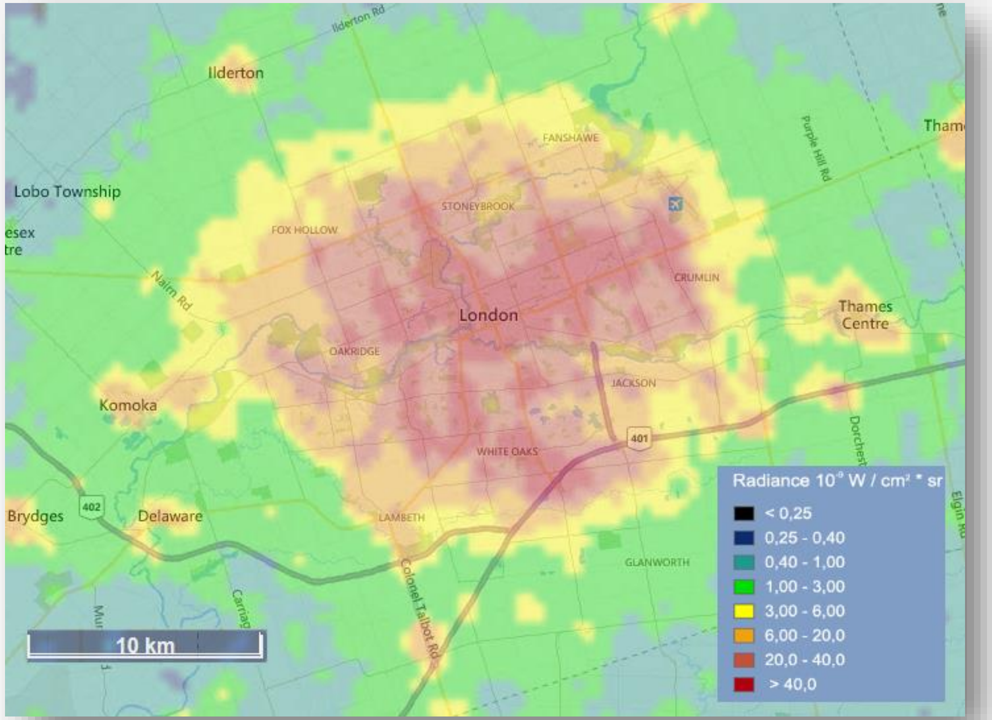


Light pollution in London, Ontario. From www.lightpollutionmap.info

1. DEFINITIONS

Definitions were derived from pre-existing standard documents of other municipalities within Ontario[1-5]. For the purpose of this document, terms shall be defined as follows:

- **Architectural lighting** – outdoor lighting to illuminate landscaping features (e.g. trees, stones, or water), building facades, etc. (excepting signage)
- **Automatic timing device** - any device which controls light fixtures to automatically turn on and off at designated times
- **City** – the City of London, Ontario
- **Council** - the elected municipal council of the City
- **Curfew** - a time defined by the City when outdoor lighting must be reduced or switched off
- **Cut-off shielding** - a luminaire having a light distribution in which zero lux intensity occurs at or above and angle of 90° nadir
- **Decorative lighting** - see *vanity lighting* (below)
- **Diode** - a device allowing one-directional flow of current
- **Direct light** - light directly emitted from the installed light fixture or off of its internal reflector or luminaire
- **Emergency conditions** - lighting that is only switched on during an emergency, exit paths during an emergency situation, or security lighting used solely during alarms
- **Glare** - undue brightness from a light source. Light emitted from fixtures which diminish a bystander’s ability to see and/or causes discomfort
- **Grandfathered** - existing light fixtures which may be exempt from these recommendations (Section 6)
- **Hardscape** - permanent human-made elements of an outdoor landscape design
- **Horizontal illuminance** - Amount of light energy landing on a horizontal surface (e.g. the ground)
- **IESNA -** Illuminating Engineering Society of North America or any successor organization
- **Indirect light** - light which is scattered or reflected off of other surfaces
- **Lamp** - any artificial source of light
- **LED** (**Light Emitting Diodes**) **-** a popular modern type of lamp
- **Light fixture** - a complete lamp assembly which includes lamp, housing, reflector, mounting bracket, and/or pole socket
- **Light pollution** - any adverse consequence of artificial light including, but not limited to, glare, light trespass, sky glow, energy waste, compromised safety and security, and impacts on the nocturnal environment
- **Light trespass** - any light which falls beyond the property it is intended to illuminate
- **Lumen** - a measurement unit that quantifies the amount of light produced by a lamp or emitted from a luminaire (distinct from ‘watt’, a measure of power consumption). Conversion to lux is possible
- **Luminaire** - see *Light fixture* (above)
- **Lux** – an international unit used to measure light intensity. Conversion to lumen is possible
- **Official Plan** - the City of London and Planning Area’s Official Plan, revised periodically
- **Outdoor lighting** - any outdoor installed or portable luminaire used for flood lighting, general illumination, or advertisement
- **Outdoor recreational facilities -** an outdoor space or venue used for sporting events or entertainment purposes within the city
- **Over-illumination** - lighting of an area beyond that which human vision is able to differentiate
- **Owner** - the registered owner according to the land registry office or the person in the actual occupation of the land
- **Point illuminance -** Amount of light energy measured at a given point
- **Shielded luminaire -** refers to luminaires with an adjustable mounting device allowing aim in any direction and contains a shield, louver, or baffle to reduce direct view of lamp
- **Sky glow** - any brightening of the nighttime sky caused by light directed and/or reflected upwards and/or sideways that reduces the ability to view the night sky
- **Sufficient daylight** - adequate natural lighting such that exterior artificial lighting is not required (approximately 30 minutes after sunrise or 30 minutes prior to sunset)
- **Vanity lighting** - lighting for the purpose of drawing attention. For example, lighting to illuminate landscaping features (e.g. trees, stones, or water), building facades, etc. (excluding signage)
- **Ventilation grate -** street grates or grills which disperse air from structures under roadways and/or sidewalks to reduce heat gain in the summer and allow for passive heating in winter
- **Visual markers** - a physical design visible within a bird’s optical wavelength to indicate a barrier is present

London, Ontario downtown at night. Photograph © Joanna Kurowski

2. PURPOSE & JUSTIFICATION

The City of London plans to become one of the greenest cities in Canada by reducing its impacts on the environment and its carbon footprint (direction 4, The London Plan)[1]. Specifically, The London Plan contains the goals of minimizing bird strikes on buildings and reducing negative environmental impacts of light pollution[1]. In Canada, it is estimated that 25 million birds die annually from collisions with buildings [22]. The purpose of this document is to provide guideline recommendations for by-law development to achieve these goals. Many specifications in this document are derived from pre-existing guidelines of other Ontario municipalities[2-9], as well as from the Illuminating Engineering Society of North America (IESNA).

2.1 Environmental Impacts

Light pollution impacts the behaviour and survival of birds, mammals, amphibians, fish, and arthropods, and diminishes ecological health both locally and nationally[10]. Specific threats to wildlife include disruption of movement and migration[11-14], changes in communication and reproductive behaviours (e.g. songbird call times)[15], shifts in species diversity, altered interactions among species[16,17], disruption of foraging behaviour, and increased mortality[18-21].

2.2 Carbon Footprint and Cost

Goals of the current London Community Energy Action Plan[23] include an 80% reduction in greenhouse emissions by 2050 and energy cost savings. Policy and design standards to reduce wasted lighting energy are crucial if the City of London is to achieve these goals. Reducing wasted energy is an easy way for the City of London to reduce its carbon footprint; total wasted light energy in the United States is estimated between 80 and 225 kg of CO_2 annually[24]. The negative economic impacts of light pollution on health, wildlife, and astronomy are estimated at $7 billion each year in the United States[10].

3.1 Light Pollution

The City of London's Advisory Committee on the Environment (ACE), Environmental and Ecological Protection Advisory Committee (EEPAC), and Animal Welfare Advisory Committee (AWAC) (or 'we the committees') collectively recognize that it is beneficial to protect dark skies through responsible city lighting policies. We the committees recognize that other Ontario municipalities have outdoor lighting ordinances to reduce glare and light intrusion while promoting energy conservation and healthy neighbourhoods.

Light pollution has been defined as "excessive or obtrusive artificial light caused by bad lighting design"[10]. Proper lighting design and illumination standards can reduce light pollution by[20]:

- Preventing lighting in specific areas
- Limiting lighting duration
- Reducing light trespass
- Reducing light intensity

The night sky in Toronto, Ontario during a power outage in 2003 (left) and on a night with power (right). Photograph © Todd Carlson

3.2 Bird-Friendly Design

Bird-friendly design is critical for city-wide progressive green development standards. Designs to reduce bird mortality may be similar to light pollution reduction strategies, with further inclusion of non-reflective glass and ventilation grates. In accordance with The City of London's Humane Urban Wildlife Conflict Policy, the City of London can take the following measures to reduce bird fatalities:

- Placement of bird-friendly exterior light fixtures in conjunction with glass design elements
- Adoption of a migratory bird policy[8]
- Provision of a comprehensive list of design-based development strategy options to architects, planners, urban designers, building owners and managers, tenants, and homeowners that can be applied to new or existing buildings
- A campaign that promotes awareness of the dangers the urban environment poses to migrating birds such as the City of Toronto's "Lights Out Toronto" event
- Bird-friendly ventilation grates with a porosity no greater than 2 cm^2 or covered with netting to prevent injured birds from falling through
- If transparent noise barriers must be used, they shall have visual markers for birds to perceive and avoid them
- Eliminate reflective glass and mirrors from exterior landscape and building design. Birds are unable to distinguish between reflected and real habitat, which results in increased collision mortality

All general recommendations found in Section 4.1 are applicable to all newly installed lighting fixtures. Specific design details can be found in the following sections categorized by site usage type (residential, non-residential, special consideration sites). These recommendations and criteria are amalgamated from the design guideline recommendations of the Model Lighting Ordinance[2], and various Ontario municipalities (e.g. Toronto, Burlington, and Richmond Hill).

4.1 Hours of Operation

Recommendations for luminance and timing of lighting are intended to reduce or eliminate unnecessary light pollution. The IESNA and other documents typically use a light curfew to achieve this. The city of London's curfew begins at and ends at . Facilities requiring a curfew adjustment (e.g. restaurants, bars, sports stadiums, hospitals) will be evaluated on a case-by-case basis. During curfew, outdoor lighting must adhere to Section 4.2, bullet 5 option A or B. All residential and non-residential areas, including illuminated signs, are subject to the curfew[36]. Some site uses may warrant a curfew extension (e.g. recreation or entertainment) (see Section 6, General Exemptions).

4.2 Universal Outdoor Light Fixture Requirements

The general recommendations laid out below apply to all properties and lots.

- All outdoor light fixture installations must use shielded or cut-off fixtures
- No installed light fixtures will emit light above 90° from a direct downward plane
- Light fixture mounts/poles must have a non-reflective finish to reduce glare
- Maximum lumen levels for different light fixture heights must conform to Table 4.2
- All outdoor installed lighting (unless stated otherwise in Section 4.5) must incorporate one of the following:
    - A. An automatic switch (or automatic timing device) to extinguish all outdoor lighting curfew. These switches can include photoelectric, astronomic, programmable, or building automation switches. The switch must include a backup power device (battery or other)
    - B. Occupancy sensors/timers/motion sensors
- Light trespass at the property line will not exceed 11.6 lumens / ft^2 for commercial/industrial property boundaries or 5.8 lumens / ft^2 for residential property boundaries. In the case of a mixed residential/commercial boundary, the value for the residential shall take precedence
- Adjustable, or swivel fixtures, are prohibited
- Pole heights cannot exceed: $\textbf{Height} = \textbf{Distance from pole to property line x 4}$ and should not exceed height of adjacent structures. Large parking lots and parking garages with >10 parking spaces are exempt from this recommendation. If a non-residential zone light fixture must be installed higher due to safety considerations, cut-off shielding greater than 90° must be installed
- Glare onto adjacent properties, roadways, and pedestrian throughways is prohibited. This may require the use of additional shielding
- All light sources (a.k.a bulbs, diodes) must be directed in such a way so that the light source is not directly visible from adjacent properties
- Openings in buildings which will contribute to light spillage must be blocked or shielded to transmit less than 10% light during the overnight hours (11 PM - 6 AM)
- The use of lasers, search lights, strobe lights, twinkle lights, or chasing lights are prohibited unless used for emergency services

Table 4.2

Mounting Height		Maximum Single Light Fixture
Feet	Meters	Lumens
6	1.83	500 – 1000
8	2.44	600 – 1600
10	3.05	1000 – 2000
12	3.66	1600 – 2400

4.3 Residential

All residential zones (R1 through R11) must adhere to the requirements listed above. If the residential zone is combined with a non-residential zone, the property is strongly encouraged to meet both residential (Section 4.3) and non-residential (Section 4.4) guidelines. Residential guidelines are as follows:

- Maximum single fixture lumen allowance at a main entrance will not exceed 1,260 lumens.
- Maximum lumen allowance for each additional fixture (excluding main entrance, driveway/parking (Section 4.5.2), and motion sensed security lighting (Section 4.5.7), is 315 lumens / fixture.
- In residential buildings with 5 or more stories, shielded directional fixtures with motion-sensors for security are not to exceed 1,260 lumens each.

Additional design criteria for specific types of sites or property uses (including parking lots and security lighting, which may be utilized for residential properties) are included in Section 4.5.

4.4 Non-Residential

For all non-residential sites, Table 4.4 must be followed. Site total lumen allowance will be determined by number of parking spaces (if site has fewer than 10) or total square footage of hardscape. These site lumens may be divided among all light fixtures on the property, so long as they adhere to the universal guidelines noted above (Section 4.2) and any specific site guidelines below. Some specific types of site usage (e.g. sale lots or service stations) will have additional design considerations or may receive additional lumen allowance (Section 4.5).

Table 4.4

		Lumen Allowance	
Light Zone Code	**City of London Property Zone Code(s)**	Lumens / parking space (for sites <= 10 parking spaces)	Lumens / ft^2 of hardscape (sites > 10 parking spaces)
LZ-0	AG, ER, OS, UR	350	0.5
LZ-1	AGC, DC, HER, OC, RO, RRC, T, TGS	490	1.25
LZ-2	AC, GI, OF, ASA, HS, OR, BDC, LI, RSC, CC, NF, NSA, CF, CSA, OB, CR	630	2.5
LZ-3	DA, RF, SS, EX, RSA, HI, RT	840	5

Values obtained from the IESNA. This table is intended for non-residential zones only.
LZ0 - "Recommended default zone for wilderness areas, parks, and preserved, and undeveloped rural areas."
LZ1 - "Recommended default zone for rural and low-density residential areas" (may include business parks).
LZ2 - "Recommended default zone for light commercial business districts and high density or mixed-use residential districts" (may include churches, schools, recreation facilities, light industrial zoning).
LZ3 - "Recommended default zone for large cities' business district" (may include business zone districts, commercial mixed-use, and heavy industrial zones).

4.5 Specific Use Design Considerations and Lumen Allowance Additions

The following sections have been provided for specific-use zones and may be applicable to residential or non-residential areas.

4.5.1 Entertainment Venues and Events

Entertainment venues and specific events are to be evaluated individually on a case by case basis.

4.5.2 Parking Lots and Garages

Lighting in parking lots and garages are primarily for the safety of pedestrians. Parking structure lighting should be modulated so that they transition to match, but not exceed, adjacent roadway lighting levels at exits/entrances. All parking lots must adhere to maximum lumens at property line as described in Section 4.2.

In general, all parking lots shall have an average horizontal illuminance of no more than 25 lux with a maximum point illuminance not to exceed 40 lux. In the individualized case that a parking lot requires enhanced security due to the threat of vandalism or personal safety, the average horizontal illuminance and maximum point illuminance may be no greater than 75 lux.

These recommendations apply to any and all residential, institutional, customer, employee, or general use parking lots.

4.5.3. Outdoor Sales Lots

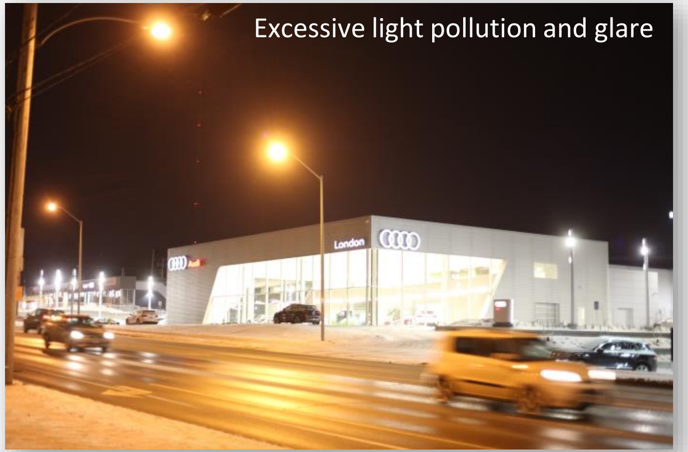
Sales lots are illuminated to draw attention to displayed products and/or for security purposes. The lighting requirements include a graduated illuminance level from the front row (between the roadway and the front row of merchandise) to the last row. In addition to the universal guidelines presented in Section 4.2, site maximum horizontal illuminance is not to exceed:

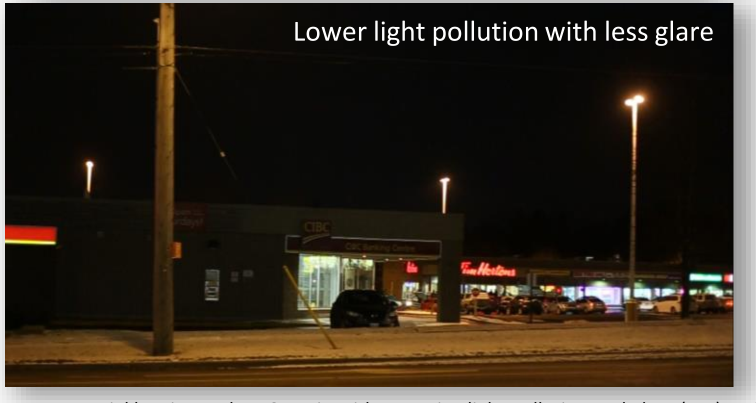
- 100 lux at the front row
- 50 lux at all other rows
- 20 lux at all pathways/drives on the property

In addition to the lumen allowance provided in Table 4.4, outdoor sales lots used exclusively for the sale of vehicles have an additional allowance of:

- LZ-1, additional 4 lumens / ft^2 hardscape
- LZ-2, additional 8 lumens / ft^2 hardscape
- LZ-3, additional 16 lumens / ft^2 hardscape

These recommendations apply to every outdoor sales lot to be illuminated and are to be incorporated into the light fixture design in accordance to the lumen allowance for non-residential areas.





Two commercial lots in London, Ontario with excessive light pollution and glare (top) and relatively low light pollution and low glare (below). Photographs © Ryan Fraser 2015

4.5.4 Service Stations and Gas Stations

The purpose of lighting a service/gas station is to ensure patron safety and to draw attention and interest to the business. Over-illumination of the property is prohibited, and the illumination limits for property boundaries (Section 4.2) must be maintained. Installed fixtures are to be limited to a canopy whenever possible. In addition to adherence to the universal guidelines presented in Section 4.2, site average horizontal illuminance is not to exceed:

100 lux for pump island/under canopy
30 lux for service areas
20 lux for pathways/drives

In addition to the allowance provided in Table 4.4, service stations/gas stations have additional allowed lumens:

LZ-1, 4000 additional lumens / pump
LZ-2, 8000 additional lumens / pump
LZ-3, 16,000 additional lumens / pump

These values are additional design criteria which need to be implemented in conjunction with the lumen allowance provided for non-residential sites.

4.5.5 Sports Recreational Fields

Outdoor sports fields require lighting for clear illumination of players. Sports/recreational fields have been divided into 4 classes:

1. More than 5,000 attendance seats (e.g. universities, colleges, semi-pro players)
2. 1,500 – 5,000 attendance seats (e.g. small universities or colleges, high-attendance high schools)
3. 500 – 1,500 attendance seats (e.g. high schools, training clubs with spectator seats)
4. Less than 500 attendance seats (e.g. leagues, elementary schools, little league, social events)

Using this classification system, illumination levels and lighting equipment must adhere to the IESNA Recommended Practice for Sports and Recreational Area Lighting (RP-6, latest edition). Illuminance values, fixture positioning, pole height, and curfew timing mandated in the IESNA RP-6 shall take precedence over the requirements outlined in this document.

4.5.6 Architectural and Vanity Lighting

Architectural lighting is used to highlight and attract attention to architectural features, heritage features, and municipal landscaping, monuments, or fountains. No fixture will be installed to emit light above the horizontal plane (e.g. directly upwards). No light fixture will be aimed at reflective or polished surfaces such as glass, smooth stone, glazed tile, etc. The maximum total illuminance shall not exceed 100 lux. Architectural/vanity lighting must be extinguished at curfew, preferably by automatic switch (Section 4.2, bullet 5, option A).

Lumens from architectural light fixtures must be included in the site maximum lumen allowance for non-residential sites (Table 4.4).

4.5.7 Security Lighting

Lighting to ensure the safety of pedestrians shall be used as required. Light fixtures for this purpose shall:

- Reduce brightness contrast
- Ensure no light is directed 90° above the horizontal
- Employ motion sensors (Section 4.2, bullet 5, option B)

These guidelines shall apply to all pedestrian trafficked areas and will be included in the site/lot lumen allowance.

4.5.8 Other

- Vehicular and temporary emergency lighting required by Fire and Police departments, or other emergency services shall be exempt from the requirements of the By-law.
- Outdoor lighting utilizing fossil fuels, including torches, lanterns, and open flames.
- Lights used by contractors, providing the lights are located on the property where such work is taking place and only during hours where work is occurring.
- Specific instances where concern for public safety conflicts with the guidelines outlined in this document will be evaluated on a case–by–case basis.

5. EXEMPTIONS

5.1 Grandfathered Lighting

All existing light fixtures in place at the time of this policy shall be grandfathered. Grandfathered light fixtures which are determined to cause excessive glare or light trespass may be required to be shielded, redirected, or removed. Any modification, relocation, repair, or reinstallation of any grandfathered light fixture must meet the design criteria laid out in Section 4. Should a property undergo a use or zoning change, all light fixtures must be updated to meet the design criteria in Section 4. All new fixtures installed after the date of this policy must meet the design criteria in Section 4.

5.2 General Exemptions

These guidelines do not take precedence over highway and road lighting bylaws.

5.2.1 Recreational use - after 11 PM - limitation
Where an outdoor recreational use in an outdoor recreational facility continues after 11 PM, outdoor light fixtures required to be on in connection with that use are permitted, but only while that use continues.

5.2.2 Entertainment event - after 11 PM - limitation
Where a concert, play or other entertainment event in a park or on other land owned by the Corporation and used for public purposes takes place or continues after 11 PM, outdoor light fixtures required to be on in connection with that event are permitted, but only while the event takes place or continues.

5.2.3 Hospitals
All hospitals shall be exempt.

5.2.4 Seasonal lighting
Lighting such as Christmas and other holiday lighting shall be exempt.

5.2.5 Temporary Exemptions
Any person may submit a written request for temporary exemption from the recommendations by completing a written request form prepared by the City. The written request should include:

- Specific exemption request
- Type and use of exterior lighting involved
- Date(s) of the event
- Duration of the event
- Location of exterior lighting
- Size, wattage, and height of proposed lighting

The owner or lease of the land upon which the prohibited light(s) will be placed shall apply to the city for an exemption. Plans for the location and fixture specifications for the specified light(s) shall be submitted with the application.

An exemption may be granted in whole or in part with terms and conditions. Any breach by the applicant of any of the terms or conditions will render the exemption null and void.

Keith Urban at Rock the Park music festival, London Ontario.
Photograph © Derek Ruttan 2015

6. BIRD-FRIENDLY DESIGN

Mortality rates of birds are increasing due to collisions with buildings, especially during the migratory season. Each year nearly 25 million birds die in Canada from building collisions alone, making reflected light from buildings one of the most deadly threats to birds. With new guidelines in place, a building that emits reflected light which injures or kills birds is now a violation of the provincial Environmental Protection Act (EPA) and the federal Species At Risk Act (SARA). Due to these legal offenses, it is important for buildings to follow bird-friendly design guidelines across Canada.

The following strategies outline recommendations for achieving green standards for bird-friendly development, and are derived from the City of Toronto Green Development Standard: Bird-Friendly Development Guidelines (2007), City of Toronto Green Development Standard Version 2.0 (2015) and City of Toronto Bird-Friendly Development Guidelines Best Practices Glass (2016). These documents work together to reduce the threat of death from buildings by making glass less dangerous to birds and by mitigating light pollution. Options for creating visual markers, treating glass, and muting reflection shall be applied to 85% of glass features and windows for the first 12 m above grade (dimensions relate to typical tree height). Dimensions for visual markers and muting reflection applications are subject to building design and site conditions.

6.1 Visual Markers

Visual markers are the most effective technique to reduce window strikes and shall be used on exterior surface glass, balcony railings, fly-through conditions and parallel glass within the first 12 m of the building. The distance between patterns or applications on glass must be a distance of 10 cm by 10 cm or less and at least 5 mm in diameter. Visual markers should have high contrast and be applied to low reflectance, exterior surface glass.

A window with visual marker stripes and a bird decal to prevent bird strikes
Photograph from www.smith.edu/news/preventing-bird-collisions-at-mcconnell/

6.2 Glass treatments

Glass treatments shall be applied above 12 m to the height of or anticipated height of the surrounding tree canopy and vegetation at maturity in sites close to natural areas such as ravines or woodlots. Glass treatments must also be applied to glass adjacent to or in the vicinity of elevated landscapes such as podium gardens and green roofs. Glass treatment options must also be applied to windbreaks, solariums and greenhouses in order to create sufficient visual markers for birds.

UV glass can be effective since birds are able to see into the UV spectrum, making UV treated glass opaque to birds but translucent to humans. Such UV glass must be tested and approved by a third party for effectiveness as outlined in the 2014 Toronto Green Standard version 2.0.

Patterned or ‘fritted’ glass refers to glass which contains opaque or translucent images or abstract patterns. The images are created by using dots in a variety of sizes and densities which are most effective on the exterior surface of the class. Only non-reflective glass should be used when combined with fritted patterns. Pattern design should follow the outlines in 6.1: Visual Markers.

Film products refers to external film applications or laminates which contain images or patterns and can be designed to enhance the architectural design of the building. **Decals** with no more than 5 to 10 cm of clear spaces between patterns can be used. Decals must be located on the exterior glass.

Decorative Grilles and Louvres refer to exterior grille features which if applied must be 10 cm by 10 cm or less.

Fenestration Patterns refer to multiple paned glass containing horizontal and vertical mullions. Panes must be no more than 28 cm with 10 cm or less the most effective visual marker.

Art work applied to the interior or exterior of windows can be used to provide sufficient visual markers while allowing for natural light.

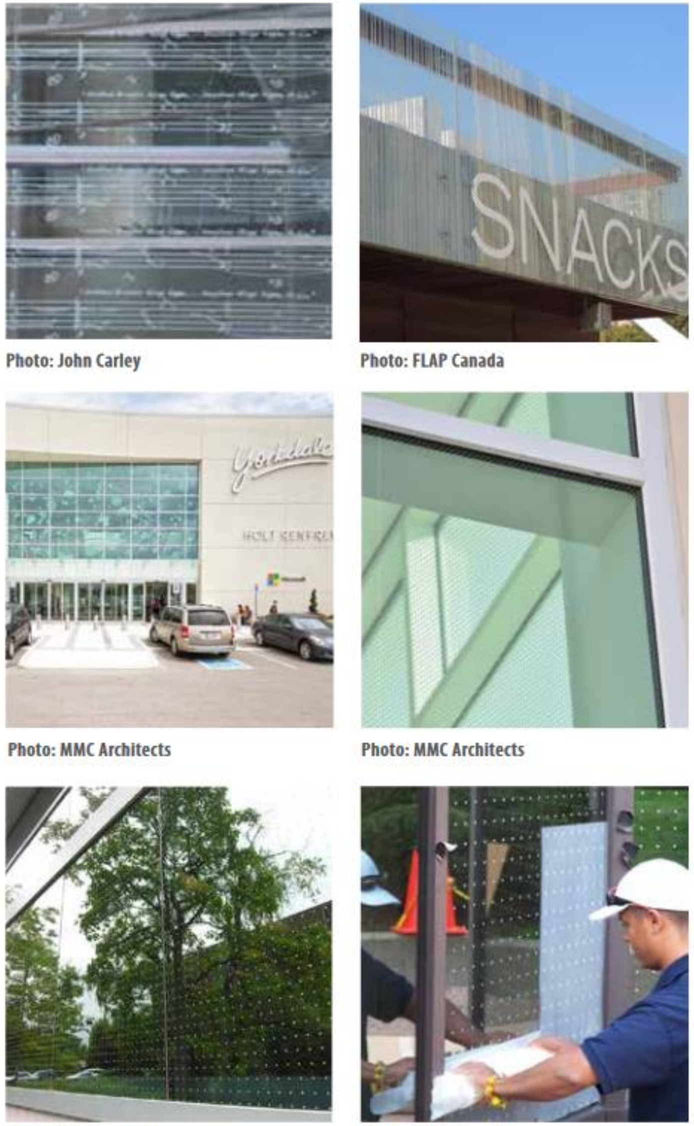


Photo: John Carley
Photo: FLAP Canada
Photo: MMC Architects
Photo: MMC Architects
Photo: FLAP Canada
Photo: FLAP Canada

Effective glass treatments for bird-friendly building design.
Photographs from Toronto Bird-Friendly Best Practices Glass [37]

6. BIRD-FRIENDLY DESIGN

6.3 Muting Reflections Options

Awnings and overhangs to mute images at ground floor level.
Sunshades refer to applications to reduce direct sunlight, while allowing indirect light into rooms. This feature mutes reflection thus reducing window strikes.

6.4 External Lighting

Decorative Lighting should be eliminated wherever possible. For existing buildings, decorative lighting should be projected downward and turned off during migratory season (September – November, March – May)

Advertising Lighting must be lit from above to reduce the volume of light being projected unnecessarily into the night sky.

Event and Festival Lighting such as spotlights and search lights must be prohibited during bird migration season.

Roof Top Lighting that should be prohibited. Vanity lighting may be allowed only if the following conditions are met:

- Exterior light fixtures are installed to prevent unnecessary light spillage.
- Vanity lighting is turned off from 11 PM - 5 AM year-round without exception utilizing an automatic device.

Overrides afterhours may be provided by a manual or occupant sensing device with a limit of 30 minutes.

6.5 Interior Lighting

Bird Friendly Operational Systems and Practices refers to the use of operating and system practices by residents, tenants, building owners, and managers to help reduce migratory bird fatalities. The following strategies can be used:

- **Installation of interior task lighting** at work stations be the recommended light source during evening work hours, increasing energy efficiency, reducing light pollution, and migratory bird fatalities. Overhead lighting be turned off at night and focused lighting such as task lighting be used during bird migration season.

- **Provision of shielding from interior generated light** with less than 10 % transmittance overnight for all fenestrations (windows, doors, skylights, curtained walls), for example blinds and curtains.

- **Motion-Sensitive Lighting** to be installed and retrofitted in lobbies, walkways, corridors, and operating systems that automatically turn off lights during after work hours.

- **Internal Location of Greenery**: Building owners and managers must locate greenery away from clear glass and minimize lighting levels through motion sensing lighting in ground floor lobbies, walkways and corridors and retrofit glass in these areas wherever possible with bird friendly window applications in order to meet the Bird Friendly Green Standard (birds drawn into cityscapes by light pollution seek safety by flying towards greenery and are extremely dangerous in these areas.)

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8. CONTRIBUTORS

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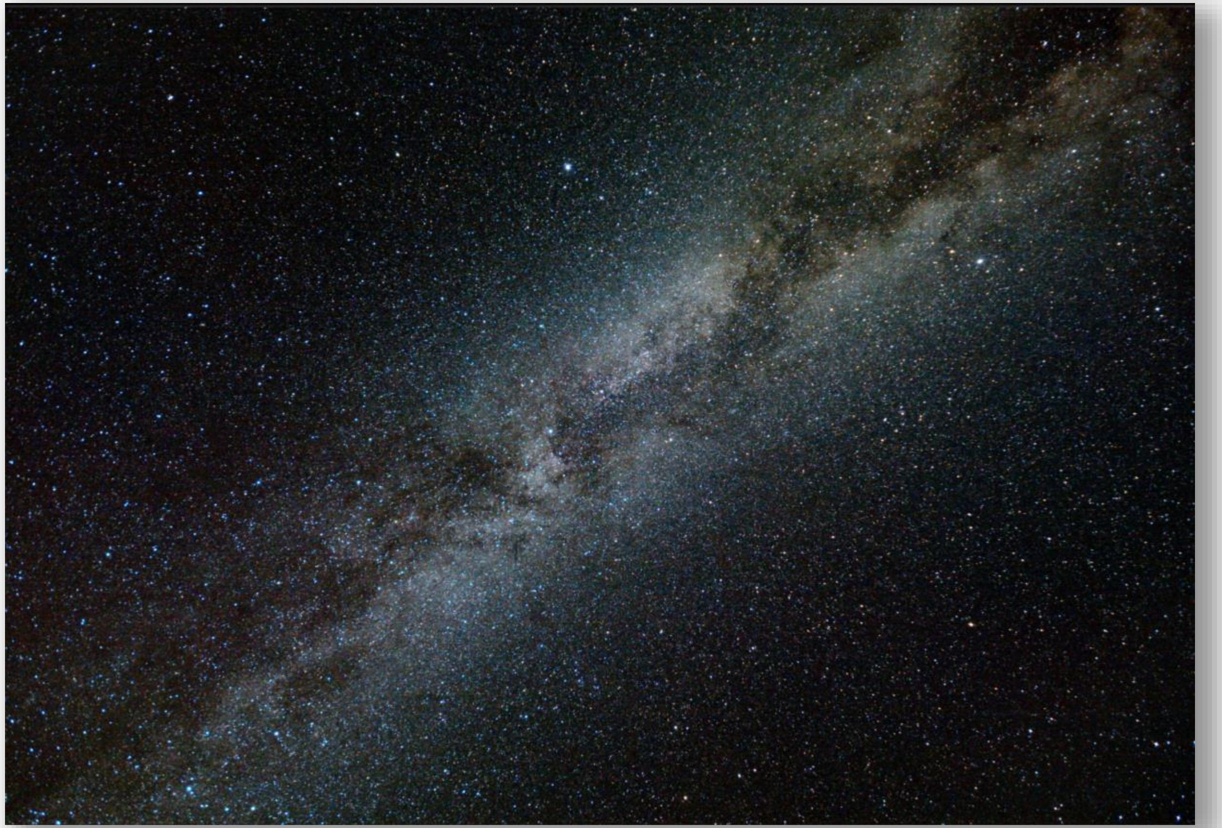

The Summer Triangle and Milky Way, from Fingal, Ontario.
Photograph © Ryan Fraser and Trevor McNaughton 2012

For discussion

a. Do we want to edit this section before sending it to staff?

4.5.7 Security Lighting

Lighting to ensure the safety of pedestrians shall be used as required. Light fixtures for this purpose shall:

- Reduce brightness contrast

- Ensure no light is directed 90° above the horizontal

  - Employ motion sensors (Section 4.2, bullet 5, option B)

These guidelines shall apply to all pedestrian trafficked areas and will be included in the site/lot lumen allowance.

Commented [1]: Concerned about impact on safety or perception of safety.

b. Once we have a final draft:

The fourth draft be referred to staff for review, it being noted that three advisory committees recommend staff prepare a version for Council consideration.

It further being noted that section 4.1 contemplates a light curfew for London. The specific times have been left blank. A suggested light curfew would be from 1 am to 7 am.

December 2017

WATER BALANCE

Parker Stormwater Management Facility Subdivision and Woodlot London, Ontario

Submitted to:
Mr. Ryan Hern, P.Eng.
Development Engineering (London) Limited
41 Adelaide Street North, Unit 71
London, Ontario
N6B 3P4

APPENDIX F

Report Number: 1542040-3000-R01

Distribution:

1 E-Copy - Development Engineering (London) Limited
1 E-Copy - Golder Associates Ltd.

Golder Associates

Table of Contents

APPENDIX B
Water Balance – Woodlot

1.0 INTRODUCTION

Golder Associates Ltd. ("Golder") was retained by Development Engineering (London) Limited ("Development Engineering") on behalf of the City of London ("City") to carry out a water balance for the proposed site of the Parker Subdivision in London, Ontario, in support of the Parker stormwater management facility (SWMF) Functional Design Report (prepared by others). The approximate location of the study area is shown on the Key Plan on Figure 1. The purpose of the water balance was to estimate the potential changes in groundwater recharge and runoff resulting from the proposed development and to identify the corresponding implications for nearby receptors. As requested by Development Engineering and the City, the study area for the water balance analysis included the SWMF and also the surrounding proposed development (hereinafter referred to as the "Study Area").

1.1 Scope of Work

The requested scope of work consisted of:

- preparation of pre- and post-development water balances for the entire Study Area;
- preparation of a detailed pre- and post-development water balance to assess the potential impacts on the woodlot as a result of the proposed development; as requested, the assessment was based on two scenarios, targeting a maximum 10 per cent (%)reduction in water reporting to the woodlot for an "interim" development scenario (given current proposed plans) and an "ultimate" development scenario (including consideration of future developments as prescribed by the City); and
- completion of a report summarizing the results of the water balance, including any recommendations for design, mitigation or construction.

2.0 SITE SETTING

The Study Area is located approximately 850 metres south of Commissioners Road and the proposed subdivision is located southeast of the intersection of Commissioners Road and Jackson Road in the southeastern region of the City of London, as shown on Figure 1. The current land use within the Study Area is predominantly woodlot and agricultural land. The woodlot area that is located east of the proposed SWMF includes a designated Provincially Significant Wetland (PSW) according to the City's Official Plan. The woodlot and its associated catchment are shown on Figure 1 as "Open Space".

The existing topography in the vicinity of the Study Area is relatively flat with a gentle slope southwards towards Tributary 'J' (also known as the Hampton-Scott Drain) of Dingman Creek. The ground surface elevations in the vicinity of the Study Area range from approximately 282 metres above mean sea level (m amsl) in the northern portion to approximately 270 m amsl near the southern boundary. The topography in the vicinity of the Study Area is shown on Figure 1.

As illustrated on the Ontario Ministry of the Environment and Climate Change (MOECC) Preliminary Map S116 entitled "Susceptibility of Ground Water to Contamination, St. Thomas Sheet (East Half)" a drainage basin divide is present in the north portion of the Study Area, generally parallel to Commissioners Road East. The surface water drainage features located on the northern part of the Study Area flow in a northerly direction before discharging to the south branch of the Thames River. The surface water drainage features located in the woodlot, in addition to the SWMF and related tributaries south of the site, flow in a generally southerly direction before discharging to Dingman Creek. At their closest approaches, Dingman Creek and the south branch of the Thames River are located approximately 2.9 kilometres (km) southeast and 600 m north of the site boundary, respectively.

3.0 WATER BALANCE

The water balance for the Study Area was estimated using the procedure and associated assumptions provided in the following sections.

3.1 Concept and Procedure

Within a drainage basin, all infiltration to the basin joins the groundwater flow system and, under steady state conditions, eventually discharges to surface watercourses as baseflow. The steady state assumption also dictates that no long-term changes occur in the volume of water stored in the surface water and groundwater reservoirs. This assumption implies that no significant interflow occurs and no significant withdrawal of groundwater (abstraction) is occurring within the drainage basin. It follows that the sum of the average annual precipitation, P, is equal to the sum of the average annual stream flow, Q, and average annual evapotranspiration, E, as follows:

$$P = Q + E$$ (Freeze and Cherry, 1979)[1]

If the discharge area within a drainage basin represents an insignificant area relative to the entire watershed, the average annual total stream flow (Q) from a drainage basin should also represent the combined total of the average direct runoff (Q_S) and the average annual baseflow (Q_G) to the stream, as follows:

$$Q = Q_S + Q_G$$ (Freeze and Cherry, 1979)

These equations provide only a preliminary means to evaluate a water balance since there is variability in the spatial and temporal distributions of precipitation, evapotranspiration, runoff and baseflow (Freeze and Cherry, 1979).

The water balance for the Study Area was estimated in general accordance with Section 3.2 of the MOECC Stormwater Management Planning and Design Manual.[2]

Based on previously determined sub-catchment mapping for the Study Area, the inferred areal extent of the combined on-site portions of the sub-catchments is approximately 106 hectares. The subcatchments are identified on Figures 2 and 5 and their respective on-site areas and imperviousness values are provided in Tables A-I and A-II.

The average annual precipitation measured at the London Airport Climate Station (Climate ID 6144475) for the period from 1981 to 2010 was 1012 millimetres per year (mm/yr).[3]

The average annual evapotranspiration rates for each of the inferred soil water holding capacities present within the Study Area were obtained from Environment Canada for the London Airport Climate Station. The soil water

[1] Freeze, R.A. and J.A. Cherry, *Groundwater*, Prentice-Hall, New Jersey, USA, 1979.

[2] Ontario Ministry of the Environment, *Stormwater Management Planning and Design Manual*, March 2003.

[3] Based on the Canadian Climate Normals available from Environment Canada for the period from 1981 to 2010.

holding capacities were determined using the MOECC Stormwater Management Planning and Design Manual, which provides a range of values depending on ground and vegetative cover and the hydrologic soil group. The ground and vegetative cover for the Study Area was inferred from available orthophotography and the hydrologic soil groups were determined using available soils mapping[4,5] and based on the soils encountered during the drilling investigation for the concurrent geotechnical exploration and hydrogeological assessments.

Following the MOECC Stormwater Management and Design Manual, site-specific infiltration factors were estimated based on assumptions of soil type, ground and vegetative cover and topography for the pre- and post-development scenarios.

An iterative "goal-seeking" type of approach was used to create two post-development scenarios (interim and ultimate) that would achieve a maximum reduction of near 10% of the water reporting to the woodlot. Within the iterative approach for each scenario, ground cover and impervious areas were varied to account for low-impact development (LID) measures and buffer drainage area in the currently proposed subdivision design and external future (ultimate) development area (Subcatchment 203a). The ultimate scenario includes potential future external development inside the urban growth boundary (UGB), as prescribed by the City, which could be reasonably diverted to the Parker SWMF (Subcatchment 202), although topographically may drain away from the woodlot and upper reaches of the Hampton-Scott Drain under existing and interim development conditions.

The post-development water balance assumed the following:

- Pre-development ground and vegetative cover will be supplanted by "urban lawn", with the exception of the existing woodlots present in areas designated as park land or open space, as specified on Drawing 1 "Draft Plan of Subdivision, Phase 1", prepared by Stantec (October 13, 2015);
- The development will be fully serviced with stormwater directed to on-site stormwater management ponds;
- Services and buildings will be constructed in such a manner as to prevent the mining of groundwater;
- The post-development drainage area will be comprised of urban lawn LID areas, features or measures as well as directly connected "buffer" and indirectly connected rear yard areas surrounding the woodlot (Figure 5);
- Surface runoff volumes directed to the woodlot (existing and all developed conditions) are largely retained and translated to interflow (recharge) to the Hampton-Scott Drain, i.e. the woodlot provides an intermediary flow function;
- Surface water in the developed subdivision (Subcatchment 202) will be directed to the proposed Parker SWMF and therefore, ultimately to the Thames River;
- Groundwater recharge and interflow in the developed subdivision (Subcatchment 202) is anticipated to flow towards and discharge into the Hampton-Scott Drain and ultimately to Dingman Creek; and,

[4] Ontario Centre for Soil Resource Evaluation, *The Soils of Middlesex County*, Report Number 56, Ontario Ministry of Agriculture and Food, Agriculture Canada and the University of Guelph Department of Land Resource Science, 1992.

[5] Ontario Ministry of Agriculture, Food and Rural Affairs, *Drainage Guide For Ontario*, Publication 29, Queen's Printer for Ontario, 2007.

- The woodlot, while it is generally the main focal point of the water balance, is not the ultimate receptor of baseflow that enters and/or is transmitted through the Study Area.

3.2 Results

Based on the pre- and post-development imperviousness values and subcatchment areas provided to Golder by Development Engineering, the areal extent of on-site impervious surfaces (e.g. buildings, driveways, sidewalks, walkways, patios, roads, etc.) will increase from approximately 0 to 43% of the total land area following development, thus reducing the available surface area for infiltration. The pre- and post- development water balance has been estimated for the Study Area through the use of visualization and spreadsheet-based methods. Water balance results, including pre- and post-development catchments (for both interim and ultimate development scenarios), hydrologic soils and ground cover are shown on Figures 2 through 10. Tabular summaries of the water balance calculations are provided in Appendices A and B. The overall water balance is summarized in Table I.

From Table I, it is noted that for the entire Study Area, the proposed development (interim scenario) is anticipated to result in a post-development decrease in groundwater recharge (infiltration) of approximately 43,100 cubic metres per year (m^3/yr), or approximately 13%; however, the ultimate post-development scenario will reduce the recharge deficit to 26,612 m^3/yr or approximately 8%. Overland flow (runoff) is anticipated to increase by approximately 275,600 m^3/yr, or approximately 234% for the interim development scenario and by 387,054 m^3/yr, or approximately 328% for the ultimate development scenario (directed to the SWMF).

An iterative water balance process targeting a maximum 10% reduction in the volume of water reporting to the woodlot was undertaken for the interim and ultimate development scenarios to assess the input of the development with focus on the woodlot's hydrologic regime (Subcatchments 203a through 203c on Figures 5 and 6). These results are provided on Table B-II and B-III and summarized on Table I. Subcatchment 203a represents a designated urban lawn area of 11.8 Hectares (ha) with an impervious surface area of 40% for the Parker subdivision, which is expanded under the ultimate development scenario to include a further 7.3 ha area with 45% impervious surface area to account for the future easterly external development (Van Hie lands). This adjustment reduces the available water (recharge and directed runoff) to the woodlot by 10% for the ultimate development scenario. The 10% maximum reduction in water reporting to the woodlot follows the MOECC guidance for LID[6]. It is assumed that any surface runoff from the area (Subcatchment 203a) would be directed to the woodlot via directly connected "buffer" zones in rear yards, via indirectly connected LID measures, or via a piped diversion system to offset the infiltration deficit. The woodlot is assumed to provide an intermediary function to largely translate surface runoff volumes retained within it to infiltrate.

It is our understanding that the Study Area will be fully serviced with municipal infrastructure (i.e. water, storm and sanitary sewers). The granular pipe bedding material and granular backfill used for the service trenches may act as a preferential pathway for groundwater flow. The impacts from dewatering by on-site services or foundation drains were not included in the analysis described herein.

With the expansion of Subcatchment 202 from the interim to the ultimate post-development scenario, the additional developed recharge area is anticipated to be directed towards the upper reaches of the Hampton-Scott Drain along

[6] Ministry of the Environment and Climate Change, *Low Impact Development (LID) Stormwater Management Guidance Manual*, Draft Version 1.0, April 20, 2017.

with the volume contributed by the woodlot. As such, the ultimate post-development recharge deficit should approach the MOECC water balance target of no more than a 10% change (deficit).

3.3 Implications

Due to the increase of impermeable surfaces (e.g. roads, buildings, etc.), development of the Study Area will inevitably lead to an increase in surface runoff and a decrease in evapotranspiration and infiltration (i.e. groundwater recharge/baseflow). This theoretical reduction in post-development groundwater recharge is not anticipated to significantly impact groundwater users in the area, which predominantly rely on the deeper overburden or bedrock aquifers for their water supply. The decrease in groundwater recharge may lead to relatively minor localized reductions in baseflow to the woodlot. It is likely that practical measures can be implemented at the Study Area to enhance post-development recharge and minimize impacts on the pre-development conditions. Possible mitigative options are discussed below.

3.4 Mitigative Options

Appropriate mitigation measures may significantly compensate for the potential reduction in post-development groundwater recharge and related baseflow to the woodlot as well as the corresponding decrease in water quality within the watercourse. In this regard, it is suggested that the following management strategies be implemented:

1) Reduce the amount of impervious surface areas, where feasible, to reduce stormwater runoff;

2) Promote diffused infiltration of stormwater so that, where feasible, runoff from impervious surfaces sheet flows over adjacent pervious surfaces that are managed to maximize infiltration capacity; and,

3) Utilize the landscape and soils to naturally move, store and filter stormwater runoff before it leaves the developed site.

Subject to site limitations, specific mitigation measures may include the following:

- Collection of roof top runoff in rain barrels or cisterns for subsequent urban irrigation applications, with overflow to grassed areas graded with swales to promote infiltration, thereby maximizing the recharge of precipitation from roof tops; this could include topsoil thickening to enhance vegetation growth and coverage to improve initial abstraction.

- Installation of appropriate concrete trench plugs at strategic locations and use of watertight pipe connections in sewer services to mitigate the potential for preferential groundwater flow through the granular pipe bedding material and granular trench backfill, if used.

- Construction of water gardens and/or vegetated swales at the rear of suitable residential lots and/or within boulevards or other open spaces to allow for the collection of overland flow (including runoff from roof downspouts) and subsequent infiltration through appropriately sized infiltration galleries. Plans for grading of the development should take into consideration the requirements for the infiltration system to ensure overland flow is allowed to flow more easily through these structures.

- Diversion of minor drainage from rear-yards and buffer areas to the woodlot via LID measures or a piped diversion system.

- Use of permeable pavements, where feasible (i.e., driveways, parking lots, sidewalks, etc.).

Further enhancements may be realized post-development that are difficult to quantify but would nonetheless partially counteract the effect of development on infiltration. For example, lawn watering activities in a dawn or dusk application program in the post-development subdivision have the potential to contribute significant quantities of recharge.

4.0 CONCLUSIONS AND RECOMMENDATIONS

- Due to an anticipated increase in impermeable surfaces (e.g. roads, buildings, etc.) and general "flattening" of the natural depressions, the development will inevitably lead to some increase in surface runoff (both volume and rate) with a corresponding decrease in infiltration (groundwater recharge/baseflow).
- The theoretical reduction in post-development infiltration (groundwater recharge/baseflow) is not anticipated to significantly impact groundwater users in the area, which predominantly rely on the deeper overburden aquifers as the water supply.
- The anticipated decrease in groundwater recharge may lead to a localized reduction in available water to the woodlot; although the reduction should be largely offset through maintenance of surface runoff via directly connected "buffer" zones in rear yards and/or indirectly connected LID measures.
- It is recommended that suitable mitigation measures be implemented (including, but not limited to, diversion of minor drainage from rear-yards and buffer areas to the woodlot via LID measures or a piped diversion system) with a post-development objective of allowing a maximum 10% reduction of flow to the woodlot (i.e., maintaining a minimum of 90% of the pre-development infiltration value) for the Study Area (to be confirmed during detailed subdivision design).
- Any further reduction in annual post-development infiltration volume to the woodlot (greater than 10%, if required) should be reviewed during an environmental impact study or assessment.
- Although it is considered unlikely that groundwater-dependent vegetation is present within the woodlot, as part of the subdivision developer's due diligence it is suggested that an assessment of the potential groundwater dependence of the vegetation within the woodlot be carried out by a qualified biologist prior to development.

Report Signature Page

GOLDER ASSOCIATES LTD.

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Hydrogeologist

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Associate, Senior Hydrogeologist

RM/STH/JM/ly

n:\active\2015\3 proj\1542040 dev eng_inv parker swmf_london\ph 3000-water balance\2-correspondence\5-rpts\1542040-3000-r01 dec 2017 (revised final) water balance - parker swm.docx

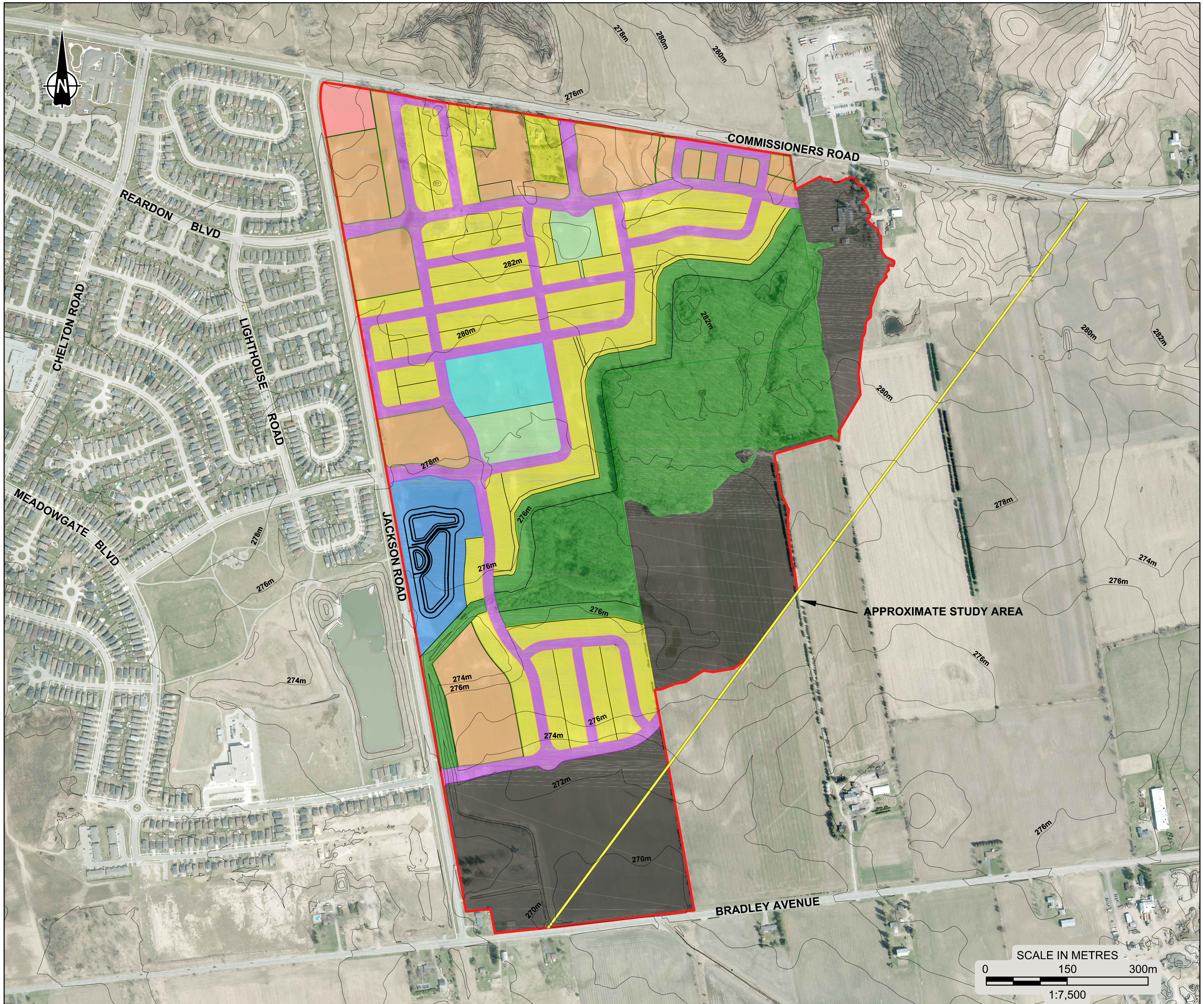
WATER BALANCE SUMMARY

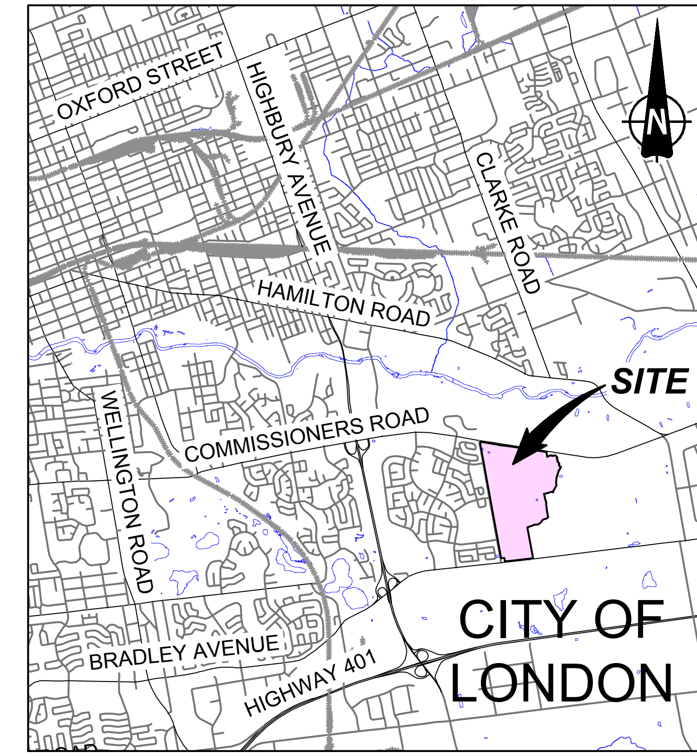
Parker SWMF-Subdivision
London, Ontario

PARAMETER	EXISTING (m^3/yr)	POST-CONSTRUCTION[1] (m^3/yr)	% DIFFERENCE[2] (m^3/yr)	(%)
Entire Study Area (Interim Development Scenario)				
Precipitation (P)	1,068,100	1,079,500	11,400	1
Evapotranspiration (E)	617,900	397,000	-220,900	-36
Recharge (Q_G) + (Q_{SW})	332,200	289,100	-43,100	-13
Runoff (Q_S)	117,900	393,500	275,600	234
Entire Study Area (Ultimate Development Scenario)				
Precipitation (P)	1,068,100	1,201,912	133,812	13
Evapotranspiration (E)	617,900	391,370	-226,530	-37
Recharge (Q_G) + (Q_{SW})	332,200	305,588	-26,612	-8
Runoff (Q_S)	117,900	504,954	387,054	328
Woodlot - 10% Reduction Target (Interim Development Scenario)				
Precipitation (P)	539,400	435,900	-103,500	-19
Evapotranspiration (E)	313,000	225,100	-87,900	-28
Recharge (Q_G)	109,300	85,800	-23,500	-22
Runoff (Q_{Sw})	117,100	124,900	7,800	7
Total to Woodlot (Q_G + Q_{SW})	226,400	210,700	-15,700	-7
Woodlot - 10% Reduction Target (Ultimate Development Scenario)				
Precipitation (P)	539,400	371,900	-167,500	-31
Evapotranspiration (E)	313,000	168,600	-144,400	-46
Recharge (Q_G)	109,300	70,800	-38,500	-35
Runoff (Q_{Sw})	117,100	132,400	15,300	13
Total to Woodlot (Q_G + Q_{SW})	226,400	203,200	-23,200	-10

NOTES:
1. Post-Construction water balance for the entire study area assumes recharge is all directed to both the Woodlot and ultimately the Hampton-Scott Drain and that seepage in or out of the SWMF will not occur
2. Negative value indicates a decrease following construction.
3. Q_{SW} Runoff is directed from buffer area to recharge woodlot for water balance
4. Table to be read in conjunction with accompanying report.

Prepared By: RM
Checked By: STH





KEY PLAN

LEGEND

- APPROXIMATE LIMITS OF PRE-DEVELOPMENT STUDY AREA
- URBAN GROWTH BOUNDARY

PROPOSED DEVELOPMENT LANDUSE:

- LOW DENSITY HOUSING
- MEDIUM DENSITY HOUSING
- OPEN SPACE
- PARK
- SCHOOL
- SWM FACILITY
- COMMERCIAL
- ROADS
- AGRICULTURAL LANDS / FUTURE DEVELOPMENT

REFERENCE

DRAWING BASED ON CITY OF LONDON CITYCD V2014; "DRAFT PLAN OF SUBDIVISION" PROVIDED BY STANTEC, OCTOBER 2015; AND CANMAP STREETFILES V.2008.

NOTES

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE ONLY.

PROJECT
WATER BALANCE
PARKER STORM WATER MANAGEMENT FACILITY
LONDON, ONTARIO

TITLE
LOCATION PLAN

Golder Associates

PROJECT No.		1542040	FILE No.	1542040-3000-R01001	
			SCALE	AS SHOWN	REV.
CADD	DCH/LMK	Dec 7/17			
CHECK			FIGURE 1		

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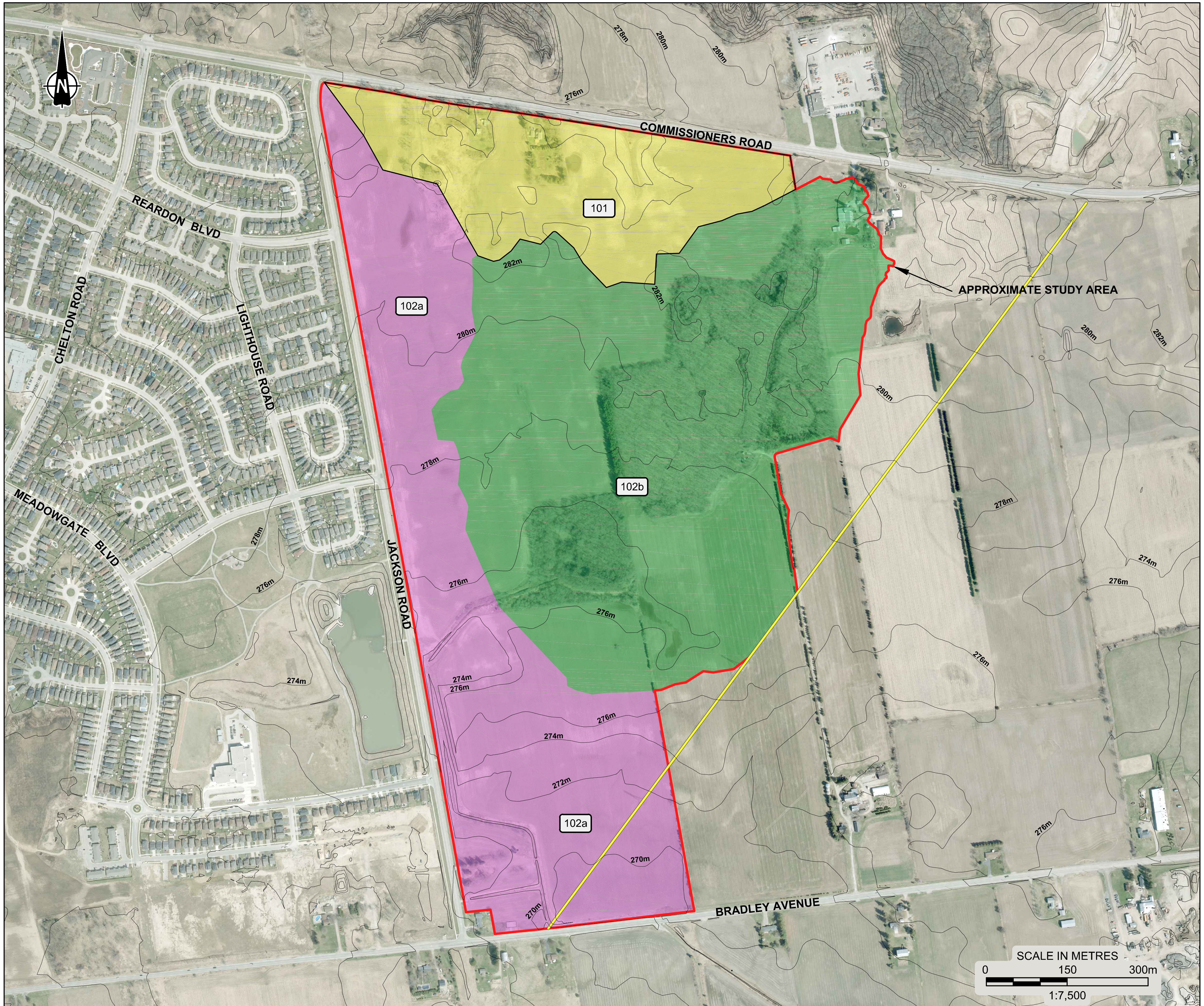

LEGEND

APPROXIMATE LIMITS OF PRE-DEVELOPMENT STUDY AREA

URBAN GROWTH BOUNDARY

101 SUB-CATCHMENT IDENTIFICATION

REFERENCE

DRAWING BASED ON CITY OF LONDON CITYCD V2014; CATCHMENTS PROVIDED BY STANTEC; AND CANMAP STREETFILES V.2008.

NOTES

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE ONLY.

PROJECT	WATER BALANCE PARKER STORM WATER MANAGEMENT FACILITY LONDON, ONTARIO
TITLE	**PRE-DEVELOPMENT CATCHMENTS**

Golder Associates	PROJECT No.		1542040	FILE No.	1542040-3000-R01002
				SCALE AS SHOWN	REV.
	CADD	DCH	Dec 7/17	**FIGURE 2**	
	CHECK				

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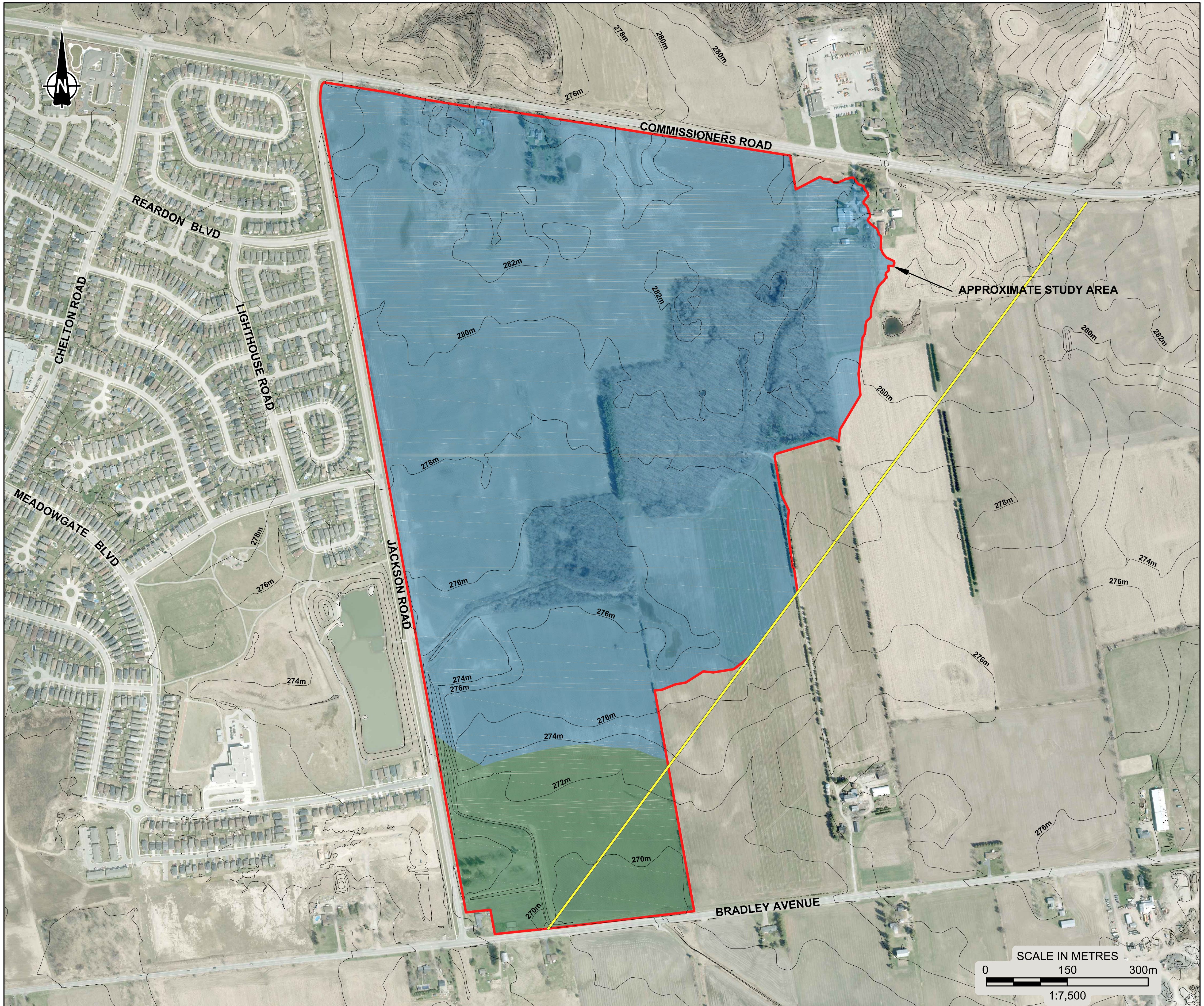

LEGEND

APPROXIMATE LIMITS OF PRE-DEVELOPMENT STUDY AREA

URBAN GROWTH BOUNDARY

HYDROLOGIC SOIL GROUP:

B

CD

REFERENCE

DRAWING BASED ON CITY OF LONDON CITYCD V2014; AND CANMAP STREETFILES V.2008.

NOTES

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE ONLY.

PROJECT

WATER BALANCE
PARKER STORM WATER MANAGEMENT FACILITY
LONDON, ONTARIO

TITLE

HYDROLOGIC SOILS
PRE-DEVELOPMENT

PROJECT No.	1542040	FILE No.	1542040-3000-R01003	
		SCALE	AS SHOWN	REV.
CADD	DCH/LMK	Dec 7/17		
CHECK			**FIGURE 3**	

Golder Associates

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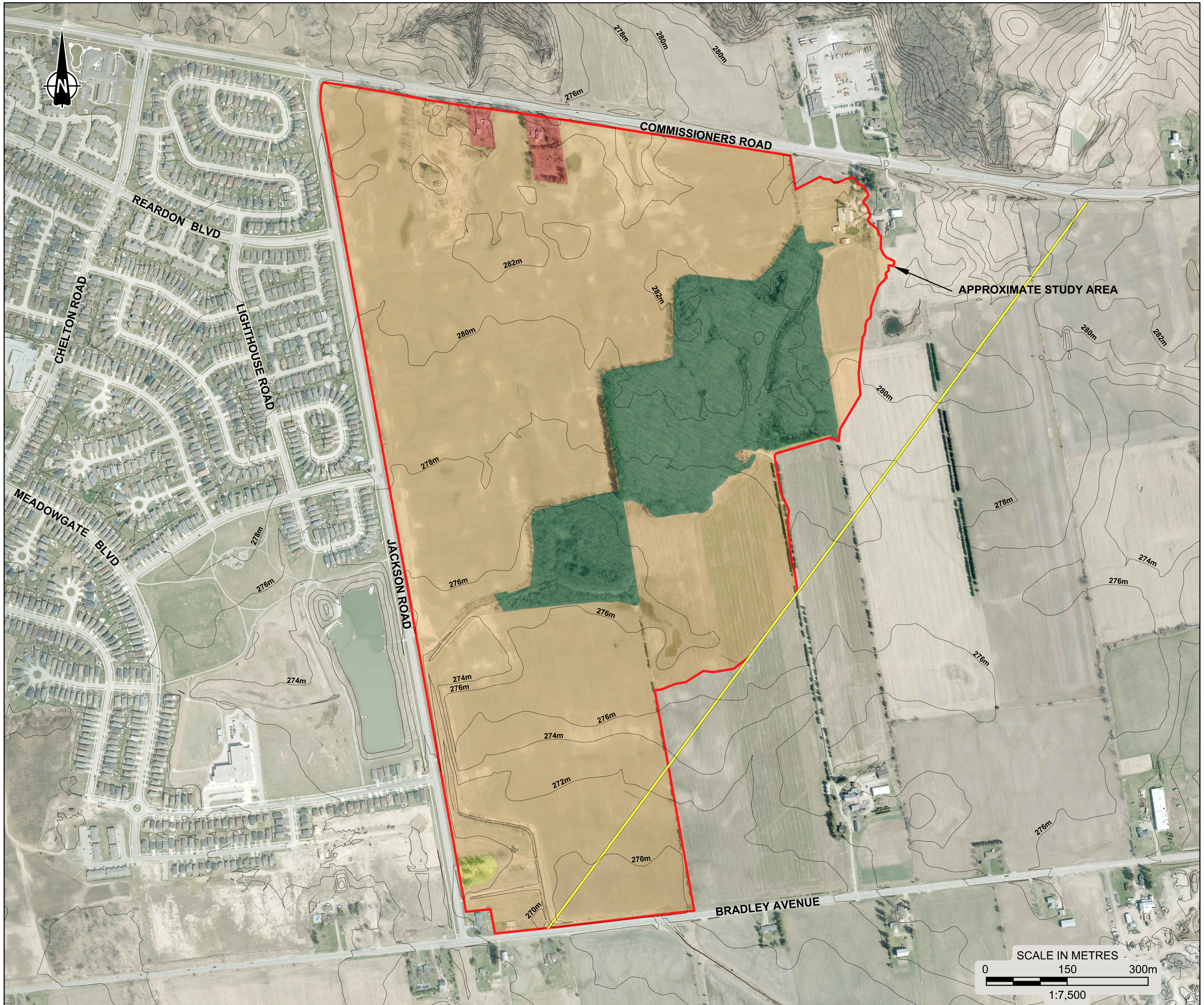

LEGEND

APPROXIMATE LIMITS OF PRE-DEVELOPMENT STUDY AREA

URBAN GROWTH BOUNDARY

GROUND COVER:

URBAN LAWN/SHALLOW ROOTED CROPS

MODERATELY ROOTED CROPS

PASTURE AND SHRUBS

MATURE FOREST

REFERENCE

DRAWING BASED ON CITY OF LONDON CITYCD V2014; AND CANMAP STREETFILES V.2008.

NOTES

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ALL LOCATIONS ARE APPROXIMATE ONLY.

PROJECT

WATER BALANCE
PARKER STORM WATER MANAGEMENT FACILITY
LONDON, ONTARIO

TITLE

GROUND COVER
PRE-DEVELOPMENT

Golder Associates	PROJECT No.		1542040	FILE No.	1542040-3000-R01004
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	CADD	DCH/LMK	Dec 7/17		
	CHECK			**FIGURE 4**	

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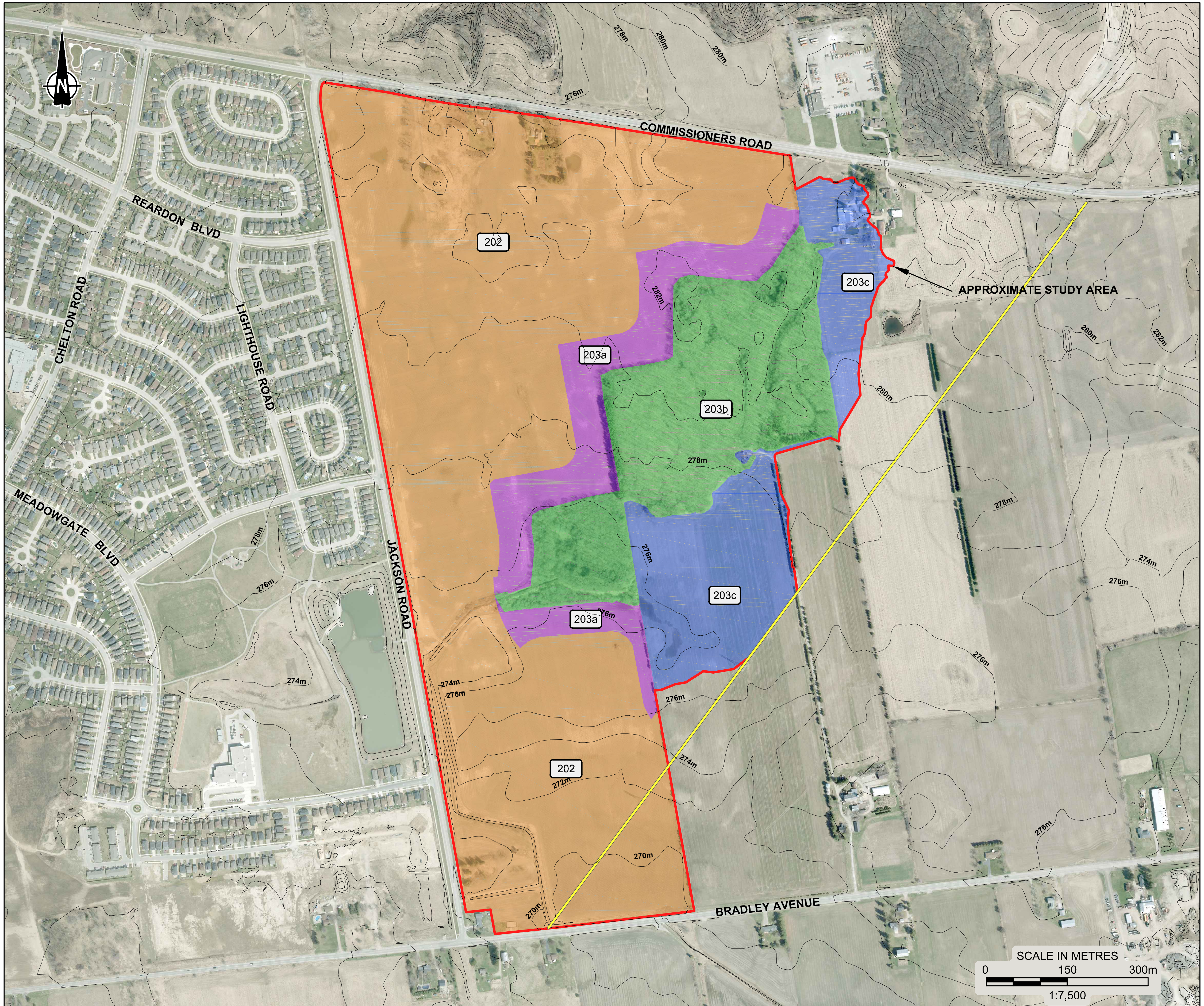

LEGEND

(red outline)	APPROXIMATE LIMITS OF POST-DEVELOPMENT STUDY AREA
(yellow line)	URBAN GROWTH BOUNDARY
202	SUB-CATCHMENT IDENTIFICATION

REFERENCE

DRAWING BASED ON CITY OF LONDON CITYCD V2014; CATCHMENTS PROVIDED BY STANTEC; AND CANMAP STREETFILES V.2008.

NOTES

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE ONLY.

PROJECT
WATER BALANCE
PARKER STORM WATER MANAGEMENT FACILITY
LONDON, ONTARIO

TITLE
POST-DEVELOPMENT CATCHMENTS
INTERIM DEVELOPMENT SCENARIO

PROJECT No.		1542040	FILE No.	1542040-3000-R01005
			SCALE AS SHOWN	REV.
CADD	DCH/LMK	Dec 7/17		
CHECK			**FIGURE 5**	

Golder Associates

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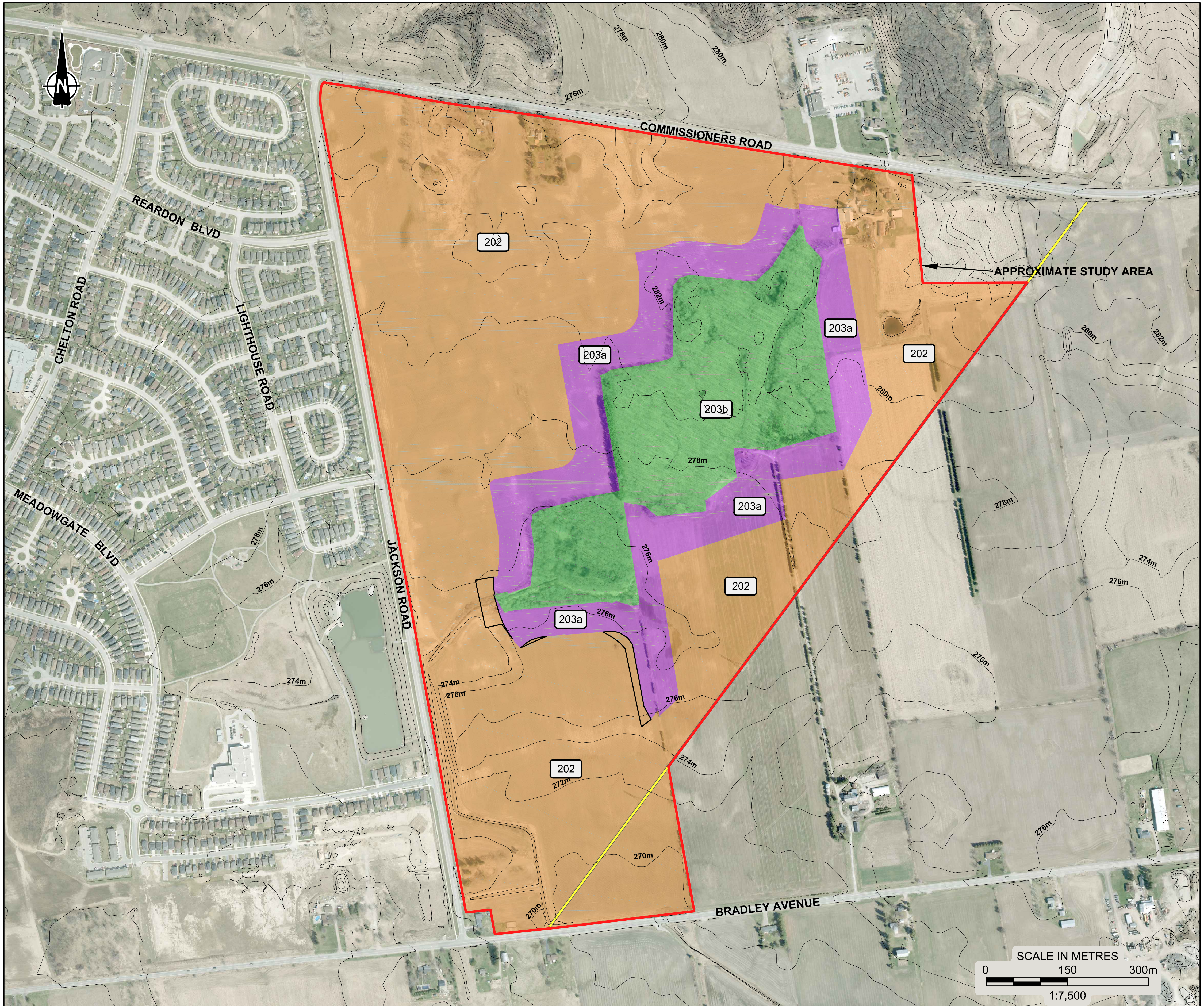

LEGEND

APPROXIMATE LIMITS OF POST-DEVELOPMENT STUDY AREA

URBAN GROWTH BOUNDARY

202 SUB-CATCHMENT IDENTIFICATION

REFERENCE

DRAWING BASED ON CITY OF LONDON CITYCD V2014; CATCHMENTS PROVIDED BY STANTEC; AND CANMAP STREETFILES V.2008.

NOTES

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE ONLY.

PROJECT
WATER BALANCE
PARKER STORM WATER MANAGEMENT FACILITY
LONDON, ONTARIO

TITLE
POST-DEVELOPMENT CATCHMENTS ULTIMATE DEVELOPMENT SCENARIO

PROJECT No.	1542040	FILE No.	1542040-3000-R01006
		SCALE	AS SHOWN REV.
CADD	DCH/LMK Dec 7/17		
CHECK			**FIGURE 6**

Golder Associates

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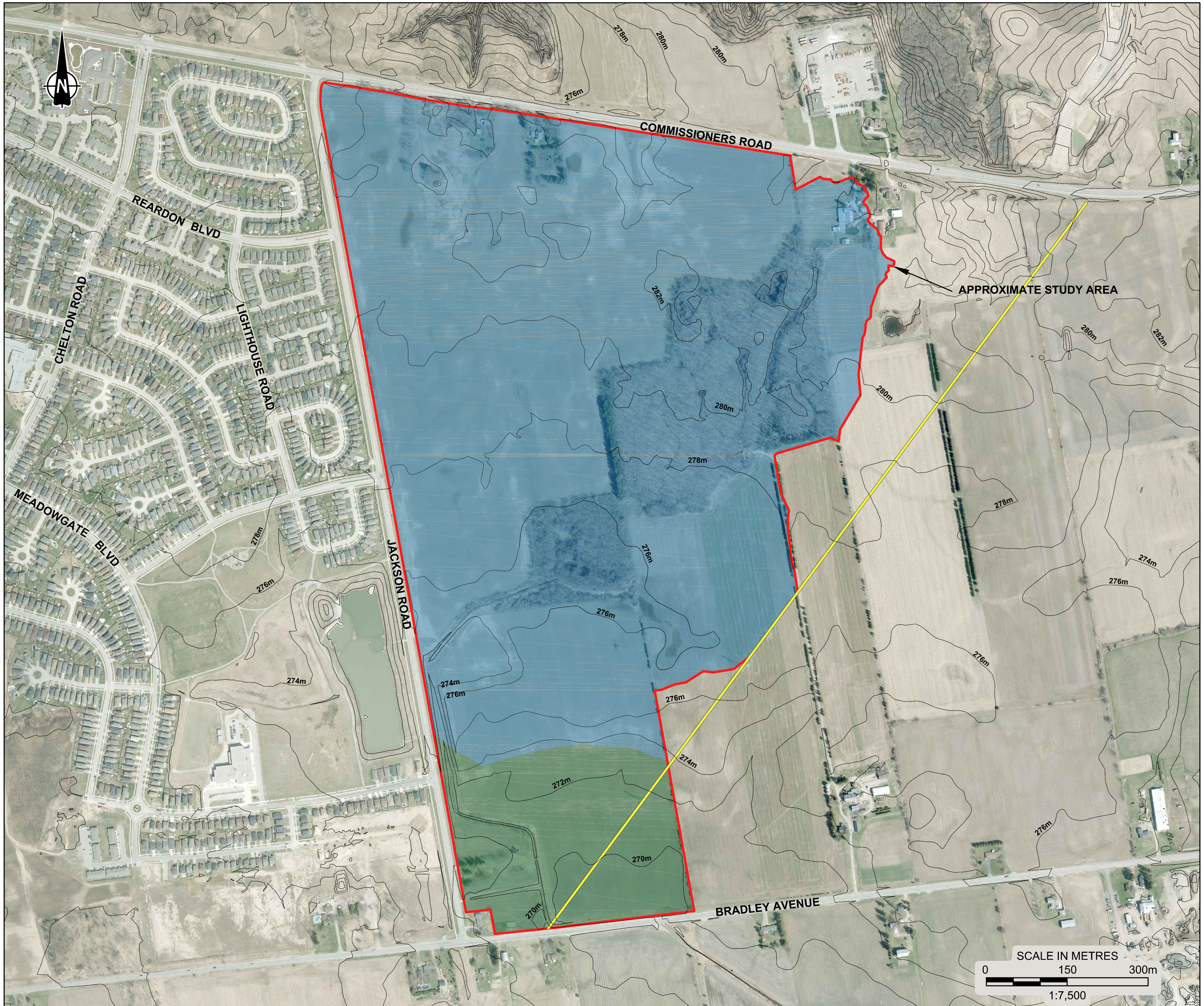

LEGEND

- APPROXIMATE LIMITS OF PRE-DEVELOPMENT STUDY AREA
- URBAN GROWTH BOUNDARY

HYDROLOGIC SOIL GROUP:

- B
- CD

NOTE: POST-DEVELOPMENT GROUND SURFACE INFORMATION NOT AVAILABLE AT TIME OF WATER BALANCE ANALYSIS,

REFERENCE

DRAWING BASED ON CITY OF LONDON CITYCD V2014; AND CANMAP STREETFILES V.2008.

NOTES

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ALL LOCATIONS ARE APPROXIMATE ONLY.

PROJECT
WATER BALANCE
PARKER STORM WATER MANAGEMENT FACILITY
LONDON, ONTARIO

TITLE
INTERIM HYDROLOGIC SOILS POST-DEVELOPMENT

PROJECT No.	1542040		FILE No.	1542040-3000-R01007
			SCALE	AS SHOWN
CADD	DCH/LMK	Dec 7/17	REV.	
CHECK			**FIGURE 7**	

Golder Associates

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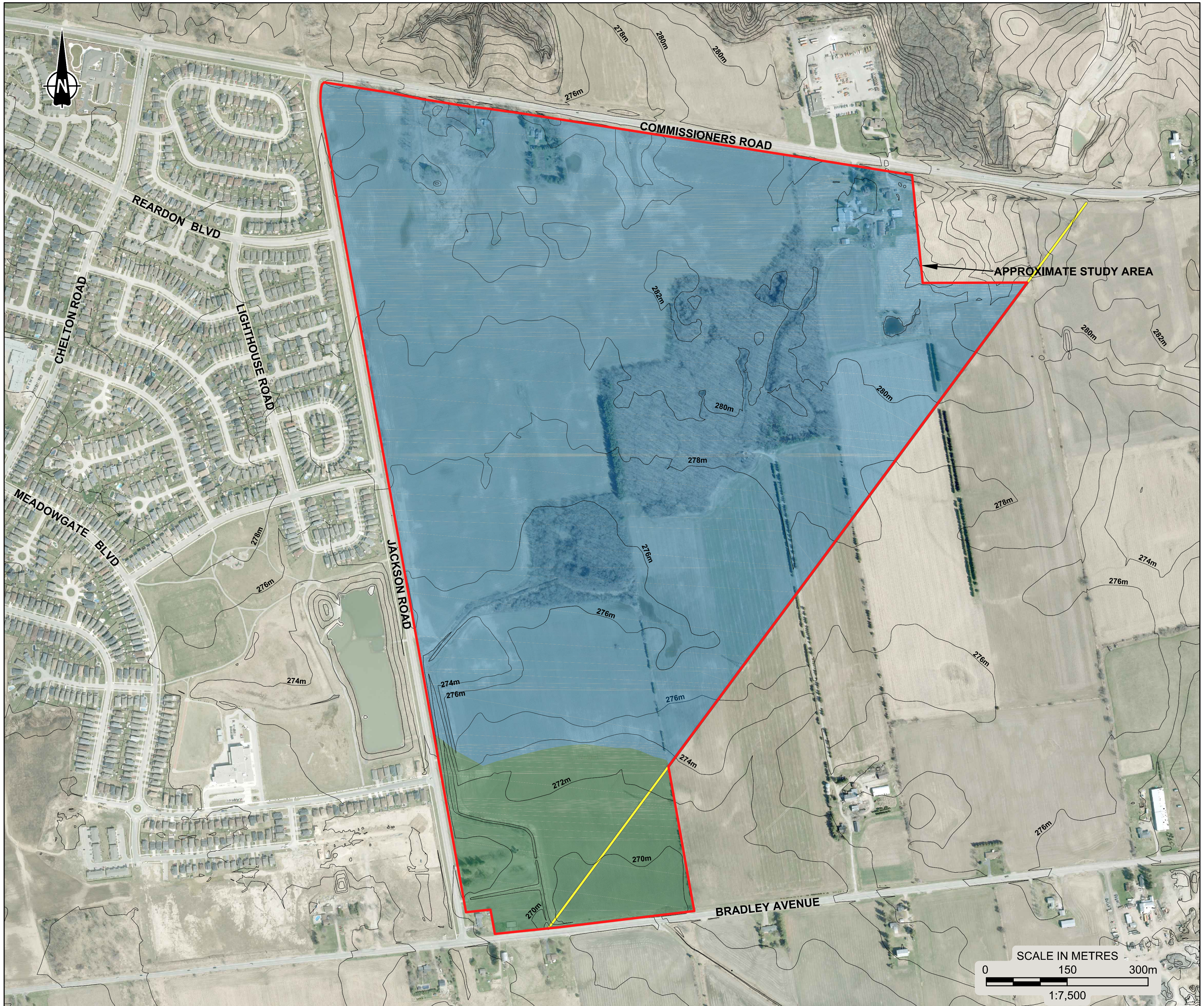

LEGEND

APPROXIMATE LIMITS OF PRE-DEVELOPMENT STUDY AREA

URBAN GROWTH BOUNDARY

HYDROLOGIC SOIL GROUP:

B

CD

NOTE: POST-DEVELOPMENT GROUND SURFACE INFORMATION NOT AVAILABLE AT TIME OF WATER BALANCE ANALYSIS,

REFERENCE

DRAWING BASED ON CITY OF LONDON CITYCD V2014; AND CANMAP STREETFILES V.2008.

NOTES

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE ONLY.

PROJECT

WATER BALANCE
PARKER STORM WATER MANAGEMENT FACILITY
LONDON, ONTARIO

TITLE

ULTIMATE HYDROLOGIC SOILS POST-DEVELOPMENT

PROJECT No.		1542040	FILE No.	1542040-3000-R01008
			SCALE AS SHOWN	REV.
CADD	DCH/LMK	Dec 7/17		
CHECK			**FIGURE 8**	

Golder Associates

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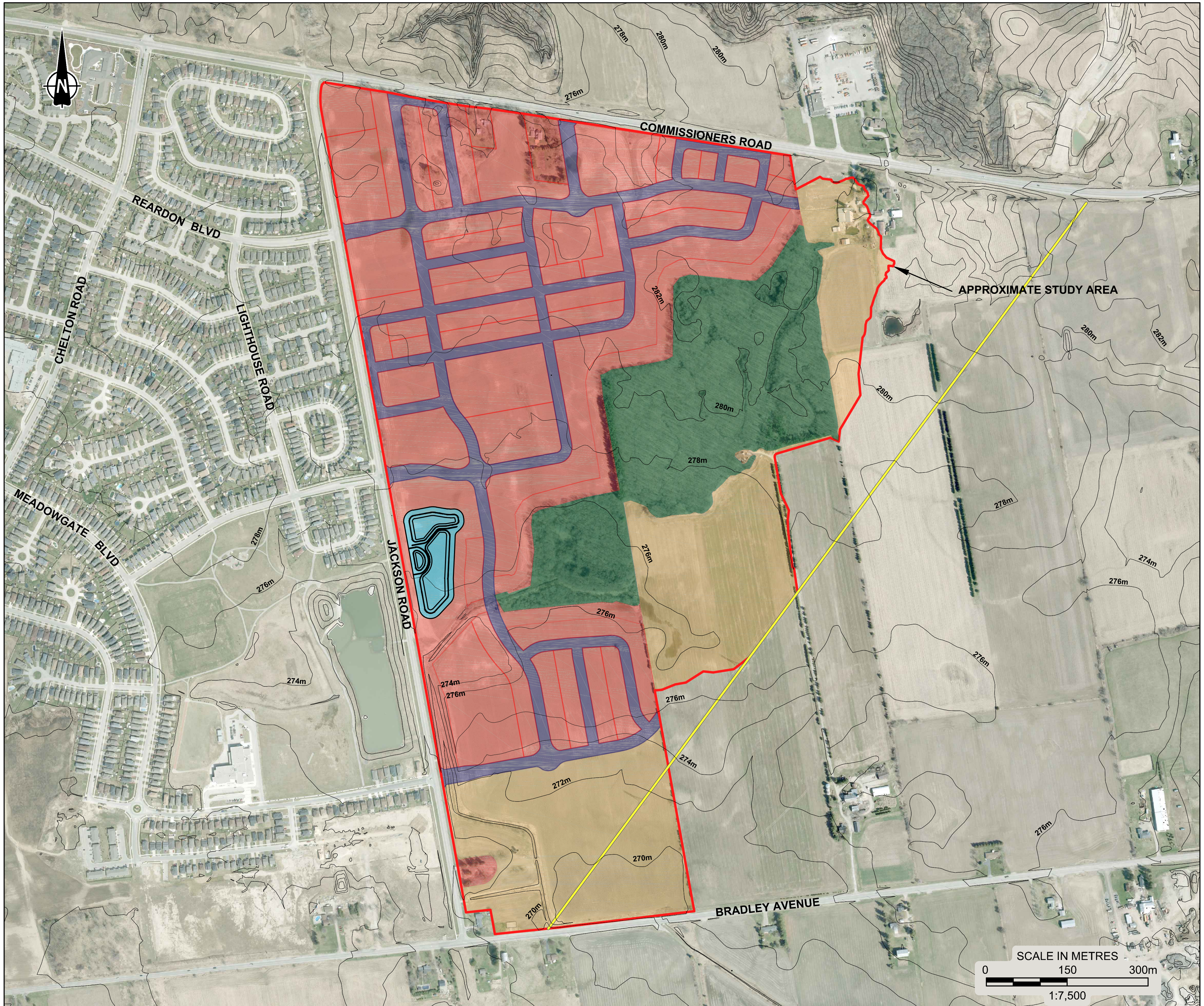

LEGEND

- APPROXIMATE LIMITS OF PRE-DEVELOPMENT STUDY AREA
- URBAN GROWTH BOUNDARY

GROUND COVER:

- URBAN LAWN/SHALLOW ROOTED CROPS
- MODERATELY ROOTED CROPS
- MATURE FOREST
- OPEN WATER
- ROAD / BOULEVARD

REFERENCE

DRAWING BASED ON CITY OF LONDON CITYCD V2014; "DRAFT PLAN OF SUBDIVISION" PROVIDED BY STANTEC, OCTOBER 2015; AND CANMAP STREETFILES V.2008.

NOTES

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE ONLY.

PROJECT
WATER BALANCE
PARKER STORM WATER MANAGEMENT FACILITY
LONDON, ONTARIO

TITLE
**GROUND COVER
POST-DEVELOPMENT
INTERIM DEVELOPMENT SCENARIO**

PROJECT No.	1542040	FILE No.	1542040-3000-R01009
		SCALE	AS SHOWN
CADD	DCH/LMK	Dec 7/17	REV.
CHECK			

Golder Associates

FIGURE 9

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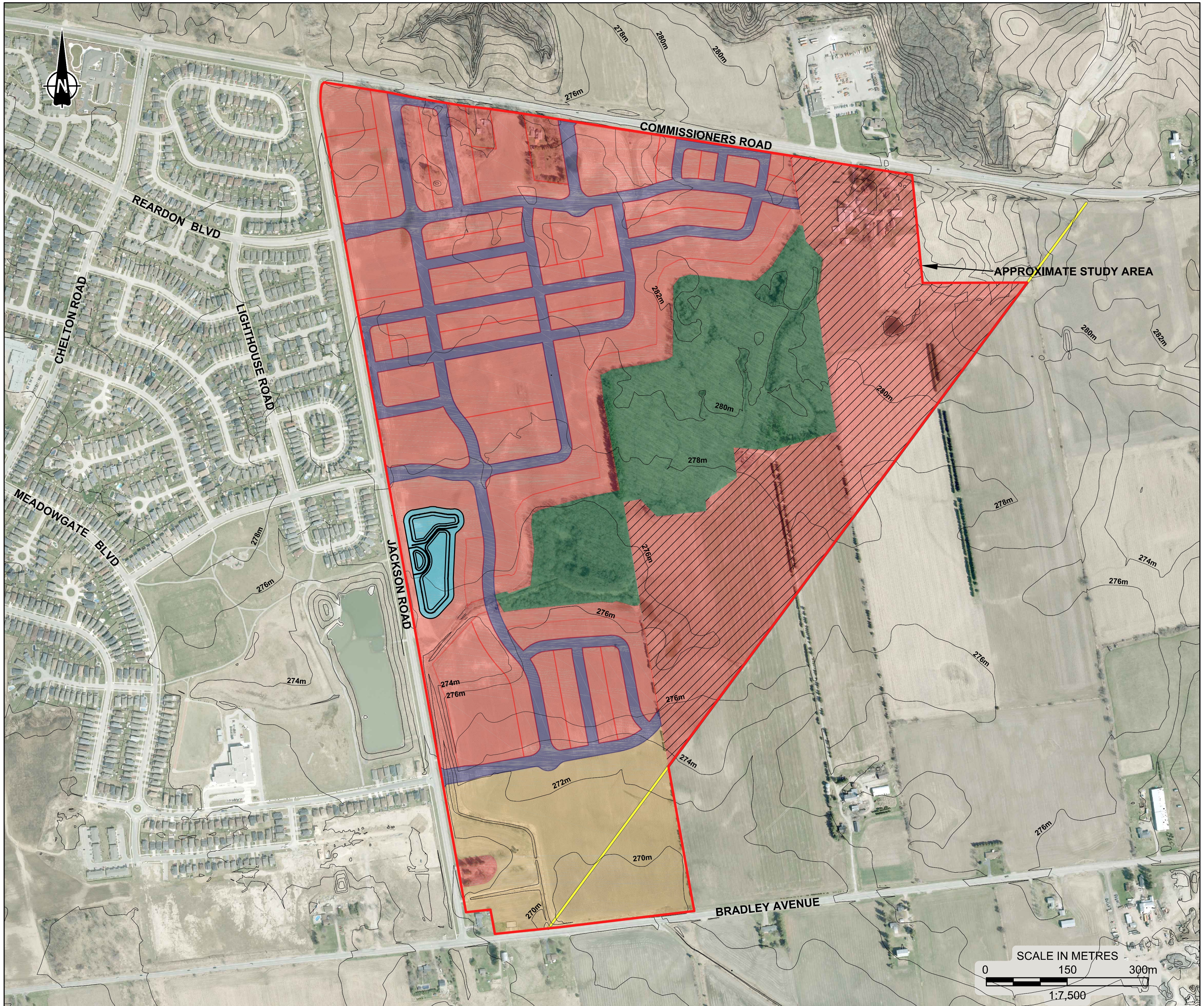

LEGEND

APPROXIMATE LIMITS OF PRE-DEVELOPMENT STUDY AREA

URBAN GROWTH BOUNDARY

GROUND COVER:

URBAN LAWN/SHALLOW ROOTED CROPS

FUTURE URBAN LAWN/SHALLOW ROOTED CROPS

MODERATELY ROOTED CROPS

MATURE FOREST

OPEN WATER

ROAD / BOULEVARD

REFERENCE

DRAWING BASED ON CITY OF LONDON CITYCD V2014; "DRAFT PLAN OF SUBDIVISION" PROVIDED BY STANTEC, OCTOBER 2015; AND CANMAP STREETFILES V.2008.

NOTES

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ALL LOCATIONS ARE APPROXIMATE ONLY.

PROJECT

WATER BALANCE
PARKER STORM WATER MANAGEMENT FACILITY
LONDON, ONTARIO

TITLE

GROUND COVER
POST-DEVELOPMENT
ULTIMATE DEVELOPMENT SCENARIO

PROJECT No.	1542040	FILE No.	1542040-3000-R01010
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CADD	DCH/LMK	Dec 10/17	REV.
CHECK			

Golder Associates

FIGURE 10

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APPENDIX A

Water Balance – Entire Study Area
Table A-I: Existing Conditions – Entire Study Area
Table A-II: Post-Development Conditions – Entire Study Area – Interim Scenario
Table A-III: Post-Development Conditions – Entire Study Area – Ultimate Scenario

EXISTING CONDITIONS - ENTIRE STUDY AREA

Parker SWMF-Subdivision
London, Ontario

Catchment		102a			102b		101	
Ground Cover		Moderately Rooted Crops		Urban Lawn	Moderately Rooted Crops	Mature Forest	Urban Lawns	Moderately Rooted Crops
Hydrologic Soil Group		B	CD	B	CD	CD	CD	CD
Area	m^2	121,000	237,000	3,400	356,000	177,000	11,000	150,000
Water Holding Capacity	mm	150	200	75	200	400	100	200
Precipitation, P	m/year	1.012	1.012	1.012	1.012	1.012	1.012	1.012
Evapotranspiration, E	m/year	0.580	0.585	0.577	0.585	0.592	0.577	0.585
Surplus	m/year	0.432	0.427	0.435	0.427	0.420	0.435	0.427
Ground Cover Factor	-	0.10	0.10	0.10	0.10	0.20	0.10	0.10
Soils Factor	-	0.25	0.15	0.25	0.15	0.15	0.15	0.15
Topography Factor	-	0.20	0.20	0.20	0.20	0.20	0.15	0.20
Infiltration Factor (sum)	-	0.55	0.45	0.55	0.45	0.55	0.40	0.45
Recharge, Q_G	m/year	0.238	0.192	0.239	0.192	0.231	0.174	0.192
Runoff, Q_S	m/year	0.194	0.235	0.196	0.235	0.189	0.261	0.235
Annual volume								
Precipitation	m^3/year	122,452	239,844	3,441	360,272	179,124	11,132	151,800
Evapotranspiration	m^3/year	70,180	138,645	1,962	208,260	104,784	6,347	87,750
Recharge	m^3/year	28,750	45,540	813	68,405	40,887	1,914	28,823
Runoff	m^3/year	23,522	55,659	666	83,607	33,453	2,871	35,228

102 Total		
Precipitation, P	905,133	m^3/year
Evapotranspiration, E	523,831	m^3/year
Recharge, Q_G	184,395	m^3/year
Runoff, Q_{SW} <=Surface Runoff to Woodlot	117,060	m^3/year
Runoff, Q_S <=Surface Runoff to Hampton-Scott	79,847	m^3/year

101 Total		
Precipitation, P	162,932	m^3/year
Evapotranspira	94,097	m^3/year
Recharge, Q_G	30,737	m^3/year
Runoff, Q_S	38,099	m^3/year

Total		
Precipitation, P	1,068,065	m^3/year
Evapotranspiration, E	617,928	m^3/year
Recharge, $Q_G + Q_{SW}$	332,191	m^3/year
Runoff, Q_S	117,946	m^3/year

Prepared By: RM
Checked By: STH

NOTES:
1. Table to be read in conjunction with accompanying report.

POST-DEVELOPMENT CONDITIONS - ENTIRE STUDY AREA - INTERIM SCENARIO

Parker SWMF-Subdivision
London, Ontario

Catchment		202				203a	203b	203c
Ground Cover		Moderately Rooted Crops	Urban Lawns	Open Water	Roads	Urban Lawns (Parker)	Mature Forest	Moderately Rooted Crops (Van Hie)
Hydrologic Soil Group		B	CD	--	--	CD	CD	CD
Area	m^2	121,000	366,000	16,000	133,000	117,700	177,000	136,000
Impervious	%	0%	55%	100%	100%	40%	0%	0%
Water Holding Capacity	mm	150	125	--	5	125	400	200
Precipitation, P	m/year	1.012	1.012	1.012	1.012	1.012	1.012	1.012
Evapotranspiration, E	m/year	0.580	0.260	0.000	0.050	0.346	0.592	0.585
Surplus	m/year	0.432	0.752	1.012	0.962	0.666	0.420	0.427
Ground Cover Factor	-	0.10	0.10	--	--	0.10	0.20	0.10
Soils Factor	-	0.25	0.10	--	--	0.10	0.15	0.15
Topography Factor	-	0.20	0.20	--	--	0.20	0.20	0.20
Infiltration Factor (sum)	-	0.55	0.40	0.00	0.00	0.40	0.55	0.45
Recharge, Q_G	m/year	0.238	0.135	0.000	0.000	0.160	0.231	0.192
Runoff, Q_S	m/year	0.194	0.617	1.012	0.962	0.506	0.189	0.235
Annual volume								
Precipitation	m^3/year	122,452	370,392	16,192	134,596	119,112	179,124	137,632
Evapotranspiration	m^3/year	70,180	95,032	0	6,650	40,748	104,784	79,560
Recharge	m^3/year	28,750	49,565	0	0	18,808	40,887	26,132
Runoff	m^3/year	23,522	225,795	16,192	127,946	59,557	33,453	31,940

202 Total - Interim		
Precipitation, P	643,632	m^3/year
Evapotranspiration, E	171,862	m^3/year
Recharge, Q_G	78,314	m^3/year
Runoff, Q_S <= Runoff Directed to Parker SWMF	393,456	m^3/year

203 Total - Interim		
Precipitation, P	435,868	m^3/year
Evapotranspiration, E	225,092	m^3/year
Recharge, Q_G	85,827	m^3/year
Runoff, Q_{SW} <= Runoff to Woodlot for Balance	124,950	m^3/year

Total - Interim		
Precipitation, P	1,079,500	m^3/year
Evapotranspiration, E	396,954	m^3/year
Recharge, $Q_G + Q_{SW}$	289,091	m^3/year
Runoff, Q_S	393,456	m^3/year

Prepared By: RM
Checked By: STH

NOTES:
1. Table to be read in conjunction with accompanying report.
2. Area 203a is based on the -10% infiltration scenario.

POST-DEVELOPMENT CONDITIONS - ENTIRE STUDY AREA - ULTIMATE SCENARIO

Parker SWMF-Subdivision
London, Ontario

Catchment		202				203a	203a	203b
Ground Cover		Moderately Rooted Crops	Urban Lawns	Open Water	Roads	Urban Lawns (Parker)	Urban Lawns (Van Hie)	Mature Forest
Hydrologic Soil Group		B	CD	--	--	CD	CD	CD
Area	m^2	148,630	494,940	16,000	160,630	117,700	72,760	177,000
Impervious	%	0%	55%	100%	100%	40%	45%	0%
Water Holding Capacity	mm	150	125	--	5	125	125	400
Precipitation, P	m/year	1.012	1.012	1.012	1.012	1.012	1.012	1.012
Evapotranspiration, E	m/year	0.580	0.260	0.000	0.050	0.346	0.317	0.592
Surplus	m/year	0.432	0.752	1.012	0.962	0.666	0.695	0.420
Ground Cover Factor	-	0.10	0.10	--	--	0.10	0.10	0.20
Soils Factor	-	0.25	0.10	--	--	0.10	0.10	0.15
Topography Factor	-	0.20	0.20	--	--	0.20	0.20	0.20
Infiltration Factor (sum)	-	0.55	0.40	0.00	0.00	0.40	0.40	0.55
Recharge, Q_G	m/year	0.238	0.135	0.000	0.000	0.160	0.153	0.231
Runoff, Q_S	m/year	0.194	0.617	1.012	0.962	0.506	0.542	0.189
Annual volume								
Precipitation	m^3/year	150,414	500,879	16,192	162,558	119,112	73,633	179,124
Evapotranspiration	m^3/year	86,205	128,511	0	8,032	40,748	23,090	104,784
Recharge	m^3/year	35,314	67,026	0	0	18,808	11,119	40,887
Runoff	m^3/year	28,894	305,342	16,192	154,526	59,557	39,423	33,453

202 Total - Ultimate		
Precipitation, P	830,042	m^3/year
Evapotranspiration, E	222,748	m^3/year
Recharge, Q_G	102,341	m^3/year
Runoff, Q_S <= Runoff Directed to Parker SWMF	504,954	m^3/year

203 Total - Ultimate		
Precipitation, P	371,870	m^3/year
Evapotranspiration, E	168,622	m^3/year
Recharge, Q_G	70,814	m^3/year
Runoff, Q_{SW} <= Runoff to Woodlot for Balance	132,433	m^3/year

Total - Ultimate		
Precipitation, P	1,201,912	m^3/year
Evapotranspiration, E	391,370	m^3/year
Recharge, $Q_G + Q_{SW}$	305,588	m^3/year
Runoff, Q_S	504,954	m^3/year

Prepared By: RM
Checked By: STH

NOTES:
1. Table to be read in conjunction with accompanying report.
2. Area 203a is based on the -10% infiltration scenario.

APPENDIX B

Water Balance – Woodlot
Table B-I: Existing Conditions – Woodlot
Table B-II: Post-Development Interim Scenario With 10% Target Reduction to Woodlot
Table B-III: Post-Development Ultimate Scenario With 10% Target Reduction to Woodlot

EXISTING CONDITIONS - WOODLOT

Parker SWMF-Subdivision
London, Ontario

Catchment		102	102
Ground Cover		Moderately Rooted Crops - Parker & Van Hie lands	Mature Forest
Hydrologic Soil Group		CD	CD
Area	m^2	356,000	177,000
Water Holding Capacity	mm	200	400
Precipitation, P	m/year	1.012	1.012
Evapotranspiration, E	m/year	0.585	0.592
Surplus	m/year	0.427	0.420
Ground Cover Factor	-	0.10	0.20
Soils Factor	-	0.15	0.15
Topography Factor	-	0.20	0.20
Infiltration Factor (sum)	-	0.45	0.55
Recharge, Q_G	m/year	0.192	0.231
Runoff, Q_S	m/year	0.235	0.189
Annual volume			
Precipitation	m^3/year	360,272	179,124
Evapotranspiration	m^3/year	208,260	104,784
Recharge	m^3/year	68,405	40,887
Runoff	m^3/year	83,607	33,453

Total		
Precipitation, P	539,396	m^3/year
Evapotranspiration, E	313,044	m^3/year
Recharge, Q_G	109,292	m^3/year
Runoff, Q_{SW}	117,060	m^3/year

Prepared By: RM
Checked By: STH

NOTES:
1. Table to be read in conjunction with accompanying report.

POST-DEVELOPMENT INTERIM SCENARIO
WITH 10% REDUCTION TO WOODLOT

Parker SWMF-Subdivision
London, Ontario

Catchment		203a	203b	203c
Ground Cover		Urban Lawns (Parker)	Mature Forest	Moderately Rooted Crops (Van Hie)
Hydrologic Soil Group		CD	CD	CD
Area	m^2	117,700	177,000	136,000
Impervious	%	40%	0%	0%
Water Holding Capacity	mm	125	400	200
Precipitation, P	m/year	1.012	1.012	1.012
Evapotranspiration, E	m/year	0.346	0.592	0.585
Surplus	m/year	0.666	0.420	0.427
Ground Cover Factor	-	0.10	0.20	0.10
Soils Factor	-	0.10	0.15	0.15
Topography Factor	-	0.20	0.20	0.20
Infiltration Factor (sum)	-	0.40	0.55	0.45
Recharge, Q_G	m/year	0.160	0.231	0.192
Runoff, Q_S	m/year	0.506	0.189	0.235
Annual volume				
Precipitation	m^3/year	119,112	179,124	137,632
Evapotranspiration	m^3/year	40,748	104,784	79,560
Recharge	m^3/year	18,808	40,887	26,132
Runoff	m^3/year	59,557	33,453	31,940

Total		
Precipitation, P	435,868	m^3/year
Evapotranspiration, E	225,092	m^3/year
Recharge, Q_G	85,827	m^3/year
Runoff, Q_{SW}	124,950	m^3/year

Prepared By: RM
Checked By: STH

NOTES:
1. Table to be read in conjunction with accompanying report.

POST-DEVELOPMENT ULTIMATE SCENARIO
WITH 10% REDUCTION TO WOODLOT

Parker SWMF-Subdivision
London, Ontario

Catchment		203a	203a	203b
Ground Cover		Urban Lawns - Parker	Urban Lawns - Van Hie	Mature Forest
Hydrologic Soil Group		CD	CD	CD
Area	m^2	117,700	72,760	177,000
Impervious	%	40%	45%	0%
Water Holding Capacity	mm	125	125	400
Precipitation, P	m/year	1.012	1.012	1.012
Evapotranspiration, E	m/year	0.346	0.317	0.592
Surplus	m/year	0.666	0.695	0.420
Ground Cover Factor	-	0.10	0.10	0.20
Soils Factor	-	0.10	0.10	0.15
Topography Factor	-	0.20	0.20	0.20
Infiltration Factor (sum)	-	0.40	0.40	0.55
Recharge, Q_G	m/year	0.160	0.153	0.231
Runoff, Q_S	m/year	0.506	0.542	0.189
Annual volume				
Precipitation	m^3/year	119,112	73,633	179,124
Evapotranspiration	m^3/year	40,748	23,090	104,784
Recharge	m^3/year	18,808	11,119	40,887
Runoff	m^3/year	59,557	39,423	33,453

Total		
Precipitation, P	371,870	m^3/year
Evapotranspiration, E	168,622	m^3/year
Recharge, Q_G	70,814	m^3/year
Runoff, Q_{SW}	132,433	m^3/year

Prepared By: RM
Checked By: STH

NOTES:
1. Table to be read in conjunction with accompanying report.

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