CITY OF OTTAWA NATURAL LANDSCAPE LINKAGE ANALYSIS

SUMMARY

Schedules L1, L2 and L3 of the Official Plan identify a Natural Heritage System Overlay that represents part of the City's natural heritage system describe in Section 2.4.2 of the Official Plan. This is consistent with the Provincial Policy Statement (2005) and the Ontario Ministry of Natural Resources Natural Heritage Reference Manual (2010) which provides guidance on the implementation of natural heritage policies.

As part of a Terms of Settlement with the Greenspace Alliance, signed and dated January 26, 2012, regarding an urban boundary issue before the Ontario Municipal Board as part of Official Plan Amendment 76, the City agreed as follows:

- The City of Ottawa acknowledges that, in principle, natural heritage connectivity at multiple scales is an appropriate consideration in decisions regarding expansion of the urban boundary, in order for consistency with the Provincial Policy Statement, 2005.
- The City commits to an explicit consideration of impacts on the connectivity of the natural heritage system at multiple scales during any future analyses and Official Plan Amendments regarding possible expansion of the urban boundary.
- The City will include explicit consideration of natural heritage connectivity at multiple scales in the Terms of Reference for any or updated subwatershed studies.
- Prior to the next comprehensive Official Plan Review in 2014, the City will identify and map existing and conceptual natural heritage linkages at a City-wide scale, including consideration of regional linkages outside the City boundaries. The city will carry out this work either in partnership with other organizations or agencies (*e.g.* The Nature Conservancy of Canada or the National Capital Commission) or on its own.

City staff has completed a natural landscape linkage analysis. Through this analysis, staff identified natural "linkage" features that qualify as part of the City's natural heritage system under Policy 2.4.2 (1j). These features consist of remnant woodlands or floodplains lying within existing or potential natural linkage areas identified in the natural linkage analysis. Although they would not necessarily qualify as part of the natural heritage system under other sub-sections of 2.4.2 (1), they contribute to the overall connectivity of the natural heritage system. If these areas are not already designated in the Natural Heritage System Overlay, then staff have proposed that they would be added to Schedules L1, L2 and L3 as part of the 2014 Comprehensive Official Plan Amendment. Inclusion of these features in Schedules L1, L2 and L3 would not modify any other policy of the Official Plan, nor would it alter the underlying land use designation or zoning of any land.

The natural landscape linkage analysis employed methods and tools commonly used in conservation land use planning for the identification of natural landscape linkages and corridors at a regional scale. The analysis was performed using ESRI ArcGIS 10 software. It generally consisted of a "least cost corridor" analysis, in which 1 km wide linkages were identified between core natural features. Linkages

were identified as those connecting landscapes between the features offering the least resistance to the dispersal and movement of plants and animals.

The analysis followed the following guiding principles, which come from research and studies in fields of Landscape Ecology and Conservation Biology:

- Short linkages are better than long linkages;
- Wide linkages are better than narrow linkages;
- Continuous linkages are better than discontinuous linkages;
- Straight linkages are better than crooked linkages.
- Linkages function best if they, themselves, provide viable habitat.

Landscape linkages are often defined in relation to a target species or group of species. In this case, the City did not identify any target species, but based the analysis on a general assessment of the extent to which certain land cover types facilitate or impede the movement of plant and animals.

The landcover mapping used for the project was produced by the environmental consulting company Morrison Hershfield, under contract to the City, using the City's 2011 color aerial photography (20 cm resolution). The land cover map followed a process and standards developed by the Rideau Valley Conservation Authority for use in Eastern Ontario. They are derived from, and consistent with, the Ecological Land Classification (ELC) system and the Southern Ontario Land Resource Inventory System (SOLRIS), which are the standard mapping systems used by the Province of Ontario and Ontario's Conservation Authorities. The landcover map appears as Figure 2 at the end of this document.

Figure 1 outlines the process and methodology that staff followed in conducting the natural landcover linkage analysis. Several concepts are important for understanding the methodology. The process, methodology and concepts are discussed following the figure.

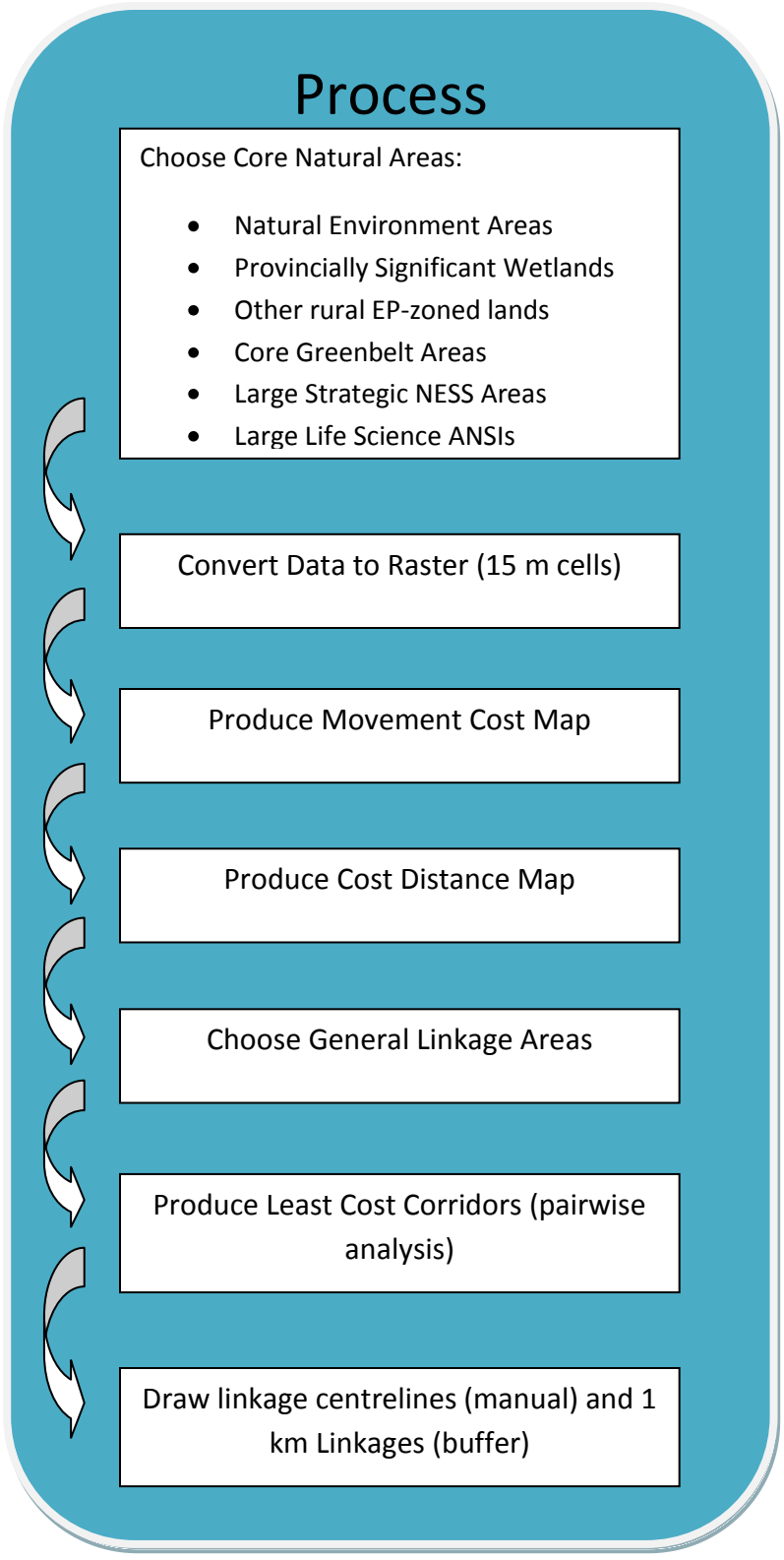

Figure 1: Natural Landscape Linkage Process

Methodology

Raster Analysis

All of the landscape linkage analysis was performed using *raster* maps. A raster map is analogous to a digital photograph, in that the map consists of individual pixels or cells which only become apparent when one zooms in very close to the image (*i.e.* at high resolution). The pixels or cells are square and arranged in rows and columns, similar to a chess board. This analysis used a cell size of 15 m x 15 m, or 225 m^2. It required 12.7 million pixels to produce a raster map of the City of Ottawa, or the equivalent of a 12.7 megapixel digital photograph.

Once a map has been converted to a raster format, it becomes possible to perform mathematical operations on each pixel in that map using GIS software. This process is analogous to the use of photo-processing software to modify a digital photograph.

Movement Cost

The first map to be produced in a landscape linkage analysis is a *movement cost map*. In a movement cost map, every pixel in the map is assigned a numerical value representing the cost to an animal of moving through that pixel. These costs are normally set *relative* to each other. For example, on a scale of 1 to 100, a forested pixel may be assigned a relative movement cost of 1, an agricultural field may be assigned a relative movement cost 30, and a fully-developed, urban pixel may be assigned a relative movement cost of 100.

The value of a pixel in a movement cost map may also be modified by multiplication factors representing other considerations, such as foreseeable future uses or land ownership. For example, in identifying lands for long-term protection as natural linkages, preference may want to be given to lands in public ownership. A multiplication factor of 0.5 might be applied to the movement cost of map pixels in areas of public ownership in order to favour their selection. Table 1 provides the movement costs and multiplication factors used in this natural landscape linkage analysis, using land cover categories from the 2011 land cover mapping and other land use planning data from the City. The movement cost map appears as Figures 3a, 3b and 3c at the end of this document.

Table 1: Movement Costs and Multiplication Factors

2011 City of Ottawa Landcover Category	Movement Cost/Resistance
Natural Cover	
Wooded - Treed	1
Wooded - Hedge	1
Wooded - Plantation	2
Wooded - Island	1
Wooded - Wetland	1
Grassland	5
Rock Outcrop	5
Evaluated Wetland - Swamp	1
Evaluated Wetland - Open Water	5
Evaluated Wetland - Bog	1
Evaluated Wetland - Wetland	1
Evaluated Wetland - Marsh	1
Unevaluated Wetland - Treed Swamp	1
Unevaluated Wetland - Swamp	1
Unevaluated Wetland - Marsh	1
Water	
Water - Lake	20
Water - River	20
Water - wetland	1
Water - Pond	1
Transportation	
Transportation - rail	5
Transportation - road	80
Developed Areas	
Aggregate Site	75
Settled - pervious	20
Settled - Impervious	100
Settled - homestead	30
Settled - residential	80
Agriculture	
Crop and Pasture	30
Crop and Pasture - Peat Moss	30
Land Use Modifiers	**Multiplication Factor**
Floodplain	0.5
Valley land	0.5
Watercourse/buffer	0.5
Prime Agricultural Area	2
Development Reserve	4
Country Lot Estate	4

Cost Distance Map

A *cost distance map* represents the cumulative movement cost for an animal travelling to a defined destination on a movement cost map. For example, let us assume that an animal must traverse four map pixels (*a*, *b*, *c*, d) from its origin (pixel *a*) to the defined destination (pixel *d*). If the movement costs for pixels *a*, *b* and *c* were 1, 5 and 50 respectively, then the total cost distance between pixels *a* and *d* would be 1 + 5 + 50 = 56. Therefore, on the cost distance map, pixel *a* would have a cost distance value of 56. As one moves closer to the destination, the total cost distance decreases. Pixel b would have a cost distance value of 55 (5 + 50) and Pixel *c* would have a cost distance of 50. Pixel *d*, as the assigned destination, would have a cumulative movement cost of 0.

For this natural landscape linkage analysis, the cost distance value for each pixel was calculated as the cumulative movement cost to the nearest core natural area. The cost distance map was used as a screening tool to identify existing and potential natural landscape linkages for a more detailed *least cost corridor analysis*. The cost distance map appears as Figures 4a, 4b and 4c at the end of this document.

Least Cost Corridor

A *least cost corridor* map represents the total movement cost between two defined areas on a map. Unlike a *least cost path* analysis, which traces only a single line of pixels between the defined destinations, a least cost corridor analysis can be used to identify broader linkages. It works by overlapping two cost distance maps – one cost distance map for each destination. Each pixel is then assigned a value equal to the sum of its value from each cost distance map.

For example, let us assume that pixel *a* has a cost distance of 256 relative to destination *A* and a cost distance of 125 relative to destination *B*. The value of the pixel in a least cost corridor analysis for *A* and *B* would be 256 + 125 = 381.

The final step in a least cost corridor analysis is to establish the width of the corridor. This is normally done by restricting the least cost corridor to those pixels below a certain threshold. This is usually done using percentages (or more precisely, quantiles). For example, the least cost corridor may be restricted to the 5% or 10% of pixels with the lowest scores.

Based upon the overall cost distance map, 39 pairs of core natural areas were identified for least cost corridor analyses. Each of the 39 least cost corridor analyses required the preparation of two new least cost distance maps. All of the least cost corridor analyses, including the preparation of the new cost distance maps, were performed at the same spatial extent (824 km^2) and map scale (1:130,000). The actual area subject to the analyses varied somewhat due to overlap with the City's boundaries (analyses were only performed on areas within the City boundary).

Several pairs of core conservation areas were chosen for least cost corridor analyses even though the overall cost distance map did not show high potential for connectedness. Pinhey Forest, within the National Capital Greenbelt, was chosen for least cost corridor analyses because of the declared intention of the National Capital Commission to identify and improve natural linkages to this important core,

greenbelt area. The Leitrim Wetland and Osgoode Swamp were also chosen for a least cost corridor analysis because the area presents the best opportunity for a north – south linkage on the east side of the Rideau River, particularly in the future when existing mineral aggregate areas are exhausted and rehabilitated.

Figures 5a, 5b and 5c display the 39, overlapping least cost corridor analyses. The figures display the best 10% and 5% solutions.

Identification of Linkages

The final analytical step was the identification of existing and potential linkages. This was a semi-automatic process. First, staff manually drew lines between the core natural areas, following the apparent path of least resistance shown in the least cost corridor analysis. Staff then "buffered" these lines by 500 m on each side to create a 1 km wide linkage area.

The linkages vary in quality from areas that remain entirely natural, through areas that are a mix of natural and non-natural land cover types, to areas that are predominantly non-natural vegetation. The latter linkages are best described as have long-term potential for restoration, generally as a result of restrictive landform features, such as floodplains, valleylands, or escarpments.

Because most of these landscape linkages include some portion of non-natural vegetation, human land uses and non-environmental land use/zoning designations, staff does not propose to identify them in the Natural Heritage Overlay Schedules L1, L2 and L3. Instead, staff recommends identification of only those existing or remnant features that overlap or lie within the linkage areas, and which are not already identified in the Natural Heritage Overlay for other reasons: *i.e.* any non-significant woodlot or forested area overlapping a natural linkage, and any portion of a floodplain contained within a natural linkage.

Figures 6a, 6b and 6c display the landscape linkage network recommended by staff, based upon the landscape linkage analysis. The actual features recommended for inclusion in Schedules L1, L2 and L3 appear in black on the figures.

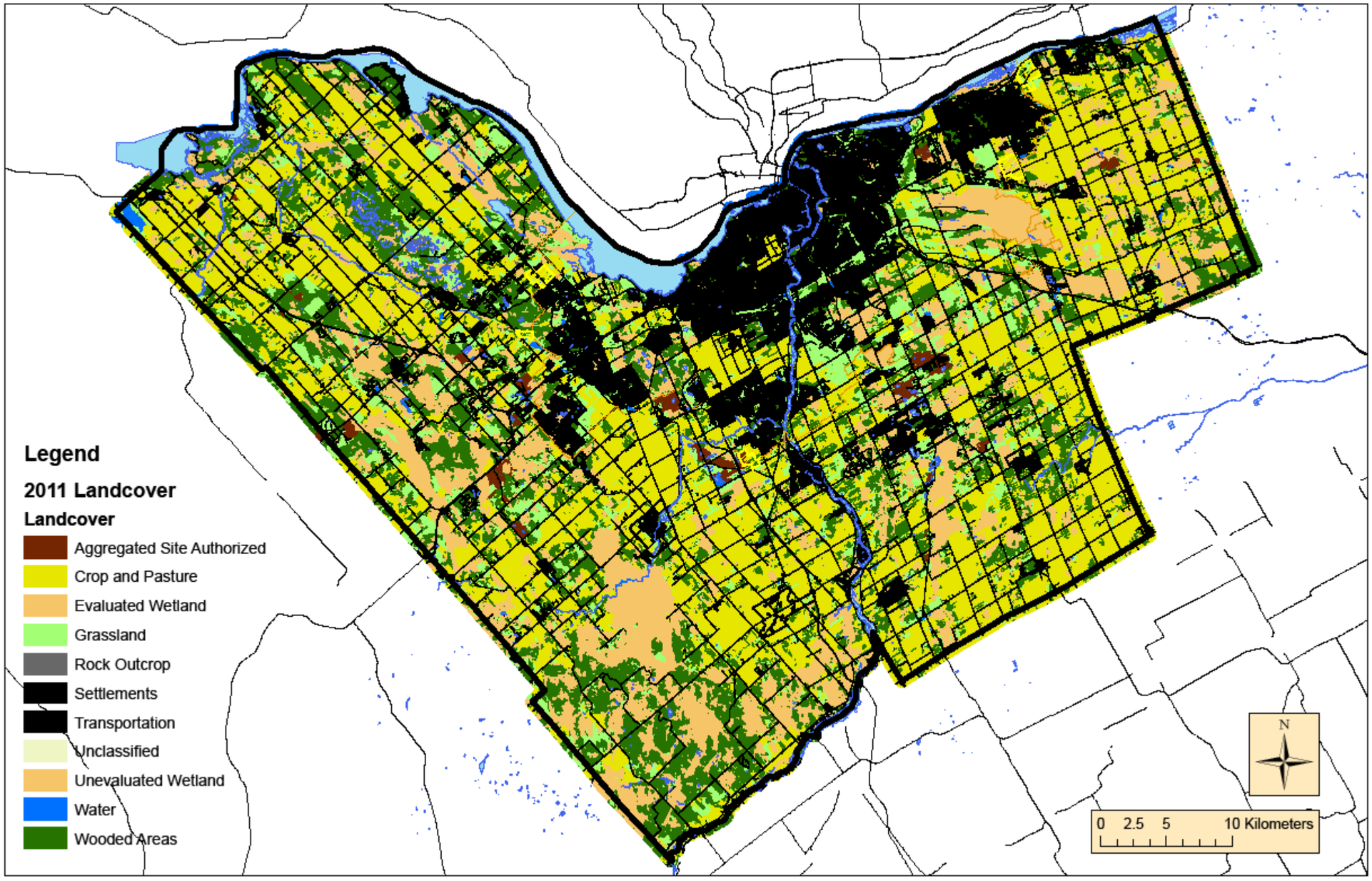

Figure 2: City of Ottawa 2011 Landcover Map.

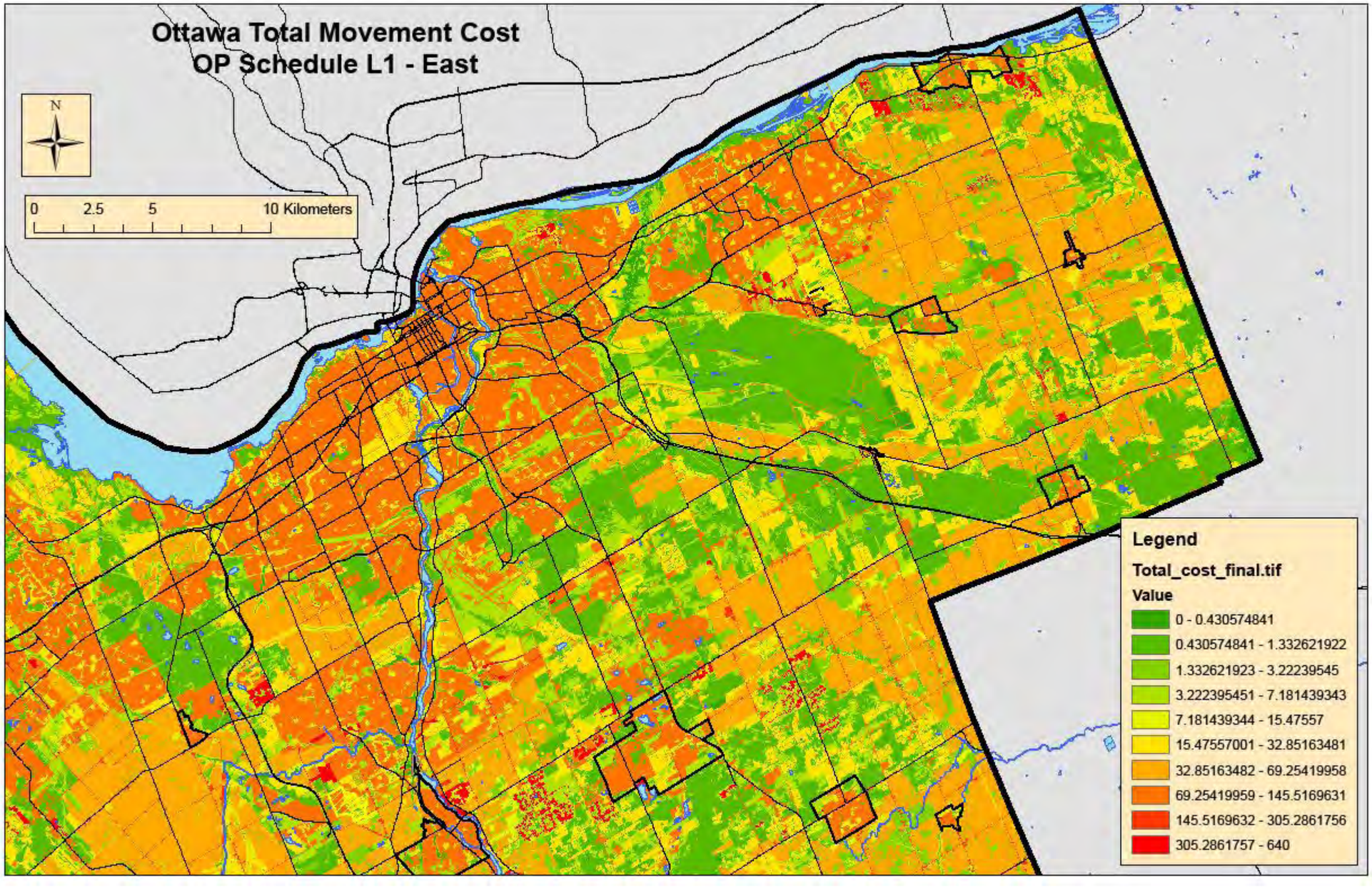

Figure 3a: Movement Cost Map for the area of Schedule L1 – East

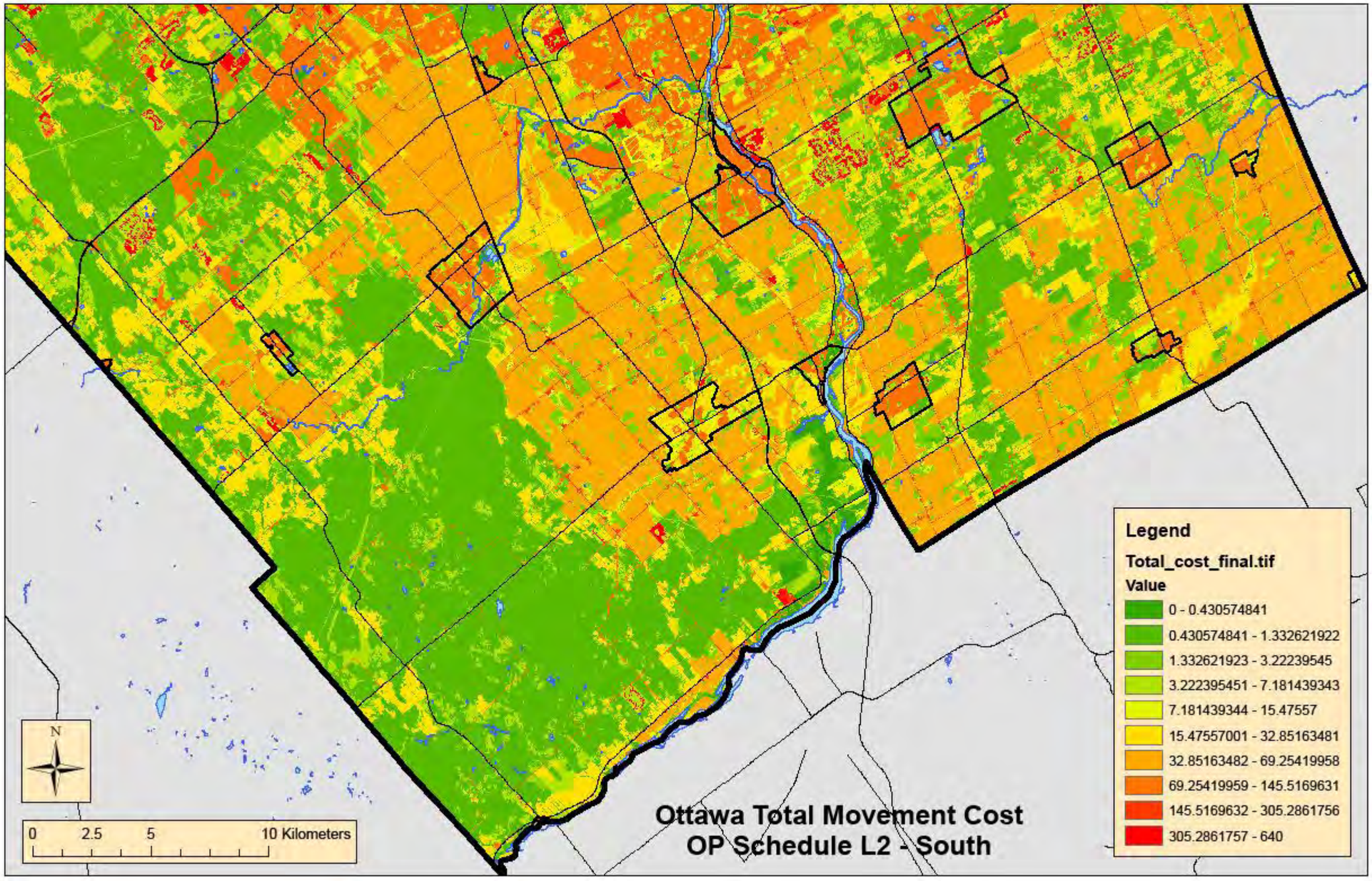

Figure 3b: Movement Cost Map for the area of Schedule L2 – South

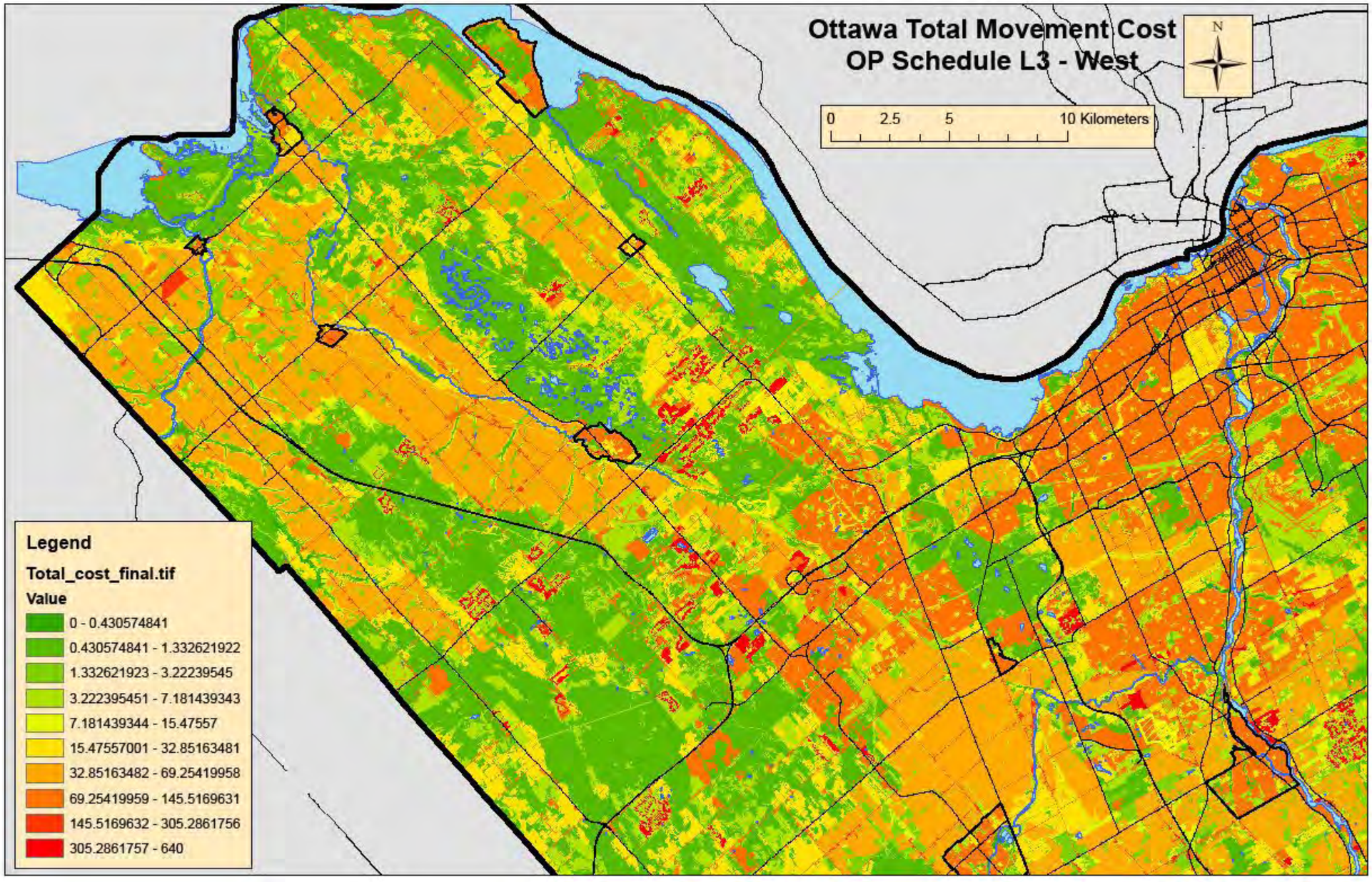

Figure 3c: Movement Cost Map for the area of Schedule L3 – West

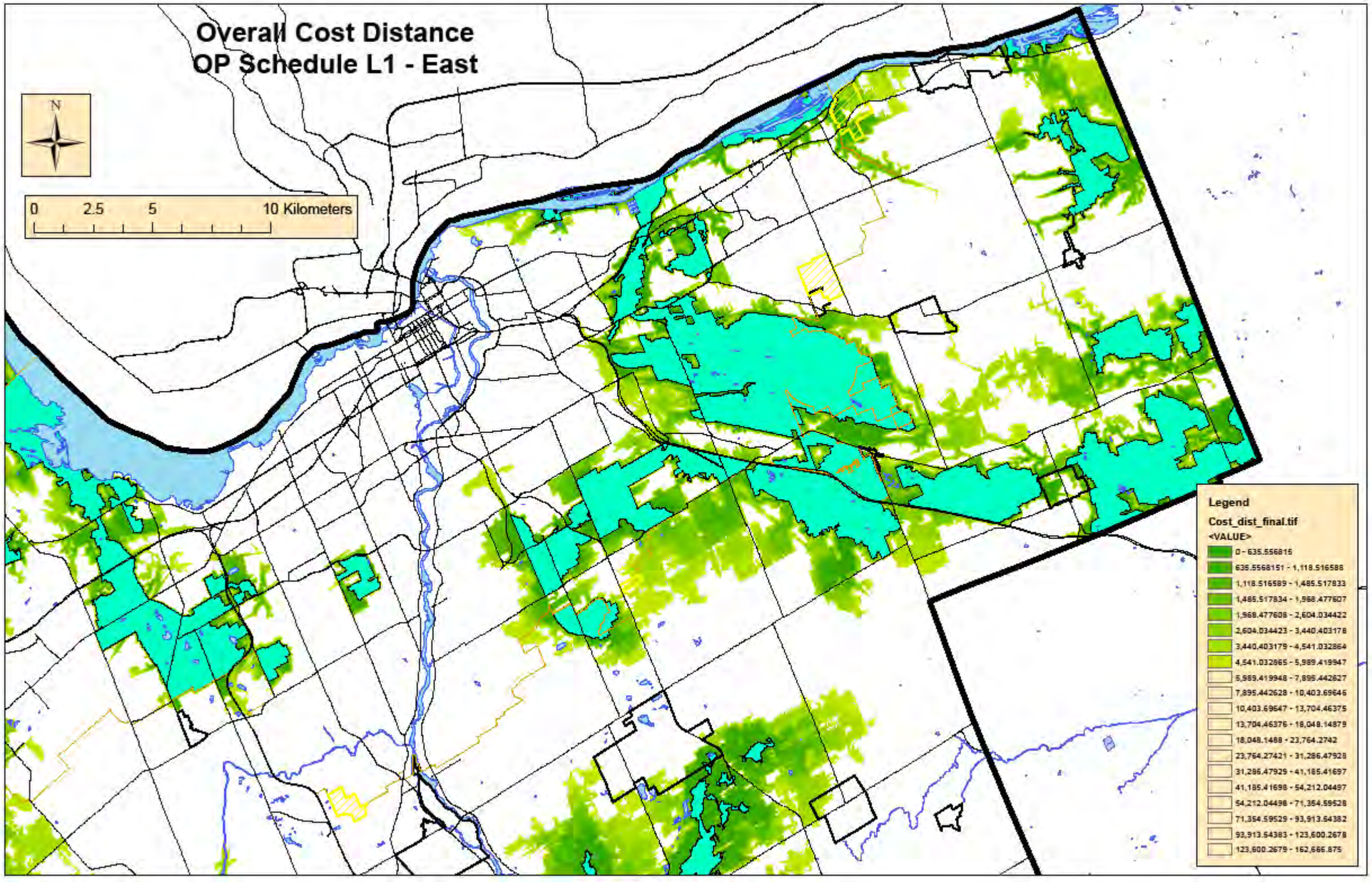

Figure 4a: Cost Distance Map for the area of Schedule L1 – East showing Core Natural Areas

(Display limited to lower cost pixels)

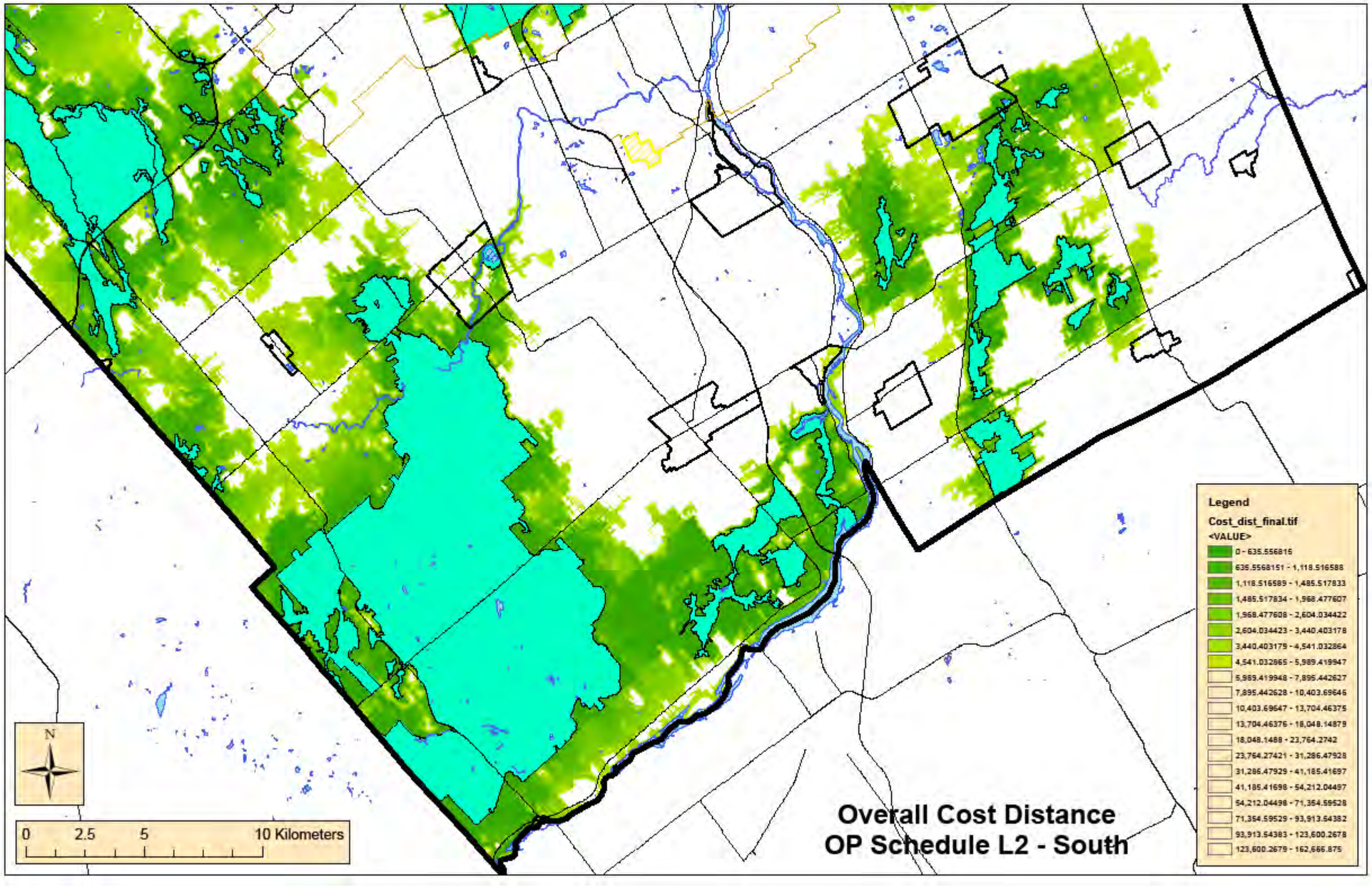

Figure 4b: Cost Distance Map for the area of Schedule L2 – South showing Core Natural Areas

(Display limited to lower cost pixels)

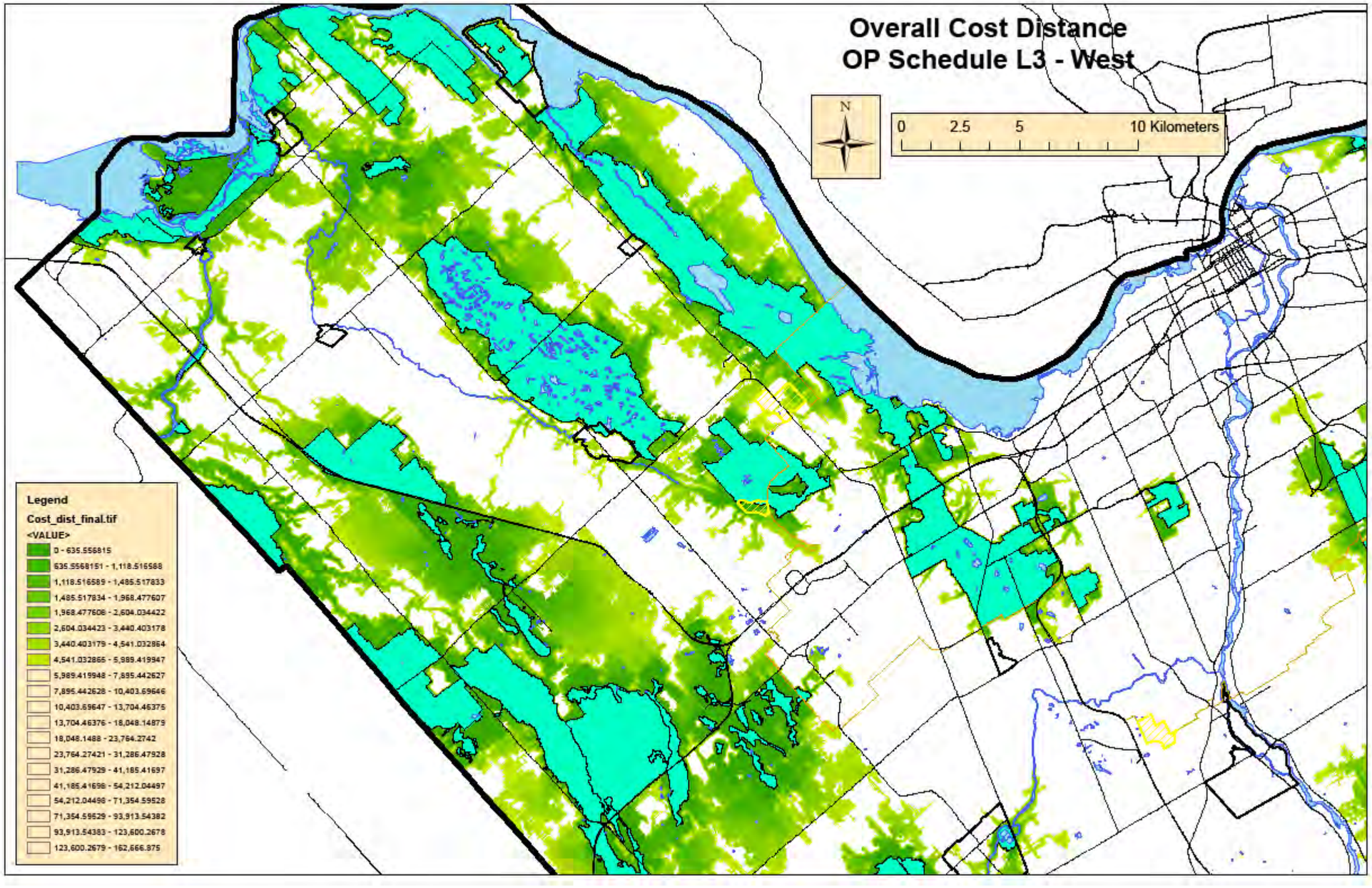

Figure 4c: Cost Distance Map for the area of Schedule L3 – West showing Core Natural Areas

(Display limited to lower cost pixels)

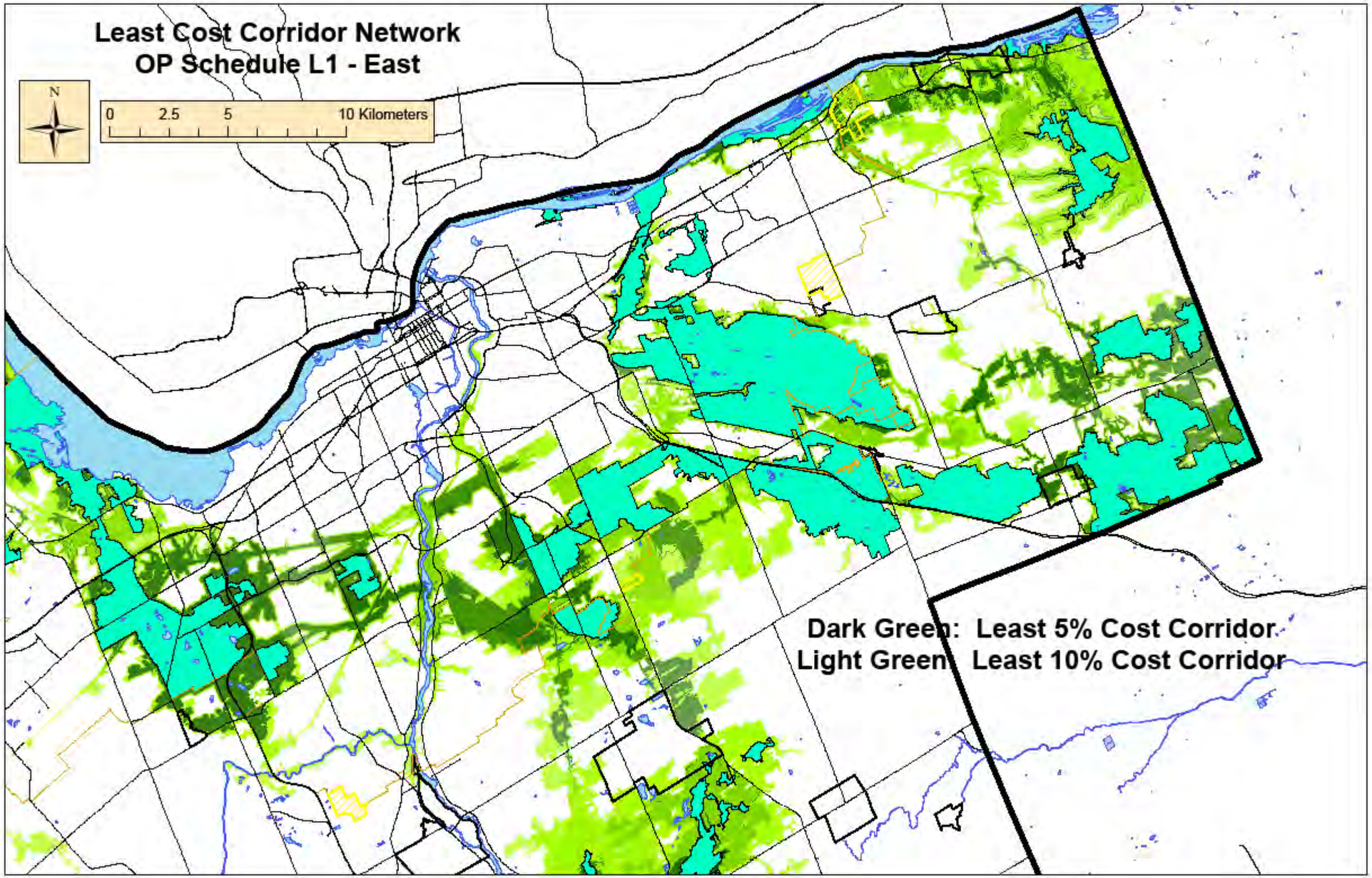

Figure 5a: Least Cost Corridor Map for the area of Schedule L1 – East showing Core Natural Areas

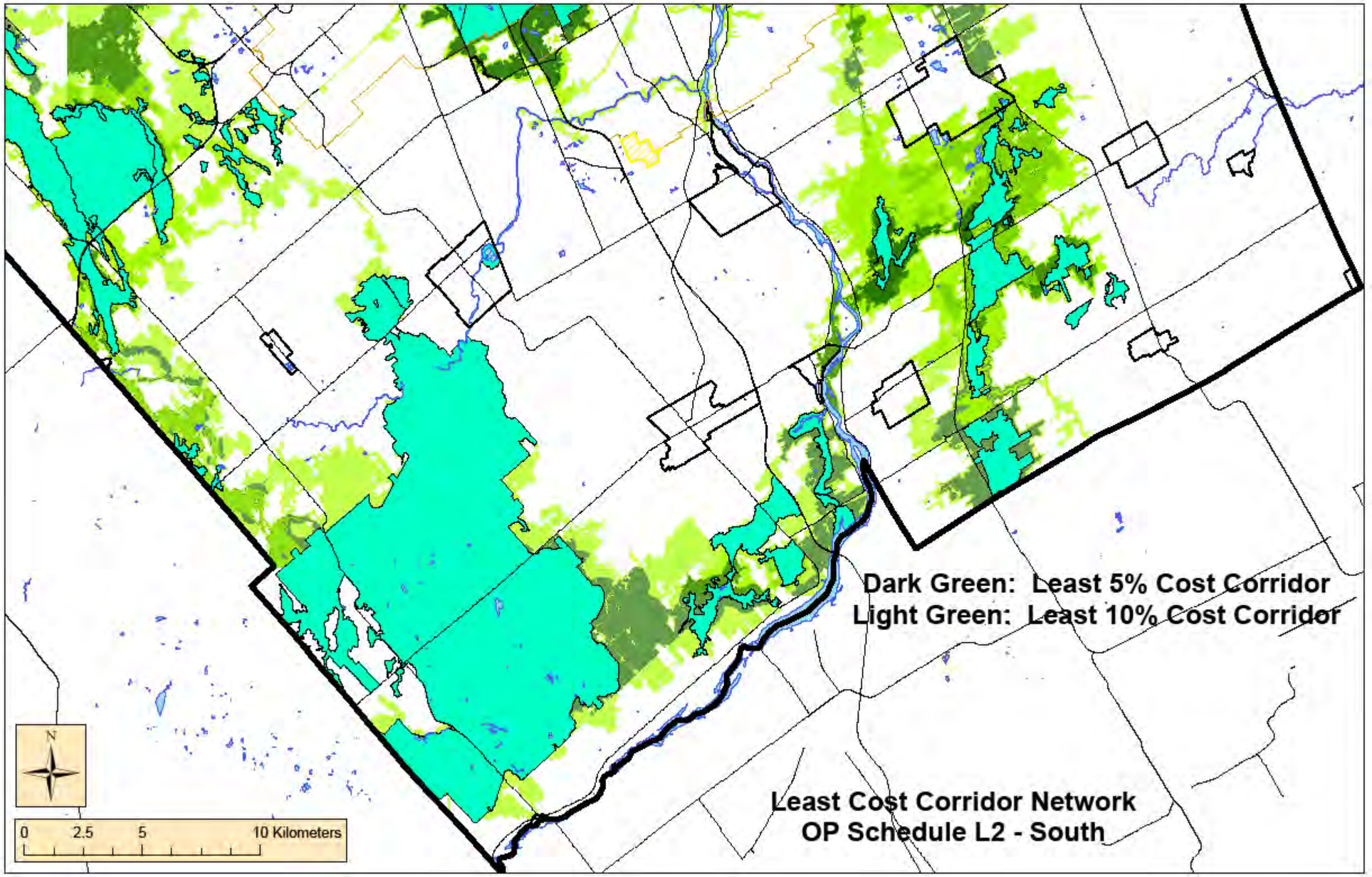

Figure 5b: Least Cost Corridor Map for the area of Schedule L2 - South showing Core Natural Areas

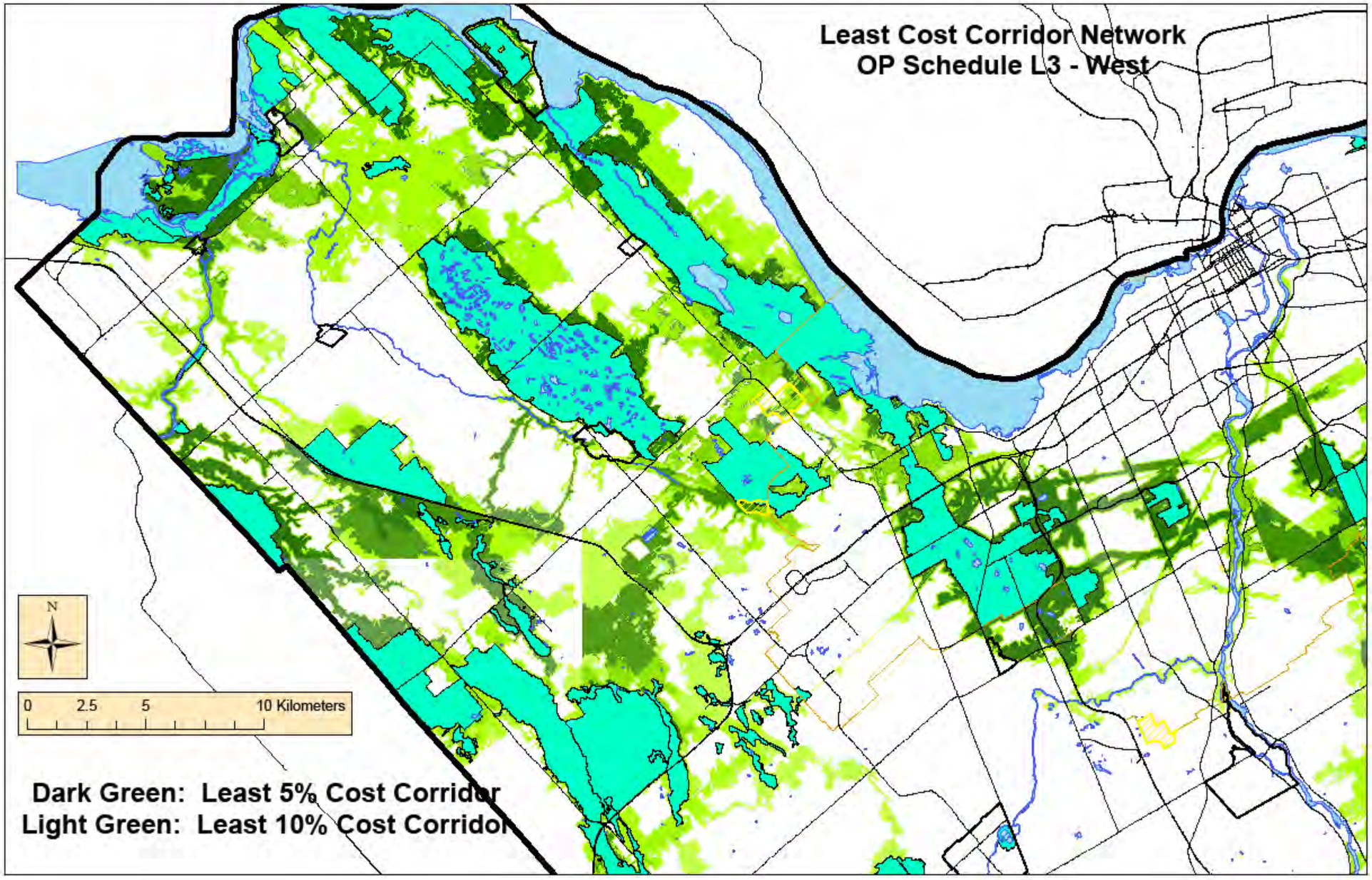

Figure 5c: Least Cost Corridor Map for the area of Schedule L3 – West showing Core Natural Areas

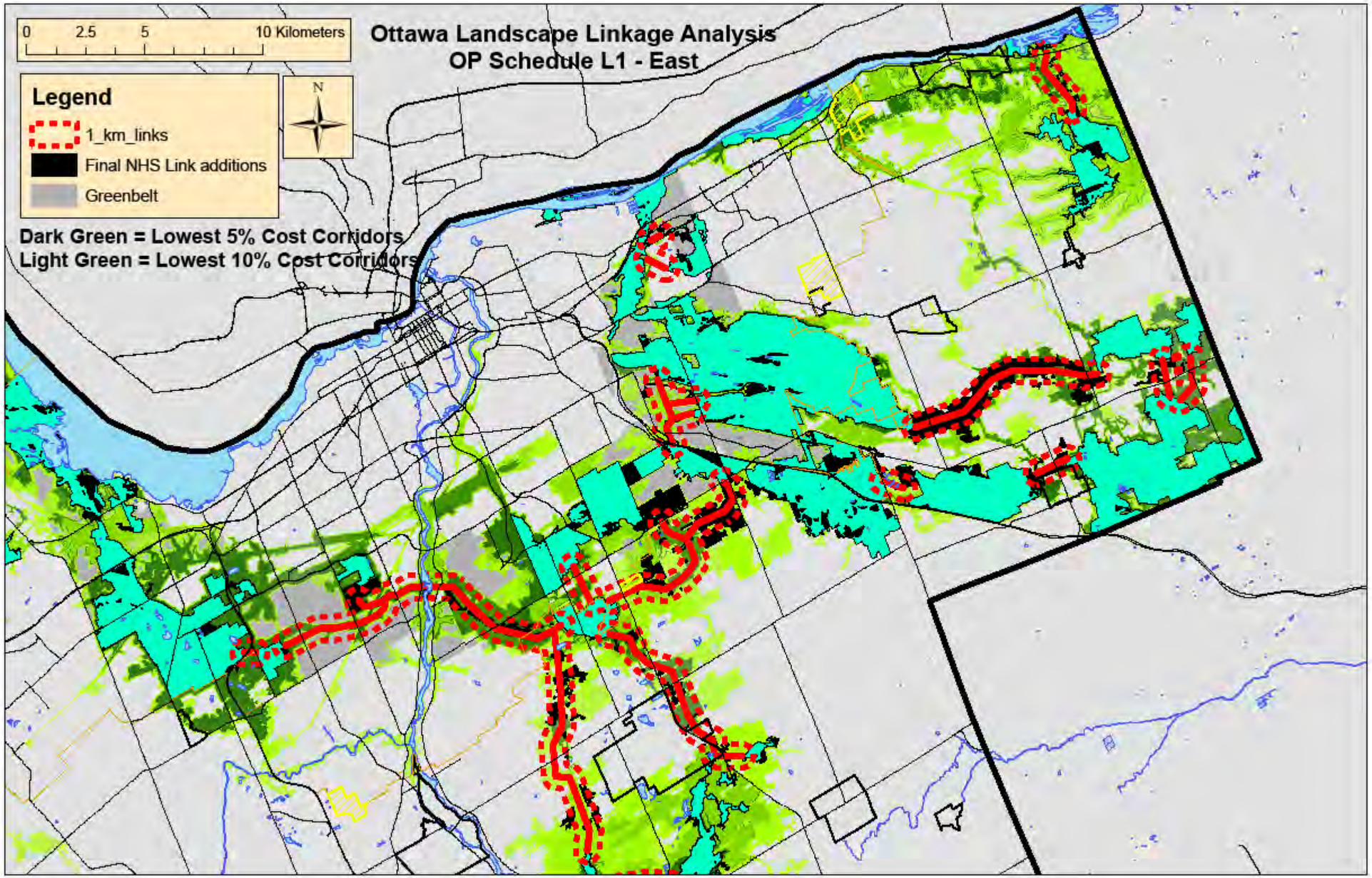

Figure 6a: Recommended Natural Landscape Linkage Network for Area of Schedule L1 – East showing Core Natural Areas

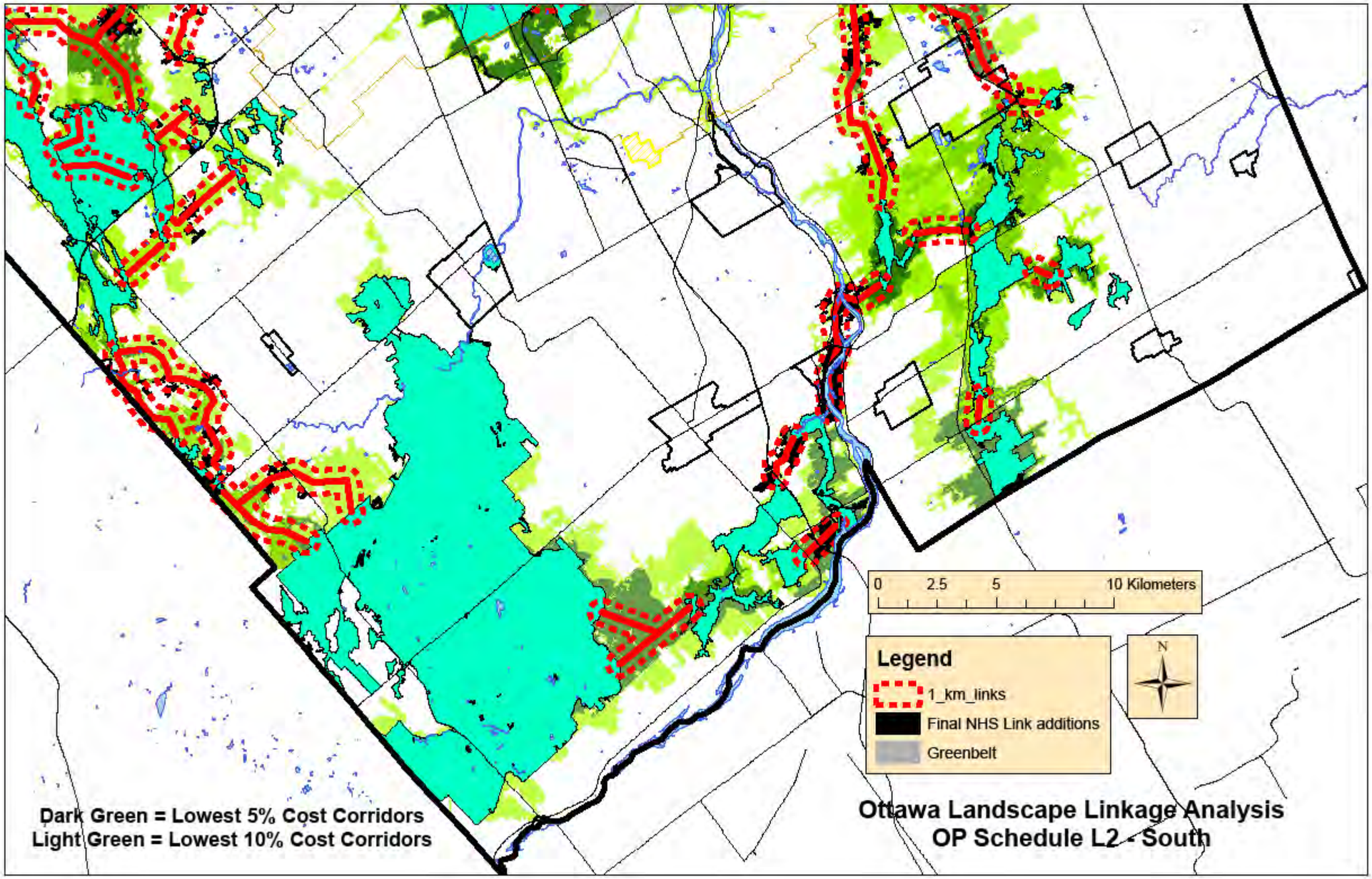

Figure 6b: Recommended Natural Landscape Linkage Network for Area of Schedule L2 – South showing Core Natural Areas

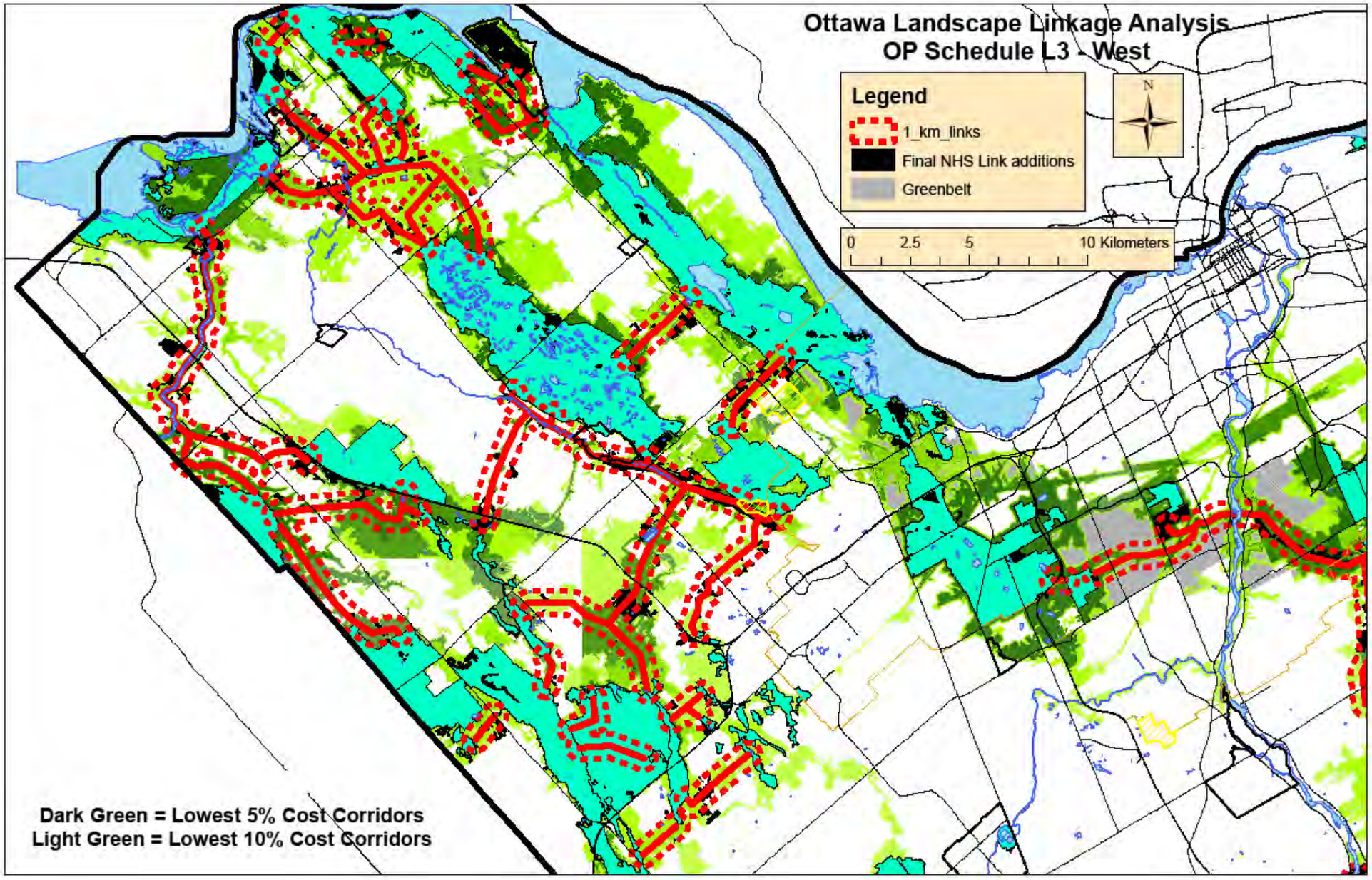

Figure 6c: Recommended Natural Landscape Linkage Network for Area of Schedule L3 - West showing Core Natural Areas