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Large-scale Traditional Neighbourhood Development and Pre-emptive Ecosystem Planning: The Markham Experience, 1989–2001

DAVID L. A. GORDON & KEN TAMMINGA

ABSTRACT *Environmental protection and restoration in 10 suburban community plans are compared to the recommendations of an innovative Natural Features Study (NFS) of Markham, Ontario. The secondary plans will accommodate 150 000 people and are North America's largest concentration of new communities planned with traditional neighbourhood design principles. Their planning and development is an early test of whether New Urbanism can collaborate with pre-emptive ecosystem planning. The results of the comparison indicate that the plans met or exceeded most objectives for environmental protection. The record on environmental restoration is mixed, with several proposed links lost during the design and development process, perhaps because the NFS was not adopted as official policy before neighbourhood planning began. It appears that environmental restoration is best approached on a regional basis, with plans and financial incentives in place before land is subject to development pressure.*

Introduction

The improvement of environmental quality during suburban development requires close attention to the principles of landscape ecology and pre-emptive ecosystems planning (Forman, 1995; Tamminga, 1996). Merely preventing development of hazard lands and designating Environmentally Sensitive Areas (ESAs) will not restore the links in the landscape matrix destroyed by agriculture and infrastructure. The improvement of environmental quality requires the municipality to specify the elements (woodlots, streams, hedgerows) that it wants restored, protected and re-connected *prior* to the landowner commencing secondary planning and urban design studies.

Markham, Ontario had a head start in this field in the early 1990s as a result of studies undertaken while planning expansion of its urban growth area. The town encouraged higher-density suburbs using traditional neighbourhood development techniques. It also commissioned a Natural Features Study (NFS) from leading environmental consultants, but compliance by the developers was not mandatory during the early planning stages. This paper compares the secondary plans and urban design studies for the new neighbourhoods to the earlier recommendations based upon landscape ecology principles.

David L. A. Gordon, School of Urban and Regional Planning, Queen's University, Kingston, Ontario K7L 3N6, Canada. Email: gordond@post.queensu.ca. Ken Tamminga, Department of Landscape Architecture, Pennsylvania State University, University Park, PA 16802-1429, USA. Email: krt1@psu.edu

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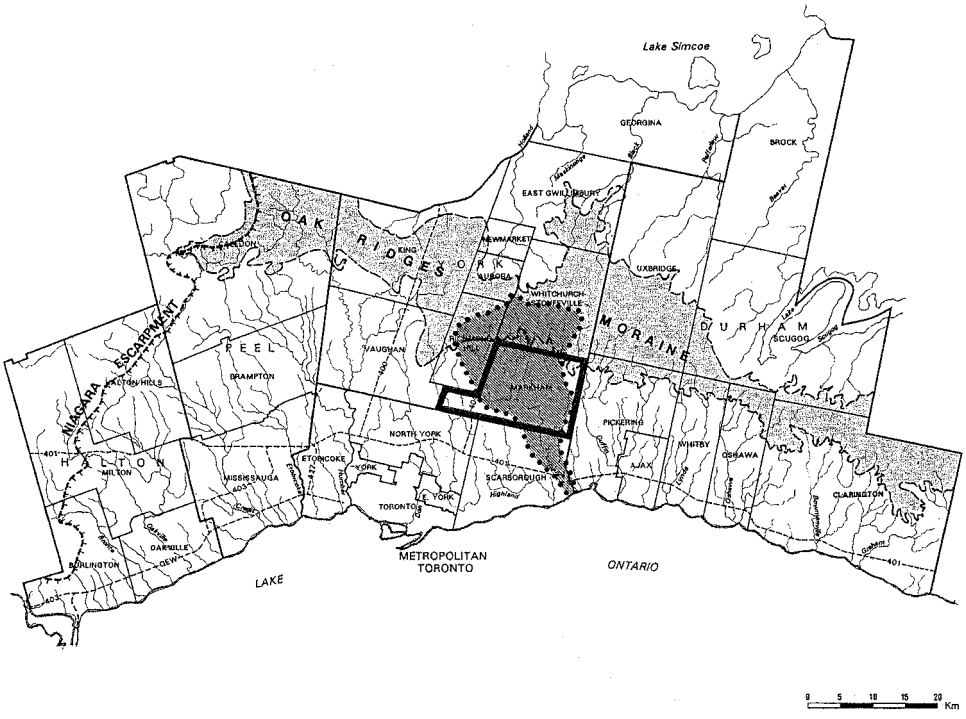


Figure 1. Location of the town of Markham within the Greater Toronto area and its bioregion. *Source*: The Rouge Park Alliance.

The Regional Setting and Planning Process

Markham, Ontario is a fast-growing, wealthy, ethnically diverse suburban municipality on the north-east edge of the Greater Toronto Area (GTA) (Figure 1). It had a 1996 population of 173 380 (Statistics Canada Census 1996) and an estimated population of 205 000 in 2000 (Markham, 2001, p. 3). The municipality pursued conventional suburban development policies during the 1970s and 1980s, preferring single-family detached homes and new roads. Planning policies began to change in the 1990s, under the leadership of a new planning commissioner and a few councillors.

Land-use planning in Canada is typically guided by policies adopted at the provincial, regional and city level (Hodge, 1998). The Ontario government prepares regional demographic projections, issues general planning policy statements and designates certain lands as ESAs. The province has also established regional conservation areas on a watershed basis. These agencies map flood plains that are typically excluded from development in regional and municipal plans.[2] At the local level, Markham has a comprehensive land-use plan for the entire municipality. This Official Plan is updated every 5–10 years and the local zoning bylaw is required to conform to the plan. Finally, the council adopts secondary plans for large tracts (typically 400 ha or 1000 acres) prior to their conversion from rural to urban uses. These secondary plans are subject to approval by the municipal staff and council, but are typically drafted by multi-disciplinary consulting teams retained by the landowners.

From the 1960s to the 1980s, these secondary plans were pure two-dimensional land-use studies containing blob diagrams, statistical charts and infrastructure maps. The plans were prepared by engineering/planning firms retained by the landowners and contained little or no urban design content. The typical site was a 400-ha (1000-acre) square defined by a 1.25-mile farm survey grid from the 1790s. The most recent group of secondary plans is quite different, although these plans are still implemented by land-use regulations. Interdisciplinary teams headed by leading urban design firms prepared the new plans. They contain detailed and explicit urban design policies for streets, public spaces, building types and environmental design. Since many small builders often implement the new plans, some landowners have gone further, preparing design guidelines for built form, building type and materials. The owners privately enforce these guidelines during the 5–10 years it takes to build out a secondary plan using land sub-division agreements.

The background studies for the latest revision to the Markham Official Plan included an innovative long-range environmental planning study at a time when this approach was rare in Canadian suburbs (Gore & Storrie/Hough Stansbury Woodland (GSHSW), 1993; Tamminga, 1996). In addition, an urban area extension study (Lehman & Associates, 1992) considered the gross density and land area required to accommodate the provincial population growth forecasts for the region.

As a result of leadership from the municipality and the Province of Ontario, Markham is home to many secondary plans inspired by Traditional Neighbourhood Development (TND) principles. The Province of Ontario decided to try TND after great citizen dissatisfaction with a conventional land-use plan (Wood-Brunet, 1994, p. 7; McCool, pers. comm., 27 May 2002). The 980-ha (2400-acre) Cornell lands were left over after the 1973 expropriation of a site for a future airport. The provincial staff group managing the lands retained Duany Plater-Zyberk (DPZ) of Miami with the support of the municipal planners. The firm led a five-day charette in April 1992 (Duany *et al.*, 2000, pp. 198–202; Plater-Zyberk, 2002). Fortunately, the municipality had two well-preserved 19th-century farm villages (Markham Village and Unionville Village) embedded into its 1980s suburban fabric. The villages were well known and appreciated by the local residents, providing good local precedents for the charette teams. The charette was a successful public participation exercise, with over 1000 citizens attending the final presentation (McCool, pers. comm., 27 May 2002). Markham citizens and politicians (who lived in lower-density single-use sub-divisions) began to accept higher-density, mixed-use neighbourhoods as a planning objective.

The municipality reinforced the change in design philosophy with the planning process for the Markham Town Centre. DPZ and Toronto's NORR Partnership, architects of the new Paris Opera House, won the commission. NORR and DPZ led a charette for the design of this 506-ha (1250-acre) site that energized the citizens, planners and council, few of whom had had any experience with New Urbanism prior to 1991.

The large private landowners on the edge of Markham were persuaded to consider traditional neighbourhood design techniques in exchange for higher densities of development (Baird, pers. comm., 19 November 2001; McCool, pers. comm., 27 May 2002). Eleven secondary plans with varying adherence to New Urbanist principles were approved between 1994 and 1997. Interdisciplinary teams led by leading Toronto urban designers prepared most of these plans,

rather than the engineering/land-use planning firms typical of the 1970s. The new secondary plans will accommodate 150 000 people, doubling Markham's population.

The Markham projects are North America's largest concentration of plans prepared with traditional neighbourhood design principles (*New Urban News*, 1997, 1998, 2000). Seaside and Kentlands are small in comparison (Figure 2). The new districts are located directly across the street from equally large-scale conventional suburbs developed in the 1970s and 1980s. The new-wave suburbs are planned for gross residential densities of almost 20 units per hectare, over 80% higher than the conventional suburbs across the street (Vipond, 2000). This density of development will consume less agricultural land during the expansion of the urban growth area.

Higher gross densities do not necessarily mean a more sustainable environment. In theory, consuming less agricultural land for suburban development is a good start. However, increasing biodiversity during suburban development requires close attention to the principles of landscape ecology and environmental planning (Forman, 1995; Hough, 1995; Dramstad *et al.*, 1996; Beatley & Manning, 1997; Beatley, 2000; Tamminga *et al.*, 2002).

The Markham Natural Environment

Markham's development has progressed outward in $1\frac{1}{4}$-mile square blocks (1000 acres or 400 ha) from two historic settlements, the core villages of Unionville and Markham (see Figure 2). The inner suburbs (mid 1950s to early 1990s) represent the second wave of development. They razed all but the largest ecological features in their paths, primarily the regulatory flood plains associated with the Rouge and Little Rouge valleys and their larger tributaries. The third wave of development, largely New Urbanist communities, is taking place from 1995 to 2011, comprising 1300–1400 ha of development land immediately beyond the conventional sub-divisions. A fourth expansion phase (2011 and beyond) entails the long-term outer swath to the north of Major Mackenzie Drive, totalling some 3200–3300 ha (Lehman & Associates, 1992).

The third-phase landscape is characterized by flat to slightly rolling tablelands that appeared after the retreat of the Wisconsin glacier some 13 000 years ago (GSHSW, 1992). The large valleys of the main Rouge River dissect the Markham Centre Area and western greenfield blocks, and the Little Rouge River valley delimits the outer edge of the easterly blocks. A dozen sub-watersheds are represented in the 10 development blocks shown in Figure 2; only two of the blocks are wholly contained within a single sub-watershed—the others each span two or three sub-watersheds.

Much of the tablelands that are not yet developed have a cover of corn or row crops, or have been left fallow and are succeeding to old field. Several first- and second-order streams, some intermittent, flow towards their confluence with the Rouge and Little Rouge Rivers, which themselves finally merge just prior to entering Lake Ontario some 12 km downstream of the Markham's southern boundary. While some smaller streams are vegetated, others have been cropped up to their banks. Discontinuous grids of hedgerows still mark the lot-and-concession pattern that was established during the original 1790s survey. Lightly scattered woodlots and several small ponds complete the slate of ecosystem patches in this development swath (see Figure 3).

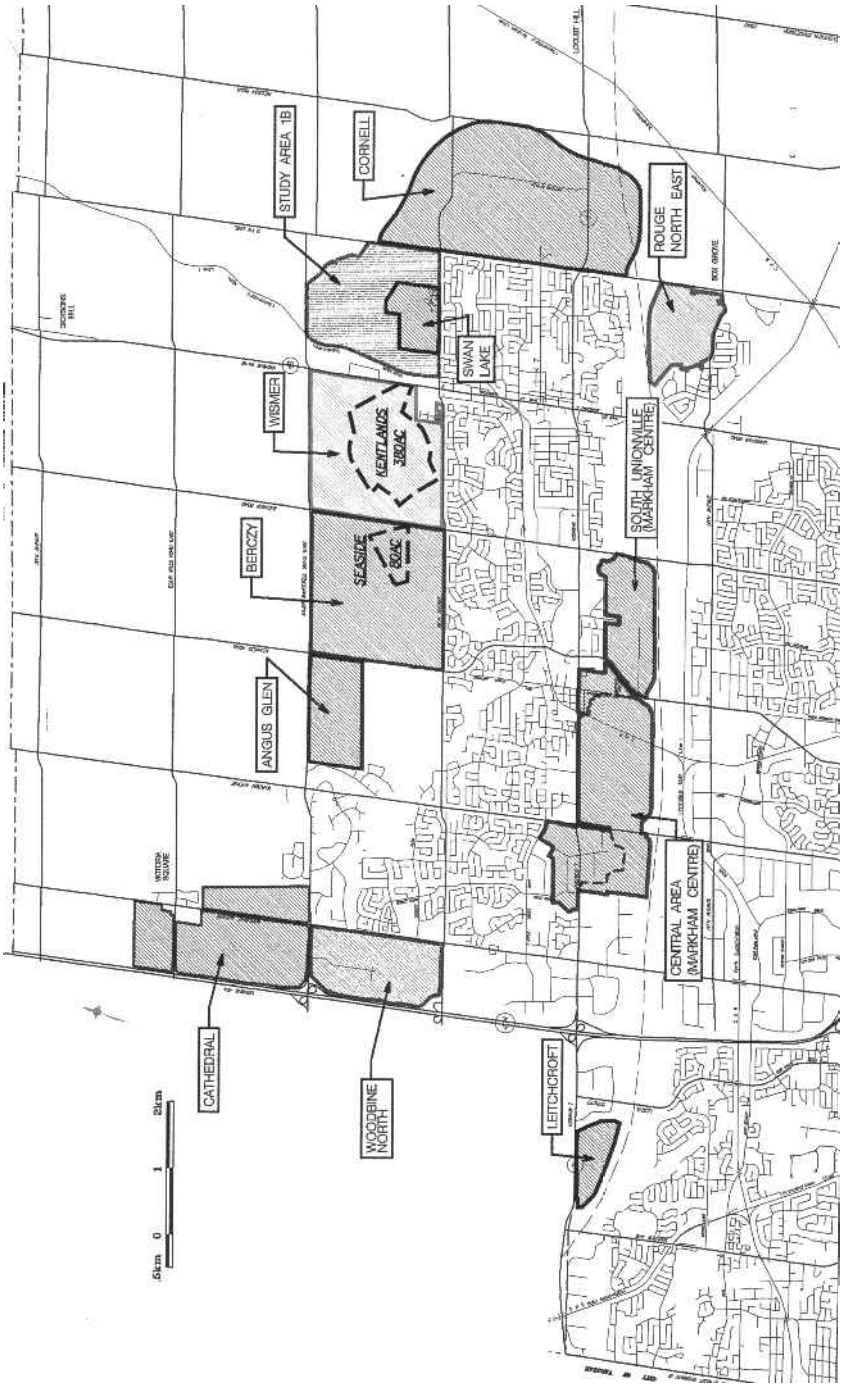


Figure 2. Location of new secondary plans in the city of Markham. *Source:* Town of Markham.

Figure 3. Aerial oblique photograph of eastern Markham and the Little Rouge River valley just prior to development of Cornell, 1995. *Source*: Ken Tamminga.

The Natural Features Study

Gore and Storrie Ltd. and Hough Stansbury Woodland prepared the Markham NFS between 1989 and 1993. It started with a comprehensive ecological inventory of the entire town. The consultants then developed recommendations for protecting sensitive sites (EPAs—Environmental Protection Areas) and restoring lost ecological paths and links (ERAs—Ecological Restoration Areas). The NFS team recognized early in their study process that Markham's environment was not sustainable. The biologists showed that species diversity and natural vegetation cover was dropping steadily and showing signs of stress. Water, material and nutrient cycling processes were dysfunctional in many areas. While riparian and aquatic habitats of the main Rouge River and Little Rouge River valleys were found to be fairly intact, the remnant tableland ecosystems were small, scattered and disconnected.[3] Species richness and abundance were low, with some species of birds, small mammals and other life forms in danger of genetic isolation. Interior forest species that would have been dominant cover to European settlement were found to be either destroyed or rare, replaced by generalist species[4] that thrive in the heterogeneous landscape mosaic found in southern Ontario.

The 1993 NFS strategy called for a concerted movement toward ecological integrity[5] across the municipality, with strong natural linkages northward to the Oak Ridges Moraine, southward to the recently-created lower Rouge Park[6], and across to adjacent watersheds. Within Markham's landscape mosaic, the NFS called for preservation of all natural features identified in the 1991–1992 field inventories. It delineated specific areas for future ecological restoration that would serve to reconnect isolated ecosystems, expand precariously small ecosystem patches, or infill larger patches (ecological nodes) showing gaps or overly

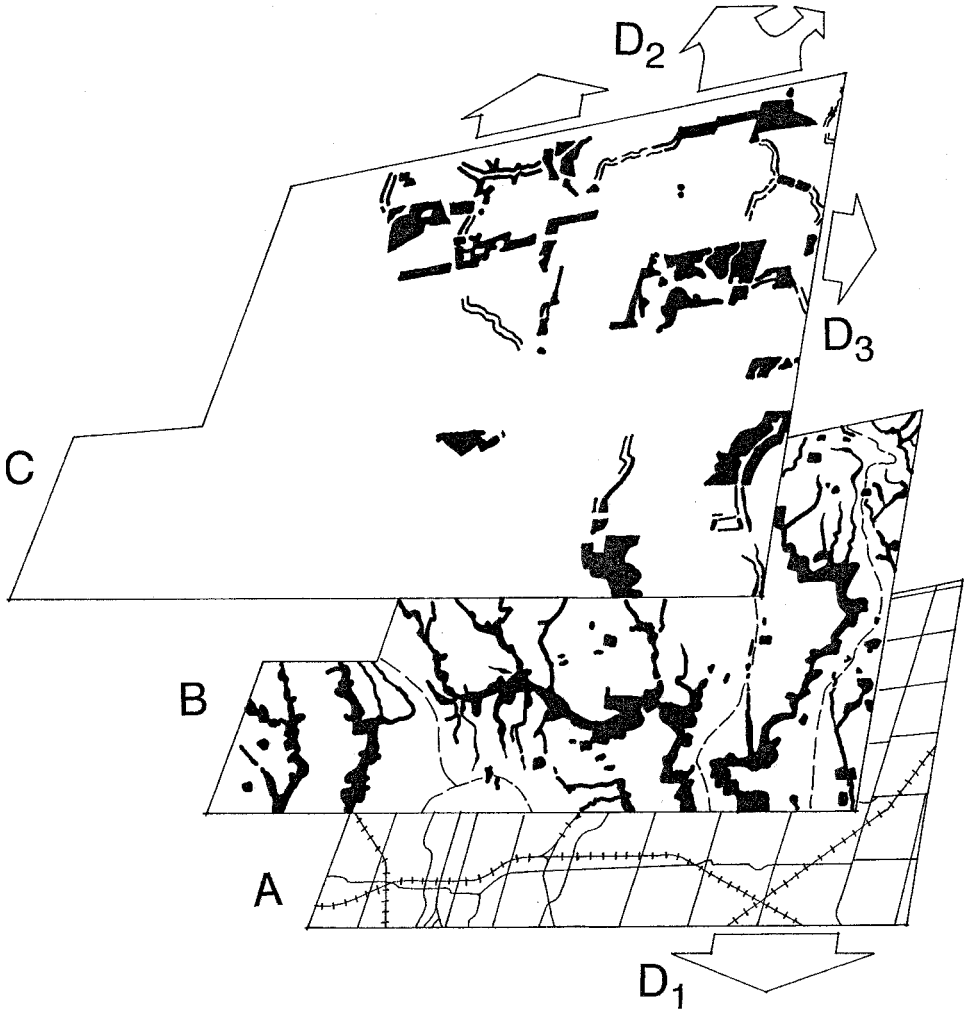


Figure 4. Markham Natural Features Study strategic layers: (A) Cultural landscape; (B) Environmental protection areas (EPAs); (C) Ecological restoration areas (ERAs); (D1) Lower Rouge Park; (D2) Oak Ridges Moraine; (D3) Trans-municipal and inter-watershed linkages. *Source*: Tamminga (1996), revised.

crenulated edge geometries that were contributing to 'edge effect'[7] (see Figure 4). As a general goal, the preservation + restoration[8] + greenway strategy in the NFS sought to buffer ecosystems internal to pending greenfield development, linking them via continuous, restored ecological corridors of 100 metres' width or more. The strategy will provide some ecological connectivity between the 1980s suburbs and the more robust valley-land and tableland forests beyond the current projects. The NFS also proposed environmental guidelines for greenfield development and a stewardship programme for landowners (GSHSW, 1993, Sections 4–6). Typical guidelines included policies for tree cutting, parkland dedication, valley lands and greenways.

Research Method

Ten approved secondary plans were compared with the recommendations of the 1993 NFS and the Markham Official Plan Amendment (OPA) 51 that implemented it. The comparisons were made by overlaying the plans at a common 1:20 000 scale. The key drawings were the urban design plans prepared for the developers, the maps from the secondary plans and the maps from the NFS and OPA 52. Aerial photographs, site photographs and land-use plans provided secondary information. The method was quite low-tech, since the data collection just pre-dated Markham's adoption of Geographic Information Systems (GIS). The urban design plans and planning maps were reduced to 1:20 000, copied onto tracing paper, overlaid and visually inspected. GIS and data collection with Global Positioning Systems (GPS) would make the mapping and comparison much easier today.

Detailed reviews of two secondary plans were conducted: Cornell, designed by Duany Plater-Zyberk, and Wismer Commons, designed by The Kirkland Partnership. Cornell is the oldest and largest of the secondary plans and had a single public-sector client. Wismer Commons is a standard centrally located block owned by multiple private interests. The comparative analysis was supplemented by key informant interviews with current and former municipal staff, environmental planners and the lead urban designers for the secondary plans.

General Results of the Analysis

Figure 5 provides a qualitative summary of the degrees to which the strategies mapped in the 1993 NFS are reflected in the New Urbanism concept plans, secondary planning documents and, to a limited extent, partial build-out on the ground. Figure 6 shows the spatial pattern of lands delineated for preservation or restoration in the NFS that were reflected in later Secondary Plans (shown in black).

The good news is that the plans follow the environmental *protection* areas initially delineated in the NFS (1993) and the related amendment to the Official Plan (OPA 52) approved in 1997. Regulated hazard lands (floodplains, valley lands and setbacks from stable top-of-banks) are protected by normal land-use planning techniques. Unfortunately, some key elements of the environmental *restoration* strategy are missing. In particular, several small woodlots and most proposed ecological corridor restorations were deleted.[9]

The extent to which the Secondary Plans accommodate EPA and ERA lands and reflect the NFS's ecological design principles is compared in Figure 5. Some New Urbanism development plans reflect the NFS policies in a limited manner, with the Cathedral and Angus Glen plans least consistent with the NFS principles. Most plans accurately follow the planning regulations that implemented the NFS in modified form following public and developer input sessions. The Cornell, Berczy and Wismer plans appear to follow the NFS principles most closely. Other plans, mostly those prepared more recently, challenge both the recommendations of the NFS and the town's regulations.

The Secondary Plans also show park space, usually designated as 'Neighbourhood Park' and 'Community Park'. These programmed and highly maintained open spaces have not been included in the analysis because, except for water infiltration, they are not particularly ecologically benign.

NFS Strategic Criteria \ Communities	Cornell	Greens-borough	Wismer Commons	Berczy	Angus Glen	Woodbine North	Cathedral	Markham Centre	South Unionville	Rouge Northeast
Reflects NFS Environmental Protection Areas?	●	◎	●	●	◎	◎	◎	◎	◎	●
Reflects NFS Ecological Restoration Areas?	●	○	○	○	NA	NA	○	NA	NA	NA
Urban edge influenced by natural features patterns?	●	◎	○	○	◎	○	○	○	○	●
Internal urban design form influenced by natural patterns?	◎	◎	◎	●	◎	◎	◎	◎	◎	●
Open space uses buffer natural features?	●	○	●	●	○	○	○	◎	◎	◎
Internal parks linked to natural vegetated corridor?	◎	◎	◎	◎	○	○	○	◎	○	◎
Internal road/path grid minimizes stream crossings?	◎	NA	◎	●	◎	●	○	◎	NA	●
Secondary Plan policies reflect NFS guidelines?	●	◎	◎	●	◎	◎	◎	NA	◎	◎
Minimizes active uses and space fragmentation in valleys?	●	◎	◎	●	○	◎	○	○	◎	◎

Legend

●	To a great extent
◎	Somewhat
○	Minimally or not at all
NA	Not applicable or no data

Figure 5. Comparative matrix of Markham new urbanist secondary plans vs Natural Features Study strategies.

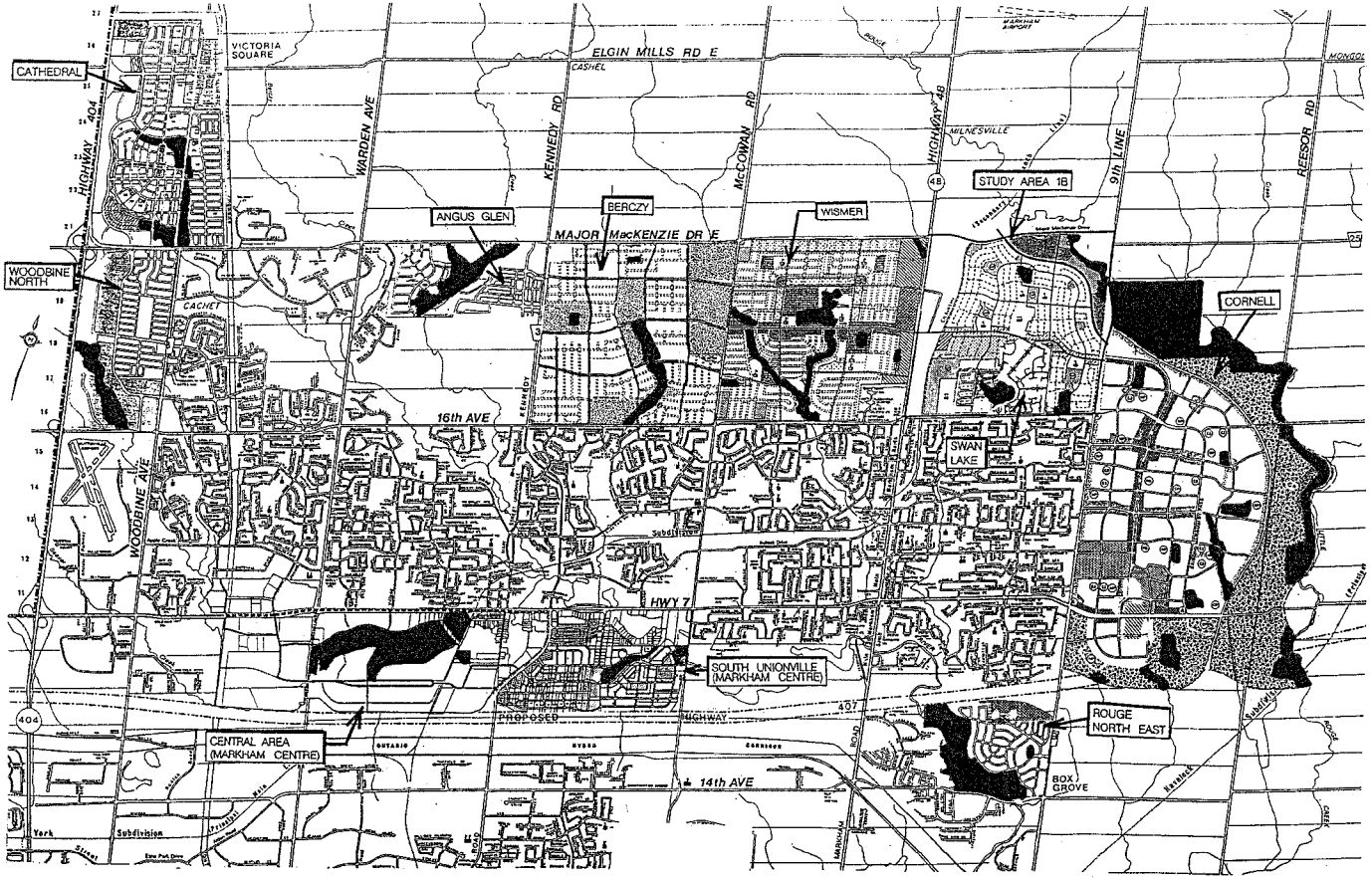


Figure 6. New urban secondary plans with Natural Features Study Environmental Protection Areas and Ecological Restoration Areas shown in black. *Sources:* Town of Markham and GSHSW (1993).

Figure 7. Aerial oblique photograph of first development phase of Cornell, ca. 2000. *Source*: Marshall Macklin Monaghan Limited, Markham.

Detailed Case Analyses: Cornell and Wismer Commons

Cornell and Wismer Commons are good examples of the key issues: both are well-designed projects based upon traditional neighbourhood development techniques. Cornell is a special case, because it served as the major New Urbanist precedent in Ontario and much of the land was publicly held. Cornell's planning had close scrutiny on the heels of the NFS, Markham Area Expansion Study and Rouge Park campaigns. Wismer Commons is centrally situated in the current development area. It balanced strong urban design with natural features influences, but, as discussed below, missed a key element of the restoration strategy for this locale.

The Cornell plan responded strongly to the NFS (see Figure 5). It incorporated all but a small parcel of early successional vegetation identified in the study. Woodlots and small stream corridors were well protected, and buffering provisions were provided for in Secondary Plan policies (Markham, 1994a). Figure 3 provides some indication of the landscape setting just prior to construction and Figure 7 illustrates the first phase of development. Extant hedgerows do not appear to have been considered as form givers or minor ecological entities in their own right.

What is remarkable about the Cornell plan is its willingness to embrace a combination of regional-scale natural lands to define its perimeter. As shown in Figures 6 and 8, the Rouge Greenlands serve as a sweeping natural boundary along Cornell's easterly edge.[10] Along the southerly edge of the development a Southeast Greenlands belt is established as a wide buffer to the newly built Highway 407 and as a westerly jutting extension of the planned reforested Rouge Park tablelands. An intriguing Central Greenlands belt extends east–west through the centre of the community, tying a large isolated woodlot into a restored natural network, and introducing an ecological spine into an otherwise highly structured series of streets, blocks and parks.

The only notable inconsistency with the NFS is at the northern extremity of the Cornell plan. Where the NFS identifies a restored 100-m-wide ecological corridor flowing directly north into the Little Rouge creek, the Cornell plan calls for a somewhat smaller, and less strategically shaped, solution crossed by three local roads.

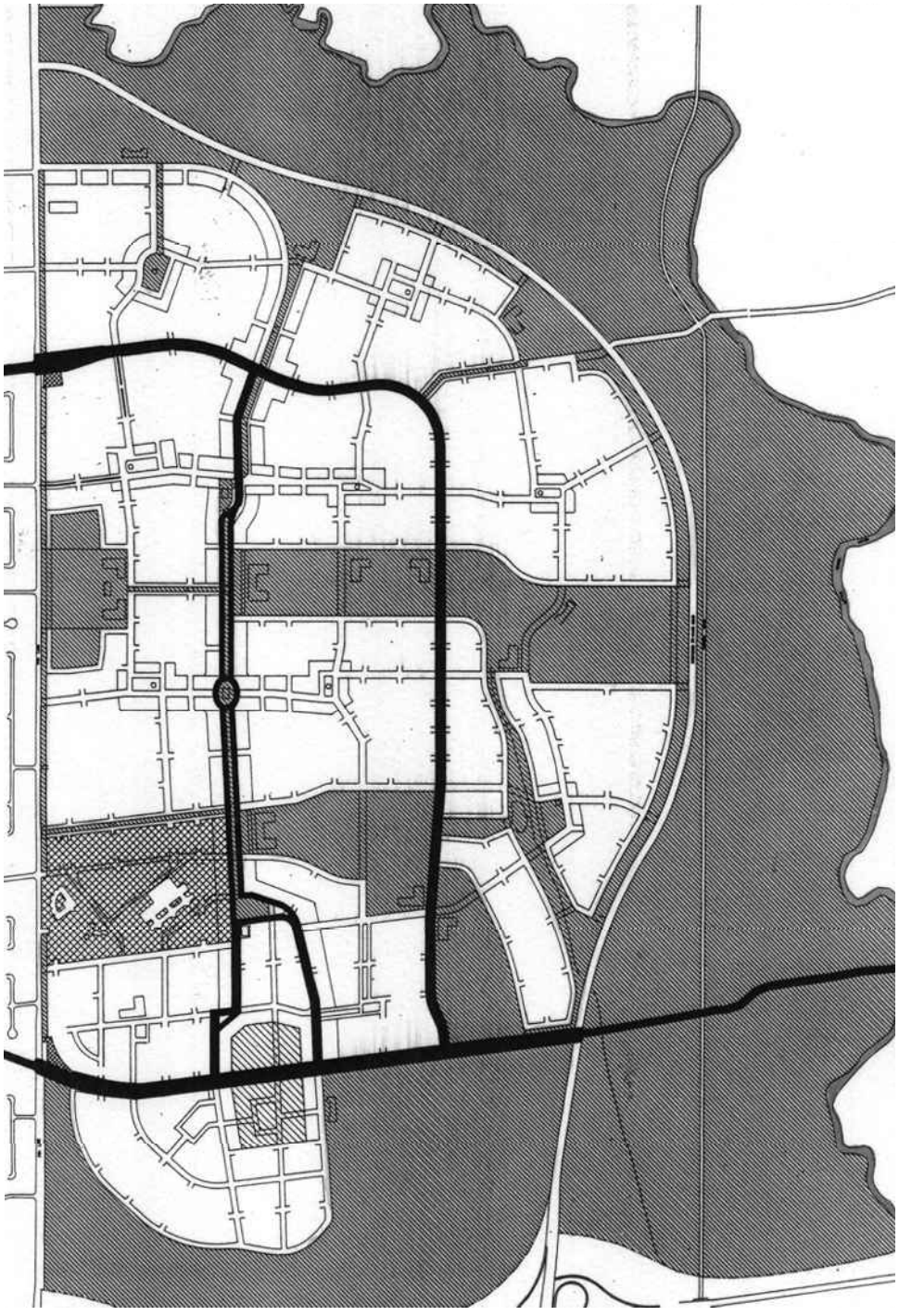


Figure 8. Cornell open-space system. *Source*: Duany Plater-Zyberk Town Planners, Miami.

The Wismer Commons plan (see Figure 9a) was free from the dominating and form-giving influence of the expanding Rouge wildlands park. For this $1\frac{1}{4}$-mile square block the NFS identified ecological corridors along branches of a creek, several woodlots and a partial grid of hedgerows. A jumble of individually owned land parcels was synthesized into a strong urban design scheme by The Kirkland Partnership in 1995. The resultant Secondary Plan cited as a goal the "preservation and protection of the natural environment, most particularly the valleys and aquatic resources of Robinson Creek and the existing mature woodlots, to the extent practical" (Markham, 1997b, p. 14). Open-space objectives included the creation of open-space areas which "conserve and enhance existing natural features", well-managed water resources, and a "continuous greenway, wherever possible" (Markham, 1997b, pp. 15–16). Hazard lands and a watercourse had 10–15-m buffer zones included in the plan. The upland woodlots identified in the NFS were designated as 'Open Space—Environmentally Significant Areas'. These areas were subject to preparation of Environmental Impact Studies. Policies called for the incorporation of hedgerows and tree stands and continuous road frontage along natural open-space amenities (Markham, 1997b, p. 29).

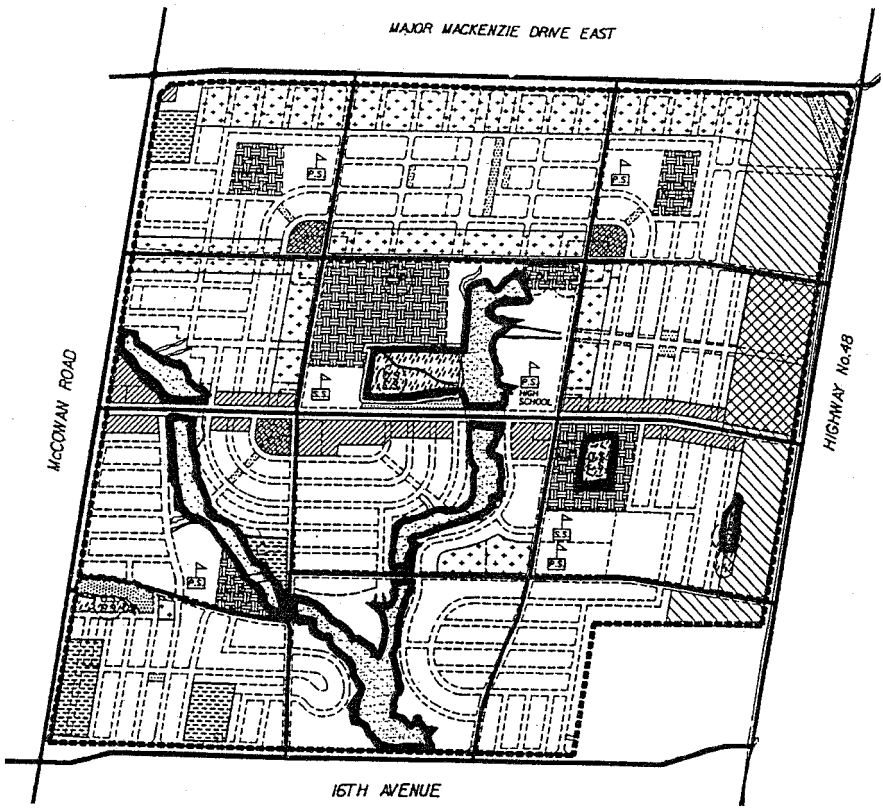
Most interesting, perhaps, were provisions for the major creek crossings that called for "minimal intrusions and alterations to existing valley landforms and functions" and "exact citing and location of crossings at the detailed design stage" (Markham, 1997b, p. 38). The crossing design must address pedestrian and wildlife access in the valley corridor, the minimization of structural intrusions on stream dynamics, and the retention and establishment of riparian habitat. It remains to be seen whether this will translate into well-crafted bridging structures. Leading urban designer Michael Kirkland stated his preference for "bridges of sufficient span and height to allow natural systems and pedestrians to run unimpeded along the stream corridor". He imagined "a shallow, vaulted bridge as a delicate physical gesture", stating his regrets that he "couldn't be there for implementation, since how you do that makes all the difference" (Kirkland, pers. comm., 11 January 2002). Unfortunately, the policy stops short of prohibiting constrictive culverts as a design option. While the Town requires Environmental Master Drainage Plans for each sub-watershed and an implementing Stormwater Management Plan for each Secondary Plan, minor watercourses and road crossings continue to pose one of the key tensions between the ecological planning and New Urbanist built form (Duoba, pers. comm., 18 January 2002).

The Wismer Commons plan was one of the few to let hedgerows and woodlots strongly influence the urban design parterre. The Secondary Plan (see Figure 9a) calls for park blocks to be built around the two major woodlots. Three more park squares and pedestrian links construct a civic design motif that recalls the classic plan of Savannah, Georgia.

How a Link was Lost

Could the Wismer Commons plan have been more ecologically receptive? A comparison between successive plans (the NFS strategy, OPA 52 and the Wismer secondary plan) suggests it could have. Figure 9a–c show three plan excerpts. The NFS (Figure 9b) clearly calls for a restored linkage (minimum 100-m-wide ecological corridor) between the Milnesville Wet Woodlot north of

(a)



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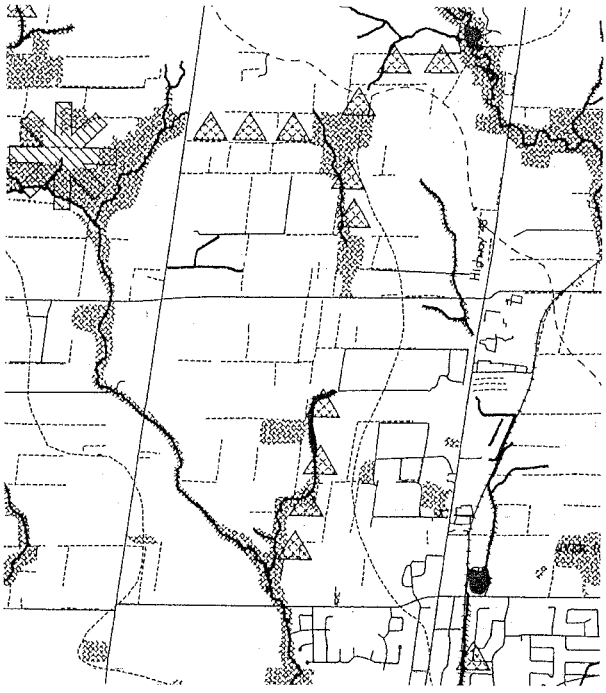

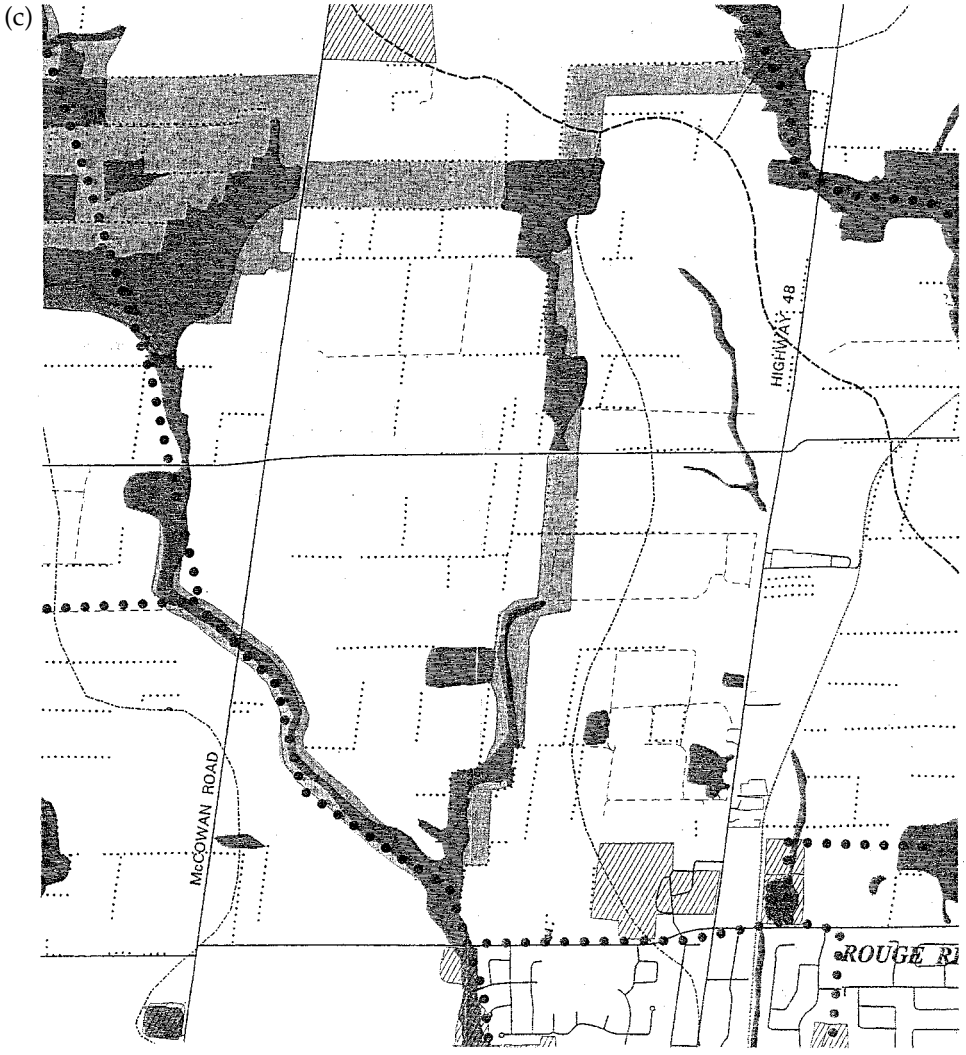

Figure 9. Comparative plan excerpts. (a) Wismer Commons Secondary Plan, 1995 (EPA lands outlined in black). (b) Natural Features Study, Schedule 2, 1993. (c) Official Plan Amendment 52, Schedule I(ii), 1997 (EPA lands shown in dark grey, ERA lands shown in light grey). *Sources*: GSHSW (1993) and Town of Markham.

the site and the remnants of the east branch of a creek in the middle of the Wismer Commons block. Milnesville Wet Woodlot is at the headwaters of the creek's other branch, providing cold, clean water downstream. This forested wetland helps establish the creek system as the only centrally located cold-water sub-watershed in the municipality (GSHWS, 1992). At stake is not only a vital ecological circuit—the restored ecological corridors linking Milnesville Woodlot to natural features east and west complete the sub-system—but also the home of the nationally rare Redside Dace (*Clinostomus elongatus*), a small minnow suscep-

tible to stream warming, turbidity and removal of riparian vegetation (GSHSW, 1992, p. 6–6).

Lilli Duoba, Manager of Environmental Planning with the town of Markham, explained that the linkage between Wismer Commons and the Milnesville Woodlot was lost through a series of events shortly after the adoption of the NFS. First, negotiations with developers and landowners throughout the municipality were long and complex. OPA 52 (Figure 9c) was finally approved in the spring of 1997. In the meantime, ongoing Secondary Planning processes were being required to 'have regard for' the NFS. When Kirkland slid the NFS map under his tracing paper to begin the design in 1993, the NFS had no legal status. The remnant creek was not vegetated and barely visible as a minor depression on the ground.

The northerly area of the Wismer block had undergone some earthworks, and the landowner would not accept the delineation of the east branch as a minor watercourse. A compromise was struck whereby the ecological corridor was downgraded to an intermittent pedestrian link (Duoba, pers. comm., 18 January 2002). The lead designer concluded, "When there is no official policy, there is only so far you can go … " (Kirkland, pers. comm., 11 January 2002).

Overlaying the map sequence results in a potential development module defined by a loop of green infrastructure: the east and west branches of the Robinson Creek (ecological corridors), Robinson Swamp (a major ecological node) to the north-west and the Milnesville Wet Woodlot (a moderate-size ecological node) at the north-east corner. The bisection of the area by east–west and north–south arterial roads presents an enticing urban design counterpoint. Considerable caution and advice from landscape ecologists would be needed in the urban design stage in order to ensure the continued hydrological integrity of the area as a cold-water sub-watershed.

As a demonstration of potential collaboration between ecosystem planning and New Urbanist design principles, this 'greater Wismer Commons' community could embrace a restorative ecosystems strategy while accommodating compact urban growth. If this were to be realized, municipal planning policy would need to give the 100 + -m-wide ecological corridors the same legal status as ESAs.[11] The smaller tentacles of the natural system that permeate development sites also need protection and restoration recognition in the Secondary Plan, and should be given status as urban design principles.

The final task would be to implement the principles through the development stages, moving beyond simple site analyses to apply ecological science throughout the design process. Well-buffered, continuously vegetated first-order streams and woodlots then become important contributors to the larger community and regional ecology. They also provide green infrastructure for planning, suggesting urban design responses that tap into the genius of the place. Local road crossings, for instance, become a collaborative design challenge that seeks to respect the integrity of riparian corridors, rather than culvert engineering.

Conclusions

The ecological information in the Markham NFS arrived in time to provide a better level of protection for ESAs than would normal regulatory practice. These patches and corridors were properly integrated into the higher-density suburban plans designed with New Urbanist principles. The more subtle requirements of

Figure 10. Cornell streetscapes. *Source*: Marshall Macklin Monaghan Limited, Markham.

ecosystem *restoration* were not well served by just-in-time natural features planning. Some of the key links were lost for want of regulatory status, expert advice and financial support. The Canadian environmental planners were negotiating at a distinct disadvantage without the formal adoption of the policies at the local level and with a new provincial government that weakened planning legislation in 1996 (Pollock-Ellwand, 2001). The private developers received higher gross residential density in the New Urbanist plans, but they still resisted the loss of property not designated as hazard lands for ecological restoration. The economic imperative collided with the environmental proposal, with predictable results.

Ideally, pre-emptive ecosystems planning should be done at a regional scale, well in advance of secondary planning, or even speculative purchase of agricultural land. It should be supported by financial incentives for purchasing land or development rights. This is probably the only possible implementation method in the USA, where the legal system probably precludes the regulatory approach taken by Markham and other Canadian planning agencies (Hostovsky *et al*., 1995). The many rural land conservation initiatives under the Smart Growth umbrella are a particularly good fit with pre-emptive ecosystem planning (O'Neill, 2000; Calthorpe & Fulton, 2001; Maryland Department of Planning, 2001). The ecological restoration plan provides a scientifically based identification of the priority lands for acquisition by publicly sponsored conservation authorities and land trusts. Maryland's GreenPrint programme is a good recent example of this approach (Maryland Department of Planning, 2001; Maryland–National Capital Park and Planning Commission, 2001).

Is pre-emptive ecosystems planning a good fit with the New Urbanism? There is nothing in the *Charter of the New Urbanism* to preclude such a combination, and much to support it (Congress for the New Urbanism, 2000). The Cornell experience shows that they can work well together with a supportive public client (see Figure 10). The green infrastructure can provide natural boundaries, or edges, to neighbourhoods and communities that can enhance the authenticity of urban design (Hough, 1990). However, a preference for web (or grid) street patterns, rather than hierarchical networks, requires additional design talent to resolve conflicts with natural systems. The cul-de-sac and the Planned Unit Development (PUD) provide easy solutions for some difficult crevices in the landscape. Ironically, the price of extra connectivity in the human ecosystem

(street webs) is more conflict with the natural ecosystem, which also desires the same pattern of multiple, inter-connected nodes and corridors.

Will the transect planning techniques (Duany & Talen, 2002) improve the fit between New Urbanism and ecosystems planning? The regional section is a useful analytic tool and it is certainly preferable to have multiple design codes, which are each tuned for their regional location. However, the major improvements in connecting ecology and the New Urbanism are likely to be made in plan, rather than in section, since natural systems are even more varied in plan than cities. Preliminary results for best practices such as water quality appear to be positive (Blais, 2000; Steuteville, 2000; Berke *et al.*, 2002).

There is a gap between landscape ecology and urban design that needs to be bridged. Some environmental planning is strong in natural areas but appears to lose prescriptive power at the suburban edge, or demonstrated low-density solutions (McHarg, 1969; Noss & Cooperrider, 1994; Forman, 1995, Chapter 13). Few natural ecologists have provided normative models for higher-density urban and suburban environments that are useful for practising urban designers (Spirn, 1982; Soule, 1991; Hough, 1995; Tamminga *et al.*, 2002). Dramstad *et al.*'s concise manual (Dramstad *et al.*, 1996) is a welcome aid to practice and teaching in this area, but it is also stronger at the sub-regional than at the neighbourhood scale. The need for accessible information is serious, because experienced urban designers are unlikely to have been trained in the relatively young field of landscape ecology, and new graduates are not likely to encounter it in the curricula of most schools.

As New Urbanism engages the regional landscape, it must acknowledge natural capital that is both apparent and hidden. Most urban designers will spot obvious surficial natural features that need protection. However, the links needed for ecosystems *restoration* are largely invisible and require scientific skills to design. Unless the ecological sciences are more fully integrated into the design and planning process, hidden or ephemeral ecological functions are likely to go unnoticed or undefended. Pre-emptive ecosystems planning cannot, alone, ensure ecological integrity in a region. It is the responsibility of the design team, local planners, political leaders and residents to protect, restore and connect the finer-grained ecologies in the on-going pursuit of healthy and convivial new communities. We need new models of co-operation and practice between urban designers and ecologists to reach this objective.

Notes

1. A regional plan designates growth nodes, regional infrastructure networks and open-space systems in most Ontario urban areas. However, the Regional Municipality of York had not yet adopted its Regional Official Plan when the events described in this article took place. Markham's policies controlled most development.
2. Only 5.6% of Markham's land cover in 1992 was non-anthropogenic ('natural') vegetation, one of the lowest rates in the province. Mature woodlots, the predominant pre-settlement condition, accounted for a mere 1.6% of Markham's land area (GSHSW, 1992).
3. In 1992, 28% of Markham's 506 plant species were non-indigenous (GSHSW, 1992).
4. Ecological integrity includes a critical range of variability in biodiversity, ecological processes and structures, regional and historical context, and sustainable cultural practices (Society for Ecological Restoration (SER), 1998). Riley & Mohr (1994) defined ecological integrity as the capability of an area to support and maintain assemblages of organisms that have a composition and functional organization comparable to that of the region's natural habitat.

5. The first phase of the Rouge Park south of Steeles Avenue was officially proclaimed in April 1995. Subsequent expansion up through Markham and to the Oak Ridges moraine will, at 4700 ha, result in the largest urban region wildlands park in North America (Rouge Park, 1997).
6. 'Edge effect' is the influence of biological and physical factors of an open landscape into an interior forest setting. In areas impoverished of interior forest habitat, edge effects generally have a negative effect on the forest ecosystem and its organisms. For a simplified description of landscape ecology principles intended for planners, urban designers and studio use, see Dramstad *et al*. (1996).
7. Ecological restoration is the process of assisting the recovery and management of ecological integrity (see above) (SER, 1998).
8. The NFS calls for proportionally much greater ecological restoration in the fourth wave (post-2011) blocks and beyond, as 'hinterland' ecosystems associated with the upper Rouge and Little Rouge Rivers come to bear.
9. At the time of writing, the Rouge North Management Plan is under negotiations between the Rouge Park Alliance (the park's governing partnership) and local, provincial and federal jurisdictions. The Town of Markham has adopted in principle (Duoba, pers. comm., 18 January 2002).
10. As Markham's development presses northward a related issue looms: lands identified in the NFS for restoration to achieve major ecological nodes of sufficient size and geometry are conceptually identified in the pending rural lands OPA with vague star symbols. Such graphic imprecision delays inevitable planning tensions, but also tends to lead to a watering down of land conservation goals.

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