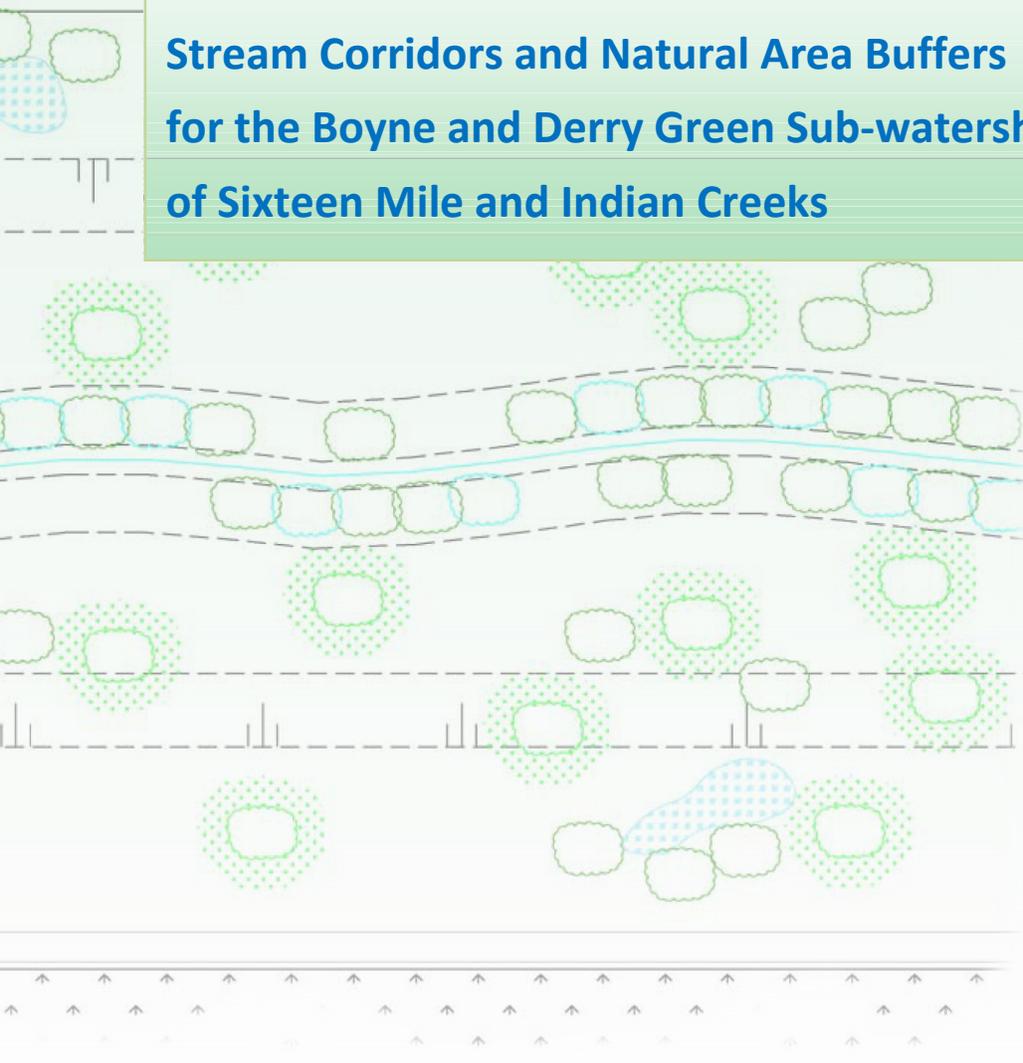




RESTORATION FRAMEWORK:

**Stream Corridors and Natural Area Buffers
for the Boyne and Derry Green Sub-watersheds
of Sixteen Mile and Indian Creeks**



ACKNOWLEDGEMENTS

The need for a sub-watershed specific restoration approach was identified in consultations with the Town of Milton, Landowners and Conservation Halton staff during the Sixteen Mile Creek Sub-watershed Update Study, which culminated in two approved Secondary Plans (Boyne and Derry Green). The Restoration Framework was built on initial drafts prepared by Renovo Watershed Sciences Inc. and Savanta Inc. for the Milton Phase 3 Landowners Group, and advanced by Dougan & Associates on behalf of the Town of Milton in consultation with representatives from Conservation Halton, the Region of Halton, and restoration design and horticulture practitioners. Special thanks to Martin Bateson and Jon Meyer (Town of Milton Engineering Services), Stephan Crispin (Beacon Environmental), Mary Gartshore (Pterophylla), Tom Hinks (Connon Nurseries), and Stephen Smith (Urban Forest Associates) for their helpful input.

**Dougan & Associates
Ecological Consulting
& Design
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Table of Contents

1	INTRODUCTION.....	1
1.1	Purpose, Scope and Design Role.....	1
1.2	Objectives.....	2
1.2.1	SUS and FSEMS Recommendations.....	2
1.2.2	Conservation Halton Regulation.....	2
1.2.3	Town of Milton Operations.....	3
1.3	Technical Basis for Restoration Framework.....	3
2	ECOLOGICAL RESTORATION GOAL AND DESIGN PRINCIPLES.....	3
2.1	Goal.....	3
2.2	Ecological Principles.....	4
2.2.1	Succession Model.....	4
2.2.2	Biodiversity.....	4
2.2.3	Channel Functions.....	5
2.2.4	Forest Cover Targets.....	6
2.2.5	Wetland and Wildlife Habitat Creation.....	7
2.2.6	Habitat for Species at Risk and Other Species of Conservation Concern.....	8
3	IMPLEMENTATION.....	8
3.1	Coordinated and Collaborative Approach.....	9
3.2	Phasing.....	10
3.3	SIS Conceptual Design.....	10
3.4	Subdivision Agreement and Securities.....	11
3.5	Designer and Contractor Prequalification and Certifications.....	11
3.6	Peer Review Requirement.....	12
4	MAINTENANCE AND MONITORING.....	12
4.1	Warranty and Performance Monitoring.....	12
4.2	Adaptive Management.....	13
5	PLANTING GUIDELINES - TOOLS AND APPROACH.....	13
5.1	Habitat Restoration Materials and Methods.....	14
5.1.1	Restoration Materials.....	14
5.1.2	Soil Preparation.....	14
5.1.3	Recommended Timing of Planting.....	15
5.1.4	Other Restoration Techniques.....	16
5.2	Watercourse Corridor Cover.....	17

5.2.1	Planting Nodes	18
5.2.2	Live Staking	21
5.3	Natural Feature Buffers	21
5.4	Hedgerow Buffers.....	22
5.5	Riparian Cultural Meadow and Cultural Thicket Establishment – Target Locations and Planting Guidance	23
5.6	Emergent Marsh Establishment – Locations and Planting Guidance.....	23
5.7	Wetland and Pool Establishment.....	23
6	CONCLUDING REMARKS	24
7	BIBLIOGRAPHY	25

Appendix A – Tables

Table 1 – Restoration Materials

Table 2a – Planting Material Quantities by Nodes and Zones

Table 2b – Planting Material Quantities for Natural Feature Buffers

Table 3 – Summary of Planting Coverage for 100m Watercourse Corridor Length

Table 4 – Watercourse Corridor Node Type Applications Table

Table 5 – Master Checklist for Implementation of Landscape Plans

Table 6 – Monitoring and Adaptive Management Plan

Table 7 – Monitoring and Adaptive Management Targets and Actions

Appendix B - Figures

Figures 1a and 1b – Typical Planting Treatment – 65m Stream Corridor

Figure 2 – Node Details

Figure 3 – Typical Stream Corridor Section and Habitat Structure Details

Figure 4 - Typical Planting Treatment – Feature Buffers

Figures 5a and 5b – Annotated Examples of SIS Level of Detail

Appendix C – Literature and Practice Basis of Approach

1 INTRODUCTION

Section 1 of the Restoration Framework document addresses the Purpose, Scope and Design Role of the Framework. Section 2 contains Ecological, Restoration and Design Principles. Section 3 provides detailed guidance on the Implementation of the Framework including Sub-watershed Impact Studies (SIS) content, and Section 4 addresses the Monitoring and Adaptive Management Plan. Finally, Section 5 contains detailed guidance on content for detailed Landscape Plans. Appendices include Tables, Figures, and Literature and Practice Basis of Approach.

1.1 Purpose, Scope and Design Role

The *Restoration Framework: Stream Corridors and Natural Area Buffers for the Boyne and Derry Green Sub-watersheds of Sixteen Mile and Indian Creeks* document was prepared to support new development of lands within the Boyne Secondary Plan (including the portions extending into the Indian Creek headwaters), and within the Derry Green Secondary Plan. The Framework addresses implementation of the respective Natural Heritage Systems recommended in the *Sixteen Mile Creek Sub-watershed Update Study* (SUS: AMECFW 2015), and the *Functional Sub-watershed Environmental Management Studies* (FSEMS: AMECFW 2015) for individual Secondary Plan areas. The need for a sub-watershed specific restoration approach was identified in consultations with the Town, landowners and Conservation Halton during the SUS process, which culminated in the approved Secondary Plans (Boyne and Derry Green). The SUS Natural Heritage System (NHS) study process identified stream corridors with enhanced buffers, an approach supported by Conservation Halton and the Town's SUS Study Team, and ultimately agreed to by landowners, subject (where contained in the specific FSEMS) to Implementation Principles.

The Framework is compliant with the intention of the *Conservation Halton Landscaping and Tree Preservation Guidelines* (CHLTPG 2010), which apply to areas falling under Conservation Halton Regulation, and is intended for use by landscape architects and other practitioners preparing landscaping plans, restoration plans and tree preservation plans. In particular, the CHLTPG states (p. 8):

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This Restoration Framework specifically references key concepts and resources in the CHLTPG, including standards for native species selection, ground covers, erosion control, adapting to moisture conditions, invasive species control, and soil treatments. It also integrates knowledge from Town staff and landowner experience in Milton, and fits into the Town's Monitoring and Adaptive Management Program for new development areas.

The Restoration Framework is intended to address the following NHS features and areas:

- Stream corridors along existing tributaries to remain, or to be relocated;
- Buffers adjacent to key NHS features comprising part of the NHS (e.g. existing woodlands, wetlands and hedgerows specified in the NHS); and

- Habitat creation and enhancement areas identified in the FSEMS and Implementation Principles/Schedules (where applicable).

The Restoration Framework supports the FSEMS vision, to implement the recommended NHS with robust habitat corridors, buffers around key natural features, and site-specific restoration in NHS features. Restoration principles, vegetation community targets and planting node densities and materials provide direction to concept plans to be prepared as part of Sub-watershed Impact Studies (SIS), and to final Landscaping Plans to be implemented under the terms of Subdivision Agreements. Plans prepared under this Framework are subject to review by the Town and Conservation Halton, with results to be confirmed through the Subdivision Agreement and Milton's monitoring program.

The Restoration Framework does not apply to landscaping of stormwater management facilities; the CHLTPG will continue to apply to those facilities.

1.2 Objectives

1.2.1 SUS and FSEMS Recommendations

The Framework is intended to guide restoration of robust riparian corridors where generally none exist today, integrating the habitat restoration works prescribed in the FSEMS for each area. Typically there is only about 4% existing forest cover on tablelands and along headwater tributaries, outside the major valley features of the East, Middle and Main Branches of Sixteen Mile Creek. The SUS and FSEMS studies for Boyne and Derry Green identify more than 24 km of new channels that will comprise at least 145 ha of new corridor area. The future NHS as envisioned in the FSEMSs emphasize habitat creation and added functionality along watercourses which will form the primary habitats in the landscape. The NHS will be implemented over several decades, encompassing important headwaters connected ultimately to protected Greenbelt valleylands to the south, east and west. The wider stream corridors represent larger planting areas than in previous Secondary Plans; the Framework will help balance this increase with tactics for efficiencies that are ecologically defensible.

The FSEMS are prescriptive regarding the targeted cover of forest and wetland within the corridors: recommending the use of more diverse plant materials and species, from seed to seedlings to selected larger materials; incorporating key colonial species to enhance expansion of woody cover towards the targets. The FSEMSs also detail recommendations for off-line wetlands (within corridor buffers), floodplain wetlands, habitat structures, hibernacula, basking areas, turtle nesting sites, and safe road crossings for wildlife. The Framework addresses the ecological focus as well as aesthetic context by providing adaptable and diverse planting node types. The techniques require specialized materials, qualified designers and contractors, and a robust monitoring and adaptive management regime to ensure outcomes.

1.2.2 Conservation Halton Regulation

The Restoration Framework was developed in keeping with the *Conservation Halton Landscaping and Tree Preservation Guidelines* (CHLTPG 2010), which apply to areas regulated under Ontario Regulation 162/06. The Restoration Framework is endorsed by Conservation Halton and specifically references key concepts and resources in the CHLTPG, including standards for native species selection, ground covers, erosion control, adapting to moisture conditions, invasive species control, and soil treatments. It also integrates knowledge from Town staff and landowner experience in Milton, and fits into the Town's Monitoring and Adaptive Management Program for new development areas. Any planting or restoration projects within the

Boyne and Derry Green Secondary Plan areas should adhere to the Restoration Framework. Approval from Conservation Halton under Ontario Regulation 162/06 must be obtained for restoration projects within regulated areas prior to works being carried out.

1.2.3 Town of Milton Operations

The Town requires operational flexibility to plan and manage corridors with respect to flood risks, trash, illegal activities, invasive species, appropriate recreational use, and aesthetic concerns of residents. This Framework includes considerations to help manage operational costs (immediately post-development and longer term) by facilitating maintenance interventions. The Framework is enforced under Subdivision Agreements, and integrates with Local and Holistic monitoring and adaptive management for corridors and other NHS elements.

1.3 Technical Basis for Restoration Framework

The ecological restoration design principles for the Framework reflect restoration literature, policy documents (PPS 2014; NHRM 2010; Region of Halton Official Plan 2006), other important guidance documents (e.g. SER 2002; *Conservation Halton Landscaping and Tree Preservation Guidelines* 2010; Havinga and Daigle 1996), contemporary experience performing large scale ecological restoration, and intensive discussion and input from the Town of Milton, Region of Halton, Conservation Halton, and consultants for landowners. Appendix C summarizes literature on the ecological benefits of the nucleation and biodiversity enhancement approaches embodied in the Framework. Other actions in the Framework reflect FSEMS recommendations by employing current restoration best practices. It is anticipated that further refinements of approach will occur both through implementation of the Framework, and based on new trends in ecological restoration practices.

2 ECOLOGICAL RESTORATION GOAL AND DESIGN PRINCIPLES

2.1 Goal

Naturalized plantings and restoration work will help to establish the ecological features and functions of a connected regional and local natural heritage system. This system will provide diverse habitat types, support increased ecological functions, and ultimately create a viable, self-sustaining natural system within an urbanized setting.

Urbanization will replace the generally rural landscapes in the approved Secondary Plan areas, which contain scattered habitat features (woodlands, wetlands and cultural communities) that are generally disconnected, with the exception of the more continuous natural areas associated with the East, Middle and Main Branch Sixteen Mile Creek valleys. The recommended NHS will increase the overall natural cover on the landscape, enhancing successional processes within new vegetation communities. Existing significant natural features will be restored and enhanced where beneficial (i.e., control and removal of invasive and/or aggressive non-native plant species), and will receive complementary restoration treatments in immediately adjacent buffers and identified areas for habitat creation/enhancement as identified in the FSEMS and SIS.

The following principles have been developed specific to the future NHS landscape. These draw upon and are supportive of general and specific restoration recommendations contained within the FSEMS.

2.2 Ecological Principles

This section summarizes the principles that guide the Restoration Framework approach, including the ecological themes and targets. These provide direction to guide the preparation of concept plans as part of individual SIS.

Section 3 provides detailed guidance on the Implementation of the Framework including SIS content and project phasing, and Section 4 addresses the Monitoring and Adaptive Management Plan. Section 5 contains detailed guidance on content for detailed Landscape Plans.

2.2.1 Succession Model

Nodal and banded plantings form the core of the ecological strategy in the Framework. Nodes (aka nuclei, pods, modules etc.) provide islands of planted woody material, set into a matrix of created old fields and riparian meadows. They mimic the natural form and progression of woody succession in open areas in southern Ontario and elsewhere: a core (nucleus) of slightly larger woody plants, with bands of shrubs and seedlings extending from the core. This encourages micro-climate development using clearly-defined planting areas that facilitate monitoring and management. Use of seed and smaller materials allow cost-effective over-planting and natural thinning to account for potential material losses. Biodiversity is achieved through the greater number of propagation units (seed, rooted plants) with concentrated nodal areas of woody materials. Species that spread vegetatively, or that produce seed early after establishment, are favoured as core plant materials. The node plantings begin to expand once established to a 'free to grow' stage, a performance concept recognized in the forestry sector.

Nucleation has been long advocated as a cost-effective restoration strategy to achieve mixed-aged forest in southern Ontario, including urban settings; Appendix C-1 provides a summary of literature. Various descriptions as planting pockets, cells, nuclei, nodes, modules or pods, Daigle and Havinga (1996) detailed the approach and numerous ecological and practical benefits that are contributed by the use of pockets of planting, to yield "*a diverse, uneven-aged forest community*". Restoration practitioners and guiding documents in southern Ontario all highlight the value of nucleation as an effective tool for large scale projects, and the use of smaller plant materials to achieve higher biodiversity. Conservation Halton has approved planting designs within their jurisdiction that included nucleation approaches.

Implementation is discussed in detail below. Nucleation fits well with phasing of NHS works, allowing new corridors and buffer areas to be graded, key habitat elements installed, followed by seeding. Woody nodal plantings can be installed 1-2 years later, facilitating sourcing or contract growing of appropriate native materials, over-seeding with diversifier species, with planting in the optimum seasons. This can help to address NHS implementation phasing that is recommended in the FSEMS.

2.2.2 Biodiversity

The created corridors will become the core natural habitats within the new urban landscapes of Milton; therefore the Framework seeks to maximize biodiversity from the outset, using diverse seed and rooted materials. The rooted material provides more immediate aesthetic effects and microclimate benefits, but seed and smaller rooted plant materials are essential for their added biodiversity benefits. As discussed under Implementation, collaborative and coordinated construction of new corridors can magnify biodiversity and cost benefits.

Knowledge shared by suppliers, contractors, growers, and restoration designers indicates that

an alarming amount of ‘native’ plant material is currently imported from sources well outside our region, and that, due to high demand, larger specimens are often clonal cultivars substituted for open-pollinated stock (i.e. with limited genetic variability and hence less adaptive). Aggressive non-native plants or cloned ornamental cultivars, often substituted for specified native materials, undermine biodiversity objectives and may contribute to future system instability. Larger woody materials require more care to establish, and higher densities of stock typically outperform larger material in the long term as larger stock creates imbalance between root mass and shoot. Larger stock requires higher initial maintenance and on large remote sites leads to replacement requirements that further challenges available supply and quality control. The net effect is the reduction of biodiversity introduced in the restoration plantings.

As discussed in Appendix C-1, over the past two decades the Nature Conservancy of Canada has demonstrated that large scale habitat restoration is feasible in southern Ontario, primarily reliant on direct seeding and incorporating approximately 100 native species of local origin. The installations have tested the use of non-persistent and non-allelopathic nurse crops, mechanical as well as hand-seeding techniques, and progressively lower seeding rates to make best use of valuable native seed. The cost savings of direct seeding compared to the use of larger plant materials are substantial – about 1% of the average cost of using rooted stock on a treatment area basis. The biodiversity benefits are also substantial; there is evidence that these seeded systems are achieving the “*portfolio effect*” described by Tilman (1999): like a financial portfolio that is more stable when diverse, statistical averaging over the new plant community provides general landscape biodiversity and higher pockets of biodiversity at a microsite level.

In keeping with the principle of biodiversity enhancement, comments on landscape plans by the Town and Conservation Halton may include recommendations for amendments to planting materials to ensure that a broad range of appropriate native species are introduced with plantings under the Restoration Framework. The CHLTPG (2010) contains several resources recommending appropriate species. The Framework has provisions for the use of a wide range of propagule types, including seed, plugs, seedlings and larger stock; given factors such as site-specific objectives, market supply, pests and diseases, and climate change effects. Therefore an adaptive approach is preferred over a more prescriptive approach to promote greater biodiversity in plantings. Implementation is discussed in greater detail below. The use of seed and smaller rooted plant material, and soil enhancement, requires designers and contractors with adequate experience in these specialized applications.

2.2.3 Channel Functions

The FSEMS provides recommendations for natural channel design of the relocated or enhanced watercourses. Landscape Plans will place a high priority on shading of the watercourse with diverse native plant cover, sustained by providing a mosaic of light conditions and canopy structure from uneven-aged trees, supported with relatively dense native shrubs and grasses, resisting development of even-aged forest cover which can trigger greater erosion due to loss of understory elements. Riparian zone shading will emphasize the establishment of a relatively continuous spine of woody-dominated cover along at least 75% of the riparian zone. The spine will be complemented by the establishment of a diversity of successional communities (open meadow, shrub thicket and treed nodes). Vigorous, diverse cover of native herbaceous species including narrow-leaved grasses, sedges and broad-leaved forbs, will provide effective water quality polishing in the growing season, and taller species will provide shade to moderate stream temperature. The meadow component serves a particular role in maintaining headwater channel form particularly where stream gradients may be less than 1%. Floodplain wetland habitat creation will occur in areas where viable and sustainable hydrologic flow and inundation patterns can be established. These will be reinforced within the overall planted corridor with planted

valley slopes and the tableland buffers.

2.2.4 Forest Cover Targets

The FSEMS direction on forest cover is as follows:

The eventual forest cover within riparian corridors and linkages should be in the 60-75% range to achieve a variety of environmental benefits. Reforestation of nodes representing 25-30% of areas to be eventually forested will trigger woody succession toward the end target.

The existing landscapes in the sub-watersheds are largely agricultural, with limited natural forest and wetland cover (about 4%). The majority of watercourses located outside the main valleys of Sixteen Mile Creek, are either farmed across, or contain narrow cultural meadow riparian zones with tiny wetland pockets. The majority of watercourses located outside the main valleys will be relocated and reconstructed as dedicated corridors.

The NHS restoration approach orients some active planting and forest cover restoration towards existing woodlands, thus increasing patch size and associated functions. This approach relies on targeted active restoration (i.e. more intensive plantings), mixed with areas of passive, successional old field restoration. It also depends upon the future spread of native woody species from the foundation plantings into areas not targeted for tree planting. This is intended to limit the establishment of non-native species such as European Buckthorn and Manitoba Maple, which would otherwise be the dominant seed sources.

Woodland plantings will also occur along creek channel banks to provide functional benefits (e.g., tributary shading, habitat and linkage functions, etc.). These nodal plantings, concentrated in proximity to the low flow channels, will contribute to shading of the tributary watercourses over 75% of the length of each reach. This will promote woody canopy closure and general continuity over a medium timeframe in riparian systems where spines of trees and shrubs will spread aggressively over time through the selective use of pioneer and clonal spreading native pioneer tree and shrub species, such as poplars and willows. Tree plantings within the floodplain will include American Elm, Silver Maple, Red Maple, Yellow Birch, Shagbark and Bitternut Hickory, Bur Oak, Black Walnut, Black and Peach-leaved Willows, and native poplars. As noted in Section 2.2.2, additional native species may be recommended by the Town and Conservation Halton as part of landscape submission reviews. Non-wooded portions of the riparian areas are favoured for the establishment of moist to wet meadows and shrub thickets with regular floodplain pools dominated by shallow marsh cover and occasional deeper pools (see Wildlife Related Principles below).

Upland buffers to stream corridors (width 10 m; 15 m where a trail is required) and side slope areas (widths vary) in the corridors will be planted with nodes containing native trees (deciduous and coniferous) and shrubs. Tree and shrub species that either spread vegetatively or produce seed early after establishment should constitute up to 50% of the stock installed as rooted material in the nodes. Nodes will be supplemented with bands of woody seedling (and/or direct seeding of woody species) to achieve greater initial cover and species diversity (see Section 5.2 for greater detail). Native groundcovers will be seeded throughout the remainder of the upland and riparian habitats of the corridor, with a nurse crop used to generate rapid initial cover and stability. Native groundcover species (shade and open-growing) that can compete with Eurasian cool season grasses will be emphasized.

NHS buffers with bands of woody and herbaceous planting will be created in the vicinity of existing woodland and wetland features, and protected hedgerows. This approach will expand

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The created corridors will become the core natural habitats within the new urban landscapes of Milton; therefore the Framework seeks to maximize biodiversity from the outset, using diverse seed and rooted materials. The rooted material provides more immediate aesthetic effects and microclimate benefits, but seed and smaller rooted plant materials are essential for their added biodiversity benefits. As discussed under Implementation, collaborative and coordinated construction of new corridors can magnify biodiversity and cost benefits.

Knowledge shared by suppliers, contractors, growers, and restoration designers indicates that

an alarming amount of ‘native’ plant material is currently imported from sources well outside our region, and that, due to high demand, larger specimens are often clonal cultivars substituted for open-pollinated stock (i.e. with limited genetic variability and hence less adaptive). Aggressive non-native plants or cloned ornamental cultivars, often substituted for specified native materials, undermine biodiversity objectives and may contribute to future system instability. Larger woody materials require more care to establish, and higher densities of stock typically outperform larger material in the long term as larger stock creates imbalance between root mass and shoot. Larger stock requires higher initial maintenance and on large remote sites leads to replacement requirements that further challenges available supply and quality control. The net effect is the reduction of biodiversity introduced in the restoration plantings.

As discussed in Appendix C-1, over the past two decades the Nature Conservancy of Canada has demonstrated that large scale habitat restoration is feasible in southern Ontario, primarily reliant on direct seeding and incorporating approximately 100 native species of local origin. The installations have tested the use of non-persistent and non-allelopathic nurse crops, mechanical as well as hand-seeding techniques, and progressively lower seeding rates to make best use of valuable native seed. The cost savings of direct seeding compared to the use of larger plant materials are substantial – about 1% of the average cost of using rooted stock on a treatment area basis. The biodiversity benefits are also substantial; there is evidence that these seeded systems are achieving the “*portfolio effect*” described by Tilman (1999): like a financial portfolio that is more stable when diverse, statistical averaging over the new plant community provides general landscape biodiversity and higher pockets of biodiversity at a microsite level.

In keeping with the principle of biodiversity enhancement, comments on landscape plans by the Town and Conservation Halton may include recommendations for amendments to planting materials to ensure that a broad range of appropriate native species are introduced with plantings under the Restoration Framework. The CHLTPG (2010) contains several resources recommending appropriate species. The Framework has provisions for the use of a wide range of propagule types, including seed, plugs, seedlings and larger stock; given factors such as site-specific objectives, market supply, pests and diseases, and climate change effects. Therefore an adaptive approach is preferred over a more prescriptive approach to promote greater biodiversity in plantings. Implementation is discussed in greater detail below. The use of seed and smaller rooted plant material, and soil enhancement, requires designers and contractors with adequate experience in these specialized applications.

2.2.3 Channel Functions

The FSEMS provides recommendations for natural channel design of the relocated or enhanced watercourses. Landscape Plans will place a high priority on shading of the watercourse with diverse native plant cover, sustained by providing a mosaic of light conditions and canopy structure from uneven-aged trees, supported with relatively dense native shrubs and grasses, resisting development of even-aged forest cover which can trigger greater erosion due to loss of understory elements. Riparian zone shading will emphasize the establishment of a relatively continuous spine of woody-dominated cover along at least 75% of the riparian zone. The spine will be complemented by the establishment of a diversity of successional communities (open meadow, shrub thicket and treed nodes). Vigorous, diverse cover of native herbaceous species including narrow-leaved grasses, sedges and broad-leaved forbs, will provide effective water quality polishing in the growing season, and taller species will provide shade to moderate stream temperature. The meadow component serves a particular role in maintaining headwater channel form particularly where stream gradients may be less than 1%. Floodplain wetland habitat creation will occur in areas where viable and sustainable hydrologic flow and inundation patterns can be established. These will be reinforced within the overall planted corridor with planted

valley slopes and the tableland buffers.

2.2.4 Forest Cover Targets

The FSEMS direction on forest cover is as follows:

The eventual forest cover within riparian corridors and linkages should be in the 60-75% range to achieve a variety of environmental benefits. Reforestation of nodes representing 25-30% of areas to be eventually forested will trigger woody succession toward the end target.

The existing landscapes in the sub-watersheds are largely agricultural, with limited natural forest and wetland cover (about 4%). The majority of watercourses located outside the main valleys of Sixteen Mile Creek, are either farmed across, or contain narrow cultural meadow riparian zones with tiny wetland pockets. The majority of watercourses located outside the main valleys will be relocated and reconstructed as dedicated corridors.

The NHS restoration approach orients some active planting and forest cover restoration towards existing woodlands, thus increasing patch size and associated functions. This approach relies on targeted active restoration (i.e. more intensive plantings), mixed with areas of passive, successional old field restoration. It also depends upon the future spread of native woody species from the foundation plantings into areas not targeted for tree planting. This is intended to limit the establishment of non-native species such as European Buckthorn and Manitoba Maple, which would otherwise be the dominant seed sources.

Woodland plantings will also occur along creek channel banks to provide functional benefits (e.g., tributary shading, habitat and linkage functions, etc.). These nodal plantings, concentrated in proximity to the low flow channels, will contribute to shading of the tributary watercourses over 75% of the length of each reach. This will promote woody canopy closure and general continuity over a medium timeframe in riparian systems where spines of trees and shrubs will spread aggressively over time through the selective use of pioneer and clonal spreading native pioneer tree and shrub species, such as poplars and willows. Tree plantings within the floodplain will include American Elm, Silver Maple, Red Maple, Yellow Birch, Shagbark and Bitternut Hickory, Bur Oak, Black Walnut, Black and Peach-leaved Willows, and native poplars. As noted in Section 2.2.2, additional native species may be recommended by the Town and Conservation Halton as part of landscape submission reviews. Non-wooded portions of the riparian areas are favoured for the establishment of moist to wet meadows and shrub thickets with regular floodplain pools dominated by shallow marsh cover and occasional deeper pools (see Wildlife Related Principles below).

Upland buffers to stream corridors (width 10 m; 15 m where a trail is required) and side slope areas (widths vary) in the corridors will be planted with nodes containing native trees (deciduous and coniferous) and shrubs. Tree and shrub species that either spread vegetatively or produce seed early after establishment should constitute up to 50% of the stock installed as rooted material in the nodes. Nodes will be supplemented with bands of woody seedling (and/or direct seeding of woody species) to achieve greater initial cover and species diversity (see Section 5.2 for greater detail). Native groundcovers will be seeded throughout the remainder of the upland and riparian habitats of the corridor, with a nurse crop used to generate rapid initial cover and stability. Native groundcover species (shade and open-growing) that can compete with Eurasian cool season grasses will be emphasized.

NHS buffers with bands of woody and herbaceous planting will be created in the vicinity of existing woodland and wetland features, and protected hedgerows. This approach will expand

existing habitat patches and will provide for enhanced functions through added diversity along the edges of features (see Sections 5.3 and 5.4 for greater detail).

2.2.5 Wetland and Wildlife Habitat Creation

The FSEMS direction on wildlife habitat is as follows:

One of the intentions of the recommended NHS is to ensure that new riparian corridors provide for passage, foraging, and residency by as many terrestrial species as possible.

In general, 75% of the length of stream channel banks will be targeted for shading by woody planting with a natural succession towards floodplain forest cover over time. Floodplains and side slopes will contain a mosaic of tree and shrub nodes, emergent marsh / wetland pools, moist meadow, and old field meadow. Upland corridor buffers will also contain a mosaic of early successional communities offering open country habitat interspersed with shrub and tree nodes. Seasonal wet pockets and pools will be included in the corridor buffers where suitable 'clean' runoff is available from adjoining development, delivered by swales that form part of the drainage density compensation and from other 'clean runoff' sources. This is intended to achieve additional diversification of wildlife and fish habitat benefits.

In order to provide a diversity of wildlife habitat, restoration strategies will promote early successional forest of pioneer species, shrub thickets, hardwood and conifer woodland nodes, and upland and wet meadows. The creation of habitat should incorporate varied micro-topography (including seasonal pools where feasible), brush piles, hibernacula and perching trees for birds.

Meadow habitats generate insects that will inevitably find their way into streams, either being blown in, or incidentally landing in the water (where they become food for fish and amphibians). Meadows with small shrubs also produce a different variety of *allochthonous* matter (leaves, grass stems, flowers, seed heads, etc.) that will fall into the streams and eventually be broken down by invertebrates to contribute to the energy content of the streams. The highest quality riparian zones will have a diverse array of deciduous and coniferous trees, open meadows and shrub thickets; such diverse food sources benefit the system

The FSEMS also recommends the creation of floodplain and tableland wetland pools of various sizes to support a range of amphibians, turtles and waterfowl. Regular spacing of wetland features contributes to enhanced wildlife habitat quality and diversity. The locations for this restoration need to be carefully planned where hydrologic conditions will permit viable and sustainable features and where conflicts with development related impacts will be minimized.

Determining suitable locations for tableland wetlands require identification and alignment with lower impervious cover land uses with cleaner runoff opportunities (i.e. natural features, parks, schools, LID sites, local use of 'third pipe' systems, etc.) to provide suitable hydrological conditions, as well as spatial organization of active uses (i.e. trails, parks) and sensitive habitats, and interfaces with roads to minimize wildlife mortality. The integration of new swales created to compensate for drainage density and from other 'clean runoff' sources will create opportunities for tableland seasonal wetland creation where these swales intersect with corridors. The specific numbers and locations for the establishment of wetland pools to contribute to amphibian productivity is discussed in the FSEMS and requires detailed consideration in the SIS.

Key considerations in wetland siting include:

- Identification of suitable/favourable hydrologic conditions;
- Identification of appropriate specific locations for floodplain pool creation, where appropriate within the watercourse blocks;
- Habitats should be buffered from more intense adjacent land uses and transportation corridors (i.e. locate where adjacent lands are natural features, parks and/or institutional uses); and,
- Integration with other stream corridor functions and natural feature restoration sites within the limits of the NHS.

General and flexible guidance is offered in the FSEMS, and summarized below, regarding the tableland and floodplain wetland features:

- Given the proposed road network, a minimum of one floodplain and one tableland wetland/pool is suggested every couple of hundred meters along the proposed NHS stream corridors to help ensure the breeding needs of most amphibians are met within the study area;
- Created wetland pools can be created singly or more preferably in a cluster where area and suitable conditions permit; and
- Created wetland pools should range in size from approximately 0.005 ha to 0.1 ha and be established with variable depths and substrates, in order to support a wide range of amphibians, turtles and waterfowl.

Each of the considerations listed above should be assessed in the SIS concepts and integrated into the detailed Landscape Plans.

2.2.6 Habitat for Species at Risk and Other Species of Conservation Concern

Some specialized habitats and features may attract and sustain some Species at Risk (SAR) as well as other species of conservation concern. Species that are more sensitive to human intrusion or those that rely upon larger patches of habitat may not occupy the urbanizing landscape or could appear as habitats mature; others that are more adaptive and able to occupy smaller and successional habitats (such as Barn Swallow, Eastern Meadowlark, butterflies, odonates and Snapping Turtle) may well continue and potentially expand their presence.

The SIS concepts and detailed Landscape Plans should include specialized habitat structures for SAR and species of conservation concern, to the extent they will provide viable and sustainable support for target species. The FSEMS identify some target species and habitats for consideration. These opportunities should be considered in association with the planting guidance contained herein and the expected habitat types created.

3 IMPLEMENTATION

A review of past corridors developed in the Town of Milton identified variable approaches and implementation costs, materials and levels of success relative to objectives. The Framework recognizes that there are constraints related to availability of qualified designers and contractors, familiarity with large scale restoration (compared to traditional landscaping approaches), and availability of plant materials certifiable as open-pollinated native stock of local provenance

(seed, rooted stock, range of sizes of materials). The Town of Milton seeks to assure outcomes and facilitate its related operational mandates through the following implementation measures.

3.1 Coordinated and Collaborative Approach

The future NHS in the approved Secondary Plans for Boyne and Derry Green represent about 24 km of corridors and approximately 145 ha of associated habitat creation. In addition, existing natural features have been identified for protection and enhancement. These collectively require a substantial investment encompassing planning, SIS conceptual and detailed design, construction, and monitoring/adaptive management. Based on direction from the FSEMS, the Framework provides detailed guidance on the approach and specialized elements for landscape development. It also provides the opportunity to innovate to achieve efficiencies, learning from other landscapes where large restoration projects focused on biodiversity have been achieved in a cost-effective manner.

Where a series of new corridors is planned in a Secondary Plan area, the Town believes that there would be efficiencies achieved from undertaking the corridor and other NHS works as a unified project. This would require collaboration, cooperation and cost-sharing among landowners, but would have key cost, timing and approval advantages, including:

- streamlining the review, approval and oversight process for the Town and Conservation Halton due to a consolidated design program allowing one-stop interpretation and implementation of the FSEMS, SIS reports and Framework;
- assembling a qualified core team of designers and contractors with experience in large scale restoration projects, who are limited in number in southern Ontario;
- facilitating a multi-phased approach to implementation;
- coordinating existing NHS protection and integration;
- using the initial developed corridors for propagation of native seed *and other plant materials (live stakes, root cuttings, etc.) for use in subsequent phases;*
- contract growing of plant materials so that the supply of diverse native plants is ensured;
- facilitating recycling of biodiversity materials such as soil seed banks, and other salvable on-site materials such as tree root wads/stumps (for bird perches and woody cover along the corridors), and boulders for basking area use;
- coordination of wildlife habitat and wetland creation efforts on various land holdings;
- efficiencies for soil management;
- coordinated timing of grading, site preparation and planting in optimal seasonal windows; and
- consistent monitoring and adaptive management tasks; efficiencies for comprehensive, cost-effective, reliable monitoring and reporting; streamlined review by Town and Conservation Halton.

The Town can assist proponents to implement the Framework by hosting a presentation to landowners and their consultants on the Framework, and providing information to facilitate a collaborative approach. The Framework has been developed as a collaborative endeavor, and it is recognized that new information on ecological restoration practices will likely emerge that can be used to continuously inform design and implementation, and to improve outcomes.

3.2 Phasing

Implementation of the Framework will likely be variably staged within individual SIS blocks; in all cases the 'priority completion phase' is defined as new corridors and buffer areas being graded, habitat elements installed, and realigned channels stabilized with native herbaceous cover established as soon as earth works are completed. The phasing approach requires the prior approval of Conservation Halton and the Town of Milton. This provides continuity of natural heritage habitat functions from pre- to post-development landscapes.

The following phasing scenarios can be applied subject to prior approval of the Town and Conservation Halton;

Expedited Phasing

It is anticipated that residential occupancy of developed lands may occur in proximity to the corridors and other NHS restoration areas subject to the Framework, prior to full completion of landscaping works. The Town of Milton's Subdivision/Pre Servicing agreement provides for the construction (and certification) of Public Work infrastructure to Town Standards and specifications to the satisfaction of the Town, and requires a Letter of Credit from the developers in the agreement(s) in a form acceptable to the Town, to ensure the works are completed to the Town's satisfaction. Therefore the Town of Milton has good leverage with developers to ensure that grading, soil management and planting works are completed in a timely manner. This may require that plantings be completed outside of optimal windows, and that additional monitoring, watering and replanting of planted areas will be required to meet the performance requirements in a manner acceptable to the Town of Milton.

Extended Phasing

Where occupancy is not residential, and/or will not occur within at least one year of the completion of the 'priority completion phase', subject to Town and Conservation Halton approval the woody plantings (rooted material) may be installed as a second phase, which may optimize sourcing of materials, and better ensure adequate biodiversity and planting in the appropriate seasons, reducing losses of plant material that typically occur when inadequate seasonal planting windows are available.

It is recognized that a staged phasing approach will require cooperation and leadership among landowners, but will help to manage costs while achieving the Framework objectives and principles, and better address the NHS implementation phasing considerations that are described in the FSEMS. It is also critical that Conservation Halton be notified and engaged early in the design process regarding phasing of works to ensure that review of designs, approval of proposed plant species, and site inspections will occur in a timely manner.

3.3 SIS Conceptual Design

The SIS (Sub-watershed Impact Study) is required to demonstrate how the Secondary Plan policies and FSEMS recommendations (including Implementation Principles where applicable) will be implemented at a conceptual design level for specific blocks of lands. The SIS must provide sufficient detail to assure the Town and Conservation Halton that the policies and recommendations are being addressed, and that the subsequent detailed design will not overlook key restoration features to be integrated. Review of contemporary draft SIS reports revealed a range of level of detail regarding proposed new corridors and other NHS implementation. Figures 5a and 5b (in Appendix B) provide annotated examples of conceptual representations for a corridor plan at the SIS stage; details will vary depending on location and

are subject to approval by the Town and Conservation Halton. Supporting SIS documentation demonstrating clear integration of multidisciplinary design information, a construction phasing strategy, designer team requirements, and plant material sourcing strategies are beneficial to ensure the SIS reviewers that proponents have adequate information to prepare a Landscape Plan that implements the conceptual plan presented in the SIS. The SIS is also required to consider the phasing of NHS implementation; as discussed above, a collaborative approach covering the overall Secondary Plan area is preferred by the Town.

3.4 Subdivision Agreement and Securities

The Town of Milton requires development proponents to enter into a Subdivision Agreement. Upon approval of the Draft Plan of Subdivision, the Town will require securities from developers covering 100% of the cost of all infrastructure works, including landscaping of corridors, buffers and restoration areas associated with natural features that will be dedicated. The securities will be held by the Town up to the time of assumption, and with due notice to the developer, may be utilized at any time to intervene where the Town is not satisfied with the implementation of works. A master checklist of the Town's specific requirements to implement and sign off on the Framework under the Subdivision Agreement is provided in Table 5 (Appendix A).

Compliance with the Subdivision Agreement will encompass the following requirements:

1. Demonstration that the designer(s) and contractors are pre-qualified and have references supporting their ability to perform habitat restoration works comparable to those that are proposed, to the satisfaction of the Town and Conservation Halton;
2. Landscape restoration plans will be completed in accordance with the Framework and approved by the Town and Conservation Halton, including a master schedule of works with milestone dates for the completion of restoration planting works;
3. A letter of certification from the designer(s) will confirm that the installation conforms to the approved landscape plans, with confirmation that any and all variations from the plans have been confirmed with the Town;
4. Under the conditions of the Subdivision Agreement, the Town will have the opportunity to review and verify, and to require remediation of any deficiencies;
5. The Town will assume the creek corridor blocks only after the planting and other corridor infrastructure are performing to the satisfaction of the Town and Conservation Halton, and the results meet the recommendations of the FSEMS; and
6. A Monitoring and Adaptive Management Plan, to be undertaken at the cost of the developer, will assess key performance measures per Town and Conservation Halton requirements (see Table 6, Appendix A), timing and reporting of monitoring, and required actions to be completed at the developer's cost when performance is not achieved. This will be integrated with the local and holistic monitoring plan requirements of the Town of Milton.

3.5 Designer and Contractor Prequalification and Certifications

The Town of Milton requires that designers and contractors engaged for channel and NHS buffer and enhancement projects be prequalified. Table 5, Section 1.1 summarizes designer requirements. Proponents and their designers must provide documentation, and references if requested, that these qualifications are met. Contractors must provide documentation and references that their lead site staff has specific restoration training and at least 3 years experience in specialized restoration work such as direct seeding of trees, use of reforestation

seedlings, soil management, habitat structure construction, and invasive plant management. Written verification is required that the plant materials supplied reflect the native species listed on the approved landscape plans; verification by a qualified botanist or horticulturalist will ensure that all materials (including live stake material) are the listed species, and that seed mix content has been reviewed and approved prior to application.

3.6 Peer Review Requirement

The Town and Conservation Halton will require a Peer Review, at the developer's expense, of the proponent's SIS, detailed Landscape Plans, and their implementation including confirmation of qualifications of designers and contractors. The review may encompass inspections of landscape works to ensure their compliance with the Framework and Conditions of approval.

4 MAINTENANCE AND MONITORING

The Town recognizes that environmental strategies require monitoring, and that changing landscape conditions and new science need to be accommodated. This forms the basis of the current approaches to Local and Holistic monitoring in Milton, that undergo regular review as part of subdivision build-out, holistic monitoring cycles and sub-watershed updates, and which are required as per the SUS and FSEMS. Results-oriented monitoring is required for adaptive management; the adaptive actions need to span from site-specific solutions to identified problems, to modifications in strategies for environmental management at the Municipal scale.

The monitoring approach for landscape works under the Restoration Framework will be integrated with the Local scale and Holistic monitoring programs, as summarized in Table 6. The Town will require developers to provide performance monitoring and reporting of outcomes. The Town may also undertake inspections as per terms in the Subdivision Agreement. Any identified deficiencies will be addressed either by the developer at their cost, or by the Town using the securities plus a management penalty. The securities will be held by the Town up to the time of assumption, which is typically 5 – 10 years according to Town practice.

The Holistic monitoring program is undertaken by the Town using consultants independent of developers, funded through development charges. This monitoring extends beyond build-out; it encompasses comprehensive data collection as summarized in Table 6.

4.1 Warranty and Performance Monitoring

The Town will require that the SIS provide standards for monitoring of planting and habitat works (corridors, buffers and other restoration works) to be completed under the Subdivision Agreement. Specific details of the monitoring approach will vary by SIS study area and the Town's monitoring practices may be adjusted over time. Site specific monitoring plans will be identified in the Monitoring and Adaptive Management Plan that is prepared according to the Sub-watershed Impact Study Terms of Reference and which is a component of the submissions required under the Subdivision Agreement. The following are key restoration performance measures that should be considered in Local Scale monitoring:

Growth Rate – Sampling using statistically valid methods to assess the relative growth rates of each size category of woody material that is utilized.

Survivorship - Sampling using statistically valid methods to assess the establishment and survivorship for each size category of plant material that is utilized.

'Free-to-grow' Performance (FTG) - Sampling using statistically valid methods to assess the relative percentage of woody plants that achieve 'free-to-grow' status 3, 5 and 10 years after planting under the relevant monitoring program(s). FTG is defined as growth exceeding the average height of surrounding herbaceous meadow cover.

Corridor Cover – Cover will be determined based on the Ecological Land Classification of plant communities at Ecosite level, determined 3 and 5 years after planting, and at assumption under the relevant monitoring program(s).

Node Coverage – Percentage of total cover of woody node cover by node type, to be determined 3 and 5 after planting, and at assumption; thereafter under with the Holistic monitoring program.

Invasive Species – Checklist of all invasive species present, and rating of level of infestations. Invasive species to be tracked include those falling within Category 1 (*Species that exclude all other species and dominate sites indefinitely*) and Category 2 (*Species that are highly invasive but tend to dominate only certain niches or do not spread rapidly from major concentrations*) of *Sustaining Biodiversity: A Strategic Plan for Managing Invasive Plants in Southern Ontario* (Havinga et. al. 2000), which is the basis of Appendix 2 of the CHLTPG (2010).

Disturbance and Encroachment – Checklist and annotated mapping of areas where disturbance and encroachment are in evidence within the NHS where it abuts other land uses. To be determined 1, 3 and 5 years after planting and at assumption, and thereafter under the Holistic monitoring program.

4.2 Adaptive Management

Table 7 in Appendix A summarizes targets, potential observations and recommended adaptive management actions related to the performance measures. Specific monitoring targets and appropriate adaptive management responses will be defined in the approved SIS. SER 2002; Clewel and Aronson 2007; and other recognized landscape management standards can be integrated. Maintenance interventions, including irrigation of planted areas, mulch top-ups, and annual control of competing vegetation, should be conducted intensively for a minimum of two years, and thereafter where necessary, until the "free to grow" stage is achieved. During this establishment period, measures to monitor and control the spread of highly invasive and competing species will be implemented (e.g. prevent establishment and achieve effective removal of Common Buckthorn, Tatarian Honeysuckle, Manitoba Maple, Giant Hogweed and Garlic Mustard, and suppression of competing Eurasian grasses).

5 PLANTING GUIDELINES - TOOLS AND APPROACH

Based on the Framework principles, this section and accompanying tables and figures provide more specific instruction regarding the overall vegetation cover by type, size and planting densities.

5.1 Habitat Restoration Materials and Methods

5.1.1 Restoration Materials

Table 1 (Appendix A) presents a long list of potential restoration and enhancement materials, and their unit measures (per specimen, treatment unit, or per square metre). The factors affecting the choice of plant materials include overall project objectives, species diversity, cost, desire for immediate visual effect, season of planting, potential vandalism, herbivory, warranty replacement approach, and maintenance compatibility.

The *Conservation Halton Landscaping and Tree Preservation Guidelines* (April 2010) provides a detailed discussion of native plant materials. There is a consistent problem with species substitutions, either intentional on the part of nurseries or contractors, or accidental due to species misidentification. This may undermine planting strategies (such as tree species being planted where shrubs are intended), and is particularly problematic for species requiring greater technical skill for accurate identification, such as willows, poplars, cherry and dogwoods. It is required that all plant material be reviewed, preferably at the nursery, or at the time of delivery, to be verified or rejected based on review by a qualified botanist or horticulturalist. With respect to live cuttings of willows, the source plants must be inspected and certified as to species prior to collection. Exotic tree and shrub willows are regularly confused with small native shrub willows, and will inevitably undermine the planting objectives.

Seed mixes need to be itemized on Landscape Plans with percentage content listed by species. Only native species that are relatively common in Halton Region are to be included. Seed for woody native species may be sourced through the Ontario Seed Plant (operated by MNR), as well as from specialized restoration suppliers who collect seed. Direct seeding has merit in terms of adaptation to poorer soils, and when properly installed, will perform on an equal timeframe to bare root seedlings. However, installation must ensure that the seed is planted (either manually or mechanically if areas are extensive) to the proper depth with good soil contact. Only pre-qualified seed planters should be utilized if this technique is employed.

Establishment of cover from native seed mixes generally requires the use of nurse crops, planted before or at the same time of the primary native seeding. Use of mechanized seed drills that accept multi-sized seed will improve seeding outcomes. The establishment of diverse species from seed mixes requires specialized techniques, and contractor prequalification is therefore required.

5.1.2 Soil Preparation

Soil conditions greatly affect the successful establishment of new landscape plantings and seeded cover. The Toronto Region Conservation Authority's (TRCA) *Preserving and Restoring Healthy Soil: Best Practices for Urban Construction v1.0* (2012) provides a recent summary of best practices for soil management in urbanized or urbanizing settings. Good soil structure to depth is key to restoration planting success, as it ensures:

- the optimized capture and storage of precipitation - infiltration sustains plant materials, but rapid runoff is lost from the planted system;
- oxygenation of the root zone - rapid root growth and penetration develops higher root mass relative to top growth, and adequate root depth to access moisture during dry periods; and
- good internal drainage that prevents shallow rooting and 'drowning' of plant materials.

The TRCA guide recommends preparation of a Soil Management Plan which assesses the soil areas to be planned, testing of *in situ* soils or topsoil to be utilized, compaction testing, targets for adequate topsoil depth depending on planting type, and calculation of amendment applications to sustain well-balanced growth. While the Framework does not specifically adopt the requirement for a Soil Management Plan, the Town recognizes that corridor and other NHS landscaping projects which do not incorporate best practices for soil management will inevitably require more maintenance and remedial work by developers prior to acceptance. More extreme periods of drought and heavy rainfall have reinforced the importance of careful soil preparation to assure rapid establishment of vegetation materials and uniform vegetation cover on sites in Milton. Where larger plant stock are utilized, a correspondingly greater emphasis on soil management is required. Therefore the use of the TRCA guide and its soil assessment protocols and amendment calculation tool is highly recommended.

Post-agricultural soils have variable capacities to either assist or compromise establishment of biodiverse native plant cover. Experience on large woodland and meadow restorations for the Nature Conservancy of Canada in Norfolk County indicated that fields that were previously in a long term rotation of corn-soybeans, generally accompanied with glyphosate herbicide use, provided the most favorable outcomes for direct seeding with woody and herbaceous native cover, due to the reduced seed bank of competing perennials (i.e. common goldenrods, asters and exotic grasses) (M. Gartshore, pers. comm., 2014). This experience is relevant in Milton where similar crop rotation practices predominate in the new Secondary Plan areas. In contemporary restoration literature, excessive soil nutrients have been highlighted as an obstacle to restoration objectives; higher soil carbon content from appropriate compost sources encourage greater diversity of plant and soil microflora. Subsoil amended with appropriate compost may produce better outcomes of diversity than topsoil. These considerations should be factored into the soil management strategy for NHS Landscape Plans.

The nucleation approach recommended for the Framework provides better opportunities to manage soil resources efficiently and cost-effectively. If a phased approach is adopted, initial stabilization can make use of shallower amended topsoil (at least 20 cm recommended with compost amendments worked in to a depth of 24 cm). The woody planting nodes can receive enhanced soil work especially if large sapling and caliper stock is to be utilized; these areas can be enhanced with amendments to a 60 cm depth in accordance with the TRCA guide.

5.1.3 Recommended Timing of Planting

Table 3 in the *Conservation Halton Landscaping and Tree Preservation Guidelines* (CHLTPG 2010) provides general guidance on timing of plantings that will support application of the Framework approaches if irrigation is readily available. However plantings of rooted material should always attempt to take best advantage of higher seasonal moisture availability to assure rapid establishment of material and minimize maintenance and replacement. Spring planting allows all materials a better opportunity to gain a season for root establishment before over-wintering herbivory occurs; this is particularly important where small rooted plant materials are employed.

Establishment of cover from native seed mixes generally requires the use of nurse crops, planted before or at the same time of the primary native seeding. Use of mechanized seed drills that accept multi-sized seed will improve seeding outcomes. The establishment of diverse species from seed mixes requires specialized techniques, and contractor prequalification is therefore required.

Some level of herbivory is inevitable, and natural plant communities adapt to herbivory by growing from seed or vegetative spread, placing the highest physiological priority on root establishment, and persisting through herbivory and drought cycles until the well-established root system can force and sustain a major spurt of top growth. Spring planting of small bare-root or container grown material is desirable as it allows a full growing season for rooting to occur before potential herbivory occurs over the first winter.

5.1.4 Other Restoration Techniques

Table 1 (Appendix A) also lists some optional treatments that can achieve ecological and cost benefits, as follows:

Sod mats typically consist of 1 X 1-2 metre sod blocks, salvaged from existing old field or native shrub thicket cover that has been mowed or 'bush-hogged' prior to salvage, and mechanically lifted with roots and soil intact. When lifted and placed in a single operation, sods are highly cost-effective to establish the banks of new creek channels, either used at the outer bends of the meandering channel, or on both sides of new channels to create banks for reaches where intense event flows are anticipated. The root mass ensures stability, and growth of cover resumes immediately upon placement. Sod mats can be lifted and moved as long as the soil is not frozen. Plantings, if required, can be limited to live staking, installed in the early spring.

Soil Seed Bank (aka soil propagule bank) is soil material salvaged from meadows or marshes that are being eliminated. According to research, seedbanks may contain more than twice the plant diversity evident at the donor site, either as dormant seed or in vegetative form. When salvaged efficiently, seed banks represent a cost-effective source of native plant materials, especially for creating new meadows and wetlands.

Typically the donor site is check-listed for composition prior to removal, to record initial diversity and ensure that problematic invasive species are not present. It is then removed by stripping (typically to a depth of 30-40 cm depending on the material), using small to large equipment depending on scale, and transferred to the recipient site (e.g. a created meadow or wetland) where it is spread at a depth of 5-15 cm over the rough-graded feature (depth dependent on availability). Spring or early fall is optimal for salvage and installation. Surface roughness should be maintained to ensure microhabitat diversity. Except when applied in the dormant season, growth will immediately resume, and supplementary seeding is usually not required (a temporary nurse crop can be over-seeded). The regenerated cover should be reviewed for two growing seasons to ensure that invasive species have not been transferred.

Other habitat elements can be installed using new or salvaged materials as appropriate.

Tree perches consist of 1-3 logs embedded into soil that provide perches for larger birds and raptors. Height can vary depending on available materials; 3-5 metres is optimal height above ground.

Snake hibernacula consist of 1-1.5 m diameter holes excavated to below frost line (outside of flood-prone areas, and 'lipped' to prevent entry of runoff), and filled to the ground surface with small logs intermixed with small boulders.

Basking sites consist of boulders, single or multiple limestone blocks (seconds), or salvaged concrete (e.g. old sidewalk sections) set into a slope where sun exposure will result in a warm microclimate. They may also be placed in the shallows of pools to serve as basking sites.

Turtle nesting sites consist of pockets of coarse sand or granular B material 1.5-2 m deep, placed in an excavated pit within a slope face, with south to west-facing exposure.

5.2 Watercourse Corridor Cover

Figure 1a (Appendix B) presents a typical nodal layout for a channel located in a residential / institutional area, including riparian nodes, reforestation nodes, shrub nodes, trailside tree planting, residential screen planting, and an enhanced gateway zone planting at a street crossing interface.

The following is a summary of ecological principles and targets:

- Overall Stream Corridor Cover Targets (including Riparian Area):
 - FSEMS forest cover targets of 60-75% forest cover within riparian corridors and linkages. **Reforestation of nodes representing 25-30%** of areas to be eventually forested will trigger woody succession toward the end target.
 - The FSEMS direction on wildlife habitat is to provide for passage, foraging, and residency by as many terrestrial species as possible.
 - Floodplains and upland corridor buffers will contain a mosaic of early successional communities offering **open country habitat** interspersed with **shrub** and **tree nodes**.
- Riparian Area Cover Targets:
 - The FSEMS places a high priority on shading of the watercourse while providing a mosaic of light conditions and canopy structure from uneven-aged trees, supported with relatively dense native shrubs and grasses, resisting development of even-aged forest cover.
 - cover targets of **75% shade cover in the riparian zone**.
 - **mosaic of cover types including trees, shrubs and ground cover**.

The nodal arrangement shown in Figure 1a and 1b (Appendix B) covers approximately 40% by area of the overall stream corridor, including the slopes and upland buffers. Shrub-only nodes represent a minimum of 5% of this planted area overall including 2% in channel margins and 3% within side slopes, buffers, and floodplain areas outside channel margins. Live stakes installed outside of nodes are not included, and must be factored into cover estimates during design to ensure that targets are met but not significantly exceeded. Screen plantings are a Town requirement at the urban/natural interface (may be omitted depending on setting subject to prior Town approval) and with their inclusion, shrub-only nodes may represent up to 10% of the stream corridor area (see Figure 1, Appendix B).

As discussed below, the nodal options include basic (lower cost, longer term establishment, low immediate visual effect), regular (moderate immediate visual effect), and enhanced (high immediate visual and buffering effect) versions that can be applied according to local circumstances with prior approval from the Town and Conservation Halton. Enhanced gateway zones are standard for street interfaces where the Town normally desires a strong aesthetic effect. Consistent with Town Engineering and Parks Standards, screen plantings are specified at the interface between private lots / recreational areas and the NHS corridor to provide a planted screen separating urban and naturalized area (see Figure 1a/b and Figure 3, and Detail 3 for Enhanced Shrub Nodes, all in Appendix B). Breaks in screen plantings may be considered by the Town based on context (i.e. connection to a park or stormwater management block). For

greater detail regarding screen plantings, refer to Town of Milton Engineering and Parks Standards, Environmental Buffer Detail, as revised.

The tree and shrub materials for each node type and the enhanced gateway zone are summarized in Table 2a (Appendix A). Figure 1a/1b (Appendix B) also show generic locations of other elements such as created wetlands, and habitat enhancement structures. Tables 3a and 3b (Appendix A) summarizes the node totals for 100 m corridor sections depending on the base floodplain width.

Figure 2 (Appendix B) is a cross-section view showing the general positioning of a range of plantings and habitat elements, including pools, hibernacula, and perch trees within a new stream corridor.

In terms of ecological benefits, greater reliance on direct seeding and seedlings can achieve greater diversity per unit area at significantly lower cost. These treatments must be coupled with the seeding of nurse cover crops and native meadow species, combined with mulching of all woody plantings. Mulch comprised of fresh organic material (e.g. woodchips) uses up nitrogen in soil when it decomposes. Aged mulch should be used to avoid reducing nitrogen content in the soil. The timing of application of seed mixes is key to establishment success for native species. Direct seeding of woody species should be conducted by contractors pre-qualified with experience in direct field seeding of woody species. Generally a blend of material sizes is preferred to create initial vertical structure in nodes, to facilitate warranty / maintenance, and to meet interim aesthetic objectives.

These prescriptive tables (Tables 2a & 3a/3b) will guide conceptual design planning at the SIS stage; and detailed design. Innovation is encouraged so long as the principles and general cover targets are met or exceeded. In particular, diverse micro-topography treatments can yield significant increases in plant and habitat diversity. The ability to introduce more varied micro-topography in some areas is a useful consideration for the SIS stage of planning (e.g., pit and mound site preparation techniques).

Species for planting will be matched to soils, micro-topography and specific locations based upon more detailed work in the SIS stage. In each case, selected species will be native and will preferably originate from the same seed zone. Conservation Halton provides a detailed planting list in the *Conservation Halton Landscaping and Tree Preservation Guidelines* (April 2010); this is a helpful reference for watershed-appropriate plant materials. Comments on landscape plans by the Town and Conservation Halton may include recommendations for amendments to planting materials to ensure that a broad range of appropriate native species are introduced.

5.2.1 Planting Nodes

To help facilitate the planting of created and realigned stream corridor floodplains / side slopes / buffers, an area specific, concentrated planting approach will be employed (i.e., nodes). Nodes are comprised of relatively small areas of concentrated plantings of trees and shrubs, in some cases augmented with seed. The purpose of these areas is to concentrate plantings versus spreading the plantings more thinly over large areas. Concentrating the plantings has a number of benefits including:

- The creation of localized micro-habitats and moister, shadier micro-climates which can be utilized by small mammals, birds, amphibians, reptiles and insects;

- Localized reduction of competition from non-native and/or aggressive pioneer species, given the relatively higher density of native plants (i.e., less available area for non-native plants to take root);
- Planting groupings that are easier to locate, monitor and maintain during the performance review period;
- Opportunities to create areas of diverse community types through the planting mix used in the nodes; and
- Reliance on localized, nodal seed and rhizomatous propagule sources and the ability for these materials to spread outwards from these nodes, thus increasing planting/plant material efficiencies and reducing planting investments required to achieve the same objectives.

Seven types of nodes are specified, which are illustrated in Figure 3 (Appendix B). Table 2a (Appendix A) summarizes planting node options and materials content. Table 3 (Appendix A) summarizes the relative quantities of plant materials for 100 m corridor sections depending on the base floodplain width. Suitable native plant species should be based on *Conservation Halton Landscaping and Tree Preservation Guidelines* (April 2010). Nodal characteristics include the following:

1. Basic Shrub Nodes

- medium to tall shrubs, planted as seedlings
- nodes applied in floodplain, slope or upland sites
- visual screening and/or thicket cover
- for low visual priority areas
- bare root material
- nodal spacing to allow access for maintenance
- protection from herbivory required

2. Regular Shrub Nodes

- medium to tall shrubs, planted as larger stock
- nodes applied in slope or upland sites
- visual screening and/or thicket cover
- for medium to high visual priority areas
- bare root or container material
- nodal spacing to allow access for maintenance
- protection from herbivory required

3. Enhanced Shrub Nodes

- medium to tall shrubs, planted as larger stock
- visual screening and physical barrier between development and corridor
- for high visual priority areas
- container material
- protection from herbivory required

4. Riparian Nodes

- low to medium height shrubs and single tree planted within 5 m of channel on each bank
- stream banks are high priority for stabilization using deep and shallow-rooting materials
- bare root B&B or container grown material
- interspersed with shrub nodes and 25% open gaps
- protection from herbivory required
- standard warranty (2 yrs)
- nodal spacing to allow access for maintenance

5. Basic Reforestation Nodes*

- low to medium height shrubs, tree whips, apron of tree and shrub seed
- for low visual priority areas
- seed, bare root, and container grown material
- nodes applied in floodplain, slope or upland sites (using appropriate species)
- protection from herbivory required
- standard warranty on larger materials (2 yrs); FTG for seedlings
- nodal spacing to allow access for maintenance

* *Note: Basic nodes have reduced material costs but require stringent sourcing of material. Prequalification of contractor is required for the application of basic nodes for successful installation and maintenance.*

6. Regular Reforestation Nodes

- low to medium height shrubs, tree whips, apron of tree and shrub seedlings
- for medium visual priority areas
- bare root, and container grown material
- nodes applied in floodplain, slope or upland sites (using appropriate species)
- protection from herbivory required
- standard warranty on larger materials (2 yrs); FTG for seedlings
- nodal spacing to allow access for maintenance

7. Enhanced Reforestation Nodes

- low to medium height shrubs, caliper tree and whips, apron of tree and shrub seedlings
- for high visual priority areas
- bare root, wire basket or B&B, and container grown material
- nodes applied in upland sites
- higher vandalism resistance required
- protection from herbivory required
- standard warranty on larger materials (2 yrs); FTG for seedlings
- nodal spacing to allow access for maintenance

Other plantings shown on Figure 1 include the 'enhanced gateway zone' (for treatment of street frontage) and 'trailside trees'. These are summarized as follows:

Enhanced Gateway Zone

- low to medium height shrubs, caliper trees and conifers, and herbaceous potted stock

- high profile locations, requires immediate visual effect
- bare root, wire basket or B&B, and container grown material
- standard warranty on larger materials (2 yrs); FTG for shrubs
- higher vandalism resistance required
- protection from herbivory required
- standard warranty on larger materials (2 yrs); FTG for seedlings

Trailside Trees

- Town of Milton's Engineering Standards spacing for parkland at an average of 10m.
- refer to Town's standards for appropriate planting size and species of medium to large trees
- immediate visual effect
- aesthetically pleasing for trailside and adjoining properties
- higher vandalism resistance required
- protection from herbivory required
- standard warranty on caliper tree materials (2 yrs)

5.2.2 *Live Staking*

Live staking for bioengineering of channels is appropriate as part of the fluvial design approach, however the mature cover area must be included in estimates of planting cover to ensure that targets are met but not exceeded. Materials for live staking must be certified as to species due to the potential for misidentified aggressive exotic tree and shrub willows being introduced into channel plantings.

5.3 **Natural Feature Buffers**

Buffers include areas adjacent to wetlands (typically 15 m buffer required), woodlands (10 m buffer required) and meadows as well as constructed and realigned tributary corridors. Plantings are recommended for buffer areas that have been recently cropped or disturbed. Planting is generally not required in buffer areas with existing naturalized vegetation cover, however it will be evaluated at the SIS stage on a case-by-case basis, with consideration of the density and species composition/ vegetation community present. Invasive species should be identified in the SIS with a strategy to remove them from such naturalized areas. Healthy woodland edges typically include a "*mantel*" or zone of shrubs and saplings, and "*saum*" or zone of perennial herbaceous plant cover (Forman & Godron, 1986). These areas are indicated on Figure 4 (Appendix B). The buffer should maintain this condition if it is already present, or establish this stable edge condition where woodlands adjoin the buffer. A mantel of at least 3 m is desirable to create a dense edge condition.

Buffers to existing natural features (Figure 4, Appendix B) must be adaptive to conditions along existing edges. The following conditions are anticipated, and responses are recommended:

- A. Existing feature edge consists of well-developed edge zone (mantel) of shrubs and tree saplings that provide a dense barrier along the feature edge, at least 3 m in depth. Prescription – native meadow (*saum*) through seeding of any disturbed or formerly cultivated soils; further planting not required.

- B. Existing feature edge continuously canopied but previous tillage close to bases of outermost trees; mantel poorly developed. Prescription – provide 3 m band of colonial and deterrent shrubs 1.5 m OC with tree whips representing 10% of planted area; outer band (*saum*) of native meadow seeding for any disturbed / formerly cultivated soils
- C. Existing feature edge with fragmented canopy conditions. Prescription - provide 3 m band of colonial and deterrent shrubs 1.5 m OC with tree whips representing 25% of planted areas. Outer band (*saum*) of native meadow seeding for any disturbed / formerly cultivated soils

Table 2b (Appendix A) summarizes the quantities of planting materials for each of these conditions, for 10 and 15 m natural feature buffers. Figure 4 (Appendix B) illustrates the typical planting layouts in 10 and 15 m natural feature buffers to address site-specific edge conditions. Preferably, fast-growing early successional tree and shrub species (*Diervilla*, *Cornus*, *Populus*, *Prunus*, *Sambucus*, *Rosa*, *Rubus*, *Viburnum*, *Salix*,) will be planted to speed canopy development and more rapidly stabilize conditions (i.e., soil, moisture, nutrients). Mid-successional tree saplings will also be planted in areas with sufficiently open canopy to facilitate their growth. Species will be selected at the SIS stage based on soil and drainage conditions, tolerance to road salt, growth rate, durability, and wildlife habitat provision (i.e., silver maple, red maple, bur oak, etc.). Deterrent species (generally any densely-growing shrub species, but in particular red/black raspberry, wild roses) can form a foundation for shrub planting to minimize intrusions by domestic pets and humans.

The outer two-thirds of 10-15 m buffers may be subjected to grading, and may contain ‘no-maintenance’ Low Impact Development facilities for local runoff management, compensation swales to address drainage density, other ‘clean runoff’ sources, and/or micro-topography designed to address the local water balance within protected wetlands. Woody plantings may be integrated with these additional features, to be determined through site investigations and discussion with the Town and Conservation Halton as part of the SIS. In all cases, seeding with adapted native meadow and wetland species will apply to any areas where soils are disturbed within the buffer.

5.4 Hedgerow Buffers

Hedgerows that are identified for protection as part of the natural heritage system will be provided with a 10 m buffer from the dripline. Woody planting is generally not required in hedgerow buffers, however this will be evaluated at the SIS stage on a case-by-case basis, with consideration of the existing hedgerow density and species composition / vegetation community present. Gaps in the hedgerow, or new edges created for road crossings, should be addressed with planting of tree and shrub species. Invasive species should be removed from the understorey. Old field herbaceous cover, if already present, should be maintained within the buffer and dripline areas; these areas should be seeded with adapted native meadow species where soils are disturbed by previous uses or new grading works.

Grading should be avoided within the dripline of hedgerow canopy trees, and minimized within 2-3 metres from the dripline. The outer two-thirds of 10 m buffers may be subjected to more extensive grading, trail placement, and also may contain ‘no maintenance’ swales or Low Impact Development facilities for local runoff management, or drainage density compensation, where it has been determined that these features are compatible with hedgerow health and functions. Protection during construction is required using sediment control fencing erected on a temporary page wire fence, placed at the limit of grading.

5.5 Riparian Cultural Meadow and Cultural Thicket Establishment – Target Locations and Planting Guidance

The majority of new riparian corridors will be established as cultural meadows (native seed mix) with nodal woody plantings. These areas will promote habitat for a variety of species of odonates and butterflies, including some that are at risk. Shrub islands with increased planting density will be placed in close proximity to watercourses.

- Plant fast growing and spreading shrub species (*Salix*, *Cornus*, *Viburnum*, *Sambucus*, *Prunus*, *Rubus*) according to moisture tolerance, for diversity and to discourage entrance by pets and off-trail access;
- Live staking for bioengineering of channels is appropriate as part of the fluvial design approach; the mature cover area of these plantings must be included in estimates of planting cover to ensure that targets are met but not exceeded;
- Plant native terrestrial seed mix or floodplain groundcover mix in association with a fast growing cover crop, if required; a diversity of fine grasses, sedges and forbs of varying heights is required to assist in maintaining narrow channel form; generally, one to two years are required for native species to establish under a cover crop; and,
- Plant concentrated pockets of *Asclepias* and other forbs known to favour Monarch butterflies.

5.6 Emergent Marsh Establishment – Locations and Planting Guidance

Linear riparian cattail emergent marshes will be established passively along channels and within small off-line pools.

5.7 Wetland and Pool Establishment

Wetland creation will be subject to more detailed consideration at the SIS and final design stages. Establishing wetlands and vernal pools in an urbanizing landscape is challenged by the ability to create suitable hydrologic conditions and by the careful selection of locations to minimize impacts of urban uses and infrastructure on wildlife movements (see Sections 2.2.4 and 2.2.5). Where suitable locations are identified through the SIS stage, these could be subject to the following considerations.

Candidate areas for wetland / pool establishment generally have the following characteristics:

- Proximity to existing amphibian habitat retained within the NHS;
- Hydrological conditions are suitable/favourable to maintaining wetland features; and,
- The area is adequately buffered from adjacent more intense land uses within the proposed NHS.

Habitat features will be created for western chorus frog and other amphibians that rely upon temporary ponds adjacent to meadows and woodlands (e.g. spring peeper, gray treefrog, American toad). Ponds used by western chorus frog generally possess the following characteristics:

- Small, shallow aquatic habitats (less than 40cm deep and generally 11 – 22 cm deep with a shallower littoral zone for egg-laying) - namely temporary ponds and wetlands with 25-60% canopy cover. These habitats contain fewer predators than permanent waters.

Vegetation associated with breeding habitat includes *Typha*, *Carex*, *Juncus*, *Sparganium*, grasses and herbaceous plants, partially submerged shrubs and trees, and submerged vegetation and plant debris (egg attachment sites, microhabitat and refugia).

- Summer foraging habitat can include a variety of habitats in close proximity to breeding ponds (e.g. other wetlands, fallow meadows, and woodlands). Consider enhancing hibernation habitat (e.g. large woody debris, rock piles, loose soil, leaf litter, small animal burrows).
- Utilize existing guidelines and reference sites to facilitate design and monitoring of aquatic and terrestrial habitat (e.g. COSEWIC 2008; Petranka et al. 2007; Conservation Halton 2005; Lichko and Calhoun 2003, etc.).

Ponds used by Snapping Turtle tend to exhibit the following characteristics:

- Mixture of shallow areas for foraging and general summer use, and deeper areas for winter hibernation in mud substrate – water depth average 0.4m and range 0.1m - 1.8m;
- Tributaries, undercut channels, springs, abandoned muskrat dens and tertiary channels can also be used as hibernation sites provided water is oxygenated and suitable habitat is available;
- Pond provides has soft substrate, supports marsh vegetation (i.e., reed canary grass, bulrush) and hiding areas for young (i.e. dense vegetation mats, root wads, woody debris); and
- Potential breeding areas have sand and/or gravel nesting areas along warmer west or south-facing slopes.

6 CONCLUDING REMARKS

This Restoration Framework provides direction to restoration plans to be prepared as part of Sub-watershed Impact Studies and detailed Landscape Plans. This Framework has considered the broad landscape context of the sub-watersheds and the nature of restoration planning across the urbanizing landscape and has defined a strong emphasis on biodiverse, indigenous forest, meadow, emergent marsh and shrub restoration within the future NHS. The successful implementation of restoration will require consultation with the Town of Milton and Conservation Halton, detailed site-specific planning, consideration of innovative phasing and larger scale implementation approaches, well-managed installation, and integrated performance monitoring to optimize outcomes.

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Appendix A

Tables

Appendix A - Tables

Table 1 – Restoration Materials

ITEM	UNIT	NOTES	ADDITIONAL INFORMATION
Used In Planting Options			
Tree - coniferous - 175cm ht	BR	Supply & Installation of all materials including mulch	<ul style="list-style-type: none"> • Caliper trees, balled and burlap and/or wire basket material are usage generally limited to trailside and street interfaces where vandalism or maintenance impacts are anticipated; • Tree whips and/or saplings are cost effective plant material for vegetating large areas. When planted in nodes with shrubs, or small tree groves; bare root is preferable because more likely to "take" and thrive when transplanted; • 2 year old bare root seedlings can supplement larger materials in nodes, direct seeding in seedbeds, or to supplement rooted material in nodes; • Live staking in nodes (selected species only).
Tree - coniferous whip - 100 cm ht	Cont	Supply & Installation of all materials including mulch	
Tree - deciduous - 60mm cal.	B&B	Supply & Installation of all materials including mulch	
Tree - deciduous whip - 100 cm ht	BR	Supply & Installation of all materials including mulch	
Tree - deciduous whip - 50 cm ht	BR	Supply & Installation of all materials including mulch	
Tree - seedling	BR	Supply & Installation of all materials including mulch	
Shrub - deciduous - 100 cm ht	BR/Cont	Supply & Installation of all materials including mulch	
Shrub - deciduous - 50 cm ht	BR	Supply & Installation of all materials including mulch	
Shrub - Coniferous - 3 gal.	Cont	Supply & Installation of all materials including mulch	
Herbaceous potted stock	Cont	Installed	Used in areas where more rapid establishment of plant cover is desired such as at the edge of a natural feature like a creek or wetland or where a visual effect is desired.
Seeding - native meadow	m ²	to be added to hydroseed mix	The use of plants in seed form rather than potted stock, is a cost-effective way to introduce a large number and wide variety of species onto a site. Direct seeding to be performed only by contractors prequalified in the installation of direct seeding.
Seeding - nurse crop	m ²	includes hydroseeding	Provides soil stabilization and helps to suppress invasive species while intended plant community becomes established.
Additional Restoration Options			
Mulch	m ²	Landscape quality	
Live Staking	linear m	Cut in dormant season and held in cold storage	Native shrub willows are the most appropriate species to use for live stakes, however, many non-native willows are easily mistaken for native species. All Willow being used for live staking should be certified at source by a qualified botanist.
Sod Mats	m ²	1 x 2 x 0.3 m sods field cut and lifted	Used where vegetated areas are slated for removal and project timing allows for harvest and relocation of blocks of vegetated "sod" containing the roots and seedbank of existing plants. Allows for rapid stabilization of new creek channel banks.
Seedbank Salvage (Emergent Marshes & Off-Line Ponds)	m ³	1 cu. m. removed = 3 sq. m; 0.05 ha off-line pool / 300 m stream lengthDouble for re-handling	Used during removal or alteration of existing wetlands. The topsoil of the wetland is stripped and then stockpiled to be re-spread on a recipient site. The root fragments and seeds within the stripped topsoil provide a "ready-made" wetland seed mix for the new site.
Fine Grading (Emergent Marshes & Off-Line Ponds)	m ²	0.05 ha off-line pool / 300 m stream length	To create raised pools outside of the 10m creek buffer zone providing habitat for reptiles and amphibians. Also used for creating micro-topography in tableland areas, simulating variability of high and low spots found in natural forest setting.
Seeding - woody - small seed (average)	kg	to be added to hydroseed mix	See Seeding - native. Direct seeding to be performed only by contractors prequalified in the installation of direct woody seeding.
Seeding - woody - large seed	kg	to be planted manually	
Basking Area	each	2 x 0.30 x 0.30m (LxWxH) limestone slab. Use lower quality material than normal landscape grade.	Positioned to capture sunlight, limestone slabs may provide basking areas for turtles and/or snakes. 20cm or greater diameter logs may also be used.
Snake Hibernacula	each	Use salvaged material where possible. 15-30cm stone / crushed concrete, 10-20cm diameter, 1m long logs.	Stone, logs and clean debris are loosely placed in a 1-2m deep pit that is dug into a south to south west facing slope, allowing for snakes to move underground. Provides breeding and overwintering habitat.
Turtle Nesting Site	m ³	Supply & install	Pockets of coarse sand or Granular B material 1.5-2m deep, placed in an excavated pit within a slope face, with south to west-facing exposure.
Tree Stump Structures	per grouping	Supply & Installation of all materials	Standing dead wood provides bird perches as well as forage site for woodpeckers and raptors.

Appendix A - Tables

Table 2a - Planting Material Quantities by Nodes & Zones

Riparian Node - 15 sq. m.	Units
Shrub - deciduous - 50 cm ht	5
Tree - deciduous whip - 50 cm ht	5
Tree - deciduous whip - 100 cm ht	1

Basic Shrub Node - 15 sq. m.	Units
Shrub - deciduous - 50 cm ht - <i>Bare Root</i>	10

Regular Shrub Node - 15 sq.m.	Units
Shrub - deciduous - 50 cm ht - <i>Container Grown</i>	10

Basic Reforestation Node - 55 sq. m.	Units
Tree/Shrub - large seed	25
Shrub - deciduous - 50 cm ht	5
Tree - deciduous whip - 50 cm ht	5
Tree - deciduous whip - 100 cm ht	1

Regular Reforestation Node - 55 sq. m.	Units
Tree - seedling	25
Shrub - deciduous - 100 cm ht	5
Tree - deciduous whip - 100 cm ht	5
Tree - deciduous - 60mm cal.	1

Enhanced Reforestation Node - 55 sq. m.	Units
Tree - seedling	17
Shrub - deciduous - 100 cm ht	20
Tree - deciduous whip - 100 cm ht	12
Tree - deciduous - 60mm cal.	1

Enhanced Gateway Zone - 1113 sq. m. for 60m Corridor	Units
Herbaceous potted stock	450
Shrub - deciduous - 100 cm ht	54
Tree - coniferous - 175 cm ht	16
Tree - deciduous - 60mm cal.	22

Trail Tree Treatment - 100 m. length of Trail	Units
Tree - deciduous - 60mm cal.	10

Appendix A - Tables

Table 2b – Planting Material Quantities for Natural Feature Buffers

Natural Feature Buffers - 100m length @ 100% treatment	10 m Buffer (Woodland)	15 m Buffer (Wetland)
	Units	Units
Condition A		
Seeding - Native & nurse crop - per m ²	700	1050
Condition B		
Seeding - Native & nurse crop - per m ²	700	1050
Shrub - deciduous - 50 cm ht - <i>Container Grown</i>	120	180
Tree - deciduous whip - 50 cm ht	10	18
Condition C		
Seeding - Native & nurse crop - per m ²	700	1050
Shrub - deciduous - 50 cm ht - <i>Container Grown</i>	100	150
Tree - deciduous whip - 50 cm ht	30	45

Table 3 - Summary of Planting Coverage for 100m Watercourse Corridor Length

Floodplain Width (m)	Stream Corridor Width Including Floodplain, Side Slopes, and Buffers* (m)	Net Stream Corridor Area to be Planted (excluding Trail and Watercourse) (m ²)	Area Required to Achieve 30% Canopy Cover	Number of Riparian Nodes to Achieve 7-10% Canopy Cover (15m ² nodes)	Number of Reforestation Nodes to Achieve 20-23% Canopy Cover (55m ² nodes)	Number of Trail Trees (60mm Cal.)	Number of Shrub-only Nodes inside Channel Margin (15m ² nodes)	Number of Shrub-only Nodes outside of Channel Margin (15m ² nodes)	Number of Shrub Screen Nodes to achieve continuous planting screen both sides (14m ² nodes)	Seeded Area (m ²)	Percent Cover - All Woody Nodal Plantings
20	55	5000	1500	32	19	10	8	3	20	3056	39%
22	57	5200	1560	32	20	10	8	3	20	3194	39%
25	60	5500	1650	32	21	10	8	3	20	3401	38%
30	65	6000	1800	32	24	10	8	5	20	3728	38%
35	70	6500	1950	32	27	10	8	7	20	4041	38%
40	75	7000	2100	32	29	10	8	10	20	4354	38%

*Assumes 5m side slopes on both sides of floodplain, one 10m, and one 15m buffer.

Appendix A - Tables

Table 4 - Watercourse Corridor Node Type Applications Table

Treatment Type	When to Use	Siting Factors
Shrub Nodes		
Basic Shrub Node	<ul style="list-style-type: none"> For use <i>outside</i> the riparian zone for all watercourses with low visual priority (Regular Shrub Nodes should be used in riparian zone) Interspersed with Reforestation Nodes (basic or regular) Require pre-qualified seed/seedling contractors 	<ul style="list-style-type: none"> Less accessible/ low aesthetic / lower visibility areas of corridors, adjacent to: <ul style="list-style-type: none"> Warehousing or Industrial
Regular Shrub Node	<ul style="list-style-type: none"> Applied as up to 20% cover of the riparian zone (5 m on each channel bank), interspersed with Riparian Nodes (see Figure 1) Applied as up to 5% cover of slope, floodplain and upland areas Massed where required to buffer created wetlands from trails, active park and school uses, etc. 	<ul style="list-style-type: none"> Medium to high public access/ visibility corridor or buffer areas adjacent to: <ul style="list-style-type: none"> Residential Areas, Office/Commercial Areas, Institutional Areas, Mixed Use Areas, Parks, Business Park Natural Heritage Oriented Areas.
Shrub Screen Node	<ul style="list-style-type: none"> For use as screen planting along interface between urban naturalized area. Areas where a narrow screen is required (eg. between trail and residential area). 	<ul style="list-style-type: none"> Medium to high public access/ visibility corridor or buffer areas adjacent to: <ul style="list-style-type: none"> Residential Areas, Office/Commercial Areas, Institutional Areas, Mixed Use Areas, Parks, Business Park Natural Heritage Oriented Areas.
Reforestation Nodes (Trees and Shrubs)		
Riparian Node	<ul style="list-style-type: none"> Within the riparian zone (5 m on either side of bank channel), for all watercourses 	<ul style="list-style-type: none"> All watercourses.
Basic Reforestation Node	<ul style="list-style-type: none"> For use outside the riparian zone (5 m on either side of bank channel), for all watercourses with low visual priority; Riparian Nodes should be used in riparian zone. Floodplain, slope or upland areas with low visual priority Particularly applicable for longer, more remote stretches of watercourse corridors 	<ul style="list-style-type: none"> Lower accessible / low aesthetic / lower visibility areas of corridors, adjacent to: <ul style="list-style-type: none"> Warehousing or Industrial

Appendix A - Tables

Treatment Type	When to Use	Siting Factors
Regular Reforestation Node	<ul style="list-style-type: none"> Floodplain, slope or upland areas with medium visual priority 	<ul style="list-style-type: none"> Moderate to high public access/ visibility corridor or buffer areas adjacent to: <ul style="list-style-type: none"> Residential Areas, Office / Commercial Areas, Institutional Areas, Mixed Use Areas, Parks Business Park Natural Heritage Oriented Areas.
Enhanced Reforestation Node	<ul style="list-style-type: none"> High profile locations requiring immediate visual effect and protection from vandalism Used to buffer created wetlands from trails, active park, etc. 	<ul style="list-style-type: none"> High public access/ visibility corridor buffer areas, including: <ul style="list-style-type: none"> Trailheads Trail intersections
Other		
Enhanced Gateway Zone	<ul style="list-style-type: none"> Road crossings, which require immediate visual & aesthetic effect and consideration of vandalism. 25 m depth from road into the watercourse corridor. 	<ul style="list-style-type: none"> All locations where roads intersect with watercourse corridors.
Trailside Trees	<ul style="list-style-type: none"> Along all trails within corridor buffers. 	<ul style="list-style-type: none"> Along the watercourse edge of all trails within the buffer.

Appendix A - Tables

Table 5 - Master Checklist for Implementation of Landscape Plans

Implementation Stage	Task Items	Description	Verification & Acceptance	Milestone Date
1.0 Detail Design Of Landscape Plans For All NHS Works	1.1 Design Consultant Pre-Qualification	Lead Design Consultant must be prequalified as a professional with restoration certification and/or OALA full member with demonstrated knowledge of at least (8) years in ecosystem restoration design and implementation of comparable project scale. References to be provided to Town for confirmation. Town must be notified of and approve any change of Lead Design Consultant during the project.	Town C Halton	
	1.2 Landscape Plan Draft Submission	Design Consultant (as qualified per Item 1.1) shall provide a Draft Submission for review by Town of Milton and Conservation Halton: a) Draft Restoration Plans for Site Preparation b) Planting Plans with detailed plant lists; proposed seed mixes with content percentage by weight; list of all other proposed plant materials with sizes, numbers and source(s) indicated. c) Details and specifications for all grading, soil treatment, plantings, seeding, habitat structures, trails, maintenance (including irrigation, rodent protection) d) Monitoring and Adaptive Management Plan e) Schedule of works with milestone dates for phasing and completion of restoration planting works, maintenance and monitoring Design Consultant shall provide written certification that the Draft Submission is in accordance with: i. Functional Servicing & Environmental Management Study (FSEMS) including recommended Natural Heritage System (NHS) including the Town of Milton Restoration Framework for Stream Corridors and Natural Area Buffers in the Sixteen Mile Creek Subwatersheds (Framework) ii. Approved Subwatershed Impact Study (SIS) iii. Town of Milton Engineering and Parks Standards. iv. Conservation Halton permitting requirements (Permit)	Town C Halton	
	1.3 Preliminary Cost Estimate	Itemized cost estimate to be provided for all works depicted on Draft Submission, including relevant earthworks, grading, soil treatments, planting and full implementation	Town	
	1.4 Monitoring & Adaptive Management Plan	Draft Monitoring and Adaptive Management Plan (AMP) per requirements in Framework Appendix A, Table 6, FSEMS and SIS detailing Warranty and Local Monitoring and Adaptive Management Responses for any identified deficiencies observed; to be submitted for review and approval by Town of Milton and Conservation Halton	Town C Halton	
	1.5 Final Plan Approval	Revisions to Landscape Plans and Adaptive Management Plan and Detailed Monitoring Plan to address comments and approval by Town and Conservation Halton.	Town C Halton	
	1.6 Securities	Securities required from developer covering 100% of the cost of all infrastructure works, including all corridor construction and planting. Securities will be held by the Town up to the time of Assumption, and with due notice to the developer, may be utilized at any time to intervene where the Town is not satisfied with the implementation of works. (See Item 3.4)	Town	
2.0 Tender & Awarding of Contract	2.1 Contractor Pre-Qualification: Submit Draft RFQ Criteria for Review	The Owner shall complete a Contractor prequalification process approved by the Town in consultation with Conservation Halton prior to commencing any landscape construction works. The Contractor prequalification process will be directed by the Qualified Design Consultant as certified under Item 1.1. Qualified Contractor(s) and Sub-contractor(s) must be approved by the Town, with documented experience with references provided for the following: a) Experience completing ecological restoration and related landscape projects of similar scale in terms of both value and scale. b) Experience in stream works including channel construction, bioengineering, erosion control; c) Experience with direct seeding of woody and herbaceous native species, planting of bare root and container grown material, meadow establishment and management; d) Demonstrated experience with municipal trail installation. e) Written confirmation that the Contractor(s) bidding will complete all works, and identifying any proposed Sub-contractor(s) who shall also be pre-qualified.	Town C Halton	
	2.2 Contractor Qualification: Request for Quotations	The Owner shall obtain quotations from Contractors prequalified as per Item 2.1. The tender process will be administered by the Design Consultant certified under Item 1.1.	Town	
	2.3 Contract Award	The Owner shall recommend the accepted bid to the Town for their approval in consultation with Conservation Halton.	Town	
3.0 Construction	3.1 Pre-Construction Meeting	The Owner shall schedule a pre-construction meeting to be conducted by the Contract Administrator for the Design Consultant, with the project managers for the Qualified Contractor and Sub-contractors. The Town and Conservation Halton will participate in this meeting; minutes to be prepared by the Design Consultant.	Town	
	3.2 Master Schedule of Works	A Master Schedule of works and site meetings will be established and maintained by the Design Consultant. The Master Schedule shall address the following construction items in conformity with the approved Landscape Plan, FSEMS recommendations, SIS recommendations, Restoration Framework, Town policies and Permit Conditions:	Town C Halton	
		a) Erosion control plan implementation and monitoring		
		b) Grading works (rough and final grading)		
		c) Habitat structures (itemized)		
		d) Plant Material Sourcing and Delivery (including on-site seed harvesting if specified) and confirmation with the Town and Conservation Halton.		
		e) Installation of B&B Caliper trees		
		f) Installation of Bare Root Materials		
g) Installation of Direct Seeding				
h) Installation of Container Materials				

Appendix A - Tables

Implementation Stage	Task Items	Description	Verification & Acceptance	Milestone Date
		i) Installation of Bioengineering Works		
		j) Installation of Other Planting Works (itemized)		
		k) Phased works (if identified on the approved Landscape Plan)		
		l) Maintenance of Works (itemized, to include inspections, irrigation schedules and warranty replacement)		
		m) Monitoring (Warranty & Performance, Local) and Adaptive Management		
	3.3 Confirmation of Plant/Seed Sourcing	Letter from qualified botanist or horticulturalist certifying that plant materials, seed and live stake materials to be supplied have been inspected and are native species per the approved Landscape Plans, with all changes or exceptions noted.	Town C Halton	
	3.4 Maintenance of Works	The Contractor shall complete all maintenance works in accordance with the approved Landscape Plans to the satisfaction of the Design Consultant and the Town.	Town	
	3.5 Remedy for Default of Performance	If the Town identifies deficiencies with the performance of the Design Consultant, Contractor or Sub-contractor(s), due notice will be provided in writing to the Owner and Design Consultant, with a deadline to address said deficiencies. If the deficiencies are not addressed by the specified deadline, the Town will undertake to address the deficiencies using securities under terms of the Subdivision Agreement. (See Item 1.7)	Town	
3.6 Progress and Inspection of Works	The Design Consultant shall is responsible for: <ul style="list-style-type: none"> a) Conducting and providing minutes for progress meetings to review construction progress and establish priorities for landscaping work. b) Finished Grading & Site Preparation: ensure site conditions are prepared according to specifications in Finished Grading & Site Preparation Plans (i.e. optimal soil type and methods for seed installation, habitat structure requirements, micro-grading, and considerations for all other planting and restoration treatments). c) Seeding Approval Inspection Certificate: based on seed packing slip from supplier prior to installation that ensures mix is in accordance with approved design drawings, specifications, and details. d) Plant Material Pre-delivery Inspection Certificate: confirm that all planting stock matches size, condition (B&B, container, etc.), species, quantities, and quality as specified on contract drawings and specifications. This Certificate will be based on verification by a qualified Botanist or Horticulturalist at nursery source or before delivery. e) Planting Layout: inspect and confirm location and spacing of plant material conforms to design intent prior to installation f) Planting: inspect and confirm plant and seed material handling and planting/seeding procedures respective of plant material type (B&B, Bare Root, Container, or Direct Seed). Inspection certificate to be provided to Town for review and acceptance. g) Seeding: inspect immediately after seeding placement, to ensure seeding specifications are met including application rate, good seed-soil contact and adequate measures to prevent excessive soil drying and/or erosion. Inspect again at 30, 60 and 90 days to confirm emergence of seed. Inspection certificate to be provided to Town for review and acceptance. h) Planting: inspect after installation to confirm planting quality and all quantities. i) Verify all quantities and prices including keeping records of all bills of sale. 	Town C Halton		
3.7 Preliminary Approval of Works	The Design Consultant shall, upon completion of all works identified in the approved Landscape Plans (and/or the completion of work phases if identified in the approved Landscape Plans), prepare a report that identifies all works which are deemed as complete, and a summary of all deficiencies. This report will be submitted to the Contractor with a timeline for the remediation of deficiency items. The Town and Conservation Halton will be circulated with this report for review and acceptance.	Town C Halton		
3.8 Final Acceptance of Works	The Design Consultant shall verify in writing that all deficiency items have been remedied, and recommend the commencement of the warranty period for works completed (including all works or phased works as applicable).	Town		
4.0 MONITORING & ADAPTIVE MANAGEMENT	4.1 Scope of Monitoring and Adaptive Management	The Owner is responsible for Warranty Monitoring, Local Monitoring and Free to Grow Monitoring and reporting per Town and Conservation Halton requirements [see Restoration Framework Appendix A Table 6]. This includes implementation and reporting of monitoring, and required adaptive management actions to be completed at the Owner's cost when performance is not achieved.	Town C Halton	
	4.2 Warranty/ Performance and Local Monitoring	The Design Consultant shall undertake Warranty, Performance Monitoring and Local on behalf of the Owner, per parameters defined in Restoration Framework Appendix A Table 6 with assistance where required from qualified Consultant(s).	Town	
	4.3 Monitoring Reports	The Owner shall ensure that Monitoring Reports for Warranty, Performance Monitoring and Local Monitoring are prepared by Consultant(s) retained with demonstrated experience with ecological monitoring, and provided to the Town for review and acceptance at the reporting periods in Restoration Framework Appendix A Table 6.	Town C Halton	
5.0 ASSUMPTION	5.1 Design Consultant's Certificate of Completion	Design Consultant to certify that the installation conforms to the approved Landscape Plans, with confirmation that any and all variations from the plan have been confirmed with the Town and Conservation Halton.	Town C Halton	
	5.2 Release of Securities	The Town will assume ownership of the creek blocks and other NHS works to be dedicated only after the plantings and other required infrastructure are implemented and performing to the satisfaction of the Town in accordance with: <ul style="list-style-type: none"> i. FSEMS including Recommended NHS and Restoration Framework ii. Approved SIS iii. Town of Milton Engineering and Parks Standards iv. Conservation Halton Permit conditions 	Town	

Appendix A - Tables

Table 6 - Monitoring And Adaptive Management Plan

Measures & Parameters	Local Scale (by Landowner) (Monitoring Years)	Holistic Monitoring (Town of Milton) (Monitoring Years)	Frequency / Approach
Growth Rate	1,3,5 To assumption		Commencing one growing season after time of planting; sampled using statistically valid methods to assess the relative growth rates of each size category of woody material that is utilized.
Survivorship	1,3,5 To assumption		Commencing one growing season after time of planting; sampled using statistically valid methods to assess the establishment and survivorship for each size category of plant material that is utilized.
Invasive Species	1,3,5 To assumption		Commencing one growing season after time of planting; see Framework Sect.4.1
Disturbance and Encroachment	1,3,5 To assumption		Commencing one growing season after time of planting; see Framework Sect. 4.1
Costs (plant material, site prep, installation, maintenance)	To assumption		To be provided by Owner/landowners at assumption
Performance: Free to Grow (90% of woody material growing above average meadow vegetation)	3,5 To assumption		Sampling using statistically valid methods to assess the relative percentage of woody plants that achieve 'free-to-grow' status 3, 5 and 10 years after planting under with the relevant monitoring program(s). FTG is defined as growth exceeding the average height of surrounding herbaceous meadow species.
Corridor Cover in representative reaches	3.5 To assumption	ELC: 1, 5,10	Subdivision Scale requires percent cover of tree, shrub and herbaceous based on plots in representative reaches Cover will be determined based on the Ecological Land Classification of plant communities at Ecosite level, determined 3 and 5 years after planting and at assumption; thereafter to be addressed under with the Holistic monitoring program.
Node Coverage	3,5 To assumption	1, 5,10	Percentage of total cover of woody node cover by node type, to be determined 3 and 5 years after planting and at assumption; thereafter to be addressed under with the Holistic monitoring program.
Resident Feedback	To assumption	Post assumption	Town will document comments / complaints received, and any interventions
Cost Effectiveness	To assumption	Post assumption	
Facility inflow/outflow	All*		Continuous: April 1 – November 30
Rainfall		10	Continuous: April 1 – November 30
Stream Temperature	All*	10	Continuous: April 1 – November 30
Erosion	All*	10	Annual
Groundwater	1, 3, 5	Reporting 1, 3, 5, 7, 9	Year One, then Bi-Annually
Fluvial Geomorphology	All*	10	Annually
Fisheries	At least once pre-development and in 1, 3, 5 years	Reporting 1, 3, 5, 7, 9	Spring/Fall
Sediment	All*	Reporting 3, 6, 10	Annually
Water Chemistry	All*	10	Local: Each season Holistic: Three times per year (2 dry, 1 wet)
Natural Heritage System (vegetation & wildlife including existing and created habitats)	At least one full year pre-development and in 1,3,5 years	ELC: 1, 5, 10 Vegetation: 1, 5, 10 Breeding Birds (forest & marsh): 1,2,5, 8,10 Amphibians 1,2,5,8,10	Local: Annual, addressing three seasons for plant communities, and key breeding periods for birds and amphibians Holistic: ELC: Year one, then every 5 years; Vegetation: Twice per year; Breeding Birds: As per applicable standards; Amphibians: 3 times per year
Natural Heritage System Disturbance Monitoring for Boundary Integrity	1, 3, 5 years	10	Local: Annually in summer season after onset of construction Holistic: Annual
Streamflow		10	Continuous: April 1 – November 30
Benthics		10	Annual

Table information as of August 2015, based on Town of Milton Integrated Monitoring and Adaptive Management Plan.

*Timeframe is not fixed because monitoring of the impacts associated with the development of each SIS area is proposed to continue until at least 80% of the respective SIS area has been developed (SIS Terms of Reference, Boyne Survey Area, May 2015).

Local Scale Monitoring by landowners is further detailed in the Restoration Framework.

Local / Holistic Monitoring Information:
Local Scale Monitoring – landowner to provide per Sixteen Mile Creek Areas 2 and 7 Subwatershed Update Study, and Subwatershed Impact Study Requirements.
Holistic Monitoring – Town of Milton standards .

Appendix A - Tables

Table 7 - Monitoring and Adaptive Management Targets and Actions

Measures & Parameters	Targets	Potential Outcomes	Adaptive Management Actions
GROWTH RATE: Sampled using statistically valid methods to assess the relative growth rates of each size category of woody material that is utilized.	Establish and achieve varied plant height and cover target during local monitoring period. Documented plant material sizes and species	Weaker or unbalanced growth performance of some plant species or sizes. For example, more aggressive plants may shade out smaller material; herbivory may cause failure or delayed top growth.	<ul style="list-style-type: none"> Investigate causes of poor performance and document findings Provide interim measures such as pruning or enhanced herbivory control. Report observations and causes of weak or unbalanced growth, and treatment outcomes, to allow Town to adjust requirements in future planting projects.
		Structural diversity clearly evident after 3-5 years	<ul style="list-style-type: none"> Report findings; no further action required.
SURVIVORSHIP: Sampled using statistically valid methods to assess the establishment and survivorship for each size category of plant material that is utilized.	Achieve at least 75% survival of plant material sizes and species	Higher losses of some plant types or species	<ul style="list-style-type: none"> Investigate causes of plant failure and document findings Replace plantings as required within warranty period Remediate conditions contributing to undue losses Report observations and causes of losses, and treatment outcomes, to allow Town to adjust requirements in future planting projects.
		Losses less than 25%	<ul style="list-style-type: none"> Investigate causes of plant failure and document findings Replace plantings as required within warranty period Report observations and causes of losses, and treatment outcomes, to allow Town to adjust requirements in future planting projects.
'FREE-TO-GROW' PERFORMANCE (FTG): Sampled using statistically valid methods to assess the relative percentage of woody plants that achieve 'free-to-grow' status 3, 5 and 10 years after planting under the relevant monitoring program(s).	FTG status achieved within 5 years (defined as growth exceeding the average height of surrounding herbaceous meadow cover).	FTG status not achieved within 5 years	<ul style="list-style-type: none"> Investigate causes of poor performance and document findings Address causes, such as competition control, mulch top-ups, irrigation, or enhanced herbivory control. Report observations of excellent to poor performance and treatment outcomes, to allow Town to adjust requirements in future planting projects.
		FTG status achieved within 5 years	<ul style="list-style-type: none"> Report findings; no further action required.

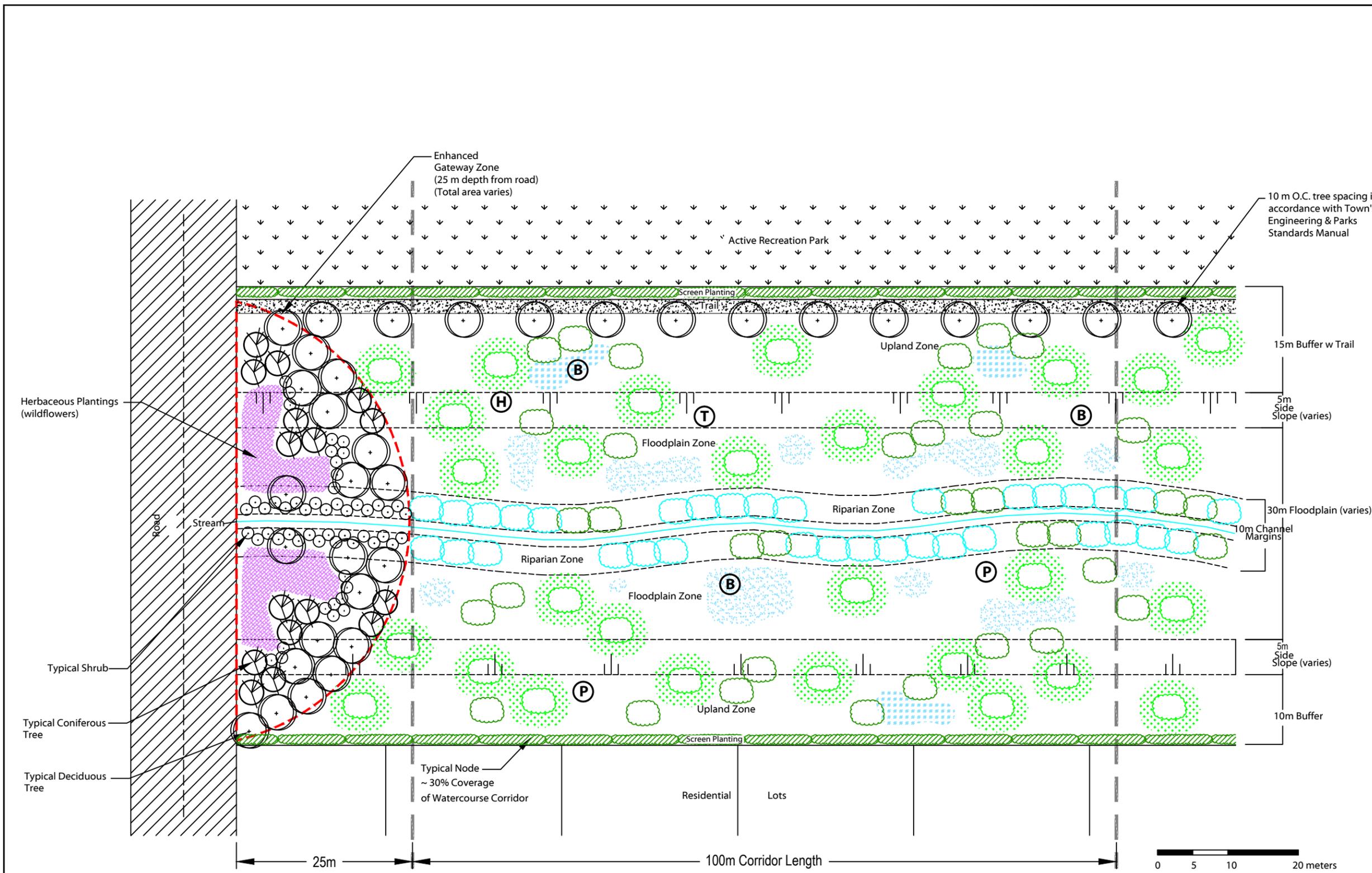
Appendix A - Tables

Table 7 - Monitoring and Adaptive Management Targets and Actions

Measures & Parameters	Targets	Potential Outcomes	Adaptive Management Actions
CORRIDOR COVER: Cover based on the Ecological Land Classification of plant communities at Ecosite level, determined 3 and 5 years after planting, and at assumption under the relevant monitoring program(s).	60-75% canopy cover after 10 years	No significant canopy cover expansion from original planted extent after 5 years	<ul style="list-style-type: none"> Investigate causes of poor performance and document findings Address causes, such as competition and invasives control, mulch top-ups, irrigation, or enhanced herbivory control. Report observations of excellent or poor performance and treatment outcomes, to allow Town to adjust requirements in future planting projects.
		Significant canopy expansion towards target after 5 years	<ul style="list-style-type: none"> Report findings; no further action required.
NODE COVERAGE: Percentage of total cover of woody node cover by node type, to be determined 3 and 5 years after planting, and at assumption; under the relevant monitoring program.	Assess node coverage by type after 3, 5 and 10 years	Nodal cover as documented	<ul style="list-style-type: none"> Investigate causes of poor performance of any nodal types and document findings Report observations of excellent or deficient performance, to allow Town to adjust requirements in future planting projects.
INVASIVE SPECIES: Checklist all invasive species present, and document levels of infestations. Invasive species to be tracked include those falling within Category 1 and Category 2 of Appendix 2 of the CHLTPG (2010).	Less than 5% of planted areas affected by Category 1 and 2 invasive species; potentially toxic species absent.	Class 1 invasives present	<ul style="list-style-type: none"> Advise Town immediately of any observations of potentially toxic species. Determine current extent, assess risk of further spread, preferred control methods, and undertake removal/eradication Monitor outcomes of control measures Report observations and follow-up actions.
		Class 2 invasives present	<ul style="list-style-type: none"> Determine extent, assess risk of further spread, and undertake removals/eradication if significant spread is likely. (Note - Some Class 2 invasives may be shaded out over time) Monitor outcomes of control measures Report observations and follow-up actions.
DISTURBANCE AND ENCROACHMENT: Checklist and annotated mapping of areas where disturbance and encroachment are in evidence where NHS abuts other land uses. To be determined 1, 3 and 5 years after under the relevant monitoring program(s).	Encroachments identified and addressed	Encroachments identified (dumping, waste, illegal gates and trails, gardens, other) within NHS	<ul style="list-style-type: none"> Photograph and document incident locations; describe details Advise Town of observations. Review in next monitoring round Report observations and follow-up actions.

Appendix B

Figures



LEGEND

- Upland Emergent Marsh
- Floodplain Emergent Marsh
- Reforestation Node
- Shrub Node
- Shrub Screen Node
- Riparian Node
- Perch Tree
- Hibernaculum (south or west facing exposure)
- Turtle Nest Site
- Basking Rocks

No.	Description	Date
x	xx	YYYY/MM/DD

Revisions

Residential Area Planting Treatment - 65m Stream Corridor

Project: Restoration Framework: Stream Corridors and Natural Area Buffers for the Boyne and Derry Green Subwatersheds of Sixteen Mile and Indian Creeks

Client: TOWN OF MILTON



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Date: 2015/05/01

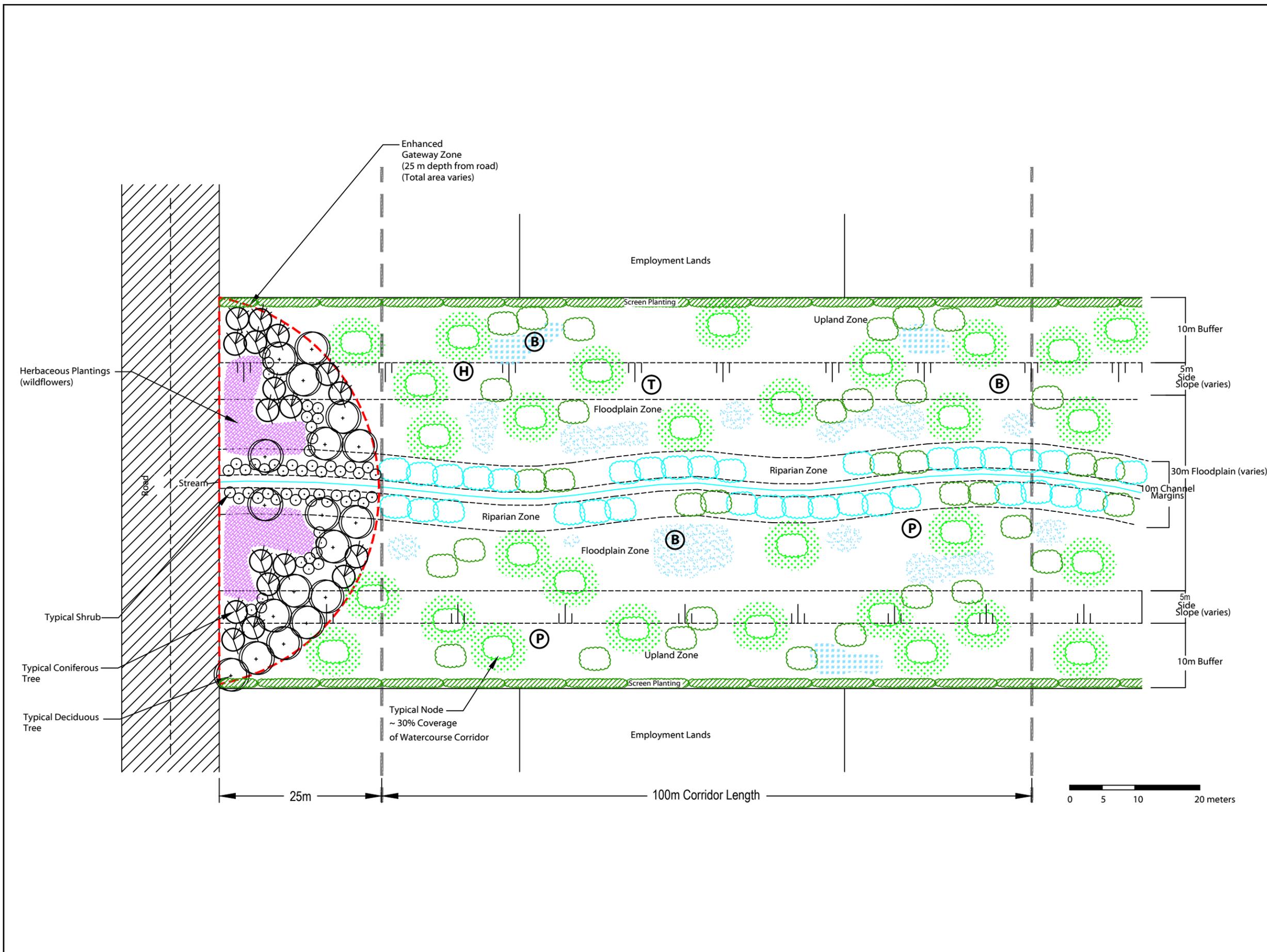
Scale: N.T.S

Drawn By: KSL/NA

Checked By: JD

Figure Number:

FIGURE_1A



LEGEND

- Upland Emergent Marsh
- Floodplain Emergent Marsh
- Reforestation Node
- Shrub Node
- Shrub Screen Node
- Riparian Node
- Perch Tree
- Hibernaculum (south or west facing exposure)
- Turtle Nest Site
- Basking Rocks

No.	Description	Date
x	xx	YYYY/MM/DD

Revisions

Employment Lands Planting Treatment - 60m Stream Corridor

Project: Restoration Framework: Stream Corridors and Natural Area Buffers for the Boyne and Derry Green Subwatersheds of Sixteen Mile and Indian Creeks

Client: TOWN OF MILTON



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Date: 2015/05/01

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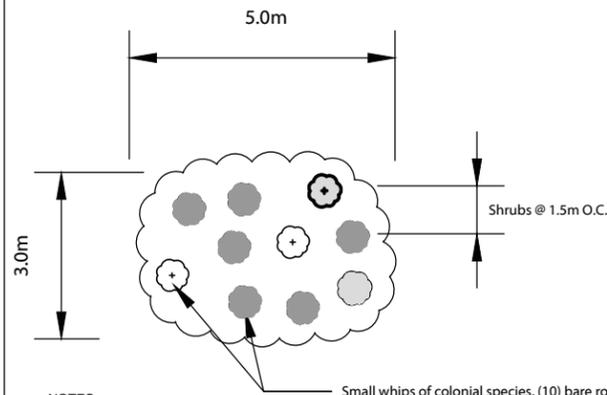
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Checked By: JD

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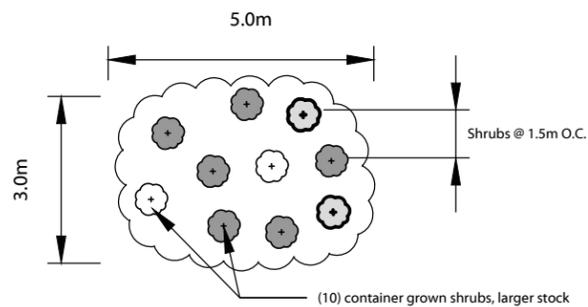
FIGURE_1B

Shrub-only Nodes



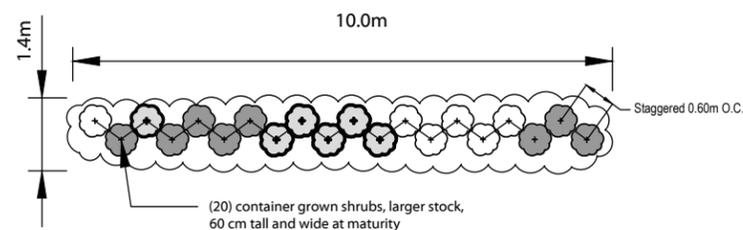
- NOTES:**
- medium to tall shrubs, planted as seedlings
 - nodes applied in floodplain, slope or upland sites
 - visual screening and/or thicket cover
 - for low visual priority areas
 - bare root material
 - nodal spacing to allow access for maintenance
 - protection from herbivory required

1 Basic Shrub Node 15 sq. m. Module
N.T.S. 15 sq. m. Total Coverage



- NOTES:**
- medium to tall shrubs, planted as larger stock
 - nodes applied in slope or upland sites
 - visual screening and/or thicket cover
 - for medium to high visual priority areas
 - bare root or container material
 - space to allow access for maintenance
 - protection from herbivory required

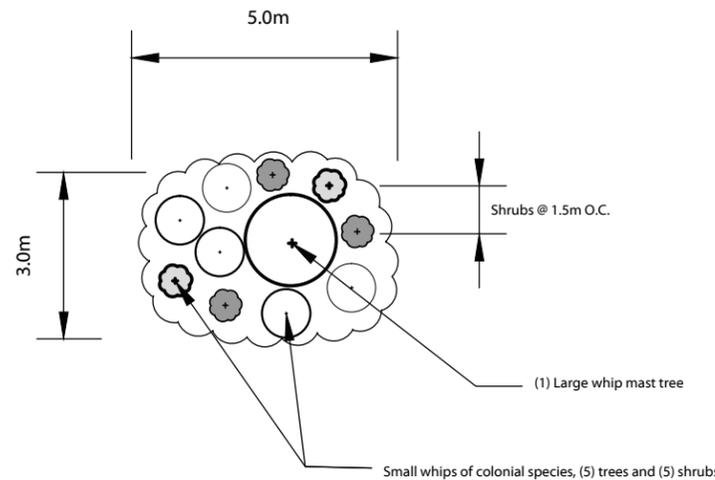
2 Regular Shrub Node 15 sq. m. Module
N.T.S. 15 sq. m. Total Coverage



- NOTES:**
- medium to tall shrubs, planted as larger stock
 - visual screening and physical barrier
 - for high visual priority areas
 - container material
 - protection from herbivory required

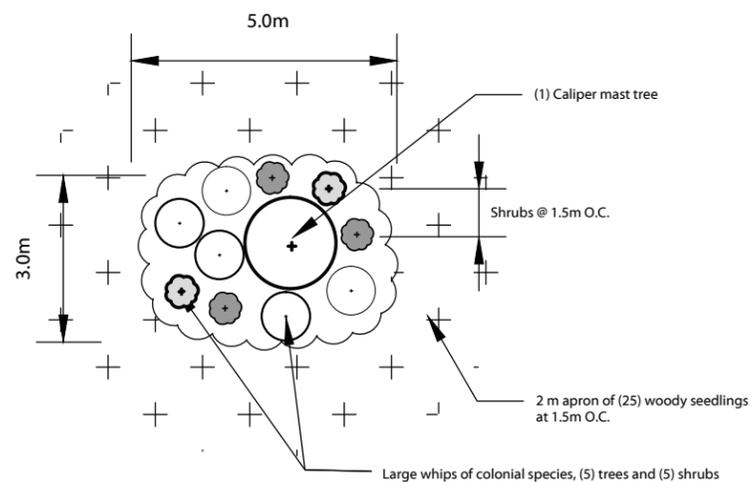
3 Shrub Screen Node 15 sq. m. Module
N.T.S. 15 sq. m. Total Coverage

Reforestation Nodes



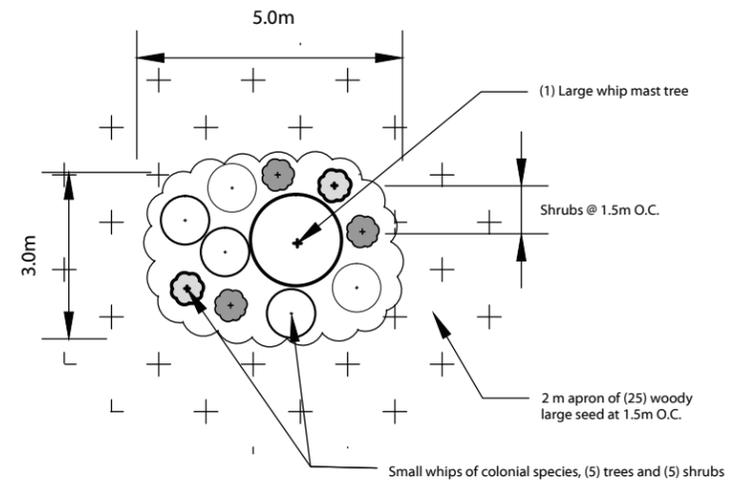
- NOTES:**
- low to medium height shrubs and single tree planted within 5 m of channel on each bank
 - streambanks are high priority for stabilization
 - bare root B&B or container grown material
 - interspersed with shrub nodes and 25% open gaps
 - tree protection from herbivory required
 - standard warranty (2 yrs)
 - nodal spacing to allow access for maintenance

4 Riparian Node 15 sq. m. Module
N.T.S. 15 sq. m. Total Coverage



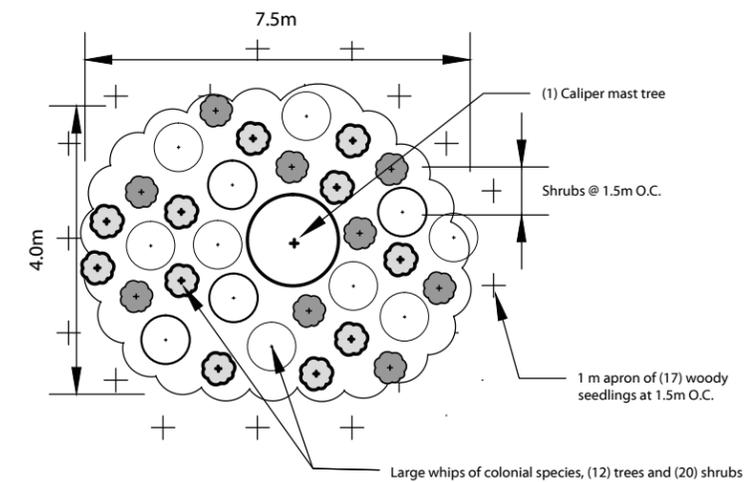
- NOTES:**
- low to medium height shrubs, tree whips, apron of tree and shrub seedlings
 - for medium visual priority areas
 - bare root, and container grown material
 - nodes applied in floodplain, slope or upland sites (using appropriate species)
 - protection from herbivory required
 - standard warranty on larger materials (2 yrs); FTG for seedlings
 - nodal spacing to allow access for maintenance

6 Regular Reforestation Node 15 sq. m. Module + 40 sq. m. Apron
N.T.S. 55 sq. m. Total Coverage



- NOTES:**
- medium to tall shrubs, planted as seedlings
 - nodes applied in floodplain, slope or upland sites
 - visual screening and/or thicket cover
 - for low visual priority areas
 - bare root material
 - nodal spacing to allow access for maintenance
 - protection from herbivory required

5 Basic Reforestation Node 15 sq. m. Module + 40 sq. m. Apron
N.T.S. 55 sq. m. Total Coverage



- NOTES:**
- low to medium height shrubs, caliper tree and whips, apron of tree and shrub seedlings
 - for high visual priority areas
 - bare root, wire basket or B&B, and container grown material
 - nodes applied in upland sites
 - higher vandalism resistance required
 - protection from herbivory required
 - standard warranty on larger materials (2 yrs); FTG for seedlings
 - nodal spacing to allow access for maintenance

7 Enhanced Reforestation Node 30 sq. m. Module + 25 sq. m. Apron
N.T.S. 55 sq. m. Total Coverage

LEGEND

- ⊕ Deciduous Caliper Tree
- Deciduous Tree Whip
- ⊗ Deciduous Shrub
- + Woody seed or seedling (representational only, locations not precise)
- ☁ Mulched Area (Mulch must be aged to avoid reducing available nitrogen due to mulch breakdown)

No.	Description	Date
x	xx	YYYY/MM/DD

Revisions

Node Details

Project: Restoration Framework: Stream Corridors and Natural Area Buffers for the Boyne and Derry Green Subwatersheds of Sixteen Mile and Indian Creeks

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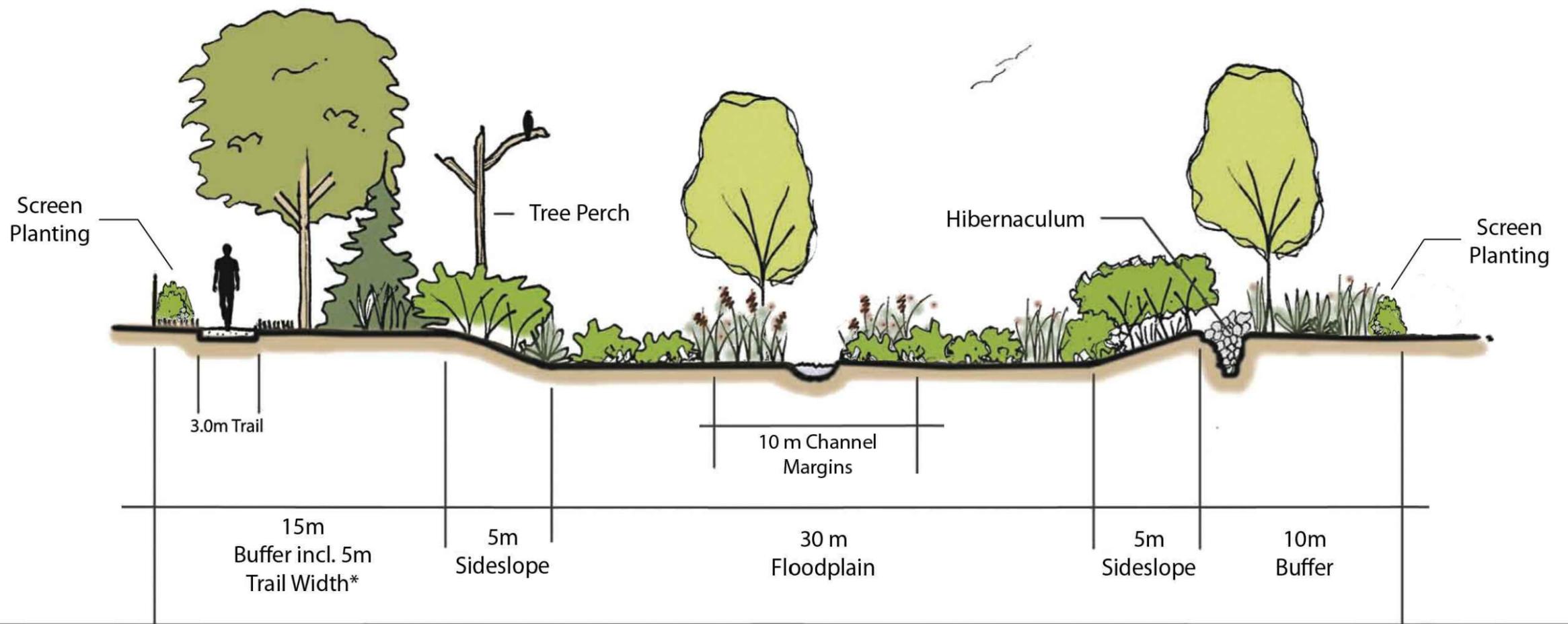
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Drawn By: KSL/NA

Checked By: JD

Figure Number:

FIGURE_2

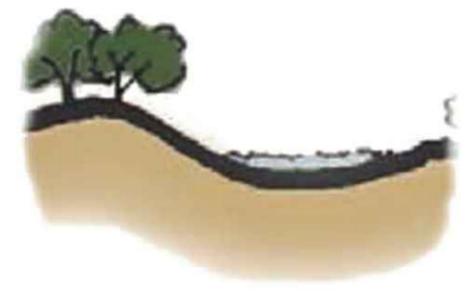


Development Lands

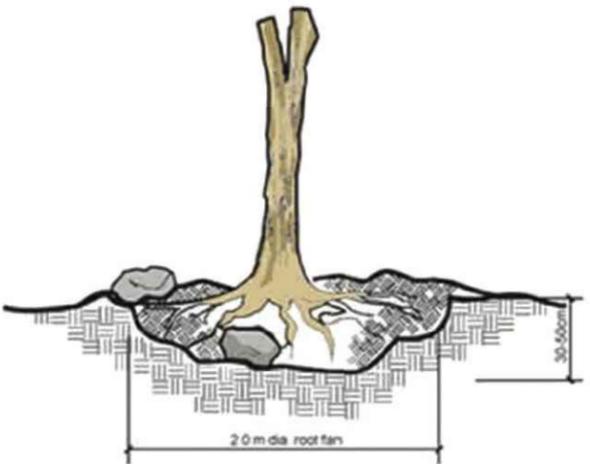
65m Stream Corridor

Development Lands

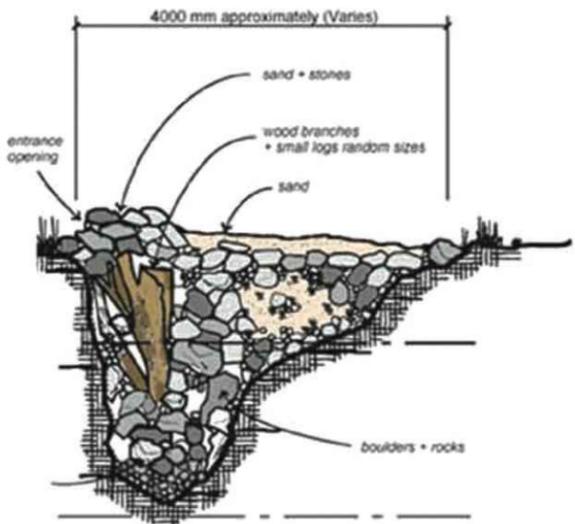
*see Town of Milton Engineering and Parks Standards, as revised.



Vernal Pool Micro-Grading



Tree Perch



Snake Hibernaculum

No.	Description	Date
x	xx	YYYY/MM/DD

Revisions

Typical Stream Corridor Section and Habitat Structure Details

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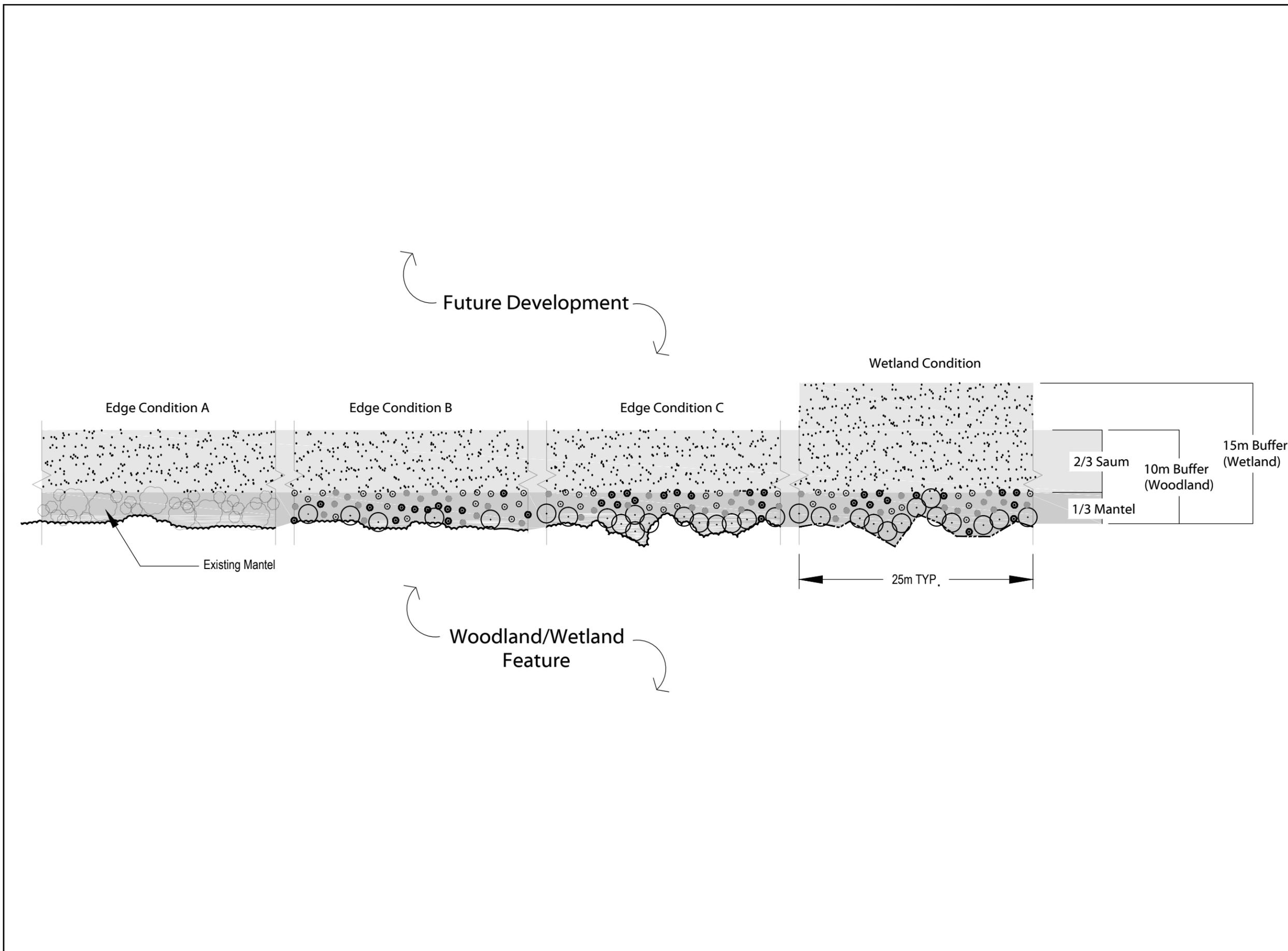
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Drawn By: KSL/NA

Checked By: JD

Figure Number:

FIGURE_3



- LEGEND**
-  Native Meadow Seeding
 -  Shrubs (colonial and deterrent species, 1.5m O.C.)
 -  Tree Whip (1.5m O.C.)

No.	Description	Date
x	xx	YYYY/MM/DD

Revisions

TYPICAL PLANTING TREATMENT - FEATURE BUFFERS

Project: Restoration Framework: Stream Corridors and Natural Area Buffers for the Boyne and Derry Green Subwatersheds of Sixteen Mile and Indian Creeks

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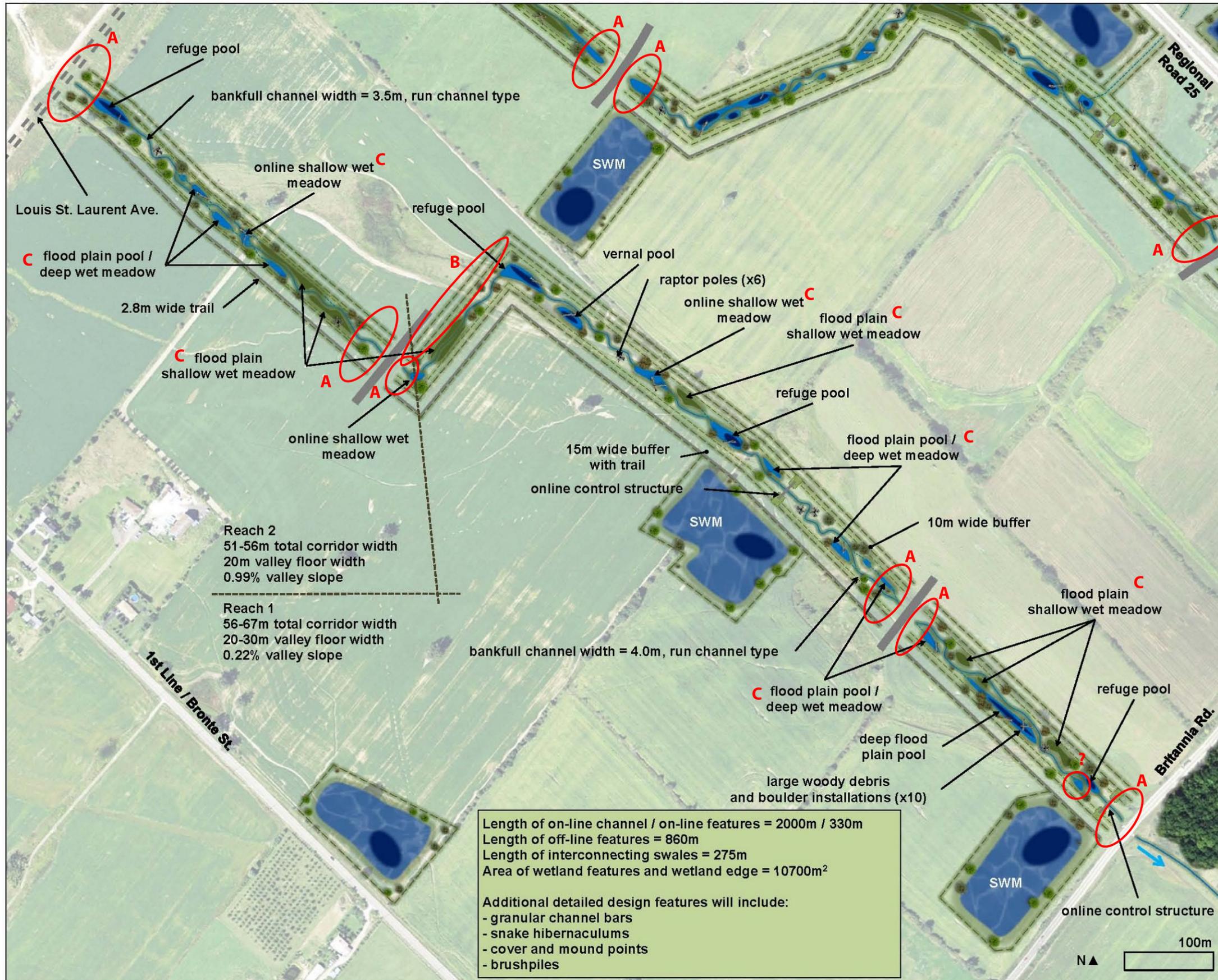
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Figure Number:

FIGURE_4



Appendix B. Town of Milton Restoration Framework

Example Notes & Comments:

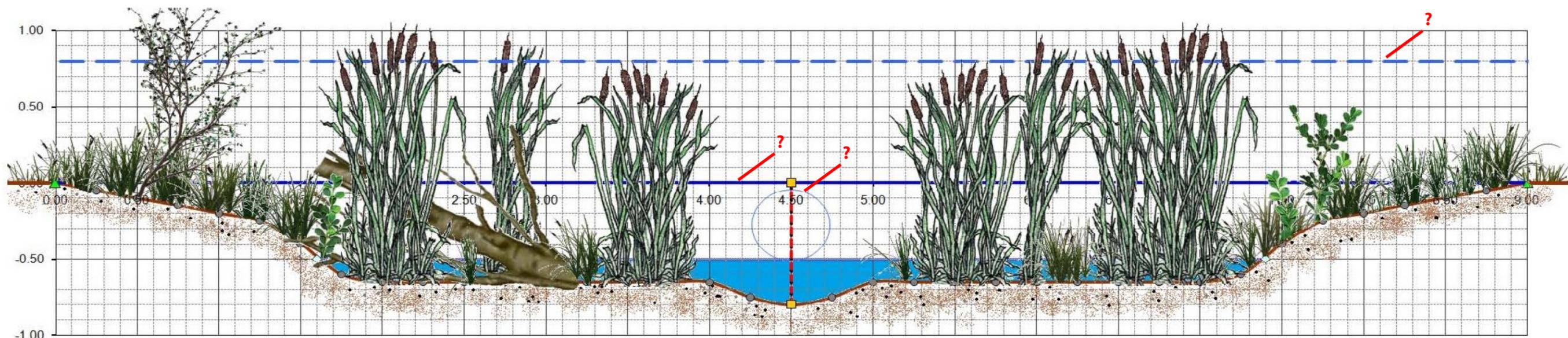
- ◆ Generally a good range of habitat features. Nesting areas, basking areas and hibernacula area should also be indicated.
- ◆ Planting node layout and cover should conform to Restoration Framework Figures 1a and 1b; this includes planting treatment along pedestrian trail.
- ◆ Drawings should include legend and date.

- A.** Identify Enhanced Gateway at all road crossings.
- B.** Identify greater diversity to buffer corridor where it abuts roadways.
- C.** Include buffer wetlands as well as floodplain wetlands as per FSEMS and Restoration Framework.
- ?** Not labelled on plan.

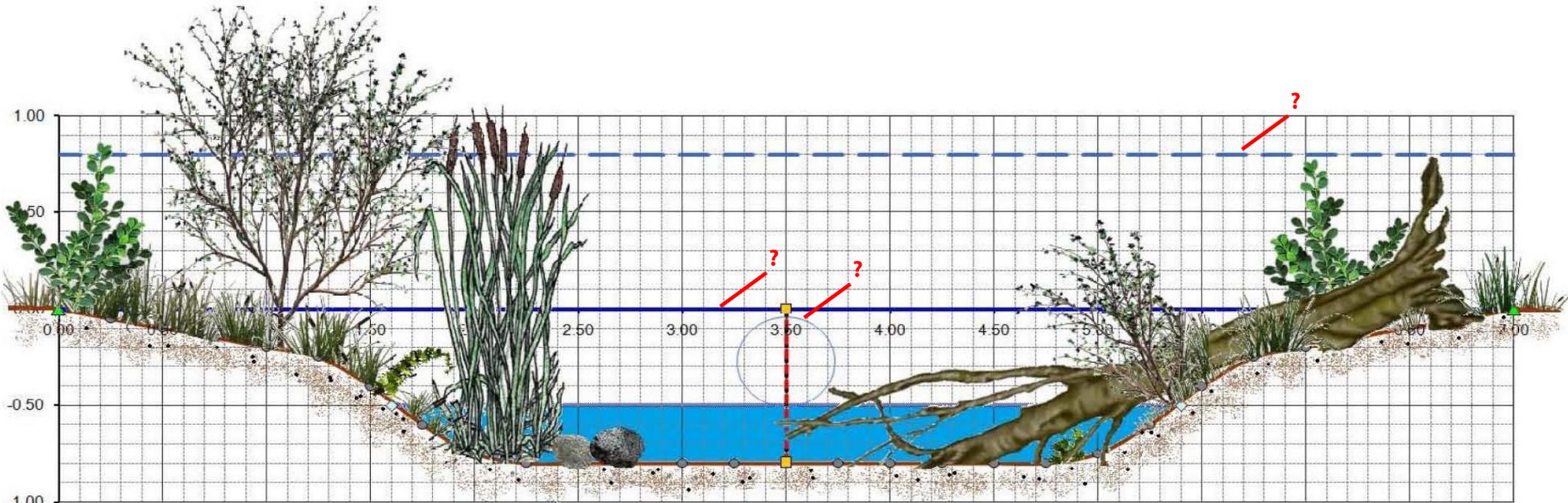
Figure 5a — Annotated Example of SIS Level of Detail



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Proposed Wet Meadow Cross-section (shallow marsh?)



Proposed Refuge Pool Cross-section

Appendix B. Town of Milton Restoration Framework

Example Notes & Comments:

- ◆ Drawing should include legend and date.
- ◆ Terminology for habitat features should be consistent with Plan view.
- ◆ Cross-sections should include buffers and their habitat features, and trails with required nodal planting representation. See Restoration Framework Figure 2.

Figure 5b— Annotated Example of SIS Level of Detail



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Appendix C

Literature and Practice Basis of Approach

Appendix C

Literature and Practice Basis of Approach

Restoration basis due to existing condition of Boyne and Derry Green sites: “*Restoration is defined as assisting the recovery of an ecosystem that has been degraded, damaged or destroyed*” (SER, 2004). The Town Restoration Framework emphasizes initial biodiversity, mosaic cover, mixed age forest, and habitat structure

Nucleation has been advocated as a cost-effective restoration strategy to achieve mixed-aged forest in southern Ontario for at least 20 years, including urban settings (Geomatics 1995, Hough et al. 1994; Daigle & Havinga 1996; Waterfront Regeneration Trust 1995). Various described as planting pockets, cells, nuclei, nodes, modules or pods, Daigle and Havinga detailed the approach and numerous ecological and practical benefits that are contributed by the use of pockets of planting, to yield “a diverse, uneven-aged forest community” (Daigle and Havinga 1996). Restoration practitioners and guiding documents intended for use in southern Ontario all highlight the value of nucleation as an effective tool for large scale projects, and the use of smaller plant materials to achieve higher biodiversity.

Nodes are shrub dominated, or composed of mixed tree and shrub groupings. Use of smaller sizes/propagules allows wider range of species. Species that provide vigorous colonial growth are emphasized. The number of species planted has been shown to be positively correlated with diversity of size classes, degree of canopy closure and dominance by shrubs over grasses (Kanowski et al., 2003).

Corbin and Holl (2012) reviewed 2-13 year long studies and found that nodal plantings have the potential to influence the trajectory and pace of restoration by mimicking nucleation; a process found in natural succession. Under the nucleation model pioneer shrubs and trees colonize in patches that facilitate further recruitment of other species by improving microclimatic conditions (Yarranton and Morrison, 1974). Nodes foster microclimate development (e.g. snow entrapment, enhanced infiltration, providing shade), reducing competition with grasses, and protection for foraging and nesting of smaller wildlife (Corbin and Holl, 2012; Zahawi et al., 2012), which in turn facilitates the recovery process.

Open meadow areas stabilize and condition soil, giving way to invasion by woody pioneer species. Nuclei expand and eventually merge (Havinga & Daigle 1996) (see Figure 1).

Blends of nodal plant material sizes creates variety in vertical structure within nodes. Further environmental heterogeneity is created by contrast in vertical structure between nodes and open meadow, which is positively correlated with biodiversity (Stewart et al., 2002; Wilson, 2002; Halpern and Spies, 1995).

Nodes become recruitment sites – attracting and providing shelter for birds and small mammals which aid in seed dispersal (McClanahan and Wolfe, 1993; Reis et al., 2010; Zahawi et al. 2013). Nodal planting may be most effective in the situation where birds are important dispersers (Corbin and Holl, 2012). Zahawi et al. found that nodes and plantations show the same rate of recruitment of animal-dispersed tree species even though only 20% of the study area was planted with nodes.

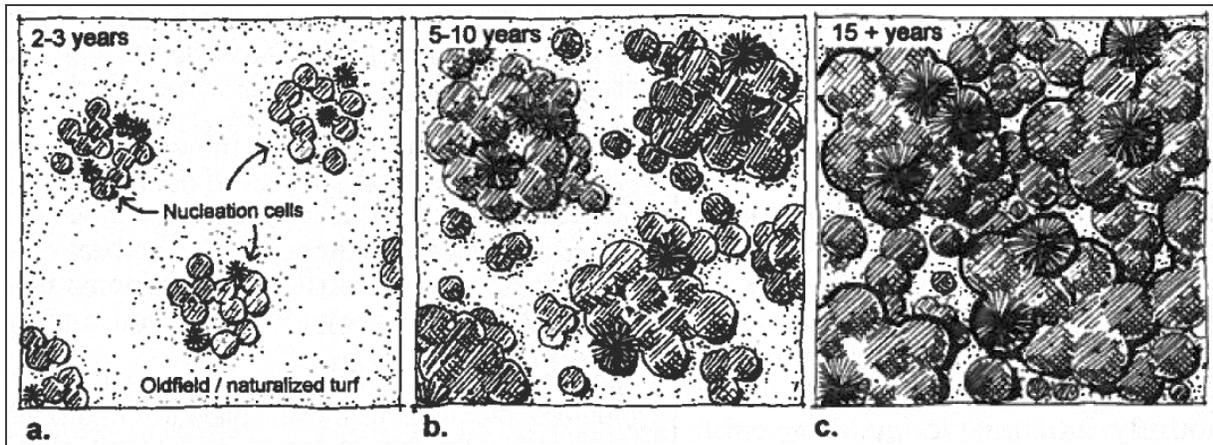


Figure 1. Gradual expansion of nuclei (nodes) over time (Daigle and Havinga, 1996)

Corbin and Holl (2012) found that 90% of animal/wind dispersed seed were early successional species for both nodal and plantation type restoration strategies. Since recruitment tends to favour early successional species, some mid-late successional species should be introduced to the site by restoration activities.

Nucleation promotes landscape connectivity both to and from the restoration site. Planting species that attract frugivorous (fruit-eating) birds contribute to seed dispersal at the node while at the same time provides a source of seed to be spread throughout the site and adjacent lands. This represents an improvement in the potential for self regeneration (Reis et al., 2010).

Species diversity is negatively correlated with initial planting density overall throughout the site since increased stem density per hectare provides less suitable habitat for seed dispersers (Vesk et al., 2008). This pattern suggests that recruitment of a diverse understory may be more likely in a nodal planting due to lower site scale tree density (Corbin and Holl, 2012).

In Norfolk County, the Nature Conservancy of Canada (NCC) has undertaken large scale restorations totalling about 500 ha, including forest, savannah, prairie and meadow. This has been ongoing for nearly two decades, and in efforts since 2006, has utilized direct seeding, typically incorporating about 100 native species per site, all of local origin. With practice the installations have perfected the use of non-persistent nurse crops, mechanical as well as spot hand-seeding techniques, and experimentation with progressively lower seeding rates to make best use of valuable native seed materials. Appendix A presents the progress on some of these sites. The cost savings of direct seeding compared to the use of larger plant materials on this scale of planting are quite phenomenal – about 1% of the average cost of using a mixed material approach on a total area basis. The biodiversity benefits are also substantial compared to approaches focused on the use of rooted stock. There is evidence that these seeded systems are achieving the “*portfolio effect*” as described by Tilman (1999); like a financial portfolio that is more stable when it is diverse, this concept is based on statistical averaging. The portfolio effect is evident where there is little variability to the plant community as a whole despite the presence of localized variability among populations of plants.

To quote Mary Gartshore, founder of Pterophylla Restoration who has pioneered the NCC restoration work over 25 years:

Town of Milton Restoration Framework: Stream Corridors and Natural Area Buffers for the Boyne and Derry Green Subwatersheds of Sixteen Mile and Indian Creeks Page C-2

“Our philosophy has been to establish biodiversity from the get-go... the trick is the complex mix of appropriate native grasses and forbs. Density is less of a factor than complexity.”

(M. Gartshore, pers. Comm., April 2014)

Our review of current practices related to naturalized plantings identified key issues: limited and unpredictable availability of diversity; species substitutions by nurseries or contractors; lack of caliper material of local provenance in the nursery sector. Knowledge shared by various practitioners (suppliers, contractors, growers, restoration designers) indicates that an alarming amount of ‘native’ plant material is coming from sources well outside our region, and that larger specimens are frequently clonal cultivars substituted for open-pollinated stock (i.e. with limited genetic variation and adaptiveness). Species substitutions regularly occur, with aggressive non-native plants or clonal ornamental cultivars substituted for specified native materials; these undermine diversity objectives and may contribute to future system instability. Larger woody materials require more care to establish, and smaller stock typically outperforms larger material; failure of large materials requires replanting which further challenges the supply and cost. Plant failure is primarily the result of an inadequate root to shoot balance.

Conclusions

Nodal approaches are well-adapted to urbanizing situations within highly fragmented landscapes, where natural seed dispersal is constrained. The emphasis on “biodiversity first”, ensures that a wide range of plant species are introduced. The nodal approach activates and prolongs structural and cover diversity. The Town’s guideline is adaptive to site conditions and scale of treatment areas. Wide range of materials are specified: seed, seedlings, whips, bare root, container, balled & burlapped, live staking, sod mats, seedbank salvage. Woody planting treatments are coupled with the seeding of nurse cover crops and native meadow species. Woody plantings are mulched to assist weed control and monitoring follow-up. Mulched nodes allow ready definition and tracking after planting, and allow clear areas for corridor maintenance access. Innovation is encouraged under the Town’s guideline; principles and cover targets should be met at a minimum, or exceeded.

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