City of Peterborough

EMERALD ASH BORER MANAGEMENT PLAN
CITY OF PETERBOROUGH

"By failing to prepare, you are preparing to fail"
Benjamin Franklin

April, 2013

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1 Executive Summary

The landscape of Peterborough includes many woodlot areas, parks, open/natural areas and tree-lined streets. The urban tree canopy established within these areas is an essential component of the City's green infrastructure.

Ash trees are an important native tree species that grow quickly and thrive in Southern Ontario, and, historically, are a major component of woodlots, fence rows, and along water courses. The growth habit and adaptability of the ash tree makes it one of the key species for planting along our urban streets.

Peterborough currently faces a threat to its public and private ash tree resource. An invasive and exotic pest known as the **Emerald Ash Borer** (EAB) has infested many ash trees throughout Southern Ontario and, so far, is responsible for the death of millions of ash trees in the USA and Southern Ontario. It is generally acknowledged as the single most destructive forest pest that has entered North America.

The City of Peterborough has an estimated 2600 ash trees along City streets. Additionally, it is estimated that there are approximately 4500 ash trees located within the City's parks and open space areas. In total, ash represents about 10% of the City's total tree canopy and ash trees have also been a popular choice for planting in many private property landscapes within the City.

EAB was first discovered in Windsor, Ontario in 2002. Since then, many other municipalities have had positive EAB identification. EAB is now confirmed in 27 Ontario Counties (Canadian Food Inspection Agency 2012). In May 2011 EAB was confirmed in Oshawa and in August 2012 EAB was confirmed in Frontenac County. This puts the confirmed outbreaks within 70 and 140 kilometres of Peterborough City on the west and east sides respectively. The spread of EAB in Southern Ontario is averaging 40 km per year west to east, and, although it has not been detected to date in Peterborough, it is predicted to be found in 2013 or 2014. In all probability it is likely here already but at low population levels that are presently undetected through pheromone traps and branch-sampling detection methods.

The City of Peterborough is fortunate to be able to learn from other municipalities' strategies, plans and accomplishments, together with a greater understanding of EAB itself. The lessons learned from other municipalities and the development of the Canadian Forest Service Ash Protection Model support a proactive approach to treating ash trees as being both economically feasible and the best method for management of EAB. EAB populations increase exponentially over time and, accordingly, a proactive plan is recommended which will ensure selective ash tree protection; preserving environmental benefits and supporting public safety through a combination of

monitoring, treatment, removals and replacement strategies.

The proposed *Emerald Ash Borer Management Plan* that will guide the City over the next 10 years includes:

- Inventory, Monitoring and Assessment;
- Treatments;
- Tree Removals;
- Tree Planting;
- Wood Waste Disposal; and
- Public Education and Communication.

The cost for EAB monitoring (including assessment, inventory and public education) in 2013 is estimated to be $173, 000 although costs will increase significantly over the next 5 – 10 years with the long-term cost being greater than $5m.

EAB infested tree in Pickering 2012

2 Introduction

On June 27, 2011 City Council adopted the Urban Forest Strategic Plan (UFSP) thereby cementing its position as a responsible steward of the City's urban forest.

The objectives and recommendations within the UFSP promote the management of the City's tree canopy through planting, maintenance, removal, and pest management programs. In particular, UFSP Recommendations 1.4 and 5.3 speak to the threat to the City's urban forest from invasive species and the need to respond through dynamic forest management practices.

Ash trees are a significant component of Peterborough's urban forest on both public and private lands. The publicly-owned urban forest occurs along streets, in parks and within public open space areas. Privately-owned trees are located on residential properties, institutional and commercial properties, and in privately held woodlots that are not under the control of the City. Private tree maintenance is the responsibility of the property owner, although the City provides forestry-related information to residents.

The City of Peterborough has approximately 2600 ash trees in the right-of-way and approximately 4500 Ash trees located within the City's parks and open spaces. There are an estimated 9000 Ash trees on private property. Ash trees are an important native tree species and a major component of woodlots, hedges and fence lines, and often grow along stream banks and disturbed areas. Ash, as a species represents up to 10% of the tree canopy cover within the urban forest of Peterborough.

EAB is a *non-native* invasive insect with no natural predators in Ontario that attacks and kills healthy ash trees. This places all *true* ash species, (*not mountain-ash),* at risk. EAB was first detected in 2002 near Windsor and despite substantial research and control efforts continues to spread throughout the province of Ontario. It is now known that one of the principal mechanisms of the rapid spread of EAB is through the movement and transport of infested wood material, particularly firewood. Efforts to control or eradicate the pest have not been effective and the only option that remains is to manage the impact of an EAB infestation. The impact of EAB on the health and biodiversity of Ontario's forested landscape is highly significant.

The threat to the longevity of ash trees in the Ontario landscape has been recognized for a number of years, and, for this reason, the City has not planted any new ash trees since the spring of 2007.

Ash trees along with many other species provide significant benefits to the City of Peterborough. Tree benefits are documented in detail within pages 15-18 of the UFSP

and include the provision of oxygen, improvements in air quality, conservation of water, prevention of soil erosion, provision of food and shelter for wildlife and moderation of the extremes of climate. Trees also increase property values and, significantly for the community, contribute to the quality of life in a neighbourhood. Ash trees are an extremely important component of the urban forest in that they are one of the principal large-stature, long-lived species conferring proportionally greater benefits than many other species in our urban forest. In addition to this, ash has a high tolerance of salt, poor soils and other urban stresses which makes its use invaluable in the urban forest, particularly for planting in the right-of-way.

With the potential for a large scale loss of ash trees, Peterborough will need to consider carefully the aesthetic and environmental benefits of the ash tree component of the urban forest and determine how best to manage and compensate for the predicted losses due to EAB. As we move through the initial outbreaks of EAB, replanting the ash component of the City's urban forest with alternative species of trees will be critical to maintaining canopy cover and the many environmental, social and economic benefits that trees give to our community.

2.1 Biology

EAB belongs to a group of metallic, wood-boring beetles (Photos 2-4 below) commonly found in Asia. The adults lay individual eggs distributed on the bark of the tree and the larvae bore through the bark and feed on the inner (vascular) tissues below, thereby disrupting the tree's ability to transport water and nutrients (Photo 5). Larvae spend approximately one season beneath the bark creating tremendous amounts of damage to the tree.

Photo 2: Emerald Ash Borer larvae

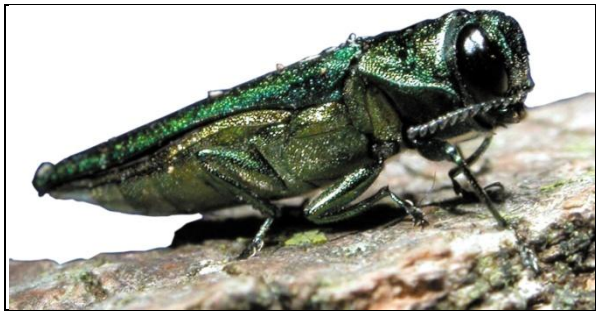


Photo 3: Adult beetle

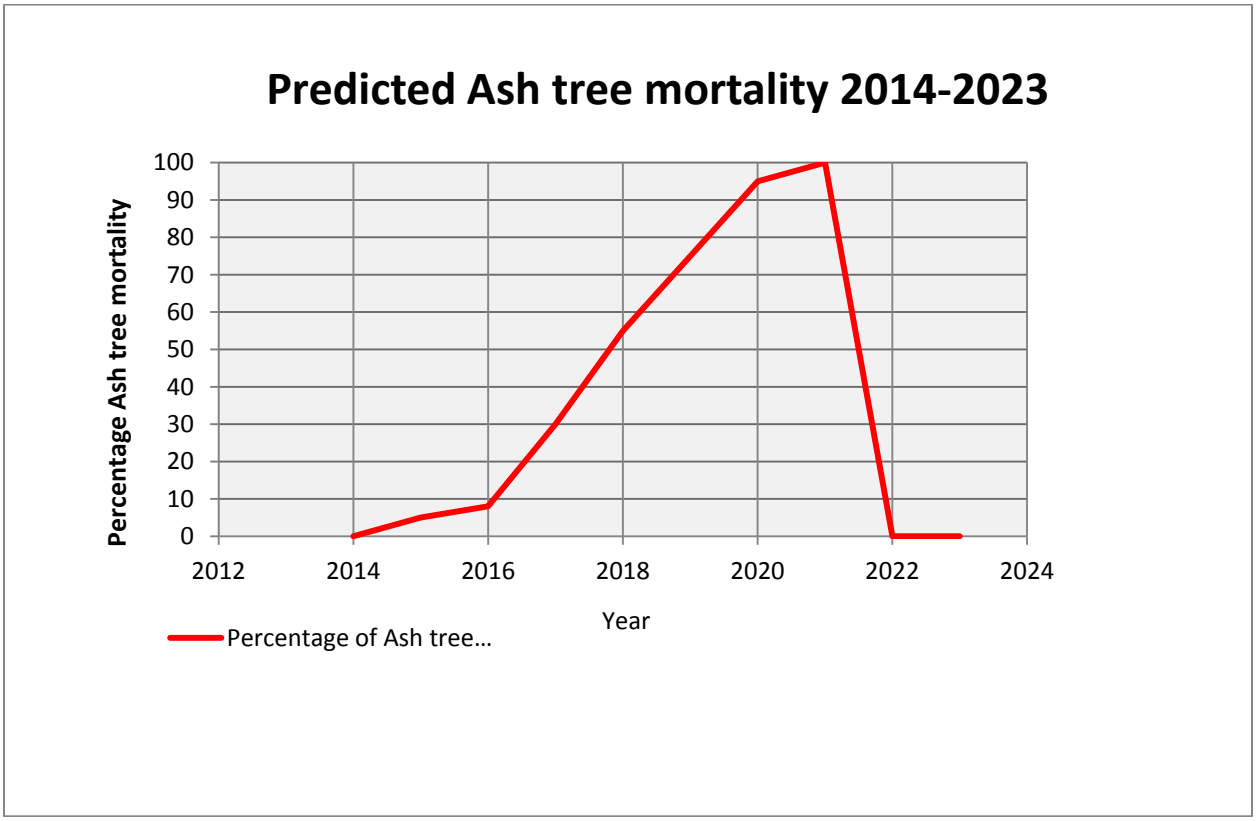
Photo 4: Adult beetle

Photo 5: Feeding galleries of EAB larvae under the bark; Laval Drive, Oshawa 2012

2.2 Mortality

Based on EAB infestations in other Ontario municipalities and scientific research it is known that EAB populations increase exponentially over a 5-10 year period. Tree mortality rate is slow in the first 2-3 years with an exponential increase in years 4–8; gradually levelling off as the ash population decreases. Chart 1 below represents the estimated decline of Peterborough's current street and park ash tree inventory assuming the confirmed presence of EAB in Peterborough in 2014.

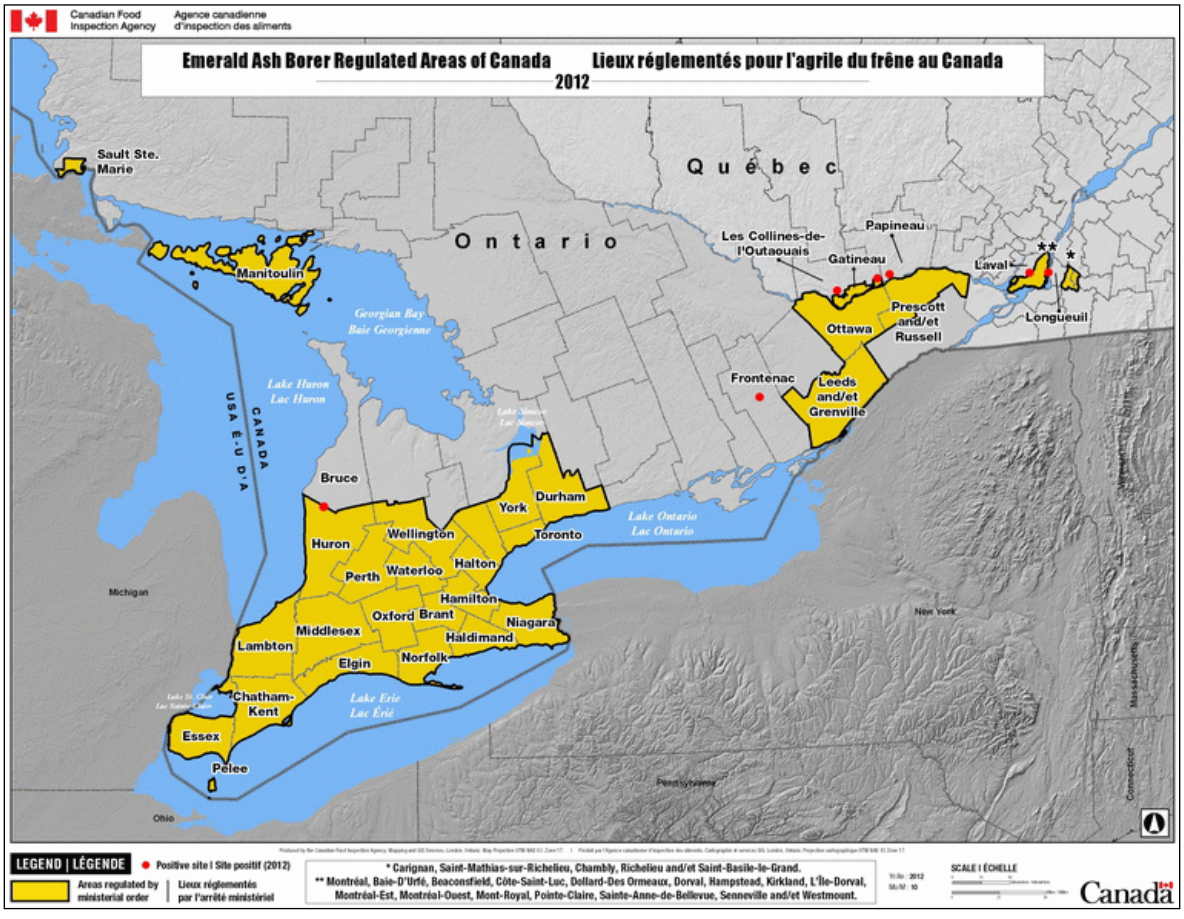
Chart 1: Predicted Ash Tree Mortality Following EAB infection



2.3 EAB Regulation

The County of Peterborough is currently located adjacent to Durham Region which is within an EAB regulated area (see Map 1) established and regulated by the Canadian Food Inspection Agency (CFIA). There are currently 27 counties or regions in Ontario that are impacted by EAB. The regulation is intended to prevent the spread of EAB by limiting the movement of infested ash wood, ash wood products and ash nursery stock through human activities. As of March 2013 the CFIA has been unable to prevent the natural spread of EAB and is considering removal of all EAB regulations in southern Ontario in 2014. This will effectively speed the spread of EAB to throughout southern Ontario as materials move freely from previously regulated areas.

Map 1: Emerald Ash Borer regulated Areas of Canada (Canadian Food Inspection Agency 2012) Areas regulated by Ministerial Order shown in yellow.



3 Roles and Responsibilities

All levels of government, as well as private property owners, play a role in the management of EAB as detailed below.

3.1 Federal Government

The Canadian Food Inspection Agency (CFIA) is the federal agency responsible for regulating introduced Forestry or Agriculture pests. Federal regulatory measures prohibit the movement of any ash tree materials and firewood of all ash species to areas not yet impacted.

CFIA has established a multi-agency approach involving the Ontario Ministry of Natural Resources (OMNR), Canadian Forest Service and the Ontario Ministry of Agriculture. Food conservation authorities and many other groups, agencies and associations are also being consulted to ensure an effective, comprehensive approach.

3.2 Provincial Government

The OMNR facilitates research on forest health through the work of scientists at the Ministry's Ontario Forest Research Institute. Forest health management includes control programs, research, expert advice, education and knowledge transfer, development of pest control methods and products, policy development and implementation, development of best practices and their inclusion in forest management activities and interagency collaboration.

3.3 Local Municipalities

Once EAB is detected, municipalities must monitor and manage the pest with their own resources. At the time of this report it is thought that none of the eight Townships or two First Nations Reserves within Peterborough County has EAB Management Plans in place.

3.4 Private Property Owners

Property owners are responsible for ash trees on their private property which includes maintenance, treatment and removal. It is expected that costs for some private ash tree removals will be extensive. The Minimum Property Standards By-Law of the Municipal Code, Chapter 611.3.34 states that property is to be maintained in a safe condition, which includes removal of dead or decayed trees or branches.

Public education and communication is essential in assisting the public with identification of EAB and recommending actions residents can take, such as treatments and/or the selection and planting of different species of trees before or after ash tree removal. This proactive step for private lands will greatly assist in preserving the City's urban tree canopy.

4 Impacts of EAB

Trees are a major component of the Urban Green Infrastructure and, consequently, widespread loss of ash trees in urban forests and residential landscapes will have devastating economic, environmental and social impacts. These impacts include the costs for implementing a management plan, the loss of tree canopy and the indirect costs associated with the environmental and social value of trees.

The urban tree canopy is an important asset that requires care, preservation, and maintenance. Invasive species like EAB threaten the health of our forests and tree canopy. Retaining and maintaining the existing tree canopy maintains property values, has a positive impact on tourism and improves the quality of life within urban environments.

Photographs 6 and 7 (below) show ash trees in Ohio before and after attack by EAB. They show the devastating impact that the loss of trees has on the community. The final step for the street in the photographs is to remove all of the dead trees changing completely, and for at least 20 years, the character of this street. Early treatment of these trees would have maintained the existing tree canopy.

Photo 6: Photograph of ash trees in Toledo, Ohio, 2006

Photo 7: The same ash trees in Toledo, Ohio, 2009 after EAB attack

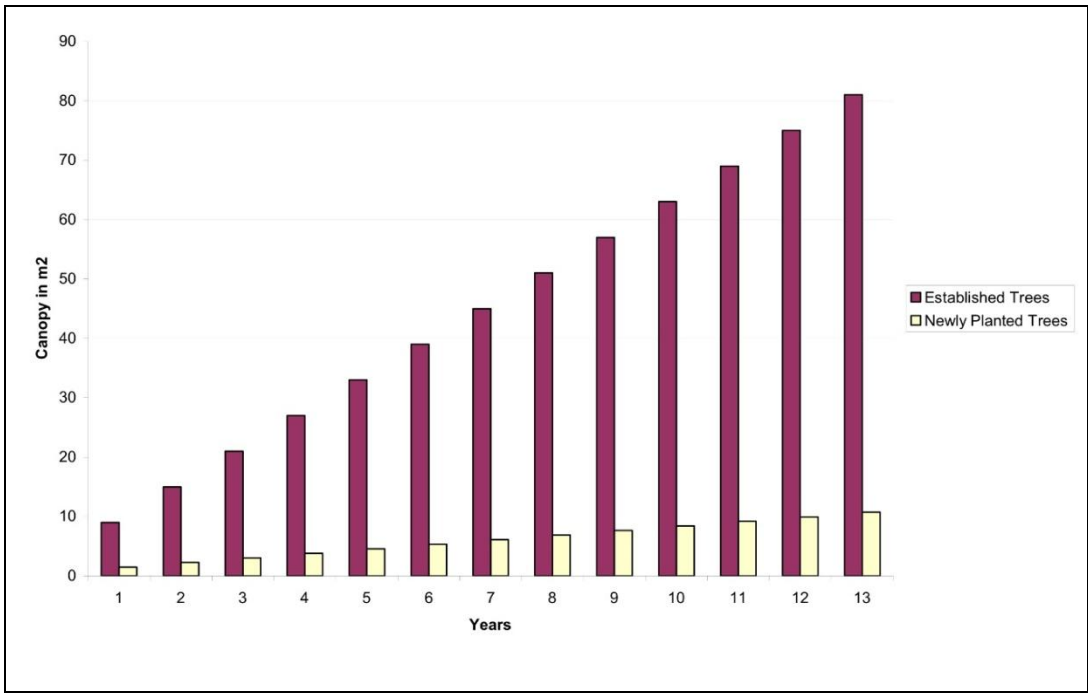
4.1 Environmental Impacts

All trees are beneficial to the environment:

- Trees influence thermal comfort, energy use, and air quality by providing shade, transpiring moisture, and reducing wind speeds.
- Trees improve air quality by lowering air temperatures and removing air pollutants through their leaves.
- Trees can affect climate change by directly storing carbon within their tissues and by reducing carbon emissions from power plants through lowered building energy use.
- Trees improve water quality and reduce the need for costly storm water treatment by intercepting and retaining or slowing the flows of precipitation.
- Trees and other plants help remediate soils at landfills and other contaminated sites by absorbing, transforming, and containing a number of contaminants.

By losing the ash species, there will be many negative effects associated with a reduced tree canopy. Chart 2 below shows a tree canopy that would exist for treated established ash trees versus a tree canopy for newly planted trees (ash removed and replaced) over a period of 13 years. The established ash tree canopy area increased more than 8 times that of the increase of the newly planted trees.

Chart 2: Comparison of retained ash tree canopy versus canopy from replanting



4.2 Economic Impacts

Trees in the urban environment increase property values and have important commercial benefits including tourism.

Two recent studies completed by Natural Resources Canada, Canadian Forest Service and Great Lakes Forestry Centre, used current data to summarize the costs associated with EAB and developed an economic model that supports a proactive management approach to EAB.

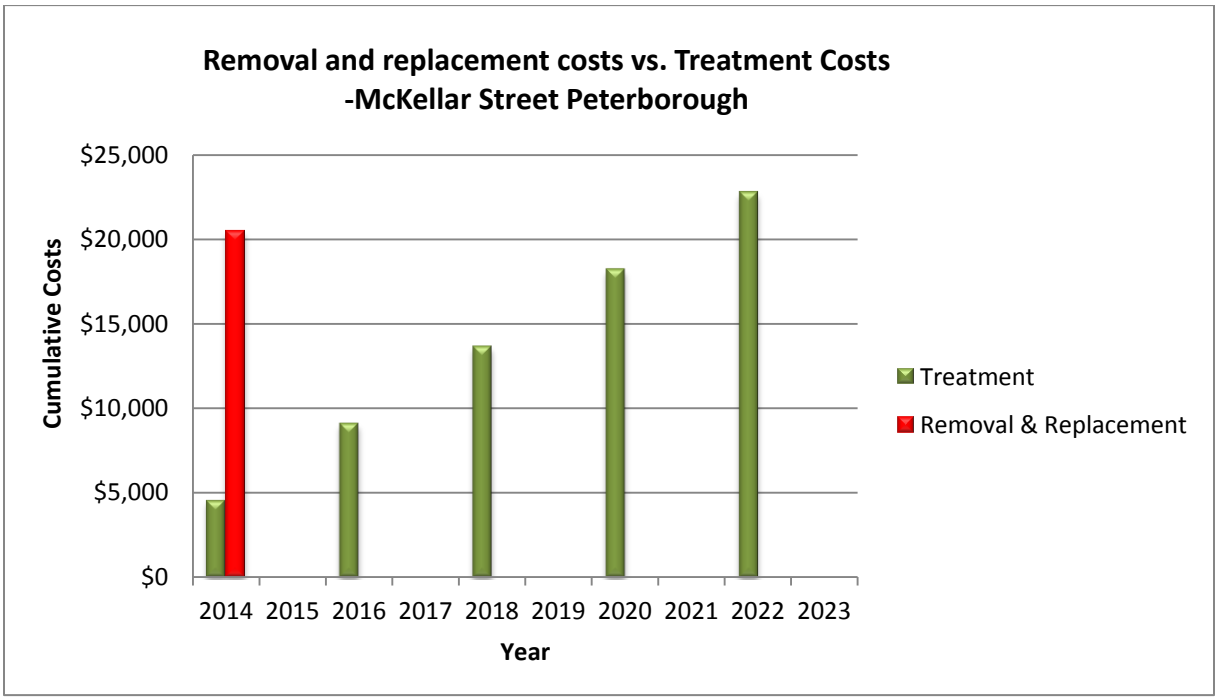
The first study entitled "Estimates of the Potential Cost of Emerald Ash Borer in Canadian Municipalities" (McKenney, D.W., Pedlar, J.H., Lyons, D.B., Campbell, K., and Lawrence, K. 2012. *Journal of Arboriculture and Urban Forestry*) estimated EAB will cause an economic impact between $0.5 and $1 billion over the next 30 years on street trees in Canadian municipalities. The study estimated costs for EAB pesticide treatments at $138 per tree together with community overhead costs of $0.40 per household for activities related to increased staffing, public education and communication, wood waste, etc.

The study shows that slowing the spread through treatments reduces the overall costs.

The second study entitled "To Treat or Remove: an Economic Model to Assist in Deciding the Fate of Ash Trees Threatened by Emerald Ash Borer".2012 (McKenney, D.W., and Pedlar, J.H. *Journal of Arboriculture & Urban Forestry, 38(4):121-129*) concluded it would take 10 years of EAB treatment to equal the cost to remove and replace a medium-sized ash tree. However when including all the benefits of a medium-sized ash tree it would take 20 years of EAB treatment to equal the cost to remove and replace that tree.

Using the information from the second study and McKellar Street with its' 14 ash trees as an example, it would take 8-10 years for the cost of treatment to equal the cost of removal and replacement, as indicated on Chart 3 below.

Chart 3: McKellar Street: Removal versus Treatment for EAB



These numbers **do not** take into consideration recognized tree benefits such as increased property values, energy savings, carbon sequestration and pollution and runoff reduction gained with maintaining the existing tree canopy (see Section 4.3 “Social Impacts”).

The seriousness of the overall economic impact is being recognized by a growing number of municipalities and Non Governmental Organizations. These groups have come together and drafted an Urban Forestry resolution to forward to the Association of Municipalities of Ontario to seek support for Provincial and Federal funding. The intent is for the Province to establish an urban forestry mandate which would assist municipalities dealing with EAB and future invasive pests.

To date there is no provincial or federal funding for the costs associated with EAB treatments, ash tree removals or replanting. It is estimated that the economic impact of Emerald Ash Borer in Canada will be in the range of $2 billion and between $30-40 billion in the United States.

4.3 Social Impacts

The social impacts of EAB can be measured primarily in the loss of benefits and aesthetics to the local community. Impacts will be greater in some areas as clusters, groups and individual trees die within a short period of time and are removed. Property values will decline as areas become denuded of trees and are perceived as less desirable places to live.

There are known decreases in quality of life and increases in crime with fewer trees in a community and in a recent observational study in the United States, tree loss from the spread of the emerald ash borer was associated with increased mortality related to cardiovascular and lower-respiratory systems.

Recognized tree benefits, such as carbon absorption and storage, air filtering, cooling and shading, storm water interception and increases in property values from the ash tree component of the urban forest are calculable. Using the national tree benefit calculator developed in the United States, the approximate annual benefit derived from each 35cm diameter (14 inch) ash tree in the right-of-way (street tree) is approximately $138 per year, where a park tree of the same size contributes approximately $110 in benefits per year. Therefore, in Peterborough, the economic benefit of all of the ash trees in the right-of-way alone is likely to be around $350,000 per year. Combined with the estimated numbers of trees in parks and open spaces the total benefit of ash trees to the City based on an average diameter of 35 cm is around $850,000 per year.

4.4 Wood Utilization and Waste Disposal

EAB infestation will result in a significant increase in the need for wood waste disposal options for public and private properties. Consideration should be given to the increased needs of residents by ensuring that there are disposal options available.

The City of Peterborough provides curb side collection of leaf and yard waste to residents. Residents and contractors can drop off larger materials at the Waste Management Facility (WMF) located at Bensfort Road. Loads delivered to the WMF may be subject to waste disposal charges based on the weight of the material disposed. Neither of these programs is intended to deal with the volume of wood waste that will result from the EAB. As part of the EAB management plan, staff will investigate possible use of the wood waste as a commodity.

The majority of trees removed as a result of EAB will be 'Amenity' trees, which are planted, pruned and maintained for their visual appearance rather than grown for lumber production. Because these trees are often retained into a stage of decline they usually have areas of rot, decay and/or dead wood and are often poorly shaped for sawmill processing. It is likely that the primary use for the ash tree removals that arise from EAB will be as firewood. However, logging potential will also be reviewed as EAB takes effect throughout the City.

Wood waste that is not suitable for firewood can be ground into landscape mulch using tub grinders that create a variety of mulch textures or material that can be added to other organics to create compost. The grinding and composting processes would destroy any EAB larvae under the bark of waste material. As with our curb side collection, our composting program is not set up to handle this additional wood waste load. In fact, it is highly unlikely that the City would be permitted to compost the additional EAB wood waste using our existing open windrow methodology at our present Harper Road site.

A comprehensive disposal plan that includes the County of Peterborough as a minimum should be considered to deal with the increasing volume of material.

4.5 Research

For the past few years' research has continued into a variety of chemical and biological treatments to assist in controlling EAB. Currently, one insecticide (a bio-pesticide), TreeAzin™ has full registration in Canada and has been proven effective for protection and treatment of the EAB larvae. The product is owned by the Canadian Forest Service and was developed in collaboration with BioForest Technologies Inc. and is a class 4 pesticide (least hazardous that is commercial). The chemical is injected into the tree and distributed throughout the canopy, where it affords 2 years protection from EAB.

Natural predators have recently been released in the United States and will likely spread into Ontario over the coming years. These natural predators take many years to assert themselves and will have no effect in Peterborough within the 10 year period of the EAB management plan. Biological control is seen as an effective longer-term solution to EAB but lies many years into the future and will not prevent the loss of trees in Peterborough unless other measures are taken now.

The City of Peterborough is in an excellent position to undertake strategic EAB management by drawing on current research and the experience of other municipalities. With developing research into biological control of EAB and the

registration of more effective and cheaper chemicals, there is a good chance that the City of Peterborough will be able to affordably protect and retain a significant percentage of its ash tree inventory.

4.6 Lessons Learned

When EAB was first detected in Windsor in 2002, it was hoped that by removing large swathes of trees, the insect would be contained. This strategy did not work, and EAB continued to spread easterly through Ontario. Windsor has stated that just a few ash trees have survived the first wave of EAB.

Monitoring has been determined to be beneficial in identifying hot spots and the rate at which EAB is progressing within the municipality. Once these areas are found, a combination of treatments and removals reduce the spread of EAB by suppressing populations of the insect.

It has been found that once visual symptoms are observed the tree is already heavily infested. Windsor noted that trees treated with TreeAzin™, which showed visual symptoms of EAB, recovered with continued treatment. Municipalities that have treated with TreeAzin™, such as Oakville (from 2008 onwards), Toronto and Ottawa have proven that it works, as shown in Photo 8 below.

Photo 8: Left: Comparison of untreated (foreground) vs. treated (background) green ash

A number of municipalities were surveyed and all municipalities with confirmed EAB have an EAB plan in place or one is being created. Estimated future costs associated with these municipalities and EAB range from $2.8M to $36M.

5 City of Peterborough EAB Management Plan

The City of Peterborough needs to develop an effective, responsible and financially viable approach to managing the spread of EAB. The development of any such plan should be directed by the following guiding principals:

- Ensure Public Safety and Minimize Liability
- Mitigate the Loss of Significant Ash Trees
- Maintain the City's Tree Canopy
- Provide Public Education and Awareness

A detailed EAB Management Plan should be structured to preserve the City's urban tree canopy, slow down the spread of EAB where possible and allow for the preservation of high value trees in order to allow more time for improved and/or other control measures to be introduced in the future.

An effective and efficient EAB Management Plan will include the following elements:

- Inventory, Monitoring and Assessment
- Treatments
- Tree and Stump Removal
- Tree Replacement (with a different species of tree)
- Wood Waste Disposal
- Public Education and Communication

5.1 Inventory, Monitoring and Assessment

Inventory is crucial to effectively managing EAB. Without an inventory of publicly-owned ash trees in the right-of-way, public parks, open spaces, woodlots and forested areas, we will not know their location, distribution, size and condition. Without this information we will not know the City's potential risk exposure or be able to strategically manage the EAB outbreak. The work done to date involves limited sampling of ash trees in sections of the right-of-way and some minimal sampling of ash trees in parks and open spaces, allowing a valid but restricted appraisal of EAB impacts in the City. It will not, however, enable selection of significant or high value ash trees for preservation or prioritize removals or identify the geographic areas for particular focus.

Using the "Suitability Criteria for Treatment of Ash Trees" described in Appendix D will help identify high value or significant trees that should be protected through treatment.

Another significant activity of this element is to undertake regular assessment and review of information gathered from monitoring, branch sampling, trapping and tree inventory to validate and amend further management actions.

Branch sampling (Photo 9) involves the collection of branch samples within the ash canopy and examination by removal of the bark. Once the bark is removed, EAB feeding galleries can be seen (Photo 5). Any larvae found would be sent away for identification/confirmation. This is a cost-effective early-warning detection system to identify and monitor the EAB infestation. Knowing the progress of infestation will assist in strategically managing EAB. Very limited branch sampling was undertaken , in Peterborough, in the winter of 2011/2012 with no identification of EAB feeding galleries to date.

Photo 9: CFIA Branch Sampling Inventory for Oakville

An EAB trapping program (Photos 10-12) will provide a straightforward way to determine if EAB adult beetles are in various areas of the City. In 2012 the CFIA provided 5 traps within the City for monitoring purposes, with no positive find of EAB. The limited resources of the CFIA mean that the City will have to supply and monitor many more additional traps to produce a reliable detection system.



Photos 10-12: EAB Trap and installation within the tree

Monitoring and assessment must also include a discussion on the strategy for managing trees on private property.

5.2 Treatment

High value and/or significant ash trees can receive injections of TreeAzin™ (or other approved pesticide treatments as available) for protection against EAB. Treatment usually focuses on street trees, and high profile specimen trees in parks or where there is a large ash tree population and therefore greater impact with their decline. Treated ash trees require ongoing treatment every two years until the threat of EAB has passed or alternative controls are available. Treatments can be invaluable in managing the outbreak and spread of EAB to other areas by suppressing local populations of the insect. TreeAzin™, a bio-pesticide derived from plant extracts, is the chemical used almost exclusively by municipalities. To date it has proven 95-97% effective when injected before the tree reaches pre-determined levels of damage.

5.3 Tree Removal

Based on the degree of infestation and health, ash trees need to be removed to limit hazardous conditions and minimize the safety risk associated with dead and declining trees. Ash wood is brittle by nature requiring removals to be carried out within a short period of time after tree death.

Recent research has shown that ash trees that die as a result of EAB infestation are extremely dry and brittle and require removal within a 12 to 18 month period after death to avoid the risk of catastrophic failure. It is anticipated that a significant number of ash trees on private property will need removal and this is likely to require the City to issue a high volume of notices to remove trees under the minimum property standards by-law.

The removal of dead ash trees in parks and open spaces is proposed to be done on a risk management basis. Those trees in parks and open spaces that are adjacent public areas will be the first to be removed once they have died. Ash trees that are far away from human activity are proposed to be left to fall on their own.

5.4 Tree Replacement and Planting

To maintain the current numbers of trees in the right-of-way, the replacement of ash trees (with a different species of tree) will be needed on a one-for-one basis, as occurs with removals at present. Replacement planting within parks and open spaces will be dependant upon inventory and site analysis. It may be possible to replace the canopy from lost ash trees more quickly and efficiently by utilizing and promoting the growth of existing non-ash species through strategic forestry management practices. These practices will include identifying and promoting the growth of desirable existing young and medium-sized trees (that are not ash species) within or adjacent groupings of ash trees. This has the advantage of promoting naturally-seeded and established trees. Resources will be required to maintain these areas in order to select and promote the growth of these desirable species, primarily by removing invasive plants and other competition. All of the EAB management options presented further on in this report assume implementation of these forestry management practices and thereby propose no wholesale replanting of lost trees in parks and open spaces.

Notwithstanding the above, it is likely that to sustain the present urban tree canopy, additional tree planting initiatives within parks and open spaces may also be required. However, the placement and species composition of any new planting will again require data from an inventory of all tree species in order to be in accord with the strategic objectives of the UFSP. It should be borne in mind that it can take upwards of 30 years for a newly planted tree to begin providing maximum benefits to the urban forest (as shown in Chart 2).

5.5 Wood Waste Disposal

Following a confirmed outbreak of EAB in Peterborough (or other area within Peterborough County) it is assumed that Peterborough County itself will be

designated as an EAB regulated area (dependant upon CFIA future decisions on regulation in Southern Ontario). Staff will work with the County to determine the best way to dispose of ash wood waste. Alternative uses for ash wood waste will be researched.

5.6 Public Education and Communication

A program of public education and outreach is an essential part of the EAB management plan. A substantially higher number of ash trees are likely to exist in private than public ownership and their management during the EAB outbreak will impact upon the strategy employed by the City.

Use of local media and communication tools such as social media and the City's website along with door hangers and posters will be used to keep the public informed, particularly in high risk areas. The City should also provide information using the growing number of leaflets and brochures available from sources such as the CFIA, OMNR and Ontario Commercial Arborist Association to assist property owners. Staff will also enlist the help of NGOs, private tree care companies and landscaping firms in the City as part of the education process. It is assumed that a greater effort of education and communications will be required in the earlier years with progressively less expense for this element occurring over time.

It is suggested that a working group comprised of upper and lower tier municipalities and larger stakeholders within the local area (south central Ontario) be formed to discuss strategy and management options for EAB. This group would represent the areas as yet unaffected by EAB to encourage co-operation and assistance with each other in response to EAB and its management. The City could adopt a lead role in the formation of such a working group.

6 Management Plan Options

A number of options are available when considering the development of an EAB Management Plan. Three such options are presented below. These options look at the two extremes (do-nothing, try to save all trees) as well as a hybrid scenario.

Regardless of the option selected, almost all elements of the management plan discussed in Section 5 are required. Full scale Monitoring & Assessment (including an inventory), together with Public Education and Communication must form integral parts of any Management Plan. Treatment, Removal, Replacement and Disposal will all vary according to the Management Plan option selected.

6.1 Option 1: Do Nothing

In essence, this option allows nature to take its course without any intervention on the part of the City. The ash tree mortality in this option would be as shown in Chart 1. The exponential nature of the tree losses would concentrate the work load of removal and waste disposal over a very short, unrealistic, period of time as it relates to labour and equipment availability. City forestry staff would have to ignore all of their existing workload, which includes removal of dangerous trees, pruning and replanting, and, even then, would still not be able to keep up with one quarter of the removals needed when the highest number of tree losses occur. Staging removals is not possible without treatments.

Although from the tenth year onward there would be no, or minimal, costs associated with this option, it is likely there would also be few, if any, ash trees left in the City. Certain streets in the City (McKellar Street for example) would be devastated by the loss of all their ash trees. The loss of the economic, environmental and social benefits provided by ash trees would be total.

6.2 Option 2: Treat Every Ash Tree

Under this option, every structurally sound ash tree in the City would be treated. Based on ash tree sampling, this option results in the treatment of 96% of the existing ash tree canopy (within the right-of-way, parks and open spaces), with removals and replacements of the remaining 4% as they die.

Treatment will be on a 2-year rotating basis so that half of the tree canopy we are trying to save is treated each year. It is assumed that treatment costs are on-going beyond the 10-year period. Retained ash trees will continue to provide benefits throughout the period and beyond (if treatment continues). There would be a significant commitment to continue treatment and if not, removal and replacement costs similar to Option 1 would then apply.

6.3 Option 3: Hybrid Plan

In the hybrid plan a combination of strategic treatment and removals is used to manage the EAB infestation. In this option about 65% of ash trees in the right-of-way and 10% of the park and open space ash trees will be treated.

This option seeks to preserve a significant proportion of ash tree benefits by targeting treatments on the best trees in condition and visual terms. The option utilises treatment as a tool to preserve the best quality trees and assist in managing the outbreak through staged removals, while adopting the longer-term view of gradually transitioning ash from the urban forest.

The option also slows the onset of EAB infestation and population build up through selective treatments and removals of the poorest quality trees and makes the problem more manageable. It preserves a proportion of ash tree benefits and attempts to apportion the likely costs over the 10-year period. Treatment of preserved trees would need to continue beyond the 10-year management period in combination with a program of further removals and replacements merged into the existing forestry programs.

Trees in the right-of-way present the highest risk to the public when they are dead and give the greatest environmental benefit to the community when they are living and, accordingly, they are the most desirable to retain intact. Although ash trees in the parks and open spaces are generally in better condition, they present a significantly lower level of risk even when dead and their loss will be less obvious when occurring among many other species of trees. The loss of untreated parks and open space trees is therefore more manageable with staged removals over the 10-year period.

Option 3 is also in accord with The Society of Municipal Arborists in its latest position paper on EAB which states that; “an integrated approach that utilizes treatment along with removal of low-grade ash trees is the best management option”.

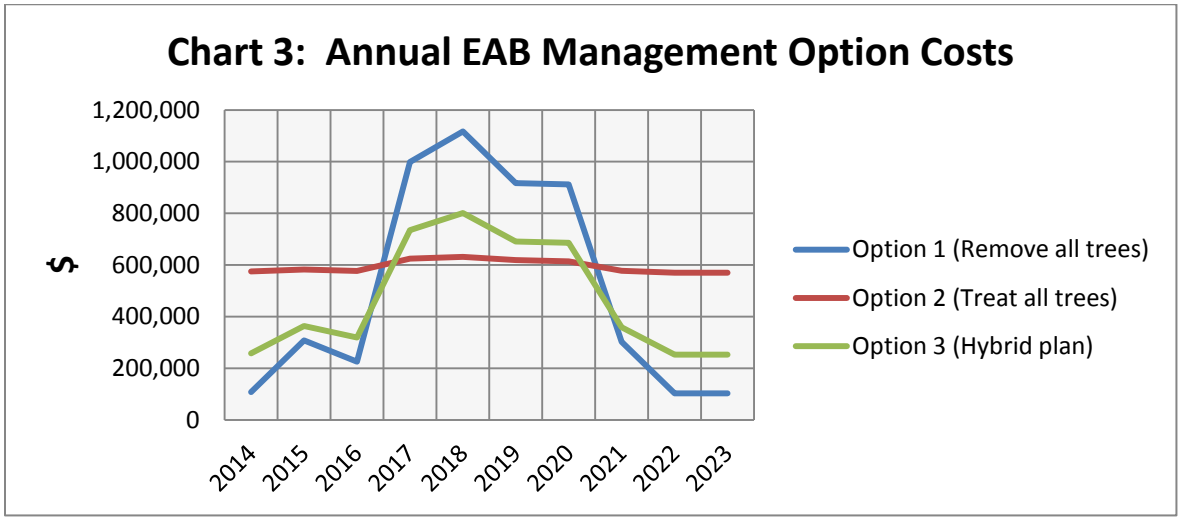
7 Financial Considerations

Costs for each of the Options provided in Section 6 are shown in Appendices A, B and C respectively. The costing model used current tree removal and replacement prices available from the Canadian Forest Service Ash Protection model (and checked against current Public Works costs) for an average 35cm diameter tree. Treatment costs were refined to reflect current market rates for municipal ash tree treatment contracts.

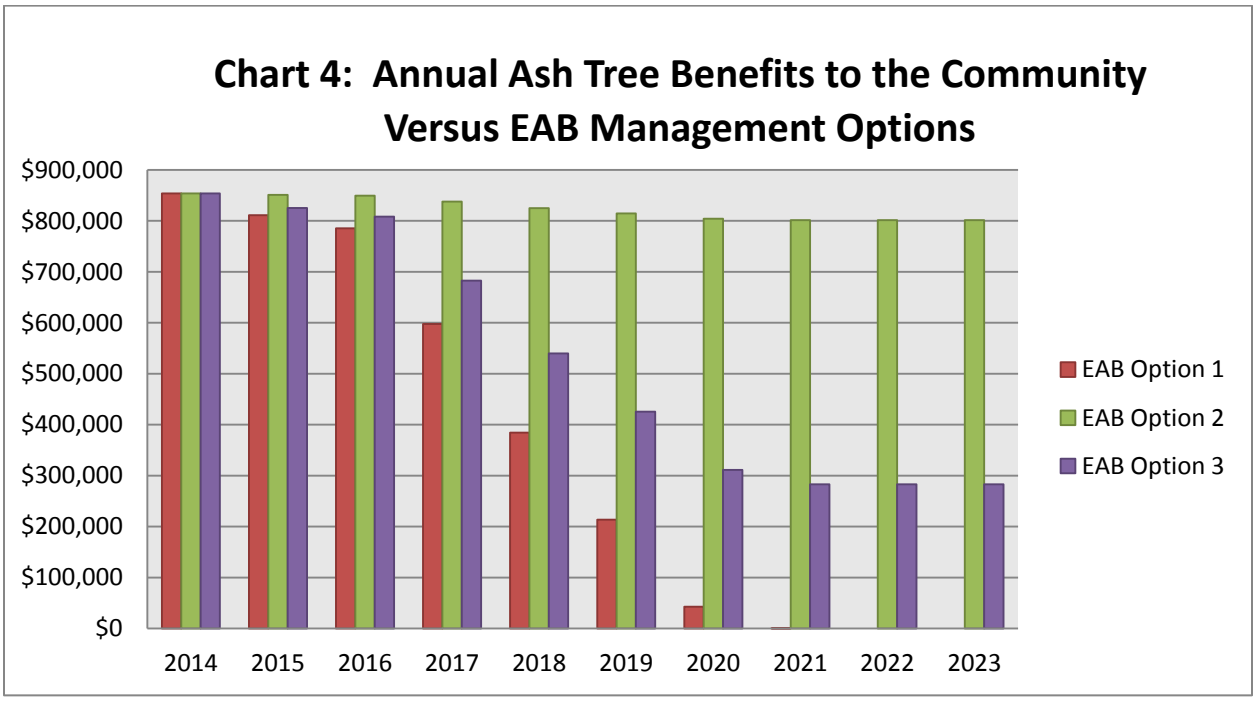
Existing staff were assumed to be involved in the EAB Management Plan to the greatest extent possible to help reduce costs. One additional full time Arborist/Urban Forest Specialist position is included in the cost for each Option because, regardless of the Option selected, a significant amount of inventory collection, monitoring, data assessment and planning, beyond what is already occurring is needed.

The cost calculations are based upon data obtained from sampling ash trees in 3 wards of the City. A 10-year plan was proposed because the latest research on EAB suggests that infestation of the insect is likely to pass through an area in a 10-year wave with significant declines as the host (the ash trees) die (or are protected through treatments) and the insect moves on to exploit new areas. It is also expected over the long-term (10+ years) that natural predators and other biological controls will begin to assert themselves on EAB, further reducing and suppressing populations.

It is likely that the treatment of ash trees will become more effective in the future, with a broader range of cheaper chemicals with extended treatment intervals. Regardless of this, the City needs to make decisions on a management plan that is based on the best presently available data (as presented in this document). The projected costs for each of the 3 options over the management period of 10 years are shown in Chart 3 below.



Section 4.3 discussed the social impacts and benefits of trees. The effect of the 3 different EAB management options upon the economic benefits provided by the ash trees in the urban forest are shown in Chart 4 below.



Although not “hard costs” in terms of monetary input, Chart 4 demonstrates the significant economic benefits associated with the City ash trees.

8 Discussion

Three possible options for the management of EAB have been provided for consideration.

Option 1 provides no control over the rate of infestation and death of the trees and preserves none of the present benefits provided by the trees. Management of the EAB outbreak is not possible with current resources without jeopardizing public safety and ignoring the present reactive and safety-driven forestry workload. Once this option is chosen there is no going back, since all management options, other than reactive removals, are lost once the outbreak takes hold.

Option 2 provides for the protection of all treatable ash trees including those that may otherwise be better removed and replaced for other reasons, including the treatment of smaller trees whose loss could be replaced quickly with newly planted trees of another species. This option requires a considerable on-going commitment to treat high numbers of trees past the 10-year period. This option does not allow for the gradual transition of ash trees from the urban forest which is regarded by many urban foresters as an inevitable outcome of EAB.

Option 3 provides a middle ground where a combination of treatments, removals and replanting are used to mange the short and longer-term effects of EAB. Treatments target and retain the best ash trees, preserving their benefits and allowing staged removals of poor quality, undesirable, smaller and dead or dying trees. The removal and replanting of poor quality ash trees with a different species allows the transition of much of the ash tree component from the urban forest and reduces future treatment commitment.

Table 1 provides a numerical comparison of projected tree removals, treatments and replanting across the City for each of the 3 options:

Table 1: Number of City Trees Removed, Treated and Replanted by Option

Location	Trees Removed (Number)			Trees Treated (Number)			Trees Replanted (Number)		
	Opt 1	Opt 2	Opt 3	Opt 1	Opt 2	Opt 3	Opt 1	Opt 2	Opt 3
Right-of-way (2600)	2600	156	910	0	2444	1690	2600	156	910
Parks & Open spaces (4500)	2250	135	2025	0	4230	450	0	0	0
Total (7100)	4850	291	2935	0	6674	2140	2600	156	910

Over the 10 years, options 1 and 3 have broadly similar costs, with Option 3 costing the least and Option 2 costing the most (Appendices A, B and C) when only the “hard costs” associated with managing EAB over a 10-year period, such as treatments, removals and replanting are considered.

When the recognized economic, environmental and social benefits from Chart 3 are included a Benefit/Cost ratio can be calculated as shown in Table 2 below.

Table 2: Benefits and Costs of the EAB Management Options (2013-2023)

Option	Cost of Option	Ash Tree Benefits During Term	Benefit/Cost ratio	Remaining Annual Ash Tree Benefits at End of Term
Option 1	**$5,268,000**	**$3,688,000**	0.70	$0
Option 2	**$6,145,100**	**$8,240,000**	1.34	$801,000
Option 3	**$4,909,450**	**$5,295,000**	1.08	$283,000

When the economic benefits of trees are considered, the following observations can be made:

- The break even period between removals and treatments extends to approximately 20 years and longer for larger diameter trees.

- Under Option 1, the recognized benefits that the ash tree component of the urban forest provides ($850,000 annually) will be completely lost at the end of the 10-year period

- Under Option 2, costs beyond the initial 10-year management period are offset by the annual benefits from retained ash trees.

- Option 3 is likely to optimize the retention of tree benefits, albeit at a lower number than Option 2, by preserving a higher number of ash trees in the right-of-way where environmental and social benefits can be up to 20% greater compared to that of parks and open space trees. The on-going annual benefits of the treated ash trees in Option 2 will cover the costs of future treatments.

9 Recommended EAB Management Plan

As an EAB management plan, Option 3 provides the best combination of costs and benefits. The best quality ash trees in the right-of-way together with significant and/or specimen ash trees in the parks and open spaces will be treated. Right-of-way trees that need to be removed will be replaced with a different species of tree and good forestry practices will be exercised in dealing with the parks and open spaces ash trees.

This option (as does Option 2) will benefit from the possibility of reductions in treatment costs in the future and also from the possibility of natural predators helping in the fight against the EAB.

10 Plan Implementation

Implementation of the EAB management plan will commence in 2013 with an inventory of trees (including the grading of treatable ash trees). At the same time branch sampling, trapping and public education and outreach would commence. EAB is expected to be found either during the summer of 2013 or early 2014 using these detection methods. Confirmation of EAB may subsequently require a delimitation survey to revise treatment and removal strategies targeted on containing the outbreak and suppressing local population build-up.

In 2014-2015, using data from the inventory, a re-appraisal of numbers and therefore costs can be undertaken together with a review of strategy and operational planning. With the benefit of inventory data, prioritized removals of low grade, poorly structured and dead or dying trees (presenting the highest potential risk) would be carried out during 2014-2015. The replanting program in the right-of-way would be phased in with the existing tree replacement program.

Replanting in parks and open spaces would be determinant upon inventory data that would investigate options such as promoting natural regeneration of other species and/or promoting the growth of existing non-ash species through good management practices. This strategy has the potential to quickly replace lost canopy and leaf area and thus an inventory of all species becomes a fundamental component of the entire EAB management plan.

In subsequent years through 2023 the plan continues with removals prioritised and guided by public safety and operational efficiencies. Review of the plan throughout implementation, particularly following inventory, is essential to ensure the best use of in-house and contracted resources and any potential returns from removed trees. Replanting species, sizes, number and location will be guided by the inventory of all tree species to reduce costs and optimize canopy replacement and sustainability in accordance with the UFSP.

11 Conclusions

The City of Peterborough is a responsible steward of its urban forest and plays a key role in maintaining the City's tree canopy through maintenance, planting, removal, and pest management programs for publicly-owned trees. The urban tree canopy is an important part of the City's green infrastructure and ash trees are a significant component of the urban forest.

Facing a complete loss of ash trees as a result of EAB, the City of Peterborough will need to consider carefully the value of the urban tree canopy and determine how best to manage and compensate for the loss due to EAB.

EAB Management Option 3 is the recommended option as it provides a proactive and comprehensive approach to managing EAB within the City. The option includes inventory and monitoring, the treatment of high value trees, removal of infested trees for public safety and replacement and planting of trees; which is critical to maintaining the City's urban forest canopy. Without the benefit of a full inventory, the location, size, condition and distribution of ash trees cannot be known and the EAB outbreak cannot be managed strategically.

This report is based upon limited but valid sample data, which has produced only estimates of tree numbers, sizes and condition and has not provided a picture of the geographic distribution or density of ash trees throughout the City. The estimation of the quantity and quality of the ash tree component of the urban forest has many shortcomings such as:

- Strategic monitoring using branch sampling and trap placement cannot be undertaken;
- Estimates of the total number of ash trees may impact significantly on costs;
- We do not know the location of all ash trees and thus our potential risk exposure;
- Sampling does not allow grading of trees both suitable and unsuitable for treatment;
- Groupings and locations of trees will impact significantly on removal costs; and
- Location and setting of trees will impact the need and/or the desirability for removal and replacement.

As data becomes available from inventory, monitoring and assessment this will allow us to refine the costs and the strategic implementation of the chosen option, producing greater efficiencies.

Appendix A **Option 1: Do Nothing**

Year	Number of Trees Removed [1]	Inventory, Monitoring & Assessment ($)	Waste Disposal[2] ($)	Treatment Cost[3] ($)	Removal Cost[4] ($)	Replanting Cost[5] ($)	Public Education & Communications ($)	Yearly Totals ($)
2013	0	148,000	0	0	0	0	25,000	173,000
2014	0	98,000	0	0	0	0	10,000	108,000
2015	243	98,000	-3,000	0	153,090	52,000	10,000	310,090
2016	145	98,000	-1,800	0	91,350	31,200	10,000	228,750
2017	1067	98,000	-13,300	0	672,210	228,800	10,000	995,710
2018	1213	98,000	-15,200	0	764,190	260,000	10,000	1,116,990
2019	970	98,000	-12,100	0	611,100	208,000	10,000	915,000
2020	970	98,000	-12,100	0	611,100	208,000	5,000	910,000
2021	242	98,000	-3,000	0	152,460	52,000	5,000	304,460
2022	0	98,000	0	0	0	0	5,000	103,000
2023	0	98,000	0	0	0	0	5,000	103,000
Totals	**4,850**	**$1,128,000**	**-$60,500**	**$0**	**$3,055,500**	**$1,040,000**	**$105,000**	**$5,268,000**

[1] Figures extrapolated from sample inventory data and predicted ash tree mortality curve.
[2] Waste disposal income based upon existing Public Works contract.
[4] Removal cost at $630/tree and based upon an average diameter ash tree of 35cm. Cost includes stump grinding (Canadian Forest Service –Ash Protection Model & Public Works data).
[5] Replanting cost of $400 per tree includes purchasing an average 30mm calliper tree (of different species) and planting cost (Canadian Forest Service –Ash Protection Model & Public Works data).

Appendix B Option 2: Treat Every Ash Tree

Year	Number of Trees Removed [1]	Inventory, Monitoring & Assessment ($)	Waste Disposal[2] ($)	Treatment Cost[3] ($)	Removal Cost[4] ($)	Replanting Cost[5] ($)	Public Education & Communications ($)	Yearly Totals ($)
2013	0	148,000	0	0	0	0	25,000	173,000
2014	0	98,000	0	467,000	0	0	10,000	575,000
2015	15	98,000	-200	467,000	9,450	3,200	10,000	587,450
2016	8	98,000	-100	467,000	5,040	1,600	10,000	581,540
2017	64	98,000	-800	467,000	40,320	14,000	10,000	628,520
2018	73	98,000	-900	467,000	45,990	15,600	10,000	635,690
2019	58	98,000	-700	467,000	36,540	12,400	10,000	623,240
2020	58	98,000	-700	467,000	36,540	12,400	5,000	618,240
2021	15	98,000	-200	467,000	9,450	3,200	5,000	582,450
2022	0	98,000	0	467,000	0	0	5,000	570,000
2023	0	98,000	0	467,000	0	0	5,000	570,000
Totals	**291**	**$1,128,000**	**-$3,600**	**$4,670,000**	**$183,330**	**$62,400**	**$105,000**	**$6,145,100**

[1] Figures extrapolated from sample inventory data and predicted ash tree mortality curve.
[2] Waste disposal income based upon existing Public Works contract.
[3] Treatment based upon treating 94% of ash trees in the right-of-way, parks and open spaces at an average diameter of 35cm and priced at $4.00/cm (predicted municipal contract price), treated every 2 years with TreeAzin™.
[4] Removal cost at $630/tree and based upon an average diameter ash tree of 35cm. Cost includes stump grinding (Canadian Forest Service –Ash Protection Model & Public Works data).
[5] Replanting cost of $400 per tree includes purchasing an average 30mm calliper tree (of different species) and all other planting costs (Canadian Forest Service –Ash Protection Model & Public Works data).

Appendix C Option 3: Hybrid Plan

Year	Number of Trees Removed [1]	Inventory, Monitoring & Assessment ($)	Waste Disposal [2] ($)	Treatment Cost [3] ($)	Removal Cost [4] ($)	Replanting Cost [5] ($)	Public Education & Communications ($)	Yearly Totals ($)
2013	0	148,000	0	0	0	0	25,000	173,000
2014	0	98,000	0	150,000	0	0	10,000	258,000
2015	147	98,000	-1,800	150,000	92,610	18,400	10,000	367,210
2016	88	98,000	-1,100	150,000	55,440	10,800	10,000	323,140
2017	646	98,000	-8,100	150,000	406,980	80,000	10,000	736,880
2018	733	98,000	-9,200	150,000	461,790	91,200	10,000	801,790
2019	587	98,000	-7,300	150,000	369,810	72,800	10,000	693,310
2020	587	98,000	-7,300	150,000	369,810	72,800	5,000	688,310
2021	147	98,000	-1,800	150,000	92,610	18,000	5,000	361,810
2022	0	98,000	0	150,000	0	0	5,000	253,000
2023	0	98,000	0	150,000	0	0	5,000	253,000
Totals	**2,935**	**$1,128,000**	**-$36,600**	**$1,500,000**	**$1,849,050**	**$364,000**	**$105,000**	**$4,909,450**

[1] Figures extrapolated from sample inventory data and predicted ash tree mortality curve.
[2] Waste disposal income based upon existing Public Works contract.
[3] Treatment based upon treating 65% of ash trees in the right-of-way and 10% of ash trees in parks and open spaces at an average diameter of 35cm and priced at $5.00/cm (predicted municipal contract price), treated every 2 years with TreeAzin™.
[4] Removal cost at $630/tree and based upon an average diameter ash tree of 35cm. Cost includes stump grinding (Canadian Forest Service –Ash Protection Model & Public Works data)
[5] Replanting cost of $400 per tree includes purchasing an average 30mm calliper tree (of different species) and all other planting costs (Canadian Forest Service –Ash Protection Model & Public Works data).

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Appendix D Suitability Criteria for Treatment of Ash Trees

(Applied During the Sample Inventory of Ash Trees in the Right-of-Way)

Category 1:	Good condition, safe useful life expectancy in excess of 20 years, visual importance, forming component part of significant ash species cluster/group/avenue/feature, few adjacent trees, pruning intervention unlikely, few or no above/below ground conflicts, 'heritage' candidate tree, providing significant environmental and other benefits and/or high cost to remove if tree dies. (In sample inventory 68% of ash trees in this category)
Category 2:	Moderate condition, pruning intervention likely to remediate defects/conflicts, less suitable location, conflicts probable within life expectancy. (In sample inventory 23% of ash trees in this category)
Category 3:	Moderate or poor condition, short safe useful life expectancy, pruning required to retain safely, significant present or future conflicts, tree less than 15cm diameter at breast height (DBH*) suppressing growth of better quality trees of other species, loss has little visual/environmental impact. (In sample inventory 9% of ash trees in this category)
Not suitable for treatment	Trees less than 15cm DBH, dead/dying/decayed/dangerous, likely to require removal within 5 years for other reasons. (In sample inventory 6% of ash trees assessed were not suitable for treatment in Categories 1-3)

*DBH = Diameter of trunk measured at 1.3m above highest grade at base of tree