

City of Baraboo Emerald Ash Borer Readiness Plan



UGA9000019

Source: David Cappaert, Michigan State University, Bugwood.org

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EAB HOTLINE 1-800-462-2803

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INTRODUCTION

During the summer and fall of 2010, Bluestem Forestry Consulting Inc. conducted a street and park tree inventory throughout the City of Baraboo, with particular attention paid to ash trees, for the purpose of preparing a plan to minimize the economic and social impacts of an emerald ash borer (EAB) infestation. Areas that received an individual tree inventory included maintained (mowed) areas of parks and street rights-of-ways. Parks that were inventoried include: City View Park, Steinhorst Park, Langer Park, Deppe Park, Pierce Park, Weber Park, Campbell Park, Kiwani's Park, Broadway Park, Mary Roundtree Park, Attridge Park, Oschner Park & Zoo, Mary Hoppe Felts Park & Ritzenthaler Park. Wooded areas were not inventoried.

While nobody can predict when the emerald ash borer will arrive in Baraboo, it is assumed that the insect *will* arrive in Baraboo in the near future. Currently, the insect has been confirmed in multiple locations in Wisconsin. Since the emerald ash borer (EAB) was first detected seven years ago, it has spread to over a dozen additional states and Canada. By all appearances it is unstoppable and is spreading quickly. New infestations are popping up quickly. An up-to-date map of current infestations can be found at: <http://www.emeraldashborer.info/surveyinfo.cfm>

Some findings/recommendations of this plan include:

- ✓ One of every five trees (20.7%) in Baraboo is an ash tree.
- ✓ 1,302 ash trees were identified and will die due to EAB (without chemical treatment).
- ✓ Bluestem recommends chemically treating 43 ash that are in excellent condition for preservation. These trees are recommended for treatment long-term. The cost to treat these trees is \$3,904 every two to three years.
- ✓ The cost to remove and replant and treat (to prolong removal time period) the remaining trees is estimated to be \$621,379 (over an approximately 5-7 year period).
- ✓ It will require approximately 3,600 work-hours to adequately manage EAB.
- ✓ As of December 2010, the nearest confirmed EAB infestation is approximately 100 miles from Baraboo in Vernon County, WI.
- ✓ It is not necessary to perform routine or training prunes on any ash tree that will not be receiving chemical treatment for preservation. It is wasteful to spend time and money completing this activity when these trees will likely be removed in the near future.
- ✓ Recommended activities begin in 2012 and continue for approximately 5-7 years.
- ✓ The 'City of Baraboo Urban Forestry Plan and Inventory Summary' is a companion guide discussing all inventory findings.

Purpose of Readiness Plan

The purpose of this Emerald Ash Borer readiness plan is to identify the essential personnel, resources, procedures and fiscal resources to combat emerald ash borer in Baraboo. The City of Baraboo anticipates utilizing proactive measures before an infestation occurs to amortize costs and minimize the impacts of EAB.

General Discussion of Emerald Ash Borer

History of the Emerald Ash Borer

The Emerald Ash Borer (*Agrilus planipennis*) is an exotic pest native to Asia that was identified in southeastern Michigan near Detroit in the summer of 2002. The adult beetles munch on ash foliage but cause little damage. The real damage is caused by the EAB larvae that feed on the inner bark of ash trees, disrupting the tree's ability to transport water and nutrients. It is suspected that the insect was initially introduced to the United States via solid wood packing material carried in cargo ships or airplanes originating in its native Asia.

The natural range of the emerald ash borer is eastern Russia, northern China, Japan, and Korea. Before June of 2002, it had never been identified in North America. In its native environment EAB feeds on a variety of plant species but in the United States thus far, it feeds exclusively on the ash tree (*Fraxinus*). In its native range it is considered a minor pest and is controlled through natural measures. In the United States, it is known to attack green ash (*Fraxinus pennsylvanica*), white ash (*Fraxinus americana*), black ash (*Fraxinus nigra*) and blue ash (*Fraxinus quadrangulata*). It attacks both healthy and declining ash trees and has been known to attack and colonize branches as small as one inch in diameter.

Since its identification in Michigan, EAB has been found in Missouri, Illinois, Indiana, Ohio, Pennsylvania, West Virginia, Maryland, Virginia, Minnesota, Kentucky, New York and Wisconsin.

Since its identification in Michigan in 2002, the emerald ash borer has:

- Killed more than 40 million ash trees in southeastern Michigan alone, with tens of millions more lost in Ohio, Illinois, Indiana, Pennsylvania, West Virginia, Missouri, Wisconsin and Virginia.
- Caused regulatory agencies and the USDA to enforce quarantines and fines to prevent potentially infested ash trees, logs or hardwood firewood from moving out of areas where EAB occurs.
- Cost municipalities, property owners, nursery operators and forest products industries tens of millions of dollars. (Source: www.emeraldashborer.info)

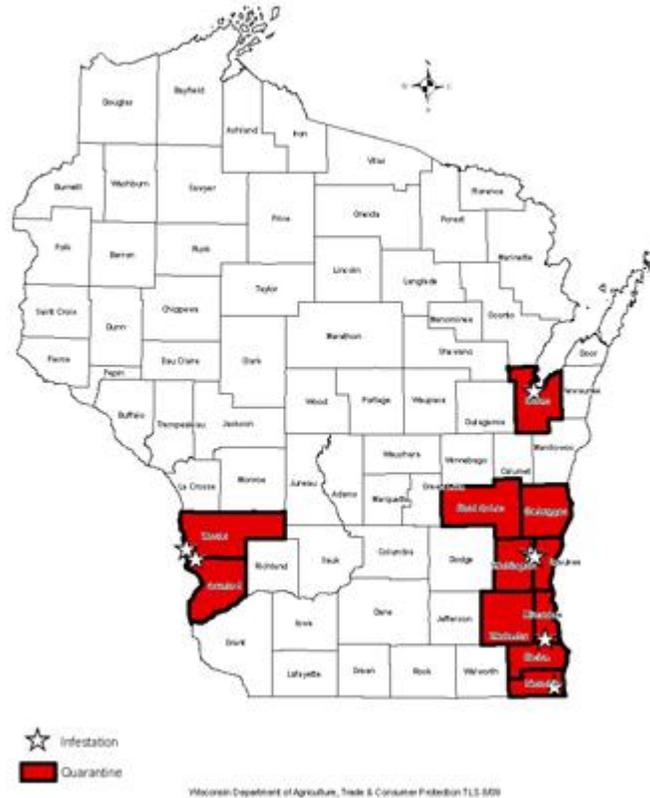
EAB HOTLINE 1-800-462-2803

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**EAB Quarantine Counties & Approximate Locations of Infestation
WI DATCP / September 2009**



Current state infestation map as of September 2009

Emerald ash borer was found for the first time in Wisconsin in August, 2008 near the community of Newburg, along the northern Ozaukee and Washington County line. In April, 2009, EAB was found in western Wisconsin, in the small town of Victory in Vernon County, alongside the Mississippi River. In July 2009, adult beetles were caught on survey traps located in Crawford and Brown counties. In August 2009, the Milwaukee County community of Franklin became the site of the latest confirmed presence of EAB when City officials alerted program staff to declining ash trees. Additional cities within quarantine areas have positively identified the borer including Cudahy and Oak Creek. Currently, eleven counties are under quarantine in Wisconsin. The find nearest to Baraboo is in Victory, Wisconsin (Vernon County). This is approximately 100 miles from Baraboo.

Description and Lifecycle of EAB

The Emerald Ash Borer adults are dark metallic green in color and belong to a group of wood boring beetles known as Buprestidae. Adults are approximately 1/2" long and 1/8" wide with very short antennae. The larvae are white in color with flattened segmented bodies and may grow to a length of one inch.

Adults emerge through the bark of ash trees in early summer, creating a D-shaped exit hole in the process. Adult emergence is thought to be staggered, beginning in May and peaking in late June. Adults live approximately 3 weeks and have been observed into August. Adults are most active during the daytime under warm, sunny conditions and have been seen feeding on the ash tree leaves. Mating occurs soon after emergence and females will begin to lay eggs about 2 weeks after emergence. A single female will lay between 60 and 90 eggs in her lifetime.

Eggs hatch in 1-2 weeks, and the tiny larvae bore through the bark and into the cambium - the area between the bark and wood where nutrient levels are high. As the larvae feed they wind back and forth, creating characteristic S-shaped or serpentine galleries in phloem and outer sapwood. The larvae feed under the bark for several weeks, usually from late July or early August through October. As mature larvae complete feeding they create a pre-pupal chamber in the outer bark or in the outer inch of wood and overwinter in this small chamber. Pupation occurs in spring and the new generation of adults will emerge in May or early June, to begin the cycle again on uninfested trees.

Unaided, the beetle is thought to move slowly through the landscape, approximately one mile annually, though the rate of spread varies by insect and host tree abundance. However, humans greatly accelerate the spread of the insect by moving infested nursery stock, firewood and logs to un-infested areas. Emerald ash borer movement into parts of Michigan outside of the Detroit area, Ohio, and Indiana has been the direct result of moving these ash products.

Ash Tree Identification

In North America, the emerald ash borer feeds exclusively on ash trees. Green ash (*Fraxinus pennsylvanica*), white ash (*Fraxinus americana*) and black ash (*Fraxinus nigra*) are all found within Baraboo's public urban forest. There are many wood boring insects, but EAB will only attack ash trees. An ash tree is most easily identified by its opposite branching pattern (the leaves will grow opposite of one another at the same spot on the branch/twig) and compound leaves with 5-11 leaflets each. The leaflets will have minor serration (teeth) along their margins. The following photographs are representative of white ash bark and green ash leaves.



Source: Paul Wray, Iowa State University, Bugwood.org



Source: Paul Wray, Iowa State University, Bugwood.org

Signs and Symptoms

The symptoms associated with EAB infestations are very similar to those of other common ash pests or diseases including other wood boring insects that attack ash trees. It is important to look for a combination of at least 2 or more symptoms before concluding that the borer may be present. EAB is extremely difficult to detect at low populations and by the time severe symptoms are evident the trees are generally heavily infested. Tree death is not instantaneous; it generally takes 4 to 5 years for a tree to die.

Local governments and residents are not expected to be able to diagnose EAB. They should call the Department of Agriculture and Consumer Trade Protection (DATCP) and DATCP will determine whether EAB is present. The DATCP hotline number which is 1-800-462-2803. This number can also be found on the cover of this plan and at the bottom of each page.



Source: Daniel Herms, The Ohio State University, Bugwood.org

Crown dieback: Trees begin to show dead branches throughout the canopy beginning at the top. Foliage at top of tree is thin and sickly. This photo represents severe, late-stage infestation most likely 4-5 years after infestation.



Source: Michigan Department of Agriculture, Bugwood.org

Epicormic sprouting: Sprouting at the base or along the trunk of the tree. This is often referred to as suckering. This photo represents severe, late-stage infestation most likely 4-5 years after infestation.

D-shaped exit holes: As adults emerge from within the tree they create an exit hole approximately 1/8" in diameter that looks distinctly like a capital 'D.'

Increased woodpecker damage: Some older infestations have increased woodpecker activity as the birds try to feed on the EAB larvae. This usually occurs in the upper portions of the tree and may be accompanied by branch dieback.



Photo of serpentine larval galleries. Source: Toby Petrice, USDA Forest Service, Bugwood.org

Serpentine larval galleries: The larvae feed just underneath the bark of the ash tree. As the insect larvae feed they wind back and forth creating serpentine or s-shaped larval galleries.

Bark splitting: Vertical splits in the bark appear and are caused by callus tissue that forms around larval galleries. Larval galleries can often be seen beneath the splits.

Presence of larvae or adults: The actual presence of the adult insect or of EAB larvae is confirmation of an infestation. Again, there are similar looking wood boring insects and DATCP will need to confirm an infestation.

EAB HOTLINE 1-800-462-2803

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Tree Inventory Findings

In the summer and fall of 2010, Bluestem Forestry Consulting Inc. conducted a street and park tree inventory within Baraboo. Areas that received an individual tree inventory included maintained (mowed) areas of the park. A map of ash locations within the City can be found as attachment 1.

Ash population information such as distribution, health and density were determined from the park tree inventory. The following data pertinent to this report was collected on each individually inventoried tree:

- GPS Coordinates: A Trimble GeoXT GPS was used to locate all trees. These coordinates were then used to map the ash tree locations (information & maps can be found on the City GIS database)
- Species of Ash: Research indicates that EAB attacks all species of ash.
- DBH: Diameter at breast height was collected. This data was used to estimate the work time and equipment necessary for tree removals.
- General Health: The general health of the tree will be useful for tree monitoring. Poor, very poor or dead condition trees can be located and removed in anticipation of EAB.
- Maintenance Recommendation: Actions were identified for each tree including pruning and removal.
- Street or Park Name: The park name was identified for each tree located within a park.

A total of 1,302 ash trees were individually inventoried in Baraboo. The total street and park tree population in Baraboo is approximately 6,300 trees. Hence, ash represents 20.7% of the public urban forest in Baraboo. Species diversity guidelines recommend not more than 5% of any one species and not more than 10% of any one genus/family. For example, green ash is an individual species and these can be found within the ash family. As with nearly all communities in Wisconsin, the ash population in Baraboo is beyond recommended limits. A database listing each individual tree and its attributes has been provided to the City.

Of these ash, 73 (5.6%) trees were located within the park system and 1,229 (94.4%) were located on the street rights-of-way or in other public areas. There are 45 black ash, 193 white ash and 1,064 green ash trees. The average condition of the ash tree population is good. In fact, as a species group, ash were the highest rated species within Baraboo. No other species was as healthy.

A total of 128 (9.8%) ash trees were identified as in dead, poor or very poor condition. As the plan will explain later, all trees, regardless of species, in these three conditions should be eliminated from the City population for health and safety reasons.

The average diameter is 14.2". Sizes range from 1" dbh (diameter at breast height) to 40" dbh green ash in Mary Roundtree Park. It is advantageous that Baraboo has a mid-sized population rather than high numbers of large trees, simply because it is easier and less costly to remove or treat smaller diameter trees.

Some additional findings of the ash in Baraboo include:

<u>Maintenance Needs</u>	<u>Count of Ash Trees</u>
Routine Prune*	1075
Training Prune*	94
Removal	43
Priority Prune	70
Monitor	15
Special Action	5

<u>Condition</u>	<u>Count of Ash Trees</u>
Good	717
Fair	351
Excellent	106
Poor	84
Very Poor	40
Dead	4

*It is not necessary to perform routine or training prunes on any ash tree that will not be receiving chemical treatment for preservation. Because EAB is a mere 100 miles from Baraboo it would be wasteful to spend time and money completing this activity when, in all likelihood, these trees will be removed in the near future.

A definition of terms and an in depth discussion of all inventory data can be found in the 'City of Baraboo Urban Forestry Plan and Inventory Summary'.

PRE-EMERALD ASH BORER ACTIVITIES

Establish Chain of Command

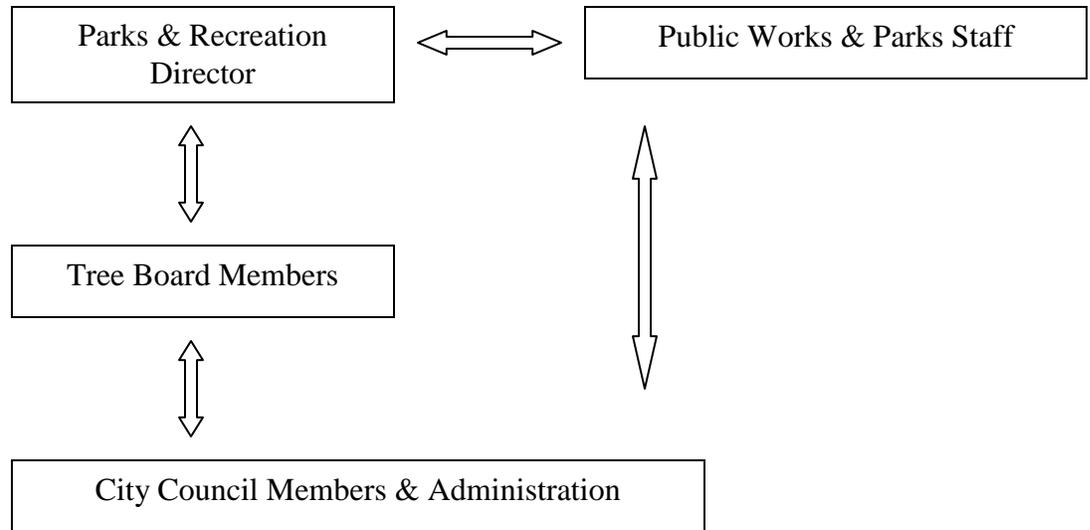
A successful action plan always has a designee who is charged with directing the response. This individual will essentially function as a 'point' for the entire City. They will coordinate all EAB related activities. This EAB project leader will have many responsibilities and duties. Some of these duties will include:

- Prioritizing and budgeting for tree removals, treatments and replanting
- Updating City administration and council members
- Public and media outreach
- Education of public
- Enforcement of ordinances
- Coordination with state and local officials
- Set up of marshalling yard
- Coordinate staff training
- Purchase equipment as needed
- Produce templates and investigate contracting/mutual aid agreements with other communities and local utilities
- Investigate wood utilization options

The Parks & Recreation Director is the clear choice for the EAB designee. The Parks & Recreation Director is within the Parks & Recreation Department, but is also charged with managing all trees, both street and park. He currently manages many of the activities listed above and he is an ISA Certified Arborist.

For EAB related activities within Baraboo, the following flowchart will apply:

City of Baraboo EAB Related Activities Flowchart



Conduct Detection Surveys

With this tree inventory, Baraboo has completed the first step of the survey process. Next, EAB/ash tree inspection should be conducted to note potential indicators of EAB activity within the City. There are several survey methods that can be utilized, but one method in particular seems well suited to Baraboo.

Visual Survey techniques include looking for outwardly visible signs/symptoms of EAB on ash trees by foot. This was completed by Bluestem Forestry Consulting Inc. during the inventory and no signs/symptoms of EAB were detected. Visual survey can be conducted systematically over a given area or by individually selecting trees thru the inventory. Taking into consideration Baraboo's ash stocking level, number of employees and duties, it seems logical to survey approximately 1/4 of the ash trees in Baraboo annually. The main disadvantage of this survey method is that by the time visual symptoms of EAB are present, it usually means the infestation has been in the area for several years. However, it is the easiest and most economical means of survey and can be completed by City staff. This survey method should begin in the summer of 2011 and continue annually thereafter. The tree inventory database can be used for recordkeeping.



If crew members find multiple symptoms of EAB on a tree they should call DATCP at 1-800-462-2803 and DATCP will assist with the inspection.

Larvae in small diameter branch. Photo courtesy of Ping Tree Service/IN DNR

Decide to Remove or Chemically Treat Trees

The first essential question that arises when a community is making decisions regarding EAB is whether to maintain an ash component within their urban forest. Simply put, the options that exist are:

- ✓ *Remove all ash from the public urban forest*
- ✓ *Save all ash thru the use of chemical treatments*
- ✓ *Treat a portion of trees deemed significant and remove the remaining ash trees*

There are pros and cons to each choice:

Removing all ash from the public forest (and replanting):

- | | |
|--------------------------------------|---|
| Pro: Costs are definitive and finite | Con: High initial cost |
| Pro: No long term costs | Con: A unique species is lost to the forest |
| Pro: Wise replanting decisions made | Con: Mature trees are replaced with small trees |
| | Con: Public sentiment against removal |

Save all ash thru the use of chemical treatments:

- | | |
|--|--|
| Pro: Ash remains a component of forest | Con: Long term treatment costs are incurred |
| Pro: Public is generally supportive | Con: Potential environmental effects unknown |
| Pro: Large trees continue contributing to forest | |

Remove a portion of trees and treat a portion of trees:

- Pro: Ash remains a component of forest
- Pro: Reduces high initial removal costs
- Pro: Only trees in good condition retained
- Con: Long term treatment costs are incurred
- Con: Public disapproval of decision criteria

Do nothing until EAB arrives in Baraboo:

- Pro: No cost incurred at present
- Pro: Allows additional time for planning
- Con: Large cost outlay at a single time
- Con: Prices for trees/contractor may increase with demand; disreputable contractors take advantage of emergency
- Con: Saving trees becomes less of an option
- Con: Other city services suffer because funds diverted to tree removal
- Con: Public safety & fiscal crisis to dead and dying trees becoming hazards

Identify Significant Ash Trees Suitable for Chemical Treatment

It is unrealistic to expect a community to chemically treat large numbers of ash trees indefinitely. A very rough, current (2010), estimate for a contractor to treat using Tree-äge™ (Emamectin benzoate) via Arborjet is \$8/inch of tree diameter on an every-other to every-third year basis. This pesticide is a restricted use pesticide and application will need to be completed by a DATCP certified and licensed applicator. Other pesticides and methods of application are available, but Tree-äge™ results in less time commitment from city staff. While city staff will not be completing the application, they will need to coordinate and bid out the treatment, resulting in a time investment. Most other treatments require annual applications resulting in an increased time commitment from staff.

Bluestem recommends that Baraboo does not retain any ash in poor or very poor condition. Additionally, no tree under 6” in diameter need be treated nor any ash growing under utility lines. Small diameter trees are easily and economically replaced with small impact to the overall tree canopy and there are many more suitable species than ash for growing under utility lines.

Excluding trees in poor or very poor condition, trees 6” in diameter and under and trees under utility lines, the following costs are projected **every-third year**:

Projected budget to chemically treat ash trees:

tree condition	# of trees to be treated	cost	treatment type*	year/timeline
Fair, Good & Excellent	1,042	\$128,696	Tree-äge™ (Emamectin benzoate) via Arborjet	When EAB is Confirmed in Sauk Co.
Good & Excellent	722	\$87,984		
Excellent	43	\$3,904		

*current recommendations are to treat once every three years.

It is unrealistic to expect Baraboo to treat all trees in fair, good and excellent condition, but it is reasonable and thoughtful to treat ash in excellent condition. Not only are these trees the very best ash in the community, but the cost to treat is only \$1,300 annually. It is recommended that ash in excellent condition be treated with Emamectin benzoate when EAB is confirmed in Sauk County.

Treating excellent condition ash will preserve 43 trees. This means over 700 ash (in good and fair condition) are in the population that will need removed or treated. Quite a number of communities are treating ash in good condition as a stop-gap measure. Treating ash in good condition 'buys' time for communities. It allows to removal of ash trees over a longer period of time as a way to amortize costs. And it serves the double purpose of waiting for a potential silver bullet to control or eliminate EAB. It is recommended that Baraboo treat their ash in excellent condition, remove trees in fair condition and treat ash in good condition so that they can eventually be removed over a longer time period.

Knowledge gained from states that have experienced longer infestations including Michigan, Indiana and Ohio indicate that the period of time for treatment appears to be indefinite. EAB is similar to Dutch Elm Disease in that even though most elm or ash will be killed in the initial infestation, some level of ash/elm are always present. As a result low levels of the insect/disease are always present to feed on the remaining trees, necessitating that treatment is continually applied to prevent tree death

Reduce Ash Tree Volume

Once infested with EAB, ash trees typically decline and die over a period of 4-5 years depending upon insect volume. The burden of dealing with volumes of dead and dying trees within a short period of time can place an enormous strain on community budgets, personnel and resources. The City of Baraboo can take small steps now to prepare for and manage for the arrival of this pest.

Baraboo should take the pro-active approach of removing some of its presumably non-infested ash over the next 5+ years as a way to minimize the impacts when EAB arrives. The order and timeline of removal should be:

Remove trees in poor or very poor condition or dead trees. The most logical method to reduce ash volume initially is to remove ash trees identified through the inventory as in dead, poor or very poor condition or dead. A tree identified as in dead, very poor or poor condition is most likely considered a high risk tree regardless of EAB and therefore has an associated liability. Any tree, dead or alive, which has the potential to entirely or partially fail and impact a target, can be considered a higher risk. A target can be a vehicle, building or a place where people gather (Source: Urban Tree Risk Management Guide, USDA Forest Service: www.na.fs.fed.us/spfo/pubs/uf/utrm). Dead or dying ash trees, whether weakened/killed by EAB or not, pose a risk to public safety and therefore a potential liability for communities if left standing. There are 128 ash trees in poor or very poor or dead condition. These removals should begin in **2012**. Due to equipment limitations, removals over 6" dbh will need to be contracted. Replanting can be completed in-house.

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Remove and replace small diameter ash trees. After removal of poor/dead/very poor trees, communities faced with EAB infestation within 1-2 years have begun removing and replanting small diameter (1-6") ash trees prior to infestation. Replanting in these locations is occurring simultaneously with the removals so that the impact of the removal on residents is lessened. The removal of small diameter ash trees is relatively easy and less expensive than large trees and it is a good opportunity to spread the expense of replanting over a longer time period. EAB infestation has been confirmed in multiple locations throughout Wisconsin and in Minnesota. The nearest find is approximately 100 miles from Baraboo. Due to the size of the current infestations and the general philosophy that there are more infestations throughout the state that have not been found yet, it seems reasonable to begin this activity immediately following removal of poor/very poor/dead trees. After removing poor, very poor or dead condition trees there are 132 ash trees from 1-6" in diameter remaining. This activity should begin following the removal of trees in poor and very poor condition, likely in **2013**.

Chemically treat ash in excellent condition. As discussed earlier, it is recommended that the 43 ash in excellent condition receive chemical treated for preservation. Current guidelines are to chemically treat using emamectin benzoate once every three years. This activity should begin when EAB is confirmed in Sauk County.

Remove ash trees growing under utility lines. Ash is a poor species for growing when overhead utility lines are present. They are much too tall, growing into the lines and interfering with transmission. This results in utilities harmfully prune the tree. In fact, many trees growing under utility lines in Baraboo have been topped or 'v' pruned resulting in weakened and disfigured trees. For this reason, removing ash under utility lines is another logical step to reduce ash population prior to infestation. After the three activities above have been completed, there will be 153 ash growing under utility lines. This activity should occur after the small diameter removals, likely in **2014**.

Remove ash in fair condition. After removal/replanting of trees in poor and very poor condition, the removal/replanting of small diameter ash, chemical treatment of excellent condition ash and removal of ash under power lines, 252 ash in fair condition will remain. Fair condition trees are neither great nor do they present an obvious risk. They are, as the name implies, just fair and there is no compelling reason to retain them in the population, so they should also be removed and replanted. This activity should occur after the removal of trees under utility lines, likely in **2014 or 2015**.

Treat ash in good condition. As discussed early, because such a large population of ash in good condition remain (594 trees), it is best to chemically treat these trees and remove them over a longer period of time as a means to amortize cost. It may also allow time for additional treatments to be developed resulting in the preserving of these trees also. Treatment should begin when EAB is confirmed in Sauk County.

A breakdown of ash trees and the recommended actions are:

1. Remove and replant 128 ash in dead, poor or very poor condition (2012)
2. Remove and replant 132 ash that are small diameter (1-6") (2013).
3. Chemically treat 43 ash in excellent condition (when EAB in Sauk County).

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4. Remove and replant 153 ash growing under utility lines (2014).
5. Remove and replant 252 ash in fair condition (2015).
6. Chemically treat 594 ash in good condition (limited time) and eventually remove.

An annual review should be completed as new information about the borer is learned. These recommendations are subject to change as research-based guidelines are developed. The Parks & Recreation Director should complete the annual review.

Budget Projections for Identified Activities

Estimates have been prepared that outlines the costs of items discussed above. Based on current equipment and staffing, all tree removals over 6" dbh (diameter at breast height – 4.5' above ground) will be contracted. Tree planting can be completed in-house. Each tree will need to be individually evaluated by the Parks & Recreation Director to determine if the tree can be safely removed in-house or if the removal should be contracted.

Projected budget to remove & replant 128 ash in dead, poor or very poor condition:						
Timeline: 2012						
	# of removals	Man hr/cost*	# trees to be replaced	man hr/cost for planting**	cost to purchase replacement trees***	TOTAL HOURS/ CONTRACT COST
In-house cost/time	15	72/\$2,016	15	n/a	\$2,625	72/\$2,625
contract removal cost	113	\$36,160	113	271/\$7,593	\$19,775	271/\$55935
TOTAL COST OF IN-HOUSE LABOR						\$9,069
TOTAL COST OF CONTRACT WORK/TREES						<u>\$59,560</u>
GRAND TOTAL						\$68,629
*based on estimate of 5 removals/replantings daily per 3 person crew @\$28.00/hour each (with benefits) OR \$320/tree contract removal cost						
**based on estimate of 10 tree plantings per day per 3 person crew @\$28.00/hour each (with benefits)						
***based on 1.75" caliper b&b tree @ \$175/ea planted in-house						

Projected budget to remove and replant 132 ash 1-6" dbh:

Timeline: 2013

	# of removals	Man hr/cost*	# trees to be replaced	man hr/cost for planting**	cost to purchase replacement trees***	TOTAL HOURS/ CONTRACT COST
In-house cost/time	132	633/\$17,724	132	n/a	\$23,100	633/\$23,100
TOTAL COST OF IN-HOUSE LABOR						\$17,724
TOTAL COST OF TREES						<u>\$23,100</u>
GRAND TOTAL						\$40,824

*based on estimate of 5 tree removal/plantings per day per 3 person crew @\$28.00/hour (with benefits).

**removals and replanting will occur simultaneously.

***based on 1.75" caliper b&b tree @ \$175/ea.

Projected budget to treat excellent condition ash:

Timeline: EAB confirmed in Sauk County

tree condition	# of trees to be treated	cost	treatment type
excellent	43	\$3,904	Tree-äge™ (Emamectin benzoate) via Arborjet
Treatment occurring once every third year. Based on price of \$8 diameter/inch			

Projected budget to remove and replant 153 trees under utility lines:

Timeline: 2014

	# of removals	Man hr/cost*	# trees to be replaced	man hr/cost for planting**	cost to purchase replacement trees***	TOTAL HOURS/ CONTRACT COST
In-house cost/time	153	244/\$5,400 (rent grinder)	153	367/\$10,276	\$26,775	611/\$32,175
TOTAL COST OF IN-HOUSE LABOR						\$17,108
TOTAL COST OF TREES & STUMP GRINDER						<u>\$32,175</u>
GRAND TOTAL						\$49,283

*utility co. will remove tree to below utility lines leaving stump; stump grinder is rented. Staff grinds 10 stumps/day (2 person crew).

**based on estimate of 10 tree plantings per day per 3 person crew @\$28.00/hour each (with benefits)

***based on 1.75" caliper b&b tree @ \$175/ea.

Projected budget to remove & replant 252 ash in fair condition :

Timeline: 2015

	# of removals	Man hr/cost*	# trees to be replaced	man hr/cost for planting**	cost to purchase replacement trees***	TOTAL HOURS/ CONTRACT COST
contract removal cost	252	\$80,640	252	604/\$16,912	\$44,100	604/\$124,740
TOTAL COST OF IN-HOUSE LABOR						\$16,912
TOTAL COST OF CONTRACT WORK/TREES						<u>\$124,740</u>
GRAND TOTAL						\$141,652

*based on estimate of 5 removals/replantings daily per 3 person crew @\$28.00/hour each (with benefits)

OR \$320/tree contract removal cost

**based on estimate of 10 tree plantings per day per 3 person crew @\$28.00/hour each (with benefits)

***based on 1.75" caliper b&b tree @ \$175/ea planted in-house

Projected budget to treat good condition ash:

Timeline: EAB confirmed in Sauk County, if not previously removed

tree condition	# of trees to be treated	cost	treatment type
good	594	\$73,496	Tree-age™ (Emamectin benzoate) via Arborjet
Treatment occurring once every third year. Based on price of \$8 diameter/inch			

Projected budget to eventually remove & replace 594 ash in good condition :

Timeline:
ongoing

	# of removals	Man hr/cost*	# trees to be replaced	man hr/cost for planting**	cost to purchase replacement trees***	TOTAL HOURS/ CONTRACT COST
contract removal cost	594	\$190,080	594	1425/\$26,660	\$103,950	1425/\$294,030
TOTAL COST OF IN-HOUSE LABOR						\$26,660
TOTAL COST OF CONTRACT WORK/TREES						<u>\$294,030</u>
GRAND TOTAL						\$320,690

*based on estimate of 5 removals/replantings daily per 3 person crew @\$28.00/hour each (with benefits)

OR \$320/tree contract removal cost

**based on estimate of 10 tree plantings per day per 3 person crew @\$28.00/hour each (with benefits)

***based on 1.75" caliper b&b tree @ \$175/ea planted in-house

TOTAL REMOVAL/REPLANTING/TREATMENT COSTS:

Cost of in-house labor (3,116 hours):	\$87,473
Cost of replacement trees (1259 trees)	\$220,325
Cost of annual treatment (43 trees)	\$1,301
Cost of contract removal: (1,259 trees)	<u>\$312,280</u>
	\$621,379

Bluestem is recommending the total ash population be reduced by half within 5 years. An annual review should be completed as new information about the borer is learned. These recommendations are subject to change as research-based guidelines are developed. The City Forester should complete this activity.

Equipment Needs & Staffing

The Parks & Recreation Department is responsible for all tree maintenance. Parks & Recreation's existing equipment includes:

- Prentice truck
- Chipper
- Chainsaws
- Pole saws, loppers, shears, hand saws
- Safety equipment (hard hats, chaps, vests, etc.)
- Stump grinder is rented as necessary

The most significant piece of equipment that is missing from this list is an aerial lift truck. It is unusual to see a community the size of Baraboo and with a tree population of roughly 7,000 without a bucket truck. A bucket truck costs from \$100,000 - \$160,000 (plus maintenance and training costs) depending on several variables such as the reach of the lift. Without this truck, in-house crews are unable to complete removals or pruning of trees 7" diameter and over. The cost to contract-out removals due to EAB is **\$312,280**.

The city could pay for a new, deluxe bucket truck twice for the price of contract work. This doesn't include the budget for removals and priority prunings identified as risks thru the inventory. Combined, the total contract cost for all actions is well over \$500,000. An in depth discussion of all inventory data can be found in the 'City of Baraboo Urban Forestry Plan and Inventory Summary'.

The purchase of a bucket truck would enable staff to complete removals in a more timely fashion and it is anticipated that when EAB arrives there will be a shortage of qualified firms to complete tree work. The cost and time of labor would increase if a bucket truck were to be purchased, but the benefits far exceed these costs.

City officials should begin the budget process for purchase of a new aerial lift truck. It is important to note that it often takes 12-18 months from order of an aerial truck until delivery. Advance planning is critical when purchasing this large piece of equipment.

Staffing includes the Parks & Recreation Director and four crew members. The Director spends approximately 15% of his time on forestry related issues. Crew members spend approximately 5%. It is important to acknowledge that when EAB arrives work duties will shift significantly. The City will not be able to leave dead standing trees because they pose a large risk to residents and property. Baraboo should anticipate that the Director and his four employees will be devoting nearly 100% of their time to forestry-related issues when EAB arrives. Other duties will become less of a priority and it is very likely that additional staff will be necessary to manage all duties.

Based on current staffing and equipment, a cut off of 6" has been established for tree work in Baraboo. Meaning, trees 1-6" dbh will be completed in-house and trees greater than or equal to 7" will be contracted out. Tree planting will be completed in-house. As always, each tree should be individually evaluated for its suitability and safety for removal in-house.

Community Education

It would be beneficial to distribute the findings of this report and general EAB information to residents. This is most likely to be effective through a direct mailing and through posting on the City website. Information to be discussed includes:

- Numbers of public ash trees found in Baraboo
- Ash identification tips
- Assistance to landowners locating ash trees on their properties
- Disposal site location
- Removal of unhealthy and other ash trees in anticipation of the EAB's arrival
- Chemical treatment options and the City treatment plan
- Replanting efforts
- FAQs

It would also be beneficial to develop a FAQ sheet for callers and interested individuals. Additionally, preparing a press release for print and live media would be beneficial.

Chemical Treatment of Trees

An estimated cost for treatment of significant trees was obtained and the best industry recommendations at this time are for treatment of trees using Tree-äge™ (Emamectin benzoate) via the Arborjet delivery system. This treatment option has proven to be very effective, reasonably priced and necessary only every other to every third year. However, different treatment options are being developed and approved at fast rates. Because of the speed of ongoing research and development, it is best to utilize a source of information that is updated quickly. The national emerald ash borer website: www.emeraldashborer.info contains up-to-date information about EAB pesticides.

A homeowner's guide to chemical treatment of ash trees can be found as attachment 4.

Sources of Information

Additional sources of EAB information include:

www.emeraldashborer.wi.gov/ - EAB portal for the state of Wisconsin

www.emeraldashborer.info/ - EAB web page administered by Michigan State University

www.dnr.state.wi.us/org/land/Forestry/Ash/index.htm - WI-DNR EAB web site

www.entomology.wisc.edu/emeraldashborer/ - UW-Extension, Dept of Entomology EAB website

www.datcp.state.wi.us/arm/environment/insects/emerald-ash-borer/index.isp - WI DATCP EAB website

<http://dnr.wi.gov/forestry/uf/eab/> - EAB toolkit developed by the WI DNR

<http://dnr.wi.gov/forestry/fh/pdf/WIEABResponsePlan.pdf> - State of Wisconsin EAB response plan

www.entomology.wisc.edu/emeraldashborer/ - University of Wisconsin Cooperative Extension Entomology website describing pesticide treatments for EAB



PRE-EAB ACTION CHECKLIST

Activities to be completed prior to arrival of EAB

1. _____ Establish chain-of-command with Parks & Recreation Director at top
2. _____ Begin visual survey for EAB.
3. _____ Remove ash in dead, poor or very poor condition and replant
4. _____ Remove ash 1-6" in diameter and replant
5. _____ Treat ash in excellent condition
6. _____ Remove ash with overhead utility lines
7. _____ Remove ash in fair condition
8. _____ Treat ash in good condition and begin removal of remaining ash
9. _____ Prepare and distribute EAB education items
10. _____ Review ordinances for effectiveness
11. _____ Investigate wood utilization options (see page 25 for additional information)
12. _____ Contact regional DNR urban forester for updates and new information

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EAB CONFIRMED INFESTATION ACTIVITIES

Removal of Ash Trees



Source: Steven Katovich, USDA Forest Service, Bugwood.org



Source: Pennsylvania Dept. of Conservation and Natural Resources – Forestry Archive, Bugwood.org

Once EAB has been confirmed in Baraboo, activities will be proceeding very rapidly. Depending upon circumstances, Baraboo may need to coordinate activities with DATCP to allow for delimitation and aging before any wholesale removal begins. A quarantine already been established in Brown County. The object of the EAB removal operation will be to remove dying and diseased ash as quickly as possible in the most economical fashion before they become severe hazards. One of the primary lessons learned by other communities that have faced and EAB infestation is that the trees need to be removed while they are green and not brittle. Removing dead, brittle trees increases the expense and time of removals due to the associated clean up costs and it is harder on equipment. Assuming a fairly heavy infestation, research has shown that from the time of infestation with EAB it takes an average tree 2-3 years to completely die.

Private Ash Trees

The majority of a community's trees are typically located on private property. In most cases, the responsibility for tree removal on private property will be that of the property owner. In situations where a hazardous condition exists on a private tree with the potential to impact a public right-of-way or park property, Baraboo should promptly address the issue. Inspection will need to be completed on private property as safety issues arise. Baraboo should evaluate its tree ordinances now so they encompass EAB. While the City will not be removing trees on private property, the City marshalling yard will most likely be accepting wood from private trees. In regards to ash

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disposal, Baraboo needs to be aware that they will be dealing with their own trees, but will likely be disposing of many times over the number of private or utility ash trees also. Estimates have indicated that there are as many as 8 times the number of private ash as publicly owned ash.

Fortunately, the Parks & Recreation Director who will be inspecting many trees both public and private is an International Society of Arboriculture (ISA) Certified Arborist (<http://www.isa-arbor.com/>). This certification is an urban forestry industry standard and requires a solid framework of forestry knowledge and continuing education is required to maintain status as a certified arborist. Anyone performing tree inspections should have this certification.

Marshalling Yard Location



Source: David Cappaert, Michigan State University, Bugwood.org

A marshalling yard is a disposal site whose purpose is to help prevent ash wood which could house the EAB from being transported out of a quarantined area. They can be used as staging sites for wood processing, such as chipping, debarking and sawing. The yard will also serve as a temporary or emergency storage site as trees are removed.

Marshalling yards allow municipalities, tree service companies, utilities and private individuals to drop off ash material for disposal and processing to slow artificial spread of EAB. A marshalling site needs to be several acres in size and big enough to accommodate large volumes of wood debris. It should also be fenced to prevent other dumping and to protect the public from accessing potential dangerous equipment.

The City currently uses a Public Works facility and smaller park properties for this activity. These sites appear to be adequate for EAB at this time. Additionally, because large numbers of ash will be removed by a contractor, that wood flow should be channeled to a site maintained by the contractor, not a City site.

Wood Utilization

If the City of Baraboo considers receiving private ash waste, they will be looking at a large amount of debris including boles, branches and grindings. Something will need to be done with this debris. Utilization and marketing of the ash debris has proven to be difficult and complicated. Baraboo currently makes their wood waste products (chips, boles suitable for firewood) available to the public. It may be possible to continue this practice, but likely, homeowners will have plenty of access to firewood and other materials through removal of their privately owned trees.

Baraboo will need to spend a significant amount of time researching uses for the wood debris prior to EAB. Some choices for utilization include:

Firewood: The wood can be made available to individuals within the quarantined area for firewood purposes. This option does present some disadvantages. Among those are: staff must be available to monitor public access to the site and assure safety, the supply of wood will greatly outstrip demand and will only account for a portion of the debris and the level of assistance to the public that the City could provide could quickly get out of hand. Decisions to be made prior to release of firewood include: hours of operation, length of logs to be provided for firewood (12", entire bole), assistance loading wood and how to protect the public from harm.

Mulching: Landscape quality mulch can be generated to be used for mulching new plantings, flower beds and playground. The mulch could possibly be sold to residents for a small fee which would help offset the cost of the chipping. The best way to create this mulch is to periodically rent a tub or horizontal grinder that can accommodate entire trees. Crew training will need to be provided on the grinder use and several operators will need to be present during the process. It may be possible to coordinate this work with neighboring communities to share the rental cost of the grinder or to potentially purchase a grinder for cooperative use. .

Portable Sawmilling: A portable sawmill operator may be interested in milling the wood. The City of Monroe, MI created a partnership with a portable sawmill operator that benefits both the operator and the City. The sawmill operator mills the wood once per week to custom sizes specified by the City and for the operators own use. Monroe uses the wood to make tables, benches and other items needed by the City. No money changes hands and the only paperwork required is a liability waiver for the sawmill operator.

Traditional Sawmilling: Traditional sawmilling is also an option. These operations mill wood for different purposes and utilize a variety of woods. Each sawmill differs with their wood requirements and it is advisable to contact these or other mills as soon as possible prior to EAB.

Paper Milling: Paper mills typically accept a small portion of mixed hardwoods for their operations (which includes ash). Each mills paper product has fiber length specifications that dictate the amount of hardwood component that is acceptable. The City would need to contact the mills to determine proper log length (typically 8 foot length or 100 inch length) and straightness requirements. Paper companies may also accept ash chips depending upon their operations. In both instances the City will most likely be required to deliver the wood to the paper mill.

Biomass: Excel Energy operates a plant in LaCrosse, WI that burns woody biomass. They may be interested in additional wood resources. Contact Excel directly to determine if an arrangement can be made.

While there will be a quarantine in place, DATCP has a process to certify transportation of firewood, mulch and logs outside the quarantined area. This information can be found at www.emeraldashborer.wi.gov

The Wisconsin Primary Wood Using Directory is a listing of companies who use or process wood products in Wisconsin. It includes sawmills, veneer plants, particle board plants, log cabin manufacturers, pulp mills and chip plants. This directory can be found at www.woodindustry.forest.wisc.edu/apps/search.asp

Replanting Strategies

If no trees are chemically treated, the City of Baraboo will lose 1,302 ash trees due to EAB. While it is not always appropriate or feasible to replant all trees that are removed, replanting a portion of these trees will be an important component in Baraboo's urban forest.

Replanting is one of the most often delayed or eliminated forestry operations. It takes quite a sum of money and staff-hours to replant large numbers of trees. However, the ultimate cost savings that trees generate is enormous. Some proven benefits of trees include:

"The net cooling effect of a young, healthy tree is equivalent to ten room-size air conditioners operating 20 hours a day."—*U.S. Department of Agriculture*

"Landscaping can reduce air conditioning costs by up to 50 percent, by shading the windows and walls of a home." — *American Public Power Association*

"If you plant a tree today on the west side of your home, in 5 years your energy bills should be 3% less. In 15 years the savings will be nearly 12%." —*Dr. E. Greg McPherson, Center for Urban Forest Research*

"A mature tree can often have an appraised value of between \$1,000 and \$10,000." —*Council of Tree and Landscape Appraisers*

"In one study, 83% of realtors believe that mature trees have a "strong or moderate impact" on the salability of homes listed for under \$150,000; on homes over \$250,000, this perception increases to 98%." —*Arbor National Mortgage & American Forests*

"Landscaping, especially with trees, can increase property values as much as 20 percent."—*Management Information Services/ICMA*

"One acre of forest absorbs six tons of carbon dioxide and puts out four tons of oxygen. This is enough to meet the annual needs of 18 people."—*U.S. Department of Agriculture*

"Trees properly placed around buildings can reduce air conditioning needs by 30 percent and can save 20 - 50 percent in energy used for heating."—*USDA Forest Service*

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"Trees can be a stimulus to economic development, attracting new business and tourism. Commercial retail areas are more attractive to shoppers, apartments rent more quickly, tenants stay longer, and space in a wooded setting is more valuable to sell or rent."—*The National Arbor Day Foundation*

"Healthy, mature trees add an average of 10 percent to a property's value."—*USDA Forest Service*

"The planting of trees means improved water quality, resulting in less runoff and erosion. This allows more recharging of the ground water supply. Wooded areas help prevent the transport of sediment and chemicals into streams."—*USDA Forest Service*

"In laboratory research, visual exposure to settings with trees has produced significant recovery from stress within five minutes, as indicated by changes in blood pressure and muscle tension."—*Dr. Roger S. Ulrich Texas A&M University*

There are three keys to proper tree planting:

1. **Diversity.** The urban forest should be comprised of a variety of tree species that have varied growth habits and longevities. Generally, tree planting recommendations are not more than 5% of any one species, not more than 10% of any one genus/family. For example, it is appropriate to plant 5% white oak, but not more than 10% of the oak family. This is the single best method to lessen the impact of disease or insect infestations.

2. **Right Tree, Right Place.** One of the most important aspects of tree planting is selecting the proper tree species for the planting location. If there are overhead utilities, make certain the species you are selecting is appropriately sized to avoid interfering with power lines. Other factors to consider include light requirements, mature height and root growth habits. Selecting and planting the right tree for the right location will ensure its survival and success for years to come.

3. **Proper Planting and Mulching.** Many trees do not survive due to improper planting techniques such as planting too deeply, digging the hole too small and not backfilling correctly. Incorrect mulching, most often seen as volcano mulching (piling the mulch too high around the tree), can cause many growth problems from inadequate water uptake to trunk rot. Be sure to follow established WI DNR planting guidelines (found at <http://dnr.wi.gov/forestry/UF/index.htm>). The goal is 100% survival of newly planted trees and planting correctly is the path to get there.

A comprehensive list of tree species (by size) recommended for Baraboo can be found as Attachment 2.



CONFIRMED INFESTATION CHECKLIST

Activities to be completed upon confirmation of EAB in Baraboo.

1. _____ Continue chemical treatment of ash in excellent condition
2. _____ Evaluate and begin systematic treatment or removal of infested ash
3. _____ Mobilize plans and agreements for wood utilization
4. _____ Prepare for a diverse replanting
5. _____ Continue ongoing public information/education campaign
6. _____ Contact regional DNR urban forester for updates and new information

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SUMMARY

This plan has one primary goal: preparation. Experience has shown that communities who develop a readiness plan and begin the preparation phase will have a much easier time managing their infestation. This plan gives Baraboo a head start on EAB activities. Baraboo is now armed with the knowledge of:

- The location of their ash trees
- An estimate of the time and money required to manage EAB
- Equipment and staffing needs
- Public education strategies
- Resources available for information and assistance

By beginning activities immediately and using the most current information, the impacts of EAB can be lessened and the costs can be distributed over a more manageable period of time.

Attachment 1:
Map highlighting ash locations in Baraboo

Attachment 2:

Recommended species for planting

Baraboo will be replanting large numbers of trees in a short time frame. It is important to diversify the forest as much as possible to help mitigate the effects of disease and insects. The general population guidelines are to plant not more than 10% of any one family/genus and not more than 5% of any one species. One illustration is to plant not more than 10% oak and not more than 5% of bur oak. This will help assure that if there is a population crash, large portions of the populations will not be lost.

Baraboo has a USDA hardiness zone rating of 4.

The following are some species recommended for planting in the City of Baraboo (partially compiled from: Alternative to Ash Trees: Commercially Available Species and Cultivars by Dr. Laura G. Jull, Department of Horticulture, University of Wisconsin-Madison).

Large to medium-sized Trees

Acer* × *freemanii: Freeman maple, Zone 3b-4 (depends on cultivar), native hybrid of red and silver maple, oval to rounded form, ascending branches, 40-60' tall, 35-40' wide, moderate to fast growth rate, yellow, orange to red fall color, smooth, light gray bark when young, red samaras in spring, not fall, adaptable to most soils and pH, some cultivars can get chlorotic at very high pH, tolerant to wet soils, drought and urban conditions, moderate salt tolerance, can get verticillium wilt and leaf hoppers, some cultivars prone to included bark formation and narrow branch crotch angles, dioecious (separate male and female flowers produced on separate plants)

'Armstrong': narrow, fastigate form, 45' tall, 15' wide, yellow fall color, female, produces seeds

'Celzam' (Celebration[®]): upright to oval form, 45' tall, 25-30' wide, better branch angles and straight central leader, yellow fall color, fast grower, male, seedless, drought tolerant

'DTR 102' (Autumn Fantasy[®]): broadly oval form, upright branches, 50' tall, 40' wide, bright to dark red fall color, female, produces seeds

'Indian Summer' or 'Morgan': broadly oval to rounded form, 45' tall, 40' wide, early, bright rosy-red fall color, vigorous, female, produces seeds, very sensitive to flooded soils

'Jeffersred' (Autumn Blaze[®]): broadly oval form with upright branches, 50' tall, 40' wide, bright orange-red to red fall color that is longer lasting, male, seedless, drought tolerant, tends to develop narrow crotch angles, included bark, and multiple leaders

'Marmo': upright, oval form, 55' tall, 45' wide, early, fair, mottled blend of deep red and green fall color starts at leaf tips and gradually works its way down leaf, good branching with straight central leader, male, seedless, slower grower

'Scarsen' (Scarlet Sentinel[®]): upright form becoming oval, 40' tall, 20' wide, yellow-orange to orange-red fall color, fast grower, male, seedless

'Sienna' (Sienna Glen[®]): pyramidal form, 50' tall, 35' wide, rusty orange to burgundy fall color, male, seedless, wider branch angles, from northern seed source, less susceptible to frost crack, hardy to zone 3

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Acer rubrum: red maple (in acidic soils (pH below 7) only or else very chlorotic), hardy to zone 3b-5b (depends on cultivar), native to eastern and central U.S., Canada, and Wisconsin, oval to rounded to irregular form, 40-60' tall, 25-35' wide, moderate to fast grower, yellow, orange to bright red fall color, smooth, light gray bark when young, reddish flowers in early spring, red samaras in spring, not fall, dioecious (separate male and female flowers produced on separate plants), adaptable to most soils, requires acid pH or else develops serious chlorosis due to lack of manganese, not iron, easy to transplant, tolerant to wet soils (some cultivars), sensitive to salt and air pollution, susceptible to verticillium wilt, leaf hoppers, frost crack, girdling roots, prone to included bark formation and narrow, branch crotch angles, shallow roots

- Autumn Flame[®]: dense, rounded with spreading branches, 40' tall, 35' wide, early, bright red fall color, male, seedless, slower grower
- Autumn Radiance[®]: rounded, open, symmetrical form, 60' tall, 40' wide, early red-orange fall color
- 'Autumn Spire': narrow to oval form, 40-50' tall, 30' wide, bright red fall color, male, seedless, from a northern seed source, newer cultivar, Zone 3
- 'Bailcraig' (Scarlet Jewell[™]): upright form, 60' tall, 30' wide, early, deep crimson-red fall color, from a northern seed source, Zone 3, new cultivar
- 'Bowhall': upright, very narrow form, 40-50' tall, 15' wide, yellowish-orange to reddish fall color, female, produces seed, prone to included bark formation
- 'Brandywine': oval form 40' tall, 30' wide, deep red fall color for a longer period, male, seedless, newer cultivar
- Fairview Flame[™]: good branching, 45' tall, fast growing, later, orange-red fall color
- 'Frank Jr.' (Redpointe[™]): broadly pyramidal form, 45' tall, 30' wide, bright red fall color, faster growing, straight central leader, better branch crotch angles, new cultivar
- 'Franksred' (Red Sunset[®]): upright, dense, oval form, symmetrical form, bright red to orange fall color, fast grower, 45-50' tall, 35' wide, female, produces seeds, dark green, glossy leaves, older cultivar
- Karpick[®]: narrow, oval, dense form, 40' tall, 20' wide, yellow to orange fall color, male, seedless, prone to included bark formation
- 'Magnificent Magenta' (Burgundy Belle[®]): oval to rounded form, 45' tall, 40' wide, bright red fall color that changes to burgundy, symmetrical form, heat tolerant, prone to leafhoppers and witches' broom
- 'New World': upright, narrow-oval form, 40' tall, 20' wide, orange-yellow to orange-red fall color, male, seedless
- 'Northwood': symmetrical, broadly oval to rounded form, ascending branches, 40' tall, 35' wide, early orange to reddish fall color, male, seedless, from a northern seed source, Zone 3
- 'Olson' (Northfire[®]): oval form, 50' tall, 35' wide, early, bright red fall color, northern seed source, Zone 3
- 'PNI 0268' (October Glory[®]): not hardy, zone 5b-6a, broadly oval to rounded form, 40' tall, 35' wide, red fall color for a longer period, female, produces seeds, old cultivar
- 'Polara' (Ruby Frost[™]): upright, dense, broad oval form, 45' tall, 40' wide, ruby-red fall color, selected in NW Wisconsin, Zone 3
- 'Red Rocket': narrow, columnar form, 35' tall, 8' wide, red fall color, northern seed source, tolerant to leaf hopper
- 'Schlesinger': broadly vase-shaped to rounded, 45' tall, 35' wide, very early orange to purplish-red fall color, female, produced seed
- 'Somerset': broadly oval to rounded form, 45' tall, 35' wide, red fall color, leaf hopper resistant newer cultivar
- Summer Red[®]: dense, broad oval form, 20' tall, 10' wide, burgundy red new leaves that turn purplish-green, yellow to orange to purple fall color, leaf hopper resistant, Zone 5
- 'Sun Valley': oval, symmetrical form, densely branched, 40' tall, 35' wide, bright red fall color

Acer saccharum: sugar maple, hardy to zone 3a-5 (depends on cultivar), native to eastern U.S., Canada, and Wisconsin (our state tree), upright, oval to rounded form, 60-75' tall, 35-50' wide, showy, bright yellow to orange-red fall color, prefers a fertile, moist, well-drained soil, will not tolerate heavy clay, poorly drained, or dry soils, sensitive to drought, salt and air pollution, susceptible to leaf tatter and leaf scorch, verticillium wilt, basal rot, girdling roots, leaf hoppers

- 'Astis' (Steeple[®]): narrow oval form, 45' tall, 20' wide, yellow-orange fall color
- 'Autumn Splendor': broadly oval to rounded form, 45' tall, 40' wide, glossy leaves, orange-red fall color, resistant to heat drought and leaf tatter, Zone 5, newer cultivar
- 'Bailsta' (Fall Fiesta[®]): broadly ovate to rounded form, 50' tall, 40' wide, glossy, leathery leaves, yellow-orange to red fall color, leaf tatter and leaf hopper resistant, faster grower, newer cultivar
- 'Barrett Cole' (Apollo[®]): symmetrical, narrow, columnar form, 35' tall, 10' wide, yellow-orange to red fall color
- 'Bonfire'[™]: broadly oval form, 50' tall, 40' wide, orange to red fall color, more heat tolerant, fast grower
- 'Commemoration'[®]: oval to rounded, dense form, 50' tall, 35' wide, thick, glossy, dark green leaves, yellow-orange to red fall color, vigorous, faster grower, resistant to leaf tatter
- 'Endowment': broad columnar form, 50' tall, 20' wide, bright yellow fall color, no leaf scorch
- 'Heartland' (Autumn Faith[™]): oval to vase-shape, dense form, 35' tall, 20' wide, new leaves are bronze opening to dark green, bronze fall color, slow grower
- 'Flax Mill' (Majesty[®]): broadly oval, symmetrical form, 50' tall, 40' wide, thicker leaves, orange to reddish fall color
- 'Jefcan' (Unity[®]): upright, oval form, 50' tall, 30' wide, yellow to orange-red fall color, selected for harsh prairie climate, from Canada, slower grower, resistant to frost crack, newer cultivar, zone 3
- 'Legacy'[®]: oval to rounded, dense form, 50' tall, 35' wide, glossy, thick, dark green leaves, later reddish-orange to red fall color or none, leaf scorch and leaf tatter resistant, faster grower, heat tolerant,
- 'Morton' (Cresendo[™]): broadly oval form, 45' tall, 40' wide, orange-red to red fall color, heat tolerant
- 'PNI 0285' (Green Mountain[®]): broadly oval form, 45-50' tall, 35' wide, reddish-orange to red fall color, leathery leaves less subject to leaf scorch, faster growing, more heat tolerant
- 'Wright Brothers': oval form, 50' tall, 35' wide, yellow-orange to red fall color, resistant to leaf scorch and frost crack, faster growing

Celtis occidentalis: common hackberry, zone 3b, native to eastern and central U.S., Canada, and Wisconsin, vase-shaped when young becoming rounded with drooping branches, moderate to fast growth rate, 50-70' tall, 40-60' wide, corky, warty looking bark, small, pea-sized, purplish-black fruit in fall, adaptable to most soils and pH, tolerates dry, sandy, rocky, and compact, heavy clay soils, slow to establish, plant in spring, drought, urban, wind, and wet soils tolerant, but sensitive to salt, susceptible to hackberry nipple gall on leaves, witches' brooming of twigs, resistant to DED, sensitive to Dicamba herbicides used near tree, branches tend to break in storms, prone to included bark formation, need to train to develop good branch structure

- 'Chicagoland': broad pyramidal form with upright branches, 55' tall, 40' wide, forms a straight central leader, rich green leaves, yellow fall color, warty bark
- 'Windy City': upright, spreading form, straight, central leader, fast grower

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Corylus colurna: Turkish filbert, hardy to zone 4b, native to southeastern Europe and western Asia, broad, pyramidal form, formal looking even with age, dense, coarse texture, 40-50' tall, 20-25' wide, no fall color, scaly to corky, gray-brown bark, long, pendulous catkins in early spring are showy, may produce nuts, difficult to transplant, heat, urban, and drought tolerant, once established, sensitive to salt

Ginkgo biloba: ginkgo, maidenhair tree, hardy to zone 4b, native to eastern China, living fossil, found in fossil records dating back 150 million years ago, deciduous gymnosperm, pyramidal when young, becoming wide-spreading with age to upright, slow grower, 50-80' tall, 30-60' wide, very interesting, fan-shaped leaves, golden-yellow fall color, dioecious (separate male and female flowers produced on separate plants), female trees produce smelly, messy fruit, but not until 20 years old, so plant male cultivars only, tolerant to most soils and pH, prefers a sandy, deep soil, difficult to transplant, plant in spring, heat, salt, urban, and drought tolerant, no pests

'Autumn Gold': broadly pyramidal, symmetrical form, 45' tall, 35' wide, golden yellow fall color, male, no fruit, good, uniform branching

'Fairmount': dense, upright, pyramidal form, straight central leader, male, no fruit

'Halka': broadly pyramidal becoming oval, 45' tall, 40' wide, bright yellow fall color, male, no fruit

'Golden Globe[™]: broad, rounded form, 60' tall, 40' wide, slightly faster growth rate, male, no fruit, dense form, golden yellow fall color, Zone 5

'Magyar': upright form, 50' tall, 30' wide, bright yellow fall color, male, no fruit

'PNI 22720' (Baraboo Sentry[®]): narrow pyramidal, upright form, 50' tall, 20-30' wide, bright yellow fall color, male, no fruit

'Saratoga': compact, dense, rounded form, with straight central leader, 20-30' tall, 15-20' wide, pendulous leaves, soft yellow fall color, slower and smaller than other ginkgos, male, no fruit

Shangri-La[®]: moderately pyramidal form, 45' tall, 25' wide, slightly faster growth rate, bright yellow fall color, male, no fruit

'Windover Gold[®]: upright, oval form, 40-60' tall, 30-40' wide, golden yellow fall color, strong grower, male, no fruit

'Woodstock' (Emperor[™]): uniform, oval form, strong, central leader, good branching, male, no fruit

Gleditsia triacanthos var. inermis: thornless honeylocust, hardy to zone 4a, native to central U.S. and southern Wisconsin (thorny type native, not var. *inermis*), fine texture, fast growing, vase-shaped form becoming flat-topped, spreading branches, open, 50-70' tall, 40-50' wide, early, bright golden-yellow fall color, no thorns, dioecious (separate male and female flowers produced on separate plants), female plants produce long, twisted, black pods that make a slippery, litter mess, tolerant to most soils and pH, tolerant to compacted, heavy clay soil, drought, salt, and urban tolerant, tolerant to periodic flooding, susceptible to leaf hoppers, plant bug, cankers, sunscald on trunk, high maintenance pruning, tends to develop co-dominant branches, can break in storms

'Christie' (Halka[™]): broad, oval to rounded form, 40' tall, 40' wide, horizontal branches, some pods, fast growing, yellowish fall color

'Emerald Cascade': irregular, weeping form with pendulous branches, grafted, 16' tall, male, no pods

'Harve' (Northern Acclaim[®]): symmetrical, upright, spreading form, 45' tall, 35' wide, yellow fall color, male, no pods, developed in North Dakota, hardy to zone 3b

'Impcole' (Imperial[®]): rounded form, symmetrical, wide-spreading, with good branching, 35' tall, 35' wide, seedless but can throw a few pods, susceptible to leaf hoppers and plant bug

'Moraine': uniform, rounded crown with vase-shaped branching, male, no pods, older cultivar
 'PNI 2835' (Shademaster[®]): vase-shaped to rounded, irregular form, 45' tall, 35' wide, uniform, ascending branches, occasionally, some trees may produce pods
 'Skycole' (Skyline[®]): broadly pyramidal form, ascending branches with wider crotch angles, 45' tall, 35' wide, develops a strong, central leader better than any other cultivar, male, no pods, bright golden yellow fall color
 'Suncole' (Sunburst[®]): irregular, oval form, 40' tall, 35' wide, 8" of new leaves are bright yellow then fades to green, yellowish fall color, susceptible to leaf hoppers, plant bug, and canker, male, no pods
True Shade[®]: broadly oval form, 40' tall, 35' wide, wider branch angles, yellow fall color, faster grower, male, no pods
 'Wandell' (Perfection[™]): develops a good crown at a younger age, 35' tall, 30' wide, dark green leaves, male, no pods

Gymnocladus dioica: Kentucky coffeetree, hardy to zone 4a, native to central U.S., southern Ontario, and Wisconsin (scattered distribution), vase-shaped form with upright branches becoming irregular and open, 50-75' tall, 40-50' wide, slow to moderate grower, coarse texture in winter with sparse branching when young, lacy texture when in leaf, yellow fall color, large, bluish-green leaves, ashy-gray, deeply furrowed bark with exfoliating plates, dioecious (separate male and female flowers produced on separate plants), females produce thick, sausage-like, pendulous pods, that can be a litter problem along with the leaf rachis in fall, adaptable to most soils and pH, slow to establish, tolerates compacted, heavy clay soil, salt, drought, periodic flooding, and urban conditions, no pests, can look a bit "gauntly" when young due to sparse branching

'Espresso': oval to vase-shaped form with arching branches, 50' tall, 35' wide, large, blue-green leaves, yellowish fall color, male, no pods, newer cultivar
 'J.C. McDaniel' (Prairie Titan[™]): oval to vase-shaped form, 50' tall, 35' wide, large, blue-green leaves, yellowish fall color, male, no pods, newer cultivar

Phellodendron amurense '**Macho**': Macho Amur corktree, hardy to zone 3b, native to northern China and Japan, broadly vase-shape, upright form, 40' tall, 30' wide, ascending branches, thick, dark green leaves, yellowish-green fall color, male, no fruit, corky bark when older, adaptable to most soils and pH, slow to establish, urban tolerant, moderate salt tolerance, no pests, shallow roots, low branching, avoid female trees as they produce invasive seeds

Quercus bicolor: swamp white oak, hardy to zone 4a, native to eastern U.S. and Wisconsin, pyramidal when young, becoming broad, rounded, wide-spreading with age, 50-60' tall, 50-60' wide, slow to moderate growth rate, easier to transplant than bur oak, prefers acidic to neutral pH, but will tolerate a bit higher, but at very high pH, it will get chlorotic, adaptable to most soils including heavy clay, tolerant to wet soil, drought, and urban conditions

Quercus macrocarpa: bur oak, hardy to zone 3a, native to eastern and midwestern U.S. and Wisconsin, pyramidal when young, becoming very wide-spreading, rounded, 70-80' tall, 60-80' wide, slow growing, coarse texture, deeply furrowed bark, no fall color, adaptable to most soils and pH, drought and urban tolerant, difficult to transplant

Quercus* × *macednielli '**Clemon's**': Heritage[®] oak, hardy to zone 4, hybrid of *Q. robur* × *Q. macrocarpa*, broadly pyramidal becoming oval form, 60-80' tall, 40-50' wide, dark green, glossy leaves, no fall color, mildew resistant, vigorous, zone 4

Quercus* × *schuettei: swamp bur oak, hybrid of *Q. bicolor* × *Q. macrocarpa*, broad, rounded form, 75' tall, 70' wide, faster growing, better tolerance to high pH and easier to transplant, may be susceptible to leaf/twig galls, zone 3b

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Tilia americana: American linden, basswood, hardy to zone 3a, native to northeast and central U.S., Canada, and Wisconsin, pyramidal when young becoming upright-oval with age, 60-80' tall, 40-50' wide, fragrant, pale yellow flowers in early summer, small nutlet fruit attached to bract, large, heart-shaped leaves, prefers a deep, fertile soil, pH adaptable, easy to transplant, tolerant to wetter soils, sensitive to salt and air pollution, susceptible to Japanese beetle, linden borer, gypsy moth, basal and stem rots, sunscald on bark, tends to sucker at base, can break in storms, prone to included bark formation and narrow, branch crotch angles, girdling roots

'Bailyard' (Front Yard[®]): broadly pyramidal when young becoming rounded and dense, symmetrical form, 60-75' tall, 40' wide

'Boulevard': narrowly pyramidal form, 50' tall, 25' wide, ascending branches, yellow fall color

'DTR 123' (Legend[®]): broadly pyramidal form, 40' tall, 30' wide, well-spaced branches, thicker leaves, single leader, yellow fall color

'Lincoln': pyramidal, compact, dense form, 40' tall, 25' wide, upright branches, dark green leaves, yellow fall color

'Mcksentry' (American Sentry[™]): symmetrical, pyramidal form with straight central leader, 45' tall, 30' wide, better branch angles, lighter gray bark, yellow fall color

Tilia 'Redmond': Redmond linden, hardy to zone 4, hybrid of *T. americana* × *T. × euchlora*, pyramidal to oval form, upright branches with terminal leader above the foliage, reddish stems and buds, can sucker at base, 50-70' tall, 30-40' wide, fragrant, pale yellow flowers in early summer, small nutlet fruit attached to bract, large, heart-shaped leaves

Tilia tomentosa: silver linden, hardy to zone 4b, native to southeastern Europe and western Asia, broad-pyramidal form becoming upright-oval, formal looking, dark green leaves with silvery-white undersides, pale yellow flowers in summer, small nutlet fruit attached to a bract, no fall color, prefers a deep, fertile soil, but is adaptable, pH adaptable, easy to transplant, more heat, drought, and urban tolerant than other lindens, does not tolerate poorly-drained, compacted soils, same pests as American linden

'PNI 6051' (Green Mountain[®]): broadly pyramidal to oval form, 50' tall, 35' wide, dark green leaves with silvery undersides, yellowish fall color, prone to included bark formation

'Wandell' (Sterling[®]): broadly pyramidal form, 45' tall, 35' wide, green leaves with silvery undersides, yellowish fall color, prone to included bark formation

Ulmus americana: American elm (DED resistant cultivars), hardy to zone 3a, native to eastern and central U.S., Canada and Wisconsin, all have vase-shaped form with pendulous branches, 70-80' tall, 60-70' wide, yellow fall color, adaptable to most soils and pH, tolerant to compacted, heavy clay soils, easy to transplant, tolerant to periodic flooding, salt, urban, air pollution, and drought tolerant, pest prone

'New Harmony' (from U.S. National Arboretum): broad, vase-shaped form, arching branches, good form, easier to grow

'Valley Forge' (from U.S. National Arboretum): broad, vase-shaped form with arching branches, 70' tall, 70' wide, wild looking form and branching, vigorous, needs training

Ulmus hybrids: hybrid elms, most are hardy to zone 4-5, all Dutch elm disease resistant, needs pruning in nursery to develop good form, adaptable to most soils and pH, tolerant to compacted, heavy clay soils, moderate salt tolerance, drought, urban, and air pollution tolerant

- 'Cathedral' (UW-Madison intro): hybrid of *U. japonica* × *U. pumila*, broadly vase-shaped, spreading form, 40-50' tall, 40-60' wide, prone to elm leaf beetle, zone 4
- 'Frontier' (from U.S. National Arboretum): hybrid of *U. carpinifolia* × *U. parvifolia*, broadly oval form, 35' tall, 25' wide, ascending branches, glossy, small, dark green, glossy leaves, late, burgundy fall color, can get elm leaf beetle, Zone 5
- 'Homestead' (from U.S. National Arboretum): hybrid of *U. pumila* × (*U.* × *hollandica* × *U. carpinifolia*), upright, narrow to oval form, 55' tall, 35' wide, upright, arching branches, prone to elm leaf beetle, fast growing, Zone 4b
- 'Morton' (Accolade[®]) (from Morton Arboretum): hybrid of *U. japonica* × *U. wilsoniana*, vase-shaped form with arching branches, 70' tall, 60' wide, resistant to elm leaf beetle, vigorous, resistant to elm leaf beetle, dark green, glossy leaves, zone 4
- 'Morton Glossy' (Triumph[™]) (from Morton Arboretum): hybrid of *U.* 'Morton Plainsman' × *U.* 'Morton', upright oval to vase-shape, 55' tall, 45' wide, very glossy, dark green leaves, good form, some elm leaf beetle, excellent drought tolerance, zone 4
- 'Morton Plainsman' (Vanguard[™]) (from Morton Arboretum): hybrid of *U. japonica* × *U. pumila*, rounded, vase-shaped form, 45' tall, 40' wide, glossy, dark green leaves, prone to elm leaf beetle, zone 4
- 'Morton Red Tip' (Danada Charm[™]) (from Morton Arboretum): complex hybrid of (*U. japonica* × *U. wilsoniana*) × *U. pumila* vase-shape form with arching branches, 70' tall, 60' wide, reddish new leaves, new leaves, prone to elm leaf beetle, zone 4
- 'Morton Stalwart' (Commendation[™]) (from Morton Arboretum): complex hybrid of *U.* 'Morton' × (*U. pumila* × *U. carpinifolia*), upright, oval form, 60' tall, 50' wide, zone 5
- 'New Horizon' (UW-Madison intro): hybrid of *U. japonica* × *U. pumila*, upright, compact form, 50' tall, 25' wide, dark green leaves, wide crotch angles, susceptible to verticillium wilt, zone 3b
- 'Patriot' (from U.S. National Arboretum): complex hybrid of *U. wilsoniana* × *U. pumila* × *U. carpinifolia* × *U. glabra*, stiffly upright branches, narrow, vase-shape form, 50' tall, 40' wide, dark green leaves, straight central leader, zone 5
- 'Pioneer' (from U.S. National Arboretum): hybrid of *U. glabra* × *U. carpinifolia*, rounded form, 50' tall, 50' wide, dark green, glossy leaves, prone to elm leaf beetle, zone 5
- 'Regal' (UW-Madison intro): complex hybrid of *U. carpinifolia* × (*U. pumila* × *U.* × *hollandica*), upright, pyramidal form, 50-60' tall, 30' wide, prone to double leaders and narrow crotches, stiff branches, zone 4

***Ulmus japonica* 'Discovery'**: Discovery Japanese elm, hardy to zone 3, native to Japan and Asia, upright, vase-shape, compact form, 35-40' tall, 35-40' wide, resistant to DED and elm leaf beetle, yellow fall color

Small Sized Trees

Acer tataricum* subsp. *ginnala: Amur maple, Zone 3a, native to China, Manchuria, and Japan, very invasive, do not plant near any natural areas, multi-stemmed, rounded form, low branches, 15-18' tall and wide (smaller cultivars are available), dagger-shaped leaves, orange to bright red fall color, red samaras in summer turn brown in fall, adaptable to most soils and pH, easy to transplant, drought, salt, and urban tolerant, very susceptible to verticillium wilt

'Compactum' or 'Bailey Compact': dense, compact, rounded, shrubby form, 6-8' tall, 6-8' wide, slower grower, orange to scarlet fall color

'Embers': rounded form, 15-20' tall, 15' wide, bright red samaras, scarlet fall color

'Emerald Elf': compact, rounded, dense, shrubby form, 5-6' tall and wide, scarlet to purple fall color

'Flame': multi-stemmed, spreading, irregular form, 15-20' tall, 20-25' wide, bright orange-red to deep red fall color

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'JFS-UGA' (Red November™): multi-stemmed, low, rounded form, 18' tall, 24' wide, later, bright red fall color, heat tolerant, Zone 5

Amelanchier × grandiflora: apple serviceberry, hardy to zone 3a, native hybrid of downy and Allegheny serviceberry, multi or single-stemmed tree to large shrub, upright to irregular form, no suckers, 15-30' tall, 15-25' wide, produces bronze to purplish-red, fuzzy leaves in spring that turn smooth and green, white flowers in early spring, edible fruit in June, smooth, gray bark, yellowish-orange to red fall color, can develop chlorosis at high pH, prefers loamy soil, does poorly in poorly drained soils, difficult to transplant, plant in spring

'Autumn Brilliance': upright, spreading form, 20-25' tall, 15' wide, orange-red fall color, leaf spot resistant, multi-stemmed

'Cole's Select': upright, spreading form, 15-20' tall, 15' wide, multi-stemmed, orange-red fall color, leaf spot resistant, thicker, glossier leaf

'Forest Prince': oval form, 20' tall, 15' wide, red-orange fall color

'Princess Diana': wide spreading form, 15-20' tall, 15' wide, multi-stemmed, red-orange fall color, leaf spot resistant

'Robin Hill': upright, open form, 20-30' tall, 15-20' wide, flowers pink in bud open to pale pink fading to white, red fall color, single-stemmed

Amelanchier laevis: Allegheny serviceberry, hardy to zone 4a, native to eastern and central U.S., Canada, and Wisconsin, upright form, single or multi-stemmed tree, 15-25' tall, 15-20' wide, can sucker, produces white flowers in early spring, bronze to purplish-red new leaves in spring that turn green, edible fruit in June, orange to reddish-bronze fall color, prefers moist, loamy soils, does poorly in poorly drained soils, difficult to transplant, plant in spring

Cumulus®: upright, open form, 20-30' tall, 15' wide, orange-red fall color, minimal suckering, single-stemmed

'JFS-Arb' (Spring Flurry®): upright, oval form, 30-35' tall, 20' wide, orange fall color, single-stemmed, straight central leader, newer cultivar

'Rogers' (Lustre®): upright, open form, 20-30' tall, 15-20' wide, orange-red fall color, minimal suckering, single-stemmed

'Snowcloud': upright, oval form, 25' tall, 15' wide, scarlet fall color, single-stemmed

Cornus mas: Corneliancherry dogwood (more of a boulevard tree), hardy to zone 4b, native to Europe and western Asia, bright yellow flowers in early spring, long lasting, fruit is in summer and is bright red changing to dark purple and becoming edible, but tart, adaptable to most soils, but prefers rich soils, pH adaptable, easy to transplant, tolerates partial shade, straight species is sensitive to drought, but cultivars are more tolerant, sensitive to salt, no pest problems, hardy to zone 4b

'Golden Glory': narrow, upright form, 20-25' tall, 10' wide, much better form and darker green, glossy, thicker leaves, more flowers and fruit, good substitute to invasive tall hedge buckthorn!

'Pyramidalis': upright, pyramidal to upright form, 20' tall, 10-15' wide, dark green leaves

Crataegus crus-galli var. inermis: thornless cockspur hawthorn, hardy to zone 4a, native to eastern and central U.S., Canada, and Wisconsin, multi-stemmed tree, broad, spreading, horizontal, low branches, flat-topped crown, 20-30' tall, 20-35' wide, adaptable to most soils and pH, difficult to transplant, plant in spring, drought, salt, and urban tolerant, susceptible to cedar quince rust (on fruit) or cedar hawthorn rust (leaves), this variety has no thorns, white flowers in late spring, deep red fruit in early to mid fall that drops creating a litter problem, bronzy-orange to reddish fall color, dark green, leathery, spoon-shaped leaves

'Cruzam' (Crusader[®]): rounded form, 15' tall, 15' wide, thornless, bright red fruit, orange fall color

Crataegus phaenopyrum: Washington hawthorn, hardy to zone 4b, native to eastern U.S. and Canada, multi-stemmed tree, vase-shaped to broadly oval form, horizontal, low branches, 20-30' tall, 20-25' wide, adaptable to most soils and pH, difficult to transplant, plant in spring, tolerant to poor, sandy soils, drought and urban tolerant, moderate salt tolerance, susceptible to cedar quince rust (on fruit) or cedar hawthorn rust (leaves), has long, sharp thorns, white flowers in late spring to early summer, showy, persistent, glossy, bright-orange-red fruit fall to winter

'Westwood I' (Washington Lustre[®]): rounded, upright form, 20-25' tall, 20-25' wide, has fewer thorns than species, vigorous

Crataegus viridis '**Winter King**': Winter King hawthorn, hardy to 4b, native to eastern U.S., vase-shaped to rounded, wide-spreading form, horizontal, low branches, adaptable to most soils and pH, difficult to transplant, plant in spring, drought and urban tolerant, moderate salt tolerance, less susceptible to cedar hawthorn rust but can get cedar quince rust on fruit, white flowers in late spring, very showy, bright orange-red, persistent fruit from mid fall to winter, silvery-gray bark that exfoliates on the trunk revealing orange inner bark, has few if any thorns, yellowish-purple fall color

Maackia amurensis: Amur maackia, hardy to zone 4a, native to Manchuria, vase-shaped to rounded form, upright, arching branches, 20-30' tall, 20-30' wide, slow grower, silvery and fuzzy leaves in spring turn olive-green and smooth, coppery-green to bronzish-brown, slightly exfoliating bark, off-white flowers in summer, small pods in fall, tolerant to most soils and pH, roots fix atmospheric N, tolerant to poor, infertile soils, urban and salt tolerant, prone to included bark formation, needs pruning when young, no pests, not invasive

'Starburst': upright, vase-shaped form with rounded crown, 25-30' tall, 20' wide, dark green leaves

'Summertime[®]': upright, rounded form, 18-20' tall, 12-15' wide, white flowers in summer

Malus spp.: flowering crabapple, most are hardy to zone 4a and are hybrids with parents originating from Asia, Europe and U.S., size and form are quite variable, adaptable to most soils and pH, prefers low nitrogen to decrease disease susceptibility, drought and urban tolerant, apple scab resistant species and cultivars listed below and have smaller fruit, some cultivars prone to suckering and watersprouts on branches

White Flowers/Red Fruit

'Adirondack': narrow, upright form, 18' tall, 10' wide, persistent fruit

'Guinzam' (Guinevere[®]): rounded form, 8-10' tall, 10' wide, persistent fruit

'Jewelcole' (Red Jewel[®]): upright, pyramidal form, 15' tall, 12' wide, persistent fruit, can get fireblight

'Kinarzam' (King Arthur[®]): upright, rounded form, 12' tall, 10' wide, can sucker from base

'Sutyzam' (Sugar Tyme[®]): upright, spreading, oval form, 18' tall, 15' wide, persistent fruit

Malus baccata 'Jackii': Jackii crabapple, hardy to zone 3, rounded form, 20' tall, 20' wide, glossy leaves, zone 3

Malus sargentii: Sargent crabapple, low, spreading form, 8' tall, 12' wide, alternate bearing, persistent fruit

'Select A' (Firebird[®]): rounded, spreading form, 7' tall, 9' wide, persistent fruit, bears annually, persistent fruit

'Tina': small, rounded, dwarf form, 5' tall, 6' wide, slow growing

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Malus × zumi var. calocarpa: redbud crabapple, rounded, spreading form, 20' tall, 24' wide, persistent fruit

White Flowers/Yellow Fruit

'Bob White': dense, rounded form, 20' tall, 20' wide, persistent fruit, but is a watersprouter

'Cinzam' (Cinderella[®]): dwarf, rounded to upright form, 8' tall, 5' wide, persistent fruit

'Excazam' (Excalibur[™]): upright form, 10' tall, 8-10' wide, good form

'Hargozam' (Harvest Gold[®]): upright, oval form, 22' tall, 18' wide, persistent fruit, may get some scab

'Lanzam' (Lancelot[®]): compact, upright, dense form, 8-10' tall, 8' wide, persistent fruit

'Ormiston Roy': broad, rounded form, 20-25' tall, 25' wide, furrowed, orangish bark, yellow fruit with a rosy blush turn orange-brown after a hard frost

Pink or Reddish Flowers/Red to Purplish-Red Fruit

'Camzam' (Camelot[™]): rounded form, 10' tall, 8' wide, pinkish-white flowers, burgundy-green leaves, persistent fruit

Malus sargentii 'Candy mint': low, spreading, horizontal form, 10' tall, 15' wide, purple tinted foliage becoming bronze-green

'Canterzam' (Canterbury[™]): rounded, compact form 10' tall, 8-10' wide, light, pinkish-white flowers

'Cardinal': irregular, spreading form, 16' tall, 22' wide, dark purplish-red, glossy leaves

'JFS-KW5' (Royal Raindrops[®]): upright, spreading form, 20' tall, 15' wide, cutleaf, purple leaves, orange-red fall color, persistent fruit

'Orange Crush': spreading form, 12-15' tall, 12-15' wide, bronze to purplish-green leaves

'Parsi' (Pink Princess[®]): low, spreading form, 8' tall, 12' wide, purple leaves become bronze-green

'Prairifire': upright, spreading to rounded form, 20' tall, 20' wide, slower growing, purple leaves become reddish-green

'Prairie Maid': rounded to spreading form, 20' tall, 25' wide, burgundy tinged leaves in spring, but is a watersprouter

'Purple Prince': rounded form, 20' tall, 20' wide, purple leaves become bronzish-green,

'Coral Cascade': semi-weeping form, 15' tall, 20' wide, white flowers, coral fruit,

'Louisa': graceful weeper, 15' tall, 15' wide, pink flowers, fruit are yellow turning orange-brown, not showy or persistent

'Luwick': graceful, low weeper, 7' tall, 14' wide, deep pink buds open to light pink to whitish flowers, bright red fruit

'Manbeck Weeper' (Anne E.[®]): wide spreading, horizontal weeper, 10-12' tall, 10-12' wide, white flowers, cherry-red fruit, persistent fruit, is difficult to find, but is one of the nicest crabs

'Molazam' (Molten Lava[®]): broadly weeping form, 14' tall, 20' wide, white flowers, bright red fruit

Pyrus calleryana: callery pear, hardy to zone 4b, native to China and Korea, upright, pyramidal to oval form, 25-35' tall, 20-30' wide, adaptable to most soils and pH, drought, urban, and salt tolerant, can get fireblight, fast grower, dark green, glossy, leathery leaves, late, reddish-orange to purple fall color, white flowers in mid spring, small, brown, rounded fruit

Aristocrat[®]: pyramidal form with open branching, 35' tall, 25' wide, yellow to red fall color but is inconsistent for fall color, wider branch crotch angles

'Autumn Blaze': rounded form, 30' tall, 25' wide, earlier, bright red to purplish fall color, wide crotch angles, less prone to included bark formation

'Cambridge': upright, narrowly pyramidal form, 35' tall, 15' wide, bright orange fall color

'Capital': narrow, columnar form, 30' tall, 12' wide, reddish-purple fall color, susceptible to limb breakage in storms, susceptible to fireblight, zone 5

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'Cleveland Select' or 'Glenn's Form' (Chanticleer[®]): formal, upright, narrowly pyramidal form, 25-30' tall, 15' wide, late orangish to reddish fall color, not as good as other cultivars for fall color, rarely produces fruit

'Redspire': pyramidal, dense, symmetrical form, 35' tall, 25' wide, yellow to reddish fall color or none at all, susceptible to fireblight, slower grower

'XP-005' (Trinity[®]): broadly oval to rounded form, 30' tall, 25' wide, glossy, lighter green leaves, orange-red fall color

Syringa reticulata: Japanese tree lilac, hardy to zone 3a, native to Japan and Manchuria, upright with a rounded to oval form, 20-25' tall, 15-20' wide, no fall color to yellowish, reddish-brown, shiny bark, creamy-white, large flowers in early summer that do not smell like lilacs but rather like a privet, tends to flower heavily every other year, adaptable to most soils and pH, easy to transplant, salt and urban tolerant, susceptible to bacterial blight and verticillium wilt, resistant to mildew

'Elliott' (Snowcap[™]): upright, more compact form, 15-20' tall 10-12' wide, uniform branching, thick, dark green leaves, good form

'Golden Eclipse': upright, compact form, 18-24' tall, 8-14' wide, new leaves in spring emerge green with a darker center, the edge of the leaf gradually turns bright gold with the dark green center remaining

'Ivory Silk': over used, upright, spreading becoming oval to rounded, 20' tall, 15' wide, susceptible to bacterial blight

'Summer Snow': broad, rounded, compact form, 20' tall, 15' wide, good form, glossy, dark green leaves

'Williamette' (Ivory Pillar[™]): upright, pyramidal, narrower form, 20-25' tall, 10-15' wide

Attachment 3: Sources of Information

Additional sources of information include:

www.emeraldashborer.wi.gov/ - EAB portal for the state of Wisconsin
www.emeraldashborer.info/ - EAB web page administered by Michigan State University
www.dnr.state.wi.us/org/land/Forestry/Ash/index.htm - WI-DNR EAB web site
www.entomology.wisc.edu/emeraldashborer/ - UW-Extension, Dept of Entomology EAB website
www.datcp.state.wi.us/arm/environment/insects/emerald-ash-borer/index.isp - WI DATCP EAB website
<http://dnr.wi.gov/forestry/uf/eab/> - EAB toolkit developed by the WI DNR
<http://dnr.wi.gov/forestry/fh/pdf/WIEABResponsePlan.pdf> - State of Wisconsin EAB response plan
www.entomology.wisc.edu/emeraldashborer/ - University of Wisconsin Cooperative Extension Entomology website describing pesticide treatments for EAB
<http://dnr.wi.gov/forestry/UF/index.htm> - WI DNR tree planting guidelines
www.woodindustry.forest.wisc.edu/apps/search.asp - Wisconsin Primary Wood Using Facilities

EAB HOTLINE 1-800-462-2803

City of Baraboo Emerald Ash Borer Readiness Plan

Prepared by Bluestem Forestry Consulting Inc.

December 14, 2010

Attachment 4: Homeowner's Guide to EAB Treatment

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Emerald Ash Borer: Homeowner Guide to Insecticide Selection, Use, and Environmental Protection



Before Using an Insecticide Consider the Following

- ✓ **Identify if EAB is Near**
Start insecticide treatments only when your property is within 15 miles of an EAB infestation, or if you are within a county that is quarantined for EAB. Check [MDA's Interactive EAB Survey Map](#) for current infestations in Minnesota.
- ✓ **Remove and Replace Ash Trees on Your Property**
It may be more cost effective to replace a small or struggling ash tree than to pay the cost of ongoing treatments. In addition, trees in poor health are not likely to respond well to treatments. Do not treat trees showing more than 50 percent canopy decline; these ash trees are unlikely to recover even if treated.
- ✓ **Treatment Requires a Long-Term Commitment**
Once EAB arrives in an area, it will remain a constant threat to ash trees. It is likely that protective insecticide treatments will be needed for the rest of the tree's life at a potentially significant cost.
- ✓ **Check Your Calendar – Timing is Everything**
To ensure the insecticide is in the leaves by the time adults emerge to feed in early June, products are most effective when applied mid-April until the end of June.

RECOMMENDED TREATMENT DATES ARE SHADED

APRIL							MAY							JUNE						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
				1	2	3						1			1	2	3	4	5	
4	5	6	7	8	9	10	2	3	4	5	6	7	8	6	7	8	9	10	11	12
11	12	13	14	15	16	17	9	10	11	12	13	14	15	13	14	15	16	17	18	19
18	19	20	21	22	23	24	16	17	18	19	20	21	22	20	21	22	23	24	25	26
25	26	27	28	29	30		23	24	25	26	27	28	29	27	28	29	30			
							30	21												

- ✓ **Contact a Certified Arborist or City Forester to Evaluate Treatment Options**
When contacting a professional, consider the following:
 - Your city or township may have requirements or prohibitions related to the treatment of EAB, especially for ash trees located on city property, which may include trees planted on or near boulevards or sidewalks. Check with your city's park and recreation or forestry departments.
 - Many effective products are best administered by professionals. If hiring a professional, check to make sure that they are licensed in Minnesota as a Commercial Pesticide Applicator for category "E: Turf and Ornamentals."
- ✓ **Have a Professional Treat Large Ash Trees**
There are homeowner treatment options for small ash trees, though these require careful application to avoid unintended environmental impacts. Homeowners wishing to protect trees larger than 48 inches in circumference (as measured 4½ feet above ground level) should have their trees professionally treated.



Insecticide Treatment Options

Professionals have access to some products that are not available to homeowners.
This document does not endorse the listed insecticide products over other options.



Products Marketed to Professionals and Arborists				
Insecticide Active Ingredient	Examples of Products	Treatment Frequency	Application Methods	Environmental Profile
Emamectin benzoate	<ul style="list-style-type: none"> • TREE-age <p><i>Restricted Use Pesticide</i> <i>Any person using this product is required to be a licensed or certified pesticide applicator.</i></p>	Every 2 years	Trunk injection	<ul style="list-style-type: none"> • Persistent in tree tissue, relatively immobile in the environment.
Azadirachtin, (neem tree seed oil)	<ul style="list-style-type: none"> • TreeAzin 	Once per year	Trunk injection	<ul style="list-style-type: none"> • Classified as a biopesticide, minimal or no exposure or risk to non-target organisms, habitats or water.
Dinotefuran	<ul style="list-style-type: none"> • Safari • Transtect 	Once per year (bark spray) 1 – 2 times per year (other methods)	Bark spray, soil injection, soil-applied drench	<ul style="list-style-type: none"> • Strong potential to leach to shallow groundwater. • Potential exposure to adjacent water bodies through spray drift and runoff events.
Imidacloprid	<ul style="list-style-type: none"> • Merit products • Xytect 2F • Ima-jet 	1 - 2 times per year	Trunk injection, soil injection, soil-applied drench	<ul style="list-style-type: none"> • Highly toxic to aquatic life. • Potential to leach to shallow groundwater or be transported in runoff when using soil injection or drench.

Products Marketed to Homeowners				
Insecticide Active Ingredient	Examples of Products	Treatment Frequency	Application Methods	Environmental Profile
Dinotefuran	<ul style="list-style-type: none"> • Green Light Tree and Shrub Insect Control with Safari 	Once per year	Granular soil-applied product	<ul style="list-style-type: none"> • Strong potential to leach to shallow groundwater. • Potential exposure to adjacent water bodies through runoff events.
Imidacloprid	<ul style="list-style-type: none"> • Bayer Advanced Tree and Shrub Insect Control • Bonide Tree and Shrub Insect Control • Ferti-lome Systemic Insect Drench • Ortho Max Tree and Shrub Insect Control 	Once per year ¹	Soil-applied drench	<ul style="list-style-type: none"> • Highly toxic to aquatic life. • Potential to leach to shallow groundwater or be transported in runoff.
Imidacloprid	<ul style="list-style-type: none"> • Bonide Systemic Insect Spray 	Check with an arborist, may not be practical for trees > 20-25 ft. in height ²	Insecticide spray to tree canopy or bark	<ul style="list-style-type: none"> • Highly toxic to aquatic life. • Tree canopy (foliar) sprays can lead to drift, posing risks to surface water, children, pets and nearby flowering plants (with potentially toxic effects to bees and other pollinators).

1. Recommended only for trees less than 48 inches in circumference (as measured 4% feet above ground level)
2. Due to the chances of insecticide drift to other areas during a canopy or bark spray, they are best applied by professionals. Additionally, there is little research to support the efficacy of canopy spray products.

Follow These Recommendations to Protect Water Quality

Generally, professionally applied tree injections have significantly fewer concerns for water quality.

For soil-applied products, bark sprays or sprays applied to tree canopies, the following considerations are important:

- Do not use within 25 feet of water bodies; such as, streams, lakes, ponds, wetlands or conduits to surface water or groundwater such as street curbs, storm drains, sumps, or well heads.
- Do not apply when heavy rainfall is expected within 24 hours of the planned treatment.
- Do not allow sprays to drift. Avoid spraying trees when there is wind. These sprays pose exposure risks to surface water, children, pets and nearby flowering plants (with potentially toxic affects to bees and other pollinators).

Avoid situations that could cause insecticides to wash away or leach, potentially contaminating water resources

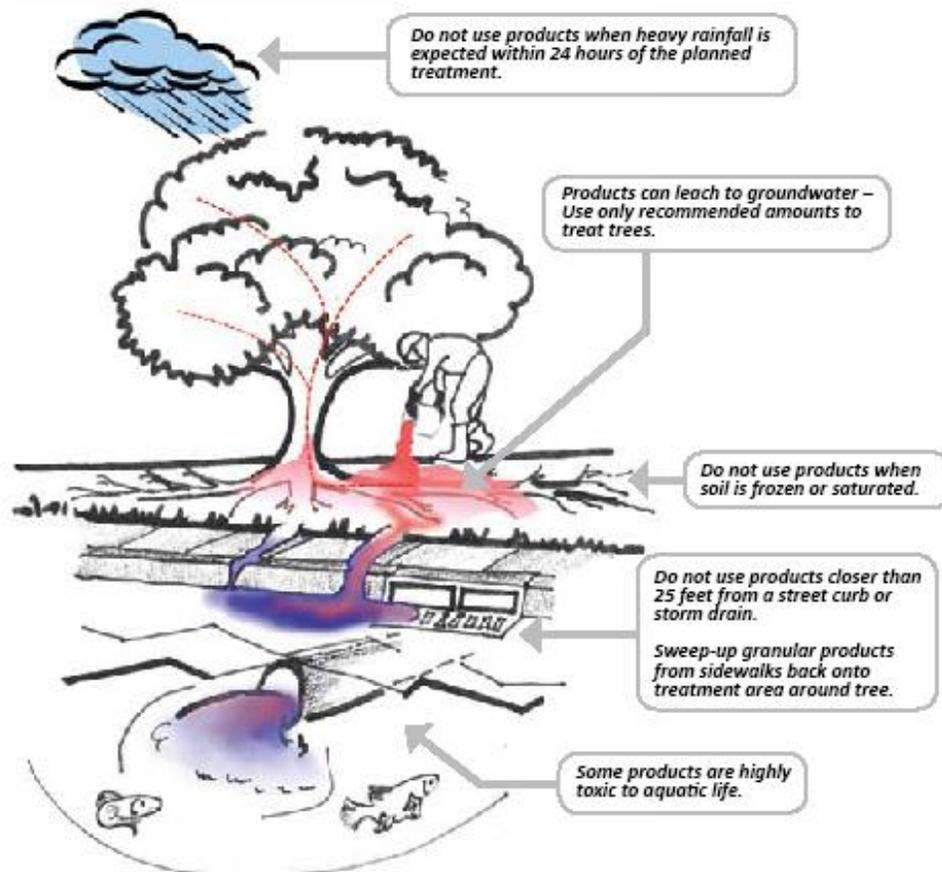


Illustration adapted from Dreistadt, S.H., J.K. Clark, M.L. Flint. 2004. Pests of Landscape Trees and Shrubs, An Integrated Pest Management Guide. Publ. 3359. Page 13.; and, Flint, M.L. 2009. Lawn and Residential Landscape Pest Control, A Guide for Maintenance Gardeners- Workbook. Publ. 3510. Page 44.

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Making Sense of EAB Insecticide Labels

Read the Label! It is your legal responsibility to read, clearly understand, and follow all current label directions for the specific insecticide product being used.

Selecting an Insecticide:

- Look for products marketed to control emerald ash borer (see table in this guide).
- Read the *Environmental Hazard Statements* on the insecticide label. Products applied as a canopy spray are likely to result in a considerable amount of insecticide drift, even when conditions are ideal.

Using an Insecticide:

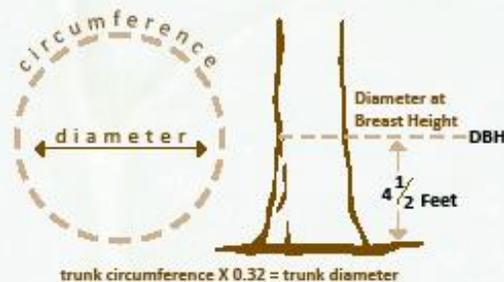
- To facilitate uptake, soil-applied insecticides should be applied when the soil is moist but not saturated or excessively dry.
- For soil drenches remove or rake any mulch or dead leaves, then pour the insecticide solution directly onto soil.
- Do not allow children and pets to re-enter treatment area until sprays or drenches have dried.
- Store insecticides where children cannot reach them.
- Many homeowner products only allow one soil drench application per year.

Disposing an Insecticide:

- When using the last of a liquid insecticide container, triple-rinse before disposal, then apply the rinse water as you would apply the insecticide.
- Unusable and unwanted insecticides must be disposed of according to the label directions, or at a county household hazardous waste disposal event.
- It is illegal to bury or burn a insecticide.

Measure your Ash Trees

Soil-applied insecticide treatments available to the general public are most effective on smaller trees, less than 48 inches in circumference.



CONVERSION TABLE	
Tree Measurements at 4 1/2 Feet Above Ground Level	
Circumference – Inches	Diameter at Breast Height (DBH) – Inches
15	5
20	6
25	8
30	9.5
35	11
40	13
45	14
> 48 inches	> 15 inches

Large trees should be treated by a professional

Additional Resources

For more information on this publication, contact the “Arrest the Pest” Hotline at 651-201-6684 or 888-545-6684.

Pesticide Disposal

For more information about disposing of unusable or unwanted pesticides, visit MDA online at www.mda.state.mn.us/chemicals/spills/wastepesticides/schedule.aspx or 651-201-6562.

Reporting and Investigating Pesticide Spills and Misuse

Complaints can be reported to the Minnesota Duty Officer at 800-422-0798. MDA staff will evaluate the information provided and if a pesticide misuse is suspected, an MDA inspector will be assigned. More information is available online at www.mda.state.mn.us/chemicals/pesticides/complaints.aspx

Emerald Ash Borer Online Resources

- Minnesota Department of Agriculture – <http://www.mda.state.mn.us/eab>
- University of Minnesota Extension – www.extension.umn.edu/issues/eab
- USDA-APHIS – www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b
- Minnesota Department of Natural Resources – www.dnr.state.mn.us/invasives/terrestrialanimals/eab
- City of St. Paul – www.stpaul.gov/index.aspx?NID=2495
- Minneapolis Park and Recreation Board – www.minneapolis.org/default.asp?PageID=1059
- EAB Multi-State Site – www.emeraldashborer.info