INVASIVE SPECIES MANAGEMENT PLAN

Residential Development

528 Boylston Street

Newton, Massachusetts

SUBMITTED TO:
City of Newton
Conservation Commission
1000 Commonwealth Avenue
Newton, Massachusetts 02459

PREPARED FOR:
Toll Brothers, Inc.
160 Gould Street
Suite 204
Needham, Massachusetts 02494

PREPARED BY:
Lucas Environmental, LLC
500A Washington Street
Quincy, Massachusetts 02169

REPORT DATE: June 17, 2024

LUCAS ENVIRONMENTAL, LLC

LUCAS
ENVIRONMENTAL, LLC

500A Washington Street, Quincy, MA 02169

June 17, 2024

City of Newton
Conservation Commission
1000 Commonwealth Avenue
Newton, Massachusetts 02459

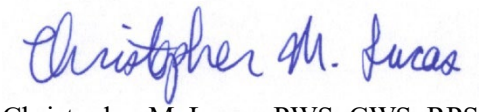
Re: Invasive Species Management Plan
Residential Development
528 Boylston Street
Newton, Massachusetts
MassDEP File #239-0977

Members of the Newton Conservation Commission,

On behalf of the Applicant, Toll Brothers, Inc., Lucas Environmental, LLC (LE) has prepared this Invasive Species Management Plan (ISMP) for the proposed residential development project located at 528 Boylston Street in Newton Massachusetts (MassDEP File #239-0977). This ISMP has been prepared by a trained environmental specialist certified in Invasive Species Management by the University of Massachusetts – Amherst. The ISMP includes treatment methods, herbicide use, seasonal timing of application, and plant species to be targeted over a three-year period.

If you have any questions, please do not hesitate to contact me at 617.405.4140 or cml@lucasenviro.com. Thank you for your consideration in this matter.

Sincerely,
LUCAS ENVIRONMENTAL, LLC



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LUCAS ENVIRONMENTAL, LLC

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SECTION I – ISMP

1.0 INTRODUCTION

Lucas Environmental, LLC, (LE) has prepared the following invasive plant species management protocol for the proposed residential development project located at 528 Boylston Street in Newton Massachusetts (MassDEP File #239-0977).

This document details measures to control invasive species and prevent their spread, and covers a wide range of potential invasive species control measures that could be implemented to effectively remove and control invasive species within the proposed limit of work. Based upon field observations that LE performed on April 25, 2024, a set of plant species has been identified which include target invasive species requiring varying degrees of management.

The most effective methods will ultimately be selected, from the options outlined herein, by the contractor performing the invasive species removal work. Invasive species removal work will be performed in accordance with all applicable state regulations and will be monitored for effectiveness. This ISMP has been prepared for the invasive vegetation management in the areas required by the Conservation Commission and includes management of all invasive plant species on the site.

A primary goal of the proposed ISMP is removal, or otherwise effective control, of invasive woody and herbaceous plant species in the target areas. To meet this goal, management activities focused on target invasive species performed over several years may be necessary. Due to the presence of invasive species outside the limit of work areas, yearly management beyond this period will likely be required to avoid re-establishment of invasive species. Successful invasive species management will be for the benefit of impacted resource areas and adjacent terrestrial habitats supporting remaining native plant assemblages and associated faunal communities.

The target species listed below include certain invasive tree, shrub, herbaceous, and woody vines species.

- Norway Maple (*Acer platanoides*)
- Garlic Mustard (*Alliaria petiolata*)
- Japanese Knotweed (*Fallopia japonica* – formerly *Polygonum cuspidatum*)

LE has reviewed available literature on each of these target species and has modeled certain elements of the management protocol after control methods recommended by The Nature Conservancy (TNC), as well as other widely accepted guidelines and agency-recommendations for invasive species management. The management protocol presents alternatives for both mechanical and chemical (herbicide) control methods, depending on the particular species, species location in the landscape, and the most effective means of managing the species based upon current knowledge.

2.0 SIGNIFICANCE OF THE INVASIVE SPECIES THREAT

Invasive plants are non-native species that have been introduced to areas outside of their native range, where they often thrive and out-compete/overtake endemic plant communities. Non-native plants are characteristically aggressive, have few natural enemies and/or limiting biological factors within their introduced range, and tend to have very effective reproductive abilities. The spread of such plants is a major concern in the United States, as they reduce the functions and values of habitat for native flora and fauna within both wetlands and uplands and are a nuisance to manage once they have become established within an area. Adverse economic and environmental impacts are also often incurred by the establishment of invasive species.

In Massachusetts, the Massachusetts Invasive Plant Advisory Group (MIPAG), a voluntary collaborative representing organizations and professionals concerned with the conservation of the Massachusetts landscape, has been charged by the Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA) to provide recommendations to the Commonwealth regarding which plants are invasive and what steps should be taken to manage these species.

Non-native invasive plants often displace native species over a relatively short period of time, often resulting in monotypic plant communities that lack species diversity. Species diversity is essential to maintaining an ecological balance. As is true with most exotic or non-native species, those found at the site are increasingly common throughout eastern North America, where their spread has led to a decline in species richness and cover of the local native plant communities.

Most exotic species are adapted to a wide variety of habitats and climactic conditions and are free of known diseases and/or insects or other predators native to the U.S. These plants reproduce either by producing large amounts of seeds that are readily dispersed by birds or small mammals (as with buckthorn or Oriental bittersweet), spread through underground stems or rhizomes (e.g., *Phragmites*), or both (as with Oriental bittersweet). As such, invasive plants quickly establish within a landscape, grow, and spread rapidly. Non-native species aggressively out-compete native plants and can dominate a plant community within a short period of time. In general, many of the introduced plants were widely cultivated in the past for their ornamental and perceived high wildlife values. Only in more recent years have conservationists and land managers come to realize the importance of preserving native plant communities.

MIPAG was instrumental in developing the Commonwealth's first list of invasive, likely invasive, and potentially invasive plants that have now been prohibited from importation, sale, or trade. As a result, future invasions by non-native species will be more likely due to the spread of naturalized populations, rather than new (accidental) introductions. MIPAG has also developed a list of early detection species for the Commonwealth. MIPAG has also published its strategic recommendations to prevent, control, and where possible, eradicate invasive plant species in the Commonwealth of Massachusetts. These recommendations complement efforts at both the regional and national levels to establish an early detection and rapid response system for invasive plants. Their recommendations are published in the "Strategic Recommendations for Managing Invasive Plants in Massachusetts." More recently, MIPAG has published both the "Massachusetts Invasive Plant Species: Early Detection Priorities," (March 16, 2011) and the "Guidance for the Effective Management of Invasive Plants, Version 2" (December 2012).

3.0 INVASIVE SPECIES MANAGEMENT OPTIONS

LE has reviewed numerous resources from state and regional agencies and private organizations with land management expertise offering plant species-specific information and recommended invasive species removal and control techniques. These groups include MIPAG, the Westfield River Watershed Invasive Species Partnership, the Pennsylvania Department of Conservation and Recreation, and other local land management experts and consultants. LE has presented much of this information in a summary format provided by Table 1 (Section II) providing information specific to the target invasive species.

The following sections of this management protocol provide species-specific information and control techniques. Because all pesticides, including herbicides, are toxic to some degree, and that even at low levels may cause serious adverse health and environmental effects, LE strongly recommends that qualified, Massachusetts-Licensed Pesticide Applicator contractors follow these or similar protocols during the project's implementation phase. Implementation should only begin once the Applicant has obtained all written approvals and all local and state review agencies have been notified as required under specific permits.

3.1 Management Techniques Overview

Selected management techniques are generally based upon the extent of a given invasive plant species within the plant community and employ a strategy that best controls the target species, while minimizing the potential for adverse impacts to other desirable (i.e., native) species. Invasive species are often difficult to completely eliminate from an area, and a practical management goal is to control, not necessarily eradicate, invasive species while simultaneously encouraging, or even introducing, a native plant community.

Methods for the management of invasive species fall into three basic categories:

- Mechanical (cutting, pulling, grubbing, covering, etc.);
- Chemical (use of herbicides); and
- Biological (using living organisms such as insects or domestic grazing animals).

In general, mechanical controls, such as cutting or pulling, have the least adverse impacts on the adjacent, native communities; however, mechanical methods are often not as effective in the control of certain plant species. When warranted and appropriate, chemical controls (through the application of herbicides) are most effective by modest applications of specific herbicides applied to the surface freshly cut stems, which is the surface of exposed plants vascular tissue. Selective application of herbicides also functions to reduce adverse impacts on desirable native species from herbicide application. For this same reason, broad foliar spraying of herbicides is generally not recommended because of the potential for negative impacts to non-target plant and animal species, although foliar spraying may be effective in controlling larger, monotypic stands of invasive plants. Biological control, or use of living organisms as a control agent, has also been proven effective on certain species. Upon effective removal or control of invasive species, native plant species are then planted or seeded in order to restore a native plant community. The initial invasive species removal should be conducted concurrently with the construction of the project.

4.0 PROPOSED SPECIFIC CONTROL METHODS

4.1 Norway Maple (*Acer platanoides*)

Norway maple is a tree native to continental Europe that now occurs in upland and wetland habitats in all regions of Massachusetts, and is especially common in woodlands with colluvial soils. It grows in full sun to full shade and can form dense stands where it is able to shade out native understory vegetation such as spring ephemerals, and eventually out-competes native tree species, such as sugar maple, in the forest canopy. Thus, it can reduce native species diversity and change the structure of forest habitats. The seeds are dispersed by water, wind, and vehicles.

Because removal from a site may entail removing a large proportion of existing plant biomass, drastic changes in site conditions and species composition may result. While such efforts will hopefully benefit native species, there is also substantial risk of facilitating invasion by other nonnative plant species.

While removal of overstory Norway maple trees is necessary to end immediate recruitment of seedlings, pre-existing seedlings and saplings are likely to be abundant and should be removed to enhance growth and survival of native species and to eliminate potential future Norway maple seed sources. In urban or suburban areas where trees provide valuable shade, a phase-out approach (removing trees gradually over time) with re-planting of native tree species may be advisable.

4.1.1 Management Protocol Options

Manual and Mechanical Control

- Seedlings can be pulled up and saplings can be pulled with a weed lever or cut, but re-sprouting will occur so follow-up will be necessary.
- Larger trees can be cut, but will also re-sprout unless the cut stump is immediately treated with concentrated herbicide (glyphosate or Triclopyr). However, this is not effective in early spring due to sap rising.
- Repeated follow-up cutting can control re-sprouting from cut stumps, but persistence is required, sometimes for many years.

Chemical Control

Foliar spray can also be effective for seedlings, short saplings, or re-sprouts (glyphosate or Triclopyr), as long as you can reach the top of the plant. For stems up to about four to six inches in diameter, the basal bark treatment can be effective any time of year (spray lower 18 to 24 inches of the trunk with Triclopyr with penetrating oil).

4.1.2 Recommended Control Methods

Removal of all the mature trees from wooded areas is not recommended at this time. However, the seedlings and small saplings ≤ three (3) inches in diameter at breast height (dbh) should be removed through manual and mechanical control methods. Chemical control is not warranted for this site.

4.2 Garlic Mustard (*Alliaria petiolata*)

Garlic mustard is an invasive herbaceous plant in the Family Brassicaceae that can invade roadsides, forests, riparian shorelines and terraces, and gardens. The species produces seed at a rate of hundreds per plant. Seed viability is four to seven years.

4.2.1 Recommended Protocol Options

Mechanical control methods including cutting and pulling should be performed when plants have reached full bloom. If seeds have begun to form on plants, seed-containing plants should be removed from site. Basal florets should be applied with an herbicide (acetic acid containing, such as Burnout 2) in early spring or late fall if necessary.

4.3 Japanese Knotweed (*Fallopia japonica*)

Japanese knotweed is an upright, herbaceous, shrub-like perennial in the Family Polygonaceae native to eastern Asia. Its stout stems are hollow, smooth, and swollen at the joints. The alternate leaves are broad and oval, triangular, or heart-shaped with a pointed tip and may become six inches long and three to four inches wide. It has greenish white flowers and can spread by seed as well as growth by rhizome, runners, and stems (vegetative growth). Damaged stem segments are able to re-grow if the buds at the nodes are viable. This exotic invasive plant can be found in fields, roadsides, waste areas, forest edges, and river shores and banks. Once a population of knotweed becomes established, it spreads primarily by growth along its large rhizomes, which can grow to a length of 30 feet.

Japanese knotweed flowers in August and September, with seeds emerging two weeks following flowering. Japanese knotweed requires high amounts of sunlight and normally does not establish within forest understories.

4.3.1 Management Protocol Options

Different control methods are recommended for the control of Japanese knotweed, depending upon the location of the plant population, and are described below. It is generally acknowledged by land managers, however, that the use of herbicides is necessary to effectively control this particular species.

Manual and Mechanical Control

Manual and mechanical management techniques are most appropriate for smaller stands of knotweed and young plants. These techniques are also more feasible in environmentally sensitive areas where limitations on herbicide application exist.

- Pulling is considered effective for removing and controlling juvenile Japanese knotweed.
- Digging may be used to control growth of very small populations of young plants. This technique is incredibly labor intensive and generally ineffective when applied to large stands and mature plants. If this technique is utilized, the entire plant, including the roots and runners, must be removed. This is generally done with a mechanical excavator.

- Cutting is another viable mechanical control technique for this species. Shoots are cut as close to the ground as possible, reducing the viability of the rhizomes. Cutting may be done at any point during the growing season before senescence. Cutting is most successful when conducted three times or more per growing season. All cut plant parts must be bagged and sealed and disposed of properly in a landfill to prevent spread. Any stem fragments left behind have potential to re-sprout.
- Repeated cutting can also be used in conjunction with covering this plant with a heavy-gauge black plastic for two to three growing seasons to essentially smother the plant.

Chemical Control Alternatives

Control by herbicide application is the most effective method for management of this species at this site.

- A "weed glove" is recommended as an option for applying the herbicide solution in dense areas with desirable neighboring vegetation to avoid herbicide application on non-target plants.
- Cut-stem herbicide application should be utilized when the knotweed is in close proximity to non-target desirable vegetation. The method is effective even in colder temperatures, as long as the ground has not frozen. Prior to applying herbicide, stems should be cut down to about two inches above the ground, between the lowest nodes along the stem. Five milliliters (5 ml) of undiluted herbicide may then be poured into the hollow stem. Foliar applications may be required as follow-up treatment for continued management. This method may not be ideal for large stands with high stem density.
- Stem injection applications are another successful management technique, albeit laborious. Herbicide is injected into the stem in the lower portion of the knotweed in the first few internodes above the ground level. An injector tool that delivers about five milliliters of solution is required for this method. The needle is inserted perpendicular to the stem, midway between the nodes (internodes), whereupon the predetermined amount of herbicide will be delivered to the plant. Knotweed generally takes up the chemical within 20 minutes of treatment. This technique causes minimal harm to nearby plants and is generally not affected by weather conditions, as the herbicide is inside of the plant. This method also eliminates the need for cutting prior to herbicide application and may be conducted at any point during the growing season. Early June is the best time for this method. Stem injection does take multiple seasons to achieve success, and becomes difficult once the knotweed stems become too small for needle insertion.
- Foliar spraying is an effective control strategy for large populations of Japanese knotweed. Glyphosate (two percent solution) and Triclopyr (three to four percent solution) are most commonly used in foliar spraying. Foliage should be sprayed generously until wet without dripping. A low-pressure sprayer and coarse spray pattern should be used when foliar spraying. Foliar spraying should be performed when knotweed shoots are three to six feet tall during non-windy conditions when the two-to three-day extended weather forecast does not call for precipitation. If larger plants exist, they must be cut to a height of approximately five feet prior to applying foliar herbicides.

4.3.2 Recommended Control Methods

The recommended method for control of Japanese knotweed includes a combination of manual and mechanical means via pulling, digging and cutting, along with chemical controls consisting of either the cut stem herbicide application or foliar spray. Of note, a monotypic stand of this species may require several years of repeated chemical treatment before the Japanese knotweed population is effectively controlled. Quickly establishing native plant vegetation in place of eradicated knotweed will help prevent the reestablishment of the invasive.

4.4 Notes on Herbicide Use

Various groups, including the Nature Conservancy, MIPAG, and the National Park Service (NPS) strongly recommend non-chemical methods of control wherever feasible. However, for large infestations, non-chemical methods are inadequate. Any herbicide use permitted at the site would be applied only by a Massachusetts-Licensed Pesticide Applicator and in accordance with all State regulations pertaining to herbicide application.

The two main herbicide treatments considered in developing this management protocol include glyphosate and Triclopyr. Glyphosate (e.g., Round-up® or Rodeo®) is a non-selective, systemic herbicide that kills both grasses and broad-leaved plants. Triclopyr (e.g., Brush-B-Gone™, Garlon™, Pathfinder™) is a selective herbicide that kills broad-leaved plants but does little or no harm to grass species. Applied carefully to avoid non-target plants, glyphosate is the least environmentally damaging herbicide in most instances. Round-up® contains a petroleum-based sticker-spreader that allows the herbicide to cling to the target species to ensure its absorption into the plant's tissues. Rodeo®, the glyphosate formulation for use in wetlands, does not contain any sticker-spreader, and thus is considered to be safer for the wetland environment.

Where appropriate and considered necessary for the successful management of the invasive species at this site, specifications for the type of herbicides will be provided. As with the timing for mechanical methods for management of invasive species, non-specific use of herbicides or use of a specific herbicide at incorrect times or in incorrect concentrations can actually lead to spreading of invasive species.

Other considerations for herbicide use include avoiding inclement weather conditions such as wind, which could result in herbicide application to non-target, possibly native species, or rainy conditions, which could dilute or wash away applied herbicides, rendering them ineffective.

5.0 DISPOSAL

The construction of project in conjunction with this invasive species management protocol will generate a substantial amount of plant debris and soil that often contain viable root fragments and seed banks. Invasive plant debris may contribute to the introduction or spread of the species at the project site or even at the disposal location if not properly disposed. Invasive plants managed using chemical control methods should be left in place to biodegrade, rather than disposing of the materials off-site. Disposal of invasive plants with flowers or seeds should be minimized to prevent the further spread of target species.

Furthermore, plant material should not be composted to prevent regrowth or spread of seeds into the compost sediment. Invasive plant material is to be bagged and allowed to rot within the bags. The bags should be stored in a location with sun for a minimum of three weeks then disposed of in a landfill or incinerated. It is possible to air dry or incinerate herbaceous (non-grass) plants (i.e., garlic mustard); however, bagging plants and storing before removal off-site may be more successful.

6.0 REVEGETATION/RESTORATION

Following implementation of the initial invasive species management protocol for the target species, native vegetation will be allowed to re-colonize the areas via natural succession as part of an active restoration plan. The area within the limit of work will be supplemented with additional plantings/seeding of appropriate native species to allow rapid re-colonization and prevent re-establishment of non-native species. The planting and seeding specification for the project are identified on the Site Plans, prepared by Bohler Engineering.

7.0 SITE MONITORING

LE will perform on-site observations during the implementation phase of the work and following completion of the initial land management work for a period of three years. LE will monitor the mechanical and chemical control efforts to manage existing populations of invasive species as identified. The primary purpose of these observations is to document and assess the effectiveness of the invasive species removal. The assessment will help determine what additional measures will be required by the land management contractor(s) to attain effective control of the target invasive species. LE would recommend a set of additional measures to both the property owner and the land management contractor following the observations.

The intent of the assessment will also be to observe and document the response of the remaining native plant assemblage to the invasive species removal efforts. If a new invasive species is observed during monitoring that has not been previously documented at the site, a monitoring and control plan will be developed for that species. Action will likely be taken immediately if new invasive plants are encountered to prevent their spread, and the appropriate agencies notified. Delays may make the problem more difficult to address.

Post-implementation observations will occur at a minimum during the early and late portions of each growing season for a three-year (minimum) monitoring period. Observations will likely be performed beyond the three-year monitoring period if necessary. LE would provide the Newton Conservation Commission with written reporting on an annual basis, or more frequently if required.

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SECTION II – TABLE 1

LUCAS ENVIRONMENTAL, LLC

TABLE 1 – TARGET INVASIVE SPECIES

SPECIES	MIPAG STATUS	DESCRIPTION	HABITAT and ECOLOGICAL THREATS	MANAGEMENT ACTIONS/OPTIONS
Norway Maple (*Acer platanoides*)	Non-native Invasive (UPL)	A tree in the Maple Family (Aceraceae) that usually grows to 40 to 60 feet in height, but can reach heights of 100 feet. The bark of the tree is grayish and regularly and shallowly grooved. The palmately lobed leaves are opposite and have five to seven sharply acuminate lobes (with large but few teeth). These leaves are four to seven inches wide. The leaf petioles exude a white sap when broken. The leaves are usually green in color, but there are some cultivars that have dark red leaves. The fall color of the green leaves is yellow. The flowers appear in April and May and are yellow-green in color. They are borne in erect, pedunculate, rounded corymbs. Each flower is 0.25 inches wide. The pendulous fruit measure 1.5 to two inches in length. The fruit are samaras that are green when young and turn yellow, then brown, with age. The samara wings are divergent, reaching nearly 180 degree angle to each other and are dispersed by wind.	Occurs in all regions of the state in upland and wetland habitats, and especially common in woodlands with colluvial soils. It grows in full sun to full shade. Escapes from cultivation; can form dense stands; out-competes native vegetation, including sugar maple; dispersed by water, wind and vehicles. Is able to shade out native understory vegetation such as spring ephemerals, and eventually out-competes native tree species in the forest canopy. Thus, it can reduce native species diversity and change the structure of forest habitats.	Management alternatives for this species include both mechanical means and chemical application. Seedlings can be pulled from moist soil before they get too large. Other types of manual removal include digging out saplings and root systems or cutting down large trees. Girdling the trees by removing the bark layer (including the cambium) can also be performed, but is most effective in the spring. Stumps can be ground out or new growth that develops from old stumps can be cut in future years. Chemical herbicides, such as glyphosate or Triclopyr may be useful for control. Removal of all the mature trees from wooded areas is not recommended at this time. However, the seedlings and small saplings ≤ three (3) inches in diameter at breast height (dbh) should be removed through manual and mechanical control methods. Chemical control is not warranted for this site.
Garlic Mustard (*Alliaria petiolata)*	Non-native Invasive (FACU)	An herbaceous plant in the Mustard Family (Brassicaceae). A biennial with garlic odor, in its first year, it appears as a basal rosette of triangular to kidney-shaped toothed leaves with heart-shaped or rounded bases. These leaves remain green throughout winter. Mature plants have kidney-shaped lower leaves and triangular alternate upper leaves that are three to six cm wide and coarsely toothed. Button-like clusters of small, white flowers appear in the early spring of its second year, each with four, five to six millimeter long cross-shaped petals. By May or June, linear, four-angled fruits appear, each containing 10 to 20 shiny black seeds.	It can grow in full sun or shade and commonly occurs in disturbed areas along the moist, shaded soils of floodplains, along roadsides, in forest openings, along woodland trail edges, and in gardens. Each plant is capable of producing thousands of seeds, which may be dispersed by flooding or wind and remain viable in soil for as long as 4 to 7 years. Its ability to tolerate shade can allow this plant to dominate the forest understory outcompeting valued native plant assemblages. A threat to certain butterfly species by out-competing the native mustard host plants they rely on for egg laying and larval feeding.	Mechanical control: methods including cutting and pulling should be performed when plants have reached their full bloom. If seeds have begun to form on plants, seed-containing plants should be removed from site. Chemical control: Basal florets can be treated with a low concentration of herbicide (glyphosate) in early spring or fall when most native vegetation is dormant, or an organic herbicide (acetic acid, such as Burnout 2) can be applied in early spring or late fall (temperatures should be 65 degrees or above). Mechanical control methods including cutting and pulling should be performed when plants have reached full bloom. If seeds have begun to form on plants, seed-containing plants should be removed from site. Basal florets should be applied with an herbicide (acetic acid containing, such as Burnout 2) in early spring or late fall if necessary.

TABLE 1 – TARGET INVASIVE SPECIES

SPECIES	MIPAG STATUS	DESCRIPTION	HABITAT and ECOLOGICAL THREATS	MANAGEMENT ACTIONS/OPTIONS
Japanese Knotweed (*Fallopia japonica)* **(also *Polygonum cuspitatum, Reynoutria japonica*)**	Non-native Invasive (FACU)	An upright, herbaceous, shrub-like perennial in the Smartweed Family (Polygonaceae) native to eastern Asia. Stems erect, stout, with hollow internodes. Joints swollen. The alternate leaves are broad and oval, triangular, or heart-shaped with a pointed tip and may become six inches long and three to four inches wide. It has greenish white flowers and can spread by seed as well as growth by rhizome, runners, and stems (vegetative growth). Damaged stem segments are able to re-grow if the buds at the nodes are viable. Flowers in August and September, with seeds emerging two weeks following flowering.	May be found in fields, roadsides, waste areas, forest edges, and river shores and banks. Dense thickets threaten native plant communities in wetlands and riparian areas. Has ability to survive severe flooding and readily colonizes island habitats and shorelines. Once a population of knotweed becomes established, it spreads primarily by growth along its large rhizomes, which can grow to a length of 20 meters, but also spreads by seed. Requires high amounts of sunlight and normally does not establish within forest understories. Highly persistent and difficult to eradicate.	Manual and mechanical management techniques are most appropriate for smaller stands of knotweed and young plants. These techniques are also more feasible in environmentally sensitive areas where limitations on herbicide application exist. Pulling and digging (by hand or by machine) with extreme care to remove entire plant, roots, rhizomes, runners included. Repeated cutting and covering over multiple growing seasons also effective. Chemical control methods most effective. Laborious cut-stem and stem-injection applications can be effective. Foliar spray options best for large populations. Glyphosate and Triclopyr solutions commonly used in foliar spray applications. Glyphosate applied in spring or early summer may stunt or yellow growth, but knotweed will generally recover and continue growing. Glyphosate treatments in late summer or early fall are much more effective in preventing regrowth of knotweed the following year. Triclopyr will kill the top growth within a few days, but knotweed may re-sprout after treatment. The recommended method for control of Japanese knotweed includes a combination of manual and mechanical means via pulling, digging and cutting, along with chemical controls consisting of either the cut stem herbicide application or foliar spray. Of note, a monotypic stand of this species may require several years of repeated chemical treatment before the Japanese knotweed population is effectively controlled. Quickly establishing native plant vegetation in place of eradicated knotweed will help prevent the reestablishment of the invasive.