**REPORT FOR OBJ1.TASK 6: PROTECTION OF EXISTING TREES ON CONSTRUCTION SITES**

To: MPCA

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Re: Contract CR5332

**SCOPE**

**Obj1.Task 6: Protection of Existing trees on Construction Sites:**

Prepare and submit a report that includes guidelines for construction activities adjacent to existing trees. The goal of this task is to provide information to stormwater specialists and other managers necessary to preserve stormwater benefits from existing trees. The guidelines will include the following information:

* 1. A summary of construction activities that may adversely impact trees and the adverse consequences caused by these activities (e.g. street reconstruction projects);
  2. Best practices for minimizing impacts from construction activities, such as installation of fences around trees;
  3. Post construction monitoring of soil compaction; and
  4. Mitigation practices following construction, such as soil ripping and use of amendments such as compost.

**LIST of FIGURES**

Figure 6.1: Pruning branches at the branch collar

Figure 6.2: Suckering or water sprouts are a symptom of construction damage

Figure 6.3: Annual growth is the distance between bud scale scars on twigs

**REPORT**

Many jurisdictions have their own tree preservation standards and/or guidelines. Toronto, for example, has detailed tree protection specifications for construction near trees, available September 2013 at: http://www.toronto.ca/trees/pdfs/TreeProtSpecs.pdf

1. A summary of construction activities that may adversely impact trees and the adverse consequences caused by these activities (e.g. street reconstruction projects);

Wounds such as open branches and torn or nicked bark can damage a tree by depleting a tree’s energy and providing entry points for disease and insects (Johnson 1999).

**Underground Damage to a Tree**

Compaction within the tree’s root zone also adversely impacts trees. Compaction can result from machinery/vehicular traffic, foot traffic, and from stockpiling materials over a tree’s root zone.

Grading within the tree’s root zone, whether cutting or filling, also negatively impacts trees.

The part of the root system in which construction activities, including material storage and traffic, should be avoided is called the Protected Root Zone (PRZ).

Only about half of the root system is under the tree canopy (University of Florida 2013). Many tree roots extend beyond the dripline a distance equal to two or more times the height of the tree (Johnson 1999). The PRZ should therefore extend beyond the tree canopy (see MnDOT specfications in Appendix A for recommended PRZ).

How much of a tree’s root zone can be disturbed before a tree’s health is compromised? Johnson (1999) writes:”Just how close an activity can come without seriously threatening the survival of a tree depends on the species, the extent of damage, and the plant’s health. Some healthy trees can survive after losing 50 percent of their roots. However, other species are extremely sensitive to root cutting, even outside the dripline. Table 1 shows the relative sensitivity of various tree species to root disturbance. If possible, disturb no more than 25 percent of the roots within the dripline for any tree, protect intermediate species to the dripline, and allow extra space beyond the dripline for sensitive species. For all trees, avoid needless or excessive damage. A qualified tree-care specialist can help you determine how much root interference a particular tree can tolerate.”

Older trees are more susceptible to damage from construction activities than younger trees (Cappiella et al 2006, Johnson 1999).

Negative impacts from construction activities within a tree’s root zone are often not visible in the tree until 3 to 7 years after the construction has ended (Johnson 1999).

Removing trees from a site can also expose the remaining trees to increased sun and wind exposure, which can shock the remaining trees (Johnson 1999). Saving groups of trees instead of individual trees can minimize sun and wind stress (Johnson 1999).

While it can generally be assumed that tree roots are found beyond the dripline a distance equal to two or more times the height of the tree, where the exact location of roots needs to be known for some reason, ground penetrating radar technology can be used to locate exactly where roots are located without digging, for example, when tree roots are under pavement (Bassuk et al 2011). Where tree roots are not under pavement, an airspade can be used to examine roots without damaging the tree.

**Damage to Tree from Soil Chemical Changes**

According to Johnson (1999) “Improper handling or disposal of materials used during construction also can harm roots. For example, wood products treated with pentachlorophenol and creosote can be deadly to tree roots; CCA-treated timber (greenish color) is a better alternative.”Changes in soil pH, for example, from concrete, alkaline clays, or limestone can also damage trees (Johnson 1999).

See the references and additional resources listed below for much more information on adverse effects of construction on trees.

1. **Best practices for minimizing impacts from construction activities, such as installation of fences around trees;**

As described by (Cappiella et al 2006), minimizing impacts from construction activities is a five step process:

1. Inventory existing trees on project site
2. Identify trees to protect
3. Design project with tree conservation in mind
4. Protect trees and soils during construction
5. Protect trees after construction
6. **Inventory existing trees on project site**

Record the location, species, size, and health of each tree. The size and health of the tree will affect whether or not the tree should be preserved or cut. According to Johnson (1999), “Wilted leaves, broken or dead limbs, trunk rot, and thin tops are all symptoms of stress. Trees that are overmature, display poor form, lean heavily over future buildings, or have severe insect or disease problems should be marked for removal prior to construction.”

The extent of the inventory will depend on the needs of the specific project. Some jurisdictions have tree preservation ordinances that require an inventory and dictate the size and types of trees that must be inventoried. The following additional features are recommended in the tree inventory (Cappiella et al 2006)

* Property boundary
* Roads
* Utilities
* Easements and covenants
* Topography
* Streams and stream buffers
* Critical habitats
* Adjacent land uses
* Cultural and historical sites
* 100 year floodplain
* wetlands
* Soil types
* Steep slopes

1. **Identify trees to protect**

Healthy, vigorous trees with good structure are the most likely to survive through construction activities and should be the top priority for preservation (University of Florida 2013). Johnson (1999) provides the following additional tips for selecting which trees to protect from construction activities:

* “Save the best and chip the rest. Use those wood chips to provide a blanket of protection over the root systems of trees that can be saved.
* Understand the characteristics of your trees or get the advice of someone who does. If you know about your trees you can help insure their survival and improve the future site appearance of the site.
* Select tree species that fit the spatial constraints of the site (Table 1), remembering that trees grow throughout their lives. Be sure to consider overhead powerlines.
* Young, small trees tend to survive disturbance better than old, large trees.
* Large trees almost never survive within five feet of a new building and should not be kept.
* Healthy young trees that fall in the construction zone may be saved by transplanting.
* Don't put all your eggs in one basket! Save a mixture of tree species to safeguard your landscape against contagious diseases or insects.
* Improve tree survival by saving groups of trees rather than individuals.”

1. **Design project with tree conservation in mind**

Cappiella et al (2006), provides the following examples of better site design techniques to conserve forests:

* “Minimize impervious cover
* Design structural elements such as roads and utilities to minimize soil disturbance and take
* advantage of natural drainage patterns.
* Where possible, place several utilities in one trench in order to minimize soil disturbance.
* Reduce building footprints by building up, not out.
* Use the minimum required street and right-of-way widths.
* Use alternative turnarounds instead of cul-de-sacs.
* Use efficient street layouts.
* Consider shared driveways for residential lots.
* Use the minimum required number of parking spaces instead of creating additional spaces.”

1. **Protect trees and soils during construction**

Project plans shall clearly mark which trees are to be protected. Numbering and field tags can effectively help avoid cutting down the wrong trees.

Value of trees to be preserved should be appraised using “Guide for Plant Appraisal”, and the value should be noted on large scale labels on each tree to be preserved. Labels shall be attached in a manner that does not damage tree.

Prepare the trees for construction disturbance by making sure they are as healthy as possible before construction begins. Regularly water them before and during construction if rainfall is not adequate (i.e. whenever soil is dry 6 inches below the soil surface), and prune branches dead, diseased, and hazardous branches.

Install a layer of wood chips at least 12 inches deep over areas that will be used for traffic or material storage in areas that will be used for future planting, and over tree roots outside of the PRZ. Where dump trucks will be moving across such areas, increase wood chip depth to 18”.

Trees shall be protected in accordance with the most recent version of MnDOT specification 2572, Protection and Restoration of Vegetation, available at September 2013 at:

<http://www.dot.state.mn.us/pre-letting/spec/2014/2014-Std-Spec-for-Construction.pdf>

Protection measures per MnDOT specification 2572 shall remain in place throughout the duration of construction, and penalties for violation should be strictly enforced. Visit the site regularly to ensure tree protection requirements are not violated.

When possible, remove trees that are not to be preserved in winter after the leaves have fallen. When they are dormant, trees to be preserved will be less susceptible to damage from the removal of adjacent trees, and frozen ground helps protect roots.

Ensure that tree roots and soils are not exposed to adverse chemical changes during construction. Johnson (1999) recommends the following, for example, “ Ask the builder about the materials to be used on the site and read product labels. Chemical spill damage can be prevented by filling gas tanks, cleaning paintbrushes and tools, and repairing mechanical equipment well outside tree PRZs. Insist that all building debris and chemical wastes be hauled away for proper disposal, and not burned or buried on the site. Finally, avoid changes in soil pH (acidity). Increases in pH are particularly dangerous to many species [*note from Kestrel team: see Task 3 species list for pH tolerances of various tree species*]. Alkaline clays or limestones should not be used for fill or paving, and concrete should be mixed on a thick plastic tarp or outside the site. Mixing trucks should never be rinsed out on the site.”

If any construction damage occurs to trees, address problems as soon as possible, photograph the damage, and inform contractor immediately (Johnson 1999). Levy liquidated damages if applicable.

Irrigate trees during construction whenever soil is dry 6 inches below the soil surface.

Also irrigate thoroughly before and after trees receive any kind of direct damage (e.g. severed roots) (Johnson 1999).

If roots are cut, “cut cleanly to promote quick wound closure and regeneration. Vibratory plows, chain trenchers, and hand tools do a better job at this than bulldozers and backhoes. Minimize damage by avoiding excavation during hot, dry weather; keeping the plants well watered before and after digging; and covering exposed roots with soil, mulch, or damp burlap as soon as possible” (Johnson 1999).

If utilities must be installed under existing tree root zone, use installation techniques that will minimize root damage. According to Johnson (1999), “As much as 40 percent of a tree's root system could be cut during the installation of a nearby utility line. This reduces water and nutrient uptake, and may compromise the stability of the tree. If it is not possible to relocate the utility line outside the tree's PRZ, you can reduce root damage by as much as 25 percent by tunneling under the tree's root system. When digging a trench near a tree, begin tunneling when you encounter roots larger than one inch in diameter.” Another technique that can minimize root damage when installing utilities is to use an airspade to excavate the utility trench under tree root zone (University of Florida 2013). An airspade pushes air at a very high speed, removing soil without damaging roots.

Johnson (1999) recommends the following for pruning and wound repair:

“Prune broken or dead branches cleanly at the branch collar (Figure 6.1). To test whether a branch is dead, bend several twigs. Twigs on live branches tend to be pliable, while twigs on dead branches tend to break. Buds also can be used to evaluate branch condition. Live buds appear full and normal in color while dead ones appear shriveled or dry.

Pruning is commonly recommended for large trees that have suffered root damage. However, opinions differ over the merits of this practice. Assuming that the tree has adequate water and is not in severe decline, some experts believe that retaining maximum leaf cover is important for root regeneration and only dead limbs should be removed. Others argue that pruning selected live limbs is necessary to compensate for lost roots. Generally, it is best to follow the recommendation of your tree-care specialist experienced in construction damage to trees.

When properly done in moderation by a skilled professional, pruning may reduce wind resistance and limb failure and improve tree health and appearance. DO NOT let anyone cut off all of the top branches to the same height (" topping").

The treatment of trunk wounds depends on the extent of damage. If 50 percent or more of the bark has been removed around the entire trunk, the tree will not likely survive and should be removed. If only a patch of bark has been removed leaving a few splinters, use a sharp knife to cleanly cut off the loose bark to a place on the stem where it is firmly attached. DO NOT make the wound any larger than necessary.

You do not need to use pruning paint or dressing to cover exposed wounds or pruned limbs. Except for special cases involving disease control, these products do little more than improve appearance.”

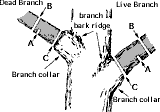


Figure 6.1: pruning branches at the branch collar (Johnson 1999)

Any activity that causes open wounds on the roots or trunks of oaks between April 1 and July 1 in Minnesota renders the oaks very vulnerable to oak wilt, a lethal fungus disease. Johnson (1999) suggests the following for construction around oaks that are to be preserved: “Immediately (within minutes) cover all open wounds with any water-based paint or shellac during this period. If you suspect oak wilt, contact your city forester or private tree-care specialist. If you have oaks on your site, obtain a copy of Oak Wilt in Minnesota (Minnesota Extension Service publication [MI-3174](http://www.extension.umn.edu/catalog/item.html?item=3174)) for additional information on identifying the disease and protecting your trees.”

1. **Protect trees after construction**

After construction activities are completely finished, evaluate condition of trees to be preserved and note indications of stress or damage.

Johnson (1999) recommends looking for the following symptoms of construction damage: “Wilted or scorched leaves and drooping branches usually are the first signs of construction damage. In deciduous plants these symptoms may be followed by early fall coloring and premature leaf drop. Damaged conifers will drop excessive amounts of inner needles. In subsequent years you may notice yellowed or dwarfed leaves, sparse leaf cover, or dead branches.

Other indicators might include flowering out of season, excessive water sprout formation on the trunk (Figure 6.2), abnormal winter dieback, or abnormally large amounts of seed. Flower and seed production and water sprout formation are defense mechanisms for ensuring species survival and commonly indicate that the plant is experiencing extreme stress.

In addition to observing a tree's appearance, monitor its annual growth. A slightly damaged plant will grow more slowly and be less resistant to insects, diseases, and weather-related stress. Examine the annual shoot and branch growth (Figure 6.3). Healthy trees generally will grow at least two to six inches at the ends of the branches each year. Photographs and records of the tree prior to construction also can help identify growth problems.”



Figure 6.2: suckering or water sprouts are a symptom of construction damage (Johnson 1999)



Figure 6.3: Annual growth is the distance between bud scale scars on twigs (Johnson 1999)

Signs of soil compaction negatively impacting a tree include leaf wilt, early fall coloring, top dieback, and slow growth (Johnson 1999).

Construction and grading can also change how much water a tree receives and may cause some trees to receive too much water. Observe drainage patterns and soil moisture after construction and contact an arborist if you suspect trees may be getting too much water. Dead twigs and branches can be a sign that the tree is receiving too much water (Johnson 1999), however, do not wait for dead twigs and branches to appear to remedy the problem if you suspect a tree may be getting too much water.

According to Johnson (1999), “Trees will not recover from construction damage in one or two years.” Trees should be watered as needed after construction is complete to minimize water stress. As much of the PRZ as possible should be mulched to further maximize tree health. Planting the area under the tree with understory shrubs or perennials herbaceous plants instead of turf will also benefit the tree (Johnson 1999).

Signs of damage may not be visible until 3-7 years after construction is finished. Therefore trees should be inspected every year or two to determine if pruning, fertilization and /or pest or disease control is needed (Johnson 1999).

1. **Post construction monitoring of soil compaction; and**

Tree BMP’s for stormwater should be designed in a way that prevents foot or vehicular traffic, to prevent compaction. For example, low fences can be installed around tree openings to prevent compaction from foot or vehicular traffic. If for any reason it is suspected that the soil may have been compacted after construction, measure soil compaction and note whether or not compaction exceeds root limiting compaction level (see task 6 of Objective 2 for table of root limiting compaction for various soil textures). Signs that the soil may have become compacted include for example:

* Observation of people or vehicles on tree BMP soil
* Signs of traffic on tree BMP soil (e.g. vehicular tracks)
* Potential symptoms of compaction visible in soil (e.g. hard crust, standing water, inability to penetrate soil with a rod or shovel)
* Potential symptoms of compaction in tree.

If soil is compacted beyond root limiting density, de-compact soil by loosening with an airspade. Then mix 4” of compost mixed into the soil with the airspade.

1. **Mitigation practices following construction, such as soil ripping and use of amendments such as compost.**

For urban trees, a bioretention soil in accordance with the bioretention soil guidelines will be used, so it contains organic matter and will not be compacted. To promote drainage into in situ soils, it is strongly recommended that the bottom of the urban tree BMP be scarified with the teeth of a backhoe as recommended in Task 9 of Objective 2, Bioretention (except for tree BMP’s with bioretention volume under pavement that need a compacted base for structural stability).

**APPENDIX A**

**MnDOT Specification 2572 PROTECTION AND RESTORATION OF VEGETATION as of September 2013**

**2572.1 DESCRIPTION**

This work consists of protecting and preserving vegetation from damage and restoring vegetation damaged by the Contractor’s operations.

**2572.2 MATERIALS**

**A Plant Materials .......................................................................................................... 2571 and 2575**

**B Temporary Fence**

Provide temporary fence meeting the following characteristics and requirements:

(1) At least 4 ft [1.2 m] high,

(2) Conspicuous in color (see Standard Detail Sheet for Protection and Restoration of Vegetation), and

(3) Commercially available snow fence or other fencing material approved by the Engineer.

**C Water ................................................................................................................................ 2571.2.C.4**

**D Sandy Loam Topsoil ................................................................................................................. 3877** 2500’s 344

**E Tree Growth Retardant (TGR)**

Provide the TGR paclobutrazol or an equal approved by the Engineer.

**2572.3 CONSTRUCTION REQUIREMENTS**

**A Protecting and Preserving**

Protect and preserve the following:

(1) Specimen trees,

(2) Threatened and endangered plants listed on the Federal and state threatened and endangered species list,

(3) Vegetation as required by the contract,

(4) Trees, brush, and natural scenic elements within the right-of-way and outside the limits of clearing and grubbing in accordance with 2101.3, “Clearing and Grubbing, Construction Requirements,” and

(5) Other vegetation as directed by the Engineer.

Do not place temporary structures, store material, or conduct unnecessary construction activities within 25¼ ft [8 m] outside of the dripline of trees designated for preservation, unless otherwise approved by the Engineer.

Do not place temporary structures or store material, including common borrow and topsoil, outside of the construction limits in areas designated for preservation, as required by the contract or as approved by the Engineer.

Do not place or leave waste material on the project, including bituminous and concrete waste that would interfere with performing the requirements of 2105.3.C, “Preparation of Embankment Foundation,” or 2575, “Establishing Turf and Controlling Erosion.” The Department defines concrete waste as excess material not used on the project, including material created from grinding rumble strips. Dispose of excess material in accordance with 2104.3.D, “Disposal of Material and Debris.”

**A.1 Temporary Fence**

Place temporary fences to protect vegetation before starting construction. Place temporary fence at the construction limits and at other locations adjacent to vegetation designated for preservation as required by the contract or as approved by the Engineer. The Department will provide tree protection signs. Place tree protection signs in accordance with the following:

(1) Along the temporary fence at 50 ft [15.25 m] intervals,

(2) At least two signs per fence, or

(3) As directed by the Engineer.

Do not remove the fence until all work is completed or until approved by the Engineer.

Ensure the fence prevents traffic movement and the placement of temporary facilities, equipment, stockpiles, and supplies from harming the vegetation.

**A.2 Clean Root Cutting**

Cleanly cut tree roots at the construction limits as required by the contract or as directed by the Engineer.

Immediately and cleanly cut damaged and exposed roots. Cut back damaged roots of trees designated for protection to sound healthy tissue and immediately place topsoil over the exposed roots. Immediately cover root ends exposed by excavation activities with 6 in [150 mm] of topsoil as measured outward from the cut root ends. Limit cutting to a minimum depth necessary for construction. Use a vibratory plow, or other approved root cutter in accordance with the Standard Detail Sheet for Protection and Restoration of Vegetation, before excavation. 2500’s 345

**A.3 Watering**

Water root-damaged trees during the growing season that root damage occurs, and water specified trees if required by the contract or directed by the Engineer. Maintain adequate but not excessive soil moisture by saturating the soil within the undisturbed portion of the dripline of impacted or identified trees to a depth of 20 in [500 mm]. Use a soil recovery probe to check the soil moisture to a depth of 20 in [500 mm], and adjust the intervals and frequency of watering in accordance with prevailing moisture and weather conditions.

**A.4 Sandy Loam Topsoil**

Place sandy loam topsoil instead of common borrow fill within the dripline of specimen trees as required by the contract or as directed by the Engineer.

Place the topsoil to avoid over-compaction as approved by the Engineer. Establish turf consistent with the adjacent areas as approved by the Engineer.

**A.5 Utility Construction**

|  |  |  |
| --- | --- | --- |
| Bore under roots of trees designated for preservation for utility installations within the tree protection zone in accordance with the following: **Table 2572-1 Tree Protection Zone** | | |
| **Tree diameter at 4.5 ft [1.4 m] above ground, *in [mm]*** | **Minimum distance from face of tree trunk, *ft [m]*** | **Minimum depth of tunnel, *ft [m]*** |
| <2 [50] | 2 [0.6] | 2 [0.6] |
| 2–4 [51–100] | 4 [1.2] | 2.5 [0.75] |
| >4–9 [101–225] | 6 [1.8] | 2.5 [0.75] |
| >9–14 [226–350] | 10 [3.0] | 3 [0.9] |
| >14–19 [351–480] | 12 [3.6] | 3.25 [1.0] |
| >19 [480] | 15 [4.8] | 4 [1.2] |

Do not perform open trenching within the tree protection zone.

**A.6 Blank**

**A.7 Pruning**

Provide an arborist certified by the International Society of Arboriculture to prune trees as required by the contract or as directed by the Engineer in accordance with 2571.3.E.1, “Pruning – Top Growth and Roots.” Ensure the arborist removes dead, broken, rubbing branches, and limbs that may interfere with the existing and proposed structures.

**A.8 Destroyed or Disfigured Vegetation**

Restore vegetation designated on the plans for preservation that is damaged or disfigured by the Contractor’s operations at no additional cost to the Department. Restore the damaged vegetation to a condition equal to what existed before the damage. The Engineer may assess damages against the Contractor for damage to vegetation not restored to the previous condition. The Engineer will assess the value of damages to trees and landscaping at not less than the appraisal damages as specified in the Council of Tree and Landscape Appraisers *Guide for Plant Appraisal*. The Engineer will determine and assess damages of other vegetation.

**A.9 Oak Trees**

Avoid wounding of oak trees during April, May, June, and July to prevent the spread of oak wilt. If the Engineer determines that work must take place near oak trees during those months, immediately treat resulting wounds with a wound dressing material consisting of latex paint or shellac. Blend paint colors with the bark color. Maintain a supply of approved wound dressing on the project at all times during this period.

**A.10 Tree Growth Retardant (TGR)**

Provide an arborist certified by the International Society of Arboriculture to treat trees with the TGR as required by the contract or as directed by the Engineer. Ensure the arborist applies the TGR paclobutrazol as a basal drench or soil injection and in accordance with the label directions. Provide the Engineer with the product label and material safety data sheet for the product used.

**A.11 (Blank)**

**A.12 Other Vegetation Protection Measures**

Provide other vegetation protection measures including root system bridging, compaction reduction, aeration, irrigation systems, J-barriers for specimen tree protection, and retaining walls as required by the contract or as directed by the Engineer.

**REFERENCES**

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