Understanding & Protecting Trees During Municipal Construction Projects

Purdue Road School
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Learn to.......

• Describe the tangible benefits of trees
• Identify political and social impacts on planning
• Identify the basic parts of a tree and their importance
• Identify a tree’s “critical root zone”
• Identify factors that affect a tree’s tolerance to damage
• Identify the steps in preparing a tree protection plan
• Identify tree protection measures
• Accept tree protection as a part of project planning
Tree Benefits

Energy Savings

*Stormwater*

Property Value

*Shade*

Air Quality

Aesthetics

Quality of Life

Urban Wildlife

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**Technical Benefits**

*Stormwater Mitigation-*

Trees intercept large amounts of water before it ever reaches the ground and can store water once it's there.

*The larger the tree, the more stormwater it can manage.*
Technical Benefits

Shading –
Shaded streets last longer.

Streets with only 20% shade can save 60% of resurfacing costs over a 30 year life span.

Political and Social Factors

Simply put…. “people” want it all.
• Security
• Comfortable Home
• Public services
• Lots of Trees
• Low taxes
• Few restrictions and regulations

So, yes – Public Works agencies have to preserve/provide trees AND safe, functional streets and pavements

Tree Benefits:
- Energy Savings
- Stormwater
- Property Value
- Shade
- Air Quality
- Aesthetics
- Quality of Life
- Urban Wildlife
Basic Parts of a Tree

- **Cells and Tissues**
  - **CAMBIUM** – cells that create xylem and phloem and produce diameter growth of a tree. Located directly under the bark.
  - **XYLEM** – formed to the inside of the cambium and moves water and nutrients UP the tree. Contains living and dead tissue.
  - **PHLOEM** – formed to the outside of the cambium and moves sugars from the leaves (photosynthesis) down to other parts of the tree. Sugars “phlow” downward!
Basic Parts of a Tree

Stems

**BRANCH COLLAR** – area where a branch joins another branch or trunk created by overlapping xylem tissues.

**BRANCH BARK RIDGE** – top area of a tree’s crotch where the growth and development of two adjoining limbs push the bark into a ridge.

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Basic Parts of a Tree

Leaves

Leaves have special cells that contain a green pigment called **chlorophyll**. Chlorophyll absorbs sunlight and stores it in the cells where it is converted to chemical energy in the form of sugar. This chemical reaction is called **photosynthesis**. Leaves absorb CO₂ and sunlight and add water to create energy in the form of sugars. The leaves then give off oxygen as a byproduct.

\[ \text{CO}_2 + \text{H}_2\text{O} + \text{Light} = \text{O}_2 + \text{Sugar} \]

Leaves also give off or lose excess H₂O in a process called **transpiration**. This cools the leaf surface and the surrounding air, in a big way!!!
3/7/2011

Basic Parts of a Tree

- Roots...

These are mostly the absorbing roots that provide WATER and NUTRIENTS

Even though the tree may be left standing.....for now;
Major trauma to these roots will kill the tree!

3 ft

1 ft

Even though the tree may be left standing.....for now;
Major trauma to these roots will kill the tree!

Tree Root Myths

Myth 1. Tree roots exist only under the tree canopy, or out to the drip line.

Tree Biology

Tree roots, especially in forests, extend well beyond the driplines of the branches, often 2 to 4 times further.
How Trees Grow

Tree Root Myths

Myth 2. Tree roots grow deep into the soil and thus are protected.

Tree Biology

All roots need oxygen to survive, so roots must stay in the upper levels to receive enough air to survive.
Tree Roots

Tulip poplar roots exposed during trenching

Tree Root Myths

Myth 3. Tree roots are woody and tough.

Tree Biology

Woody structural roots near tree trunks are tough and they help support and anchor the tree, but the small, fleshy roots at the outer reaches of root zones gather most of the water and nutrients needed for healthy trees.
Tree Root Myths

Myth 4. Damage to tree roots can be seen immediately.

Tree Biology

Trees have stored energy in their branches and trunks that they use to survive after the roots are damaged. It may take 2 or 3 years for a tree to begin to look like it is declining. And, it may take up to 5 years for root damage to result in tree death.

Root System Loss

2 years after trenching
Root System Loss

A single branch root = altered health and vigor
Two or more branch roots = declining and unetable tree

Tree Roots Are Important

- Roots anchor the tree
- Roots absorb water
- Roots absorb nutrient elements
- Roots need soil aeration
- Roots need soil moisture
The CRZ is the starting point when planning for tree protection. Typically, it encompasses all tree roots out to the drip-line of a tree. It can be estimated with this formula:

\[ \text{Diameter}_{4.5} \text{ (inches)} \times 1.5 = \text{CRZ radius (feet)} \]

**Critical Root Zone (CRZ)**

**Structural Critical Root Zone (S-CRZ)**

S-CRZ is the absolute minimum that should be considered for protection. Any violation of this zone creates a high probability of tree failure.
Structural Critical Root Zone (S-CRZ)

S-CRZ is the absolute minimum that should be considered for protection. Any violation of this zone creates a high probability of tree failure.

The impact of violating the S-CRZ is greatly compounded if damage occurs on multiple sides. The loss of multiple flare roots sets the stage for catastrophic tree failure.

The Difference in Root Area

- A 15 foot radius zone = 707 square feet.
- A 20 foot radius zone = 1257 square feet.
- The 20 foot zone is 78% bigger.
### Structural Critical Root Zone (S-CRZ)

S-CRZ relative distance based on tree diameter:

<table>
<thead>
<tr>
<th>Tree Diam (in)</th>
<th>Dist (ft)</th>
<th>Tree Diam (in)</th>
<th>Dist (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-9</td>
<td>5</td>
<td>19-23</td>
<td>9</td>
</tr>
<tr>
<td>10-11</td>
<td>6</td>
<td>24-36</td>
<td>10</td>
</tr>
<tr>
<td>12-14</td>
<td>7</td>
<td>37-45</td>
<td>11</td>
</tr>
<tr>
<td>15-18</td>
<td>8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Factors That Affect A Tree’s Tolerance to Construction Activity

- **Species**: Some species tolerate disturbance better than others.
- **Maturity Class**: Vigorous young trees generally tolerate disturbance better than overmature trees.
- **Health / Structural Integrity**: Choose trees to preserve wisely.
- **Soils**: Sandy soils resist compaction more than clays.
How Can We Protect Trees?

Techniques exist to protect the WHOLE tree:

- Crown
- Trunk
- Roots

Assess and map the location all of the existing trees and identify:

- Species,
- Size,
- Location,
- Condition.

Use site plan or create a new map...aerial photos

Develop a Tree Protection Plan

- Tree Stand Delineation (TSD) or Tree Survey
Develop a Tree Protection Plan

- Tree Stand Delineation (TSD) or Tree Survey
  
  Identify Critical Root Zones (CRZ)

  Identify Structural Critical Root Zones (S-CRZ) if needed.

- Design Project With Tree Protection In Mind

  Understand and mark where ALL construction activities may occur on the site and how they will affect the tree population. (Grading, traffic, material storage, irrigation lines, utilities, etc)

  Even expensive projects can be planned poorly...
### Develop a Tree Protection Plan

- Prepare the Tree Protection Plan

Create and follow a plan!

Create a list of trees to be protected and what actions will be required

<table>
<thead>
<tr>
<th>Tree Number</th>
<th>Species</th>
<th>Diameter (in)</th>
<th>PROTECT?</th>
<th>Root Pruning</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sweetgum</td>
<td>18</td>
<td>YES</td>
<td>YES</td>
<td>Install fence as shown</td>
</tr>
<tr>
<td>2</td>
<td>Sweetgum</td>
<td>18</td>
<td>YES</td>
<td>YES</td>
<td>Root prune along edge of proposed driveway. Install fence as shown</td>
</tr>
<tr>
<td>3</td>
<td>Sweetgum</td>
<td>16</td>
<td>YES</td>
<td>Install fence as shown</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Gingko</td>
<td>18</td>
<td>YES</td>
<td>Install fence as shown</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Walnut</td>
<td>14</td>
<td>YES</td>
<td>YES</td>
<td>Root prune along limit of disturbance line (or remove tree).</td>
</tr>
<tr>
<td>6</td>
<td>Walnut</td>
<td>16</td>
<td>YES</td>
<td>Install fence as shown</td>
<td>Woodland tree within protected area</td>
</tr>
<tr>
<td>7</td>
<td>Black Cherry</td>
<td>14</td>
<td>NO</td>
<td></td>
<td>To be removed</td>
</tr>
<tr>
<td>8</td>
<td>White Oak</td>
<td>14</td>
<td>YES</td>
<td>Woodland tree within protected area</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Black Cherry</td>
<td>12</td>
<td>NO</td>
<td></td>
<td>To be removed</td>
</tr>
<tr>
<td>10</td>
<td>Green Ash</td>
<td>18</td>
<td>YES</td>
<td>Install fence as shown</td>
<td>Root prune along limit of disturbance line (or remove tree).</td>
</tr>
</tbody>
</table>

**TREE PROTECTION ACTION KEY (for trees >12")**

- Create and follow a plan!
- Create a list of trees to be protected and what actions will be required
- Develop a Tree Protection Plan
- Prepare the Tree Protection Plan

As a general rule, the **Critical Root Zone** should extend at least to the drip-line of a tree.

If the CRZ can not be protected...

Disturbance may come as close as 5 times the diameter of the protected tree on ONLY ONE SIDE!!

5x...then protect the rest!!
Within Tree Protection Zone

It is important to prohibit heavy machinery traffic, material storage and other such construction stress within the Critical Root Zone!!! Use tree protection signs to communicate!

Fencing can be used to restrict traffic to designated routes. Fencing typically delineates and protects critical root zones.

Tree Protection Measures

**FENCING**
Fencing can be used to restrict traffic to designated routes. Fencing typically delineates and protects critical root zones.
ROOT PRUNING

Root pruning allows roots to be cut cleanly and avoids ripping or tearing of roots. Clean-cut roots will cover over the wound quicker and will generate additional roots on remaining tissue.

Roots that are ripped or torn (back-hoe, etc) will decay over time and can compromise the structural integrity of the tree.

ROOT PRUNING

If compaction, excavation, or soil filling must occur within the CRZ,...root prune and fence along the limits of disturbance.
Tree Protection Measures

AIR SPADES

Pipes that blast a stream of pressurized air can be used to “dig away” soil with only minimal damage to tree roots. The technique can be used as an “exploratory” dig to see what lies beneath.

Underground Utilities

Utilities:

- Electric
- Water
- Natural Gas
- Telephone
- Cable
Underground Construction Site Considerations

Utility to be installed
- Size and type of carrier line, slope of gravity, size of casing/wall thickness

Location
- Access, commercial/residential, open cut or trenchless, method, length of bore, surface conflicts, traffic

Geotechnical reports
- Nature of soils, depth & nature of bedrock, surface drainage, groundwater

Length & depth of the bore
- Size of bore pit, depth of bore pit, shore boxes & sheet piling

Underground/overhead conflicts
- Local one-call center, survey for utilities, as built

Typical Underground Utility Installations

Open Cut:
- Involves digging a trench along the length of the proposed pipeline, placing the pipe in the trench on suitable bedding materials, and then backfilling.

Trenchless Technology:
- Methods of pipeline and utility installation with minimal amount of surface disruption.
Open Cut – Benefits

- Well suited for open areas with undeveloped land and few buried obstacles.
- Most cost-effective solution in circumstances where traffic disturbance/detour is unavoidable regardless of the method used.

Open Cut – A Tree’s Perspective

- Trenching kills roots
Trenchless – Benefits

Minimizes disturbance to traffic, living and working areas, and tree roots.

Reduces chances of interfering with or damaging existing utilities or abandoned pipes, and tree roots.

Requires less exposed area, which is safer for workers and the community.

Trenchless – A Tree’s Perspective

Tree City USA Bulletin 35, How to Protect Trees During Underground Work
National Arbor Day Foundation, 2003
Trenchless Saves Trees

Trenchless installations reduce damage to tree roots.

Trenchless Technology

Trenchless technology minimizes surface conflicts. **However, access pits are still required.**

- Auger Boring
- Bore Machine Tunneling Attachment
- Horizontal Directional Drilling
- Pipe Ramming
- Pipe Bursting
- Tunnel Boring Machine
- Hand Tunneling

**How can we do better?**

- Include trees in planning process
- Include CRZ on plans
- Plan the location of the access pits to minimize impacts to trees

Photo courtesy of Murv Morehead, ROW Coordinator City of Overland Park, Kansas
When Digging Near Trees

Access Pit too Close to a Tree

Root Loss
Tree Protection Measures

**TUNNEL vs TRENCH**

Tunneling should occur at least two feet below ground to avoid most roots that grow near the surface and slightly to one side of the tree rather than directly below the trunk. The distance of the tunneling is dictated by the tree’s diameter. Utilize the following guidelines:

<table>
<thead>
<tr>
<th>Tree Diameter (DBH)</th>
<th>Minimum Distance From Tree to Start Tunneling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 6 inches</td>
<td>Drip line of tree</td>
</tr>
<tr>
<td>6-9 inches</td>
<td>5 feet</td>
</tr>
<tr>
<td>10-14 inches</td>
<td>10 feet</td>
</tr>
<tr>
<td>15-19 inches</td>
<td>12 feet</td>
</tr>
<tr>
<td>More than 19 inches</td>
<td>15 feet</td>
</tr>
</tbody>
</table>

Tree Protection Measures

**LIMB PRUNING**

Provide adequate clearance ahead of time for machinery that is expected to be on site.
CHEMICAL TREATMENTS

Applications of a chemical growth regulator can limit shoot growth and stimulate root growth. The boost in root growth can help trees tolerate construction damage.

RETAINING WALLS

Though the cost of engineering and building a wall can be high, they can keep the critical root zone intact.
Tree Protection Measures

**ROOT ZONE PROTECTION**

Bridging over roots is an option if a critical root zone must be used for vehicle access.

Another option is adding 8-10 inches of mulch over ground protection mats (www.alturnamat.com). This creates a temporary bridge that minimizes soil compaction and root damage.
Accommodating Trees & Sidewalks

Bridge over the roots

Tree Protection Measures

ALTERNATIVE PAVING

Porous paving allows water and oxygen to reach critical roots and will reduce long-term damage.
“It starts at the beginning....”
Communication is KEY at all phases of project planning, design, construction monitoring, and follow-up. Create clear channels of communication between team members.

Tree Protection Measures

**COMMUNICATION**

Public Works Staff
Engineer/Architect
Certified Arborist
Contractors (plumbing, concrete, arborist)

-Include public involvement where needed. Trees create a lot of emotion and everyone is an expert! With an experienced certified arborist as part of the team, you’ll have an expert on board to answer questions.
Tree Protection Measures

COMMUNICATION – Selecting an ISA Certified Arborist

- Just as engineers specialize, arborists have areas of specialty as well....
- Residential/Commercial Tree Care
- Consulting Arborist
- Municipal Arborist
- Utility Arborist
- When utilizing a certified arborist to prepare a tree protection plan, be sure to ask for references. Not all Certified Arborists have experience in this field.

Roots cutting effects in “3 easy steps”!

Step one

Step two

Step three
Trees Are Important!

“To exist as a nation, to prosper as a state, and to live as a people, we must have trees.”

Theodore Roosevelt

Questions?

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