MONTGOMERY COUNTY HISTORIC PRESERVATION COMMISSION
STAFF REPORT

Address:	213 Ethan Allen Avenue, Takoma Park	**Meeting Date:**	7/24/2019
Resource:	Contributing Resource **Takoma Park Historic District**	**Report Date:**	7/17/2019
		Public Notice:	7/10/2019
Applicant:	Chris and Seema Meighan	**Tax Credit:**	No
Review:	HAWP	**Staff:**	Michael Kyne
Case Number:	37/03-19DD		
PROPOSAL:	Tree removal		

STAFF RECOMMENDATION

Staff recommends that the HPC **approve with one (1) condition** the HAWP application.

1. **The applicants must adhere to the terms stipulated in the City's tree replacement agreement, as detailed by the City's Urban Forest Manager in the letter dated June 25, 2019.**

ARCHITECTURAL DESCRIPTION

SIGNIFICANCE: Contributing Resource within the Takoma Park Historic District
STYLE: Bungalow
DATE: c. 1910-20s

Fig. 1: Subject property, as marked by the yellow star.

PROPOSAL

The applicants propose to remove one 35" dbh Chestnut Oak tree from the rear center of the moderately forested subject property.

APPLICABLE GUIDELINES

Montgomery County Code; Chapter 24A-8

(b) The commission shall instruct the director to issue a permit, or issue a permit subject to such conditions as are found to be necessary to insure conformity with the purposes and requirements of this chapter, if it finds that:
  (1) The proposal will not substantially alter the exterior features of an historic site or historic resource within an historic district; or
  (2) The proposal is compatible in character and nature with the historical, archeological, architectural or cultural features of the historic site or the historic district in which an historic resource is located and would not be detrimental thereto or to the achievement of the purposes of this chapter; or
  (3) The proposal would enhance or aid in the protection, preservation and public or private utilization of the historic site or historic resource located within an historic district in a manner compatible with the historical, archeological, architectural or cultural value of the historic site or historic district in which an historic resource is located; or
  (4) The proposal is necessary in order that unsafe conditions or health hazards be remedied; or
  (5) The proposal is necessary in order that the owner of the subject property not be deprived of reasonable use of the property or suffer undue hardship; or
  (6) In balancing the interests of the public in preserving the historic site or historic resource located within an historic district, with the interests of the public from the use and benefit of the alternative proposal, the general public welfare is better served by granting the permit.

(c) It is not the intent of this chapter to limit new construction, alteration or repairs to any 1 period or architectural style.

(d) In the case of an application for work on an historic resource located within an historic district, the commission shall be lenient in its judgment of plans for structures of little historical or design significance or for plans involving new construction, unless such plans would seriously impair the historic or architectural value of surrounding historic resources or would impair the character of the historic district. (*Ord. No. 9-4, § 1; Ord. No. 11-59.*)

Takoma Park Historic District Guidelines

There are two very general, broad planning and design concepts which apply to all categories. These are:

- The design review emphasis will be restricted to changes that are all visible from the public right-of-way, irrespective of landscaping or vegetation (it is expected that the majority of new additions will be reviewed for their impact on the overall district), and

- The importance of assuring that additions and other changes to existing structures act to reinforce and continue existing streetscape, landscape, and building patterns rather than to impair the character of the historic district.

A majority of structures in the Takoma Park Historic District have been assessed as being "Contributing Resources." While these structures may not have the same level of architectural or historical significance as Outstanding Resources or may have lost some degree of integrity, collectively, they are the basic

building blocks of the Takoma Park district. However, they are more important to the overall character of the district and the streetscape due to their size, scale, and architectural character, rather than for their particular architectural features.

Contributing Resources should receive a more lenient level of design review than those structures that have been classified as Outstanding. This design review should emphasize the importance of the resource to the overall streetscape and its compatibility with existing patterns rather than focusing on a close scrutiny of architectural detailing. In general, however, changes to Contributing Resources should respect the predominant architectural style of the resource.

The *Guidelines* that pertain to this project are as follows:

- All exterior alterations, including those to architectural features and details, should be generally consistent with the predominant architectural style and period of the resource and should preserve the predominant architectural features of the resource; exact replication of existing details and features is, however, not required.
- All changes and additions should respect existing environmental settings, landscaping, and patterns of open space.

Secretary of Interior's Standards for Rehabilitation

The Secretary of the Interior defines rehabilitation as "the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features, which convey its historical, cultural, or architectural values." The *Standards* are as follows:

2. The historic character of a property shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided.

9. New additions, exterior alterations, or related new construction shall not destroy historic materials that characterize the property. The new work shall be differentiated from the old and shall be compatible with the massing, size, scale, and architectural features to protect the historic integrity of the property and its environment.

STAFF DISCUSSION

The subject property is a c. 1910-20s Bungalow-style Contributing Resource on the eastern edge of the Takoma Park Historic District. The adjacent properties to the east, as well as the confronting properties to north, are outside the boundaries of the historic district.

The applicants propose to remove one 35" dbh Chestnut Oak tree from the rear center of the moderately forested subject property. In their HAWP application, the applicants stated that the City's arborist deemed the tree diseased and dying; however, this information was not included in the arborist's letter. Staff contacted the City's arborist for additional information, and the following was provided:

- The current condition of the tree did not meet the requirements for a tree removal waiver from the City (or from the HPC).
- The tree is in fair condition, but exhibits early signs of decline, including:
    - Hollowness at the base.
    - Signs of insect boring activity, as evidenced by sawdust at the base.
    - The presence of fungal fruiting bodies further up the trunk of the tree.

- While the tree does not pose an immediate threat, the construction of a rear addition (approved by the HPC at the December 19, 2018 HPC meeting) will likely further the decline of the tree.
- While the timeframe for decline to the point of becoming an immediate threat cannot be known, the construction of the addition may accelerate the process, necessitating removal in as little as one year.

Given the information provided by the City's arborist, staff recommends that the HPC approve the proposed tree removal. The subject property is moderately forested, with two large trees in the front yard and several smaller trees at the east and west sides. Staff finds that the proposed tree removal will not remove or alter character-defining features of the subject property, in accordance with *Standards #2* and *#9* and the *Guidelines*.

After full and fair consideration of the applicant's submission staff finds the proposal, as modified by the condition, as being consistent with the Criteria for Issuance in Chapter 24A-(b) 1 and 2, having found the proposal is consistent with the *Secretary of the Interior's Standards for Rehabilitation #2,* and *#9,* and *Takoma Park Historic District Guidelines* outlined above.

STAFF RECOMMENDATION

Staff recommends that the Commission **approve with one (1) condition** the HAWP application under the Criteria for Issuance in Chapter 24A-8(b), having found that the proposal, as modified by the condition, is consistent with the *Takoma Park Historic District Guidelines* identified above, and therefore will not substantially alter the exterior features of the historic resource and is compatible in character with the district and the purposes of Chapter 24A;

and with the *Secretary of the Interior's Standards for Rehabilitation #2* and *#9*;

and with the general condition that the applicant shall present the **3 permit sets of drawings, if applicable to Historic Preservation Commission (HPC) staff for review and stamping** prior to submission for the Montgomery County Department of Permitting Services (DPS) building permits;

and with the general condition that final project design details, not specifically delineated by the Commission, shall be approved by HPC staff or brought back to the Commission as a revised HAWP application at staff's discretion;

and with the general condition that the applicant shall notify the Historic Preservation Staff if they propose to make **any alterations** to the approved plans. Once the work is completed the applicant will contact the staff person assigned to this application at 301-563-3400 or michael.kyne@montgomeryplanning.org to schedule a follow-up site visit.

[redacted]

DPS - #8

HISTORIC PRESERVATION COMMISSION
301/563-3400

APPLICATION FOR HISTORIC AREA WORK PERMIT

Contact Email: CHRISMEIGHAN@YAHOO.COM Contact Person: CHRIS MEIGHAN
Daytime Phone No.: 619-892-2700

Tax Account No.: _____

Name of Property Owner: CHRIS & SEEMA MEIGHAN Daytime Phone No.: 619-892-2700

Address: 213 ETHAN ALLEN AVE TAKOMA PARK MD 20912
Street Number *City* *State* *Zip Code*

Contractor: _____ Phone No.: _____

Contractor Registration No.: _____

Agent for Owner: _____ Daytime Phone No.: _____

LOCATION OF BUILDING/PREMISE

House Number: 213 Street: ETHAN ALLEN AVE

Town/City: TAKOMA PARK Nearest Cross Street: WOODLAND AVE

Lot: 3 Block: 22 Subdivision: B.F. GILBERT'S ADDITION TO TKPK

Liber: 30324 Folio: 0013 Parcel: _____

PART ONE: TYPE OF PERMIT ACTION AND USE

1A. CHECK ALL APPLICABLE:

☐ Construct ☐ Extend ☐ Alter/Renovate

☐ Move ☐ Install ☐ Wreck/Raze

☐ Revision ☐ Repair ☐ Revocable.

CHECK ALL APPLICABLE:

☐ A/C ☐ Slab ☐ Room Addition ☐ Porch ☐ Deck ☐ Shed

☐ Solar ☐ Fireplace ☐ Woodburning Stove ☐ Single Family

☐ Fence/Wall (complete Section 4) ☒ Other: TREE REMOVAL

1B. Construction cost estimate: $ 6,000

1C. If this is a revision of a previously approved active permit, see Permit # _____

PART TWO: COMPLETE FOR NEW CONSTRUCTION AND EXTEND/ADDITIONS

2A. Type of sewage disposal: 01 ☒ WSSC 02 ☐ Septic 03 ☐ Other: _____

2B. Type of water supply: 01 ☒ WSSC 02 ☐ Well 03 ☐ Other: _____

PART THREE: COMPLETE ONLY FOR FENCE/RETAINING WALL

3A. Height _____ feet _____ inches

3B. Indicate whether the fence or retaining wall is to be constructed on one of the following locations:

☐ On party line/property line ☐ Entirely on land of owner ☐ On public right of way/easement

I hereby certify that I have the authority to make the foregoing application, that the application is correct, and that the construction will comply with plans approved by all agencies listed and I hereby acknowledge and accept this to be a condition for the issuance of this permit.

Signature of owner or authorized agent 7-1-2019 *Date*

Approved: _____ *For Chairperson, Historic Preservation Commission*

Disapproved: _____ Signature: _____ Date: _____

Application/Permit No.: _____ Date Filed: _____ Date Issued: _____

Edit 6/21/99

SEE REVERSE SIDE FOR INSTRUCTIONS

THE FOLLOWING ITEMS MUST BE COMPLETED AND THE REQUIRED DOCUMENTS MUST ACCOMPANY THIS APPLICATION.

1. **WRITTEN DESCRIPTION OF PROJECT**

   a. Description of existing structure(s) and environmental setting, including their historical features and significance:

   EXISTING HOUSE IS LOCATED ON THE BORDER OF THE TAKOMA PARK HISTORIC DISTRICT. THE HOUSE IS A STANDARD BUNGALOW SET BACK 36' FROM THE FRONT OF THE PROPERTY LINE

   b. General description of project and its effect on the historic resource(s), the environmental setting, and, where applicable, the historic district:

   NEED TO REMOVE 35" d.b.h. CHESTNUT OAK TREE FROM THE REAR CENTER OF THE PROPERTY. THE TREE HAS BEEN DEEMED DISEASED AND DYING BY THE CITY ARBORIST.

2. **SITE PLAN**

   Site and environmental setting, drawn to scale. You may use your plat. Your site plan must include:

   a. the scale, north arrow, and date;

   b. dimensions of all existing and proposed structures; and

   c. site features such as walkways, driveways, fences, ponds, streams, trash dumpsters, mechanical equipment, and landscaping.

3. **PLANS AND ELEVATIONS**

   You must submit 2 copies of plans and elevations in a format no larger than 11" x 17". Plans on 8 1/2" x 11" paper are preferred.

   a. ***Schematic construction plans***, with marked dimensions, indicating location, size and general type of walls, window and door openings, and other fixed features of both the existing resource(s) and the proposed work.

   b. Elevations (facades), with marked dimensions, clearly indicating proposed work in relation to existing construction and, when appropriate, context. All materials and fixtures proposed for the exterior must be noted on the elevations drawings. An existing and a proposed elevation drawing of each facade affected by the proposed work is required.

4. **MATERIALS SPECIFICATIONS**

   General description of materials and manufactured items proposed for incorporation in the work of the project. This information may be included on your design drawings.

5. **PHOTOGRAPHS**

   a. Clearly labeled photographic prints of each facade of existing resource, including details of the affected portions. All labels should be placed on the front of photographs.

   b. Clearly label photographic prints of the resource as viewed from the public right-of-way and of the adjoining properties. All labels should be placed on the front of photographs.

6. **TREE SURVEY**

   If you are proposing construction adjacent to or within the dripline of any tree 6" or larger in diameter (at approximately 4 feet above the ground), you must file an accurate tree survey identifying the size, location, and species of each tree of at least that dimension.

7. **ADDRESSES OF ADJACENT AND CONFRONTING PROPERTY OWNERS**

   For **ALL** projects, provide an accurate list of adjacent and confronting property owners (not tenants), including names, addresses, and zip codes. This list should include the owners of all lots or parcels which adjoin the parcel in question, as well as the owner(s) of lot(s) or parcel(s) which lie directly across the street/highway from the parcel in question.

PLEASE PRINT (IN BLUE OR BLACK INK) OR TYPE THIS INFORMATION ON THE FOLLOWING PAGE.
PLEASE STAY WITHIN THE GUIDES OF THE TEMPLATE, AS THIS WILL BE PHOTOCOPIED DIRECTLY ONTO MAILING LABELS.

HAWP APPLICATION: MAILING ADDRESSES FOR NOTIFING
[Owner, Owner's Agent, Adjacent and Confronting Property Owners]

Owner's mailing address	**Owner's Agent's** mailing address
213 ETHAN ALLEN AVE TAKOMA PARK, MD 20912	

Adjacent and confronting Property Owners mailing addresses

CHARLES & GRACIELA HAYES 215 ETHAN ALLEN AVE TAKOMA PARK, MD 20912	ERIC & SAMADRA SMITH 7123 SYCAMORE AVE TAKOMA PARK, MD 20912
BADIA ALBANNA 211 ETHAN ALLEN AVE TAKOMA PARK, MD 20912	
DARIUS D. SIVIN & HEATHER F. HURLBURT 211 MANOR CIRCLE TAKOMA PARK, MD 20912	

City Of Takoma Park
Public Works Department

31 Oswego Avenue, Silver Spring, Maryland 20910
Office: 301-891-7633 Fax: 301-585-2405

139063
04410

June 25, 2019

Christopher and Seema Meighan
213 Ethan Allen Avenue
Takoma Park, MD 20912

Re: same

Dear Christopher and Seema Meighan,

The City of Takoma Park has granted preliminary permit approval for you to remove the 35" d.b.h. Chestnut Oak tree (6 replants) from the rear center of your property.

Preliminary approval means that the City will post your property for a 15 day period beginning 06/24/19 and ending 07/09/19 for public comment. **You will be granted a permit to remove the tree(s) pending the City's receipt of your signed agreement to adhere to the City's tree replacement requirements. Additionally, since your property is located within the Historic District, you are required to receive a HISTORIC AREA WORK PERMIT.** To apply for a HAWP, contact Montgomery County Department of Permitting Services at 240-777-3400 or online at:
http://permittingservices.montgomerycountymd.gov/dps/building/HistoricAreaWorkPermit.aspx

Please submit both the signed replanting agreement and a copy of your HAWP to Takoma Park Public Works, in order to be issued a tree removal permit.

The replacement agreement is enclosed, the terms of which require you to replant SIX 1 ½ inch caliper category 4 Deciduous tree(s), or make a contribution of $1,050.00 to the City's tree fund.

Please contact me at 301-891-7612 if you have any questions.

Sincerely,

Jan van Zutphen
Urban Forest Manager

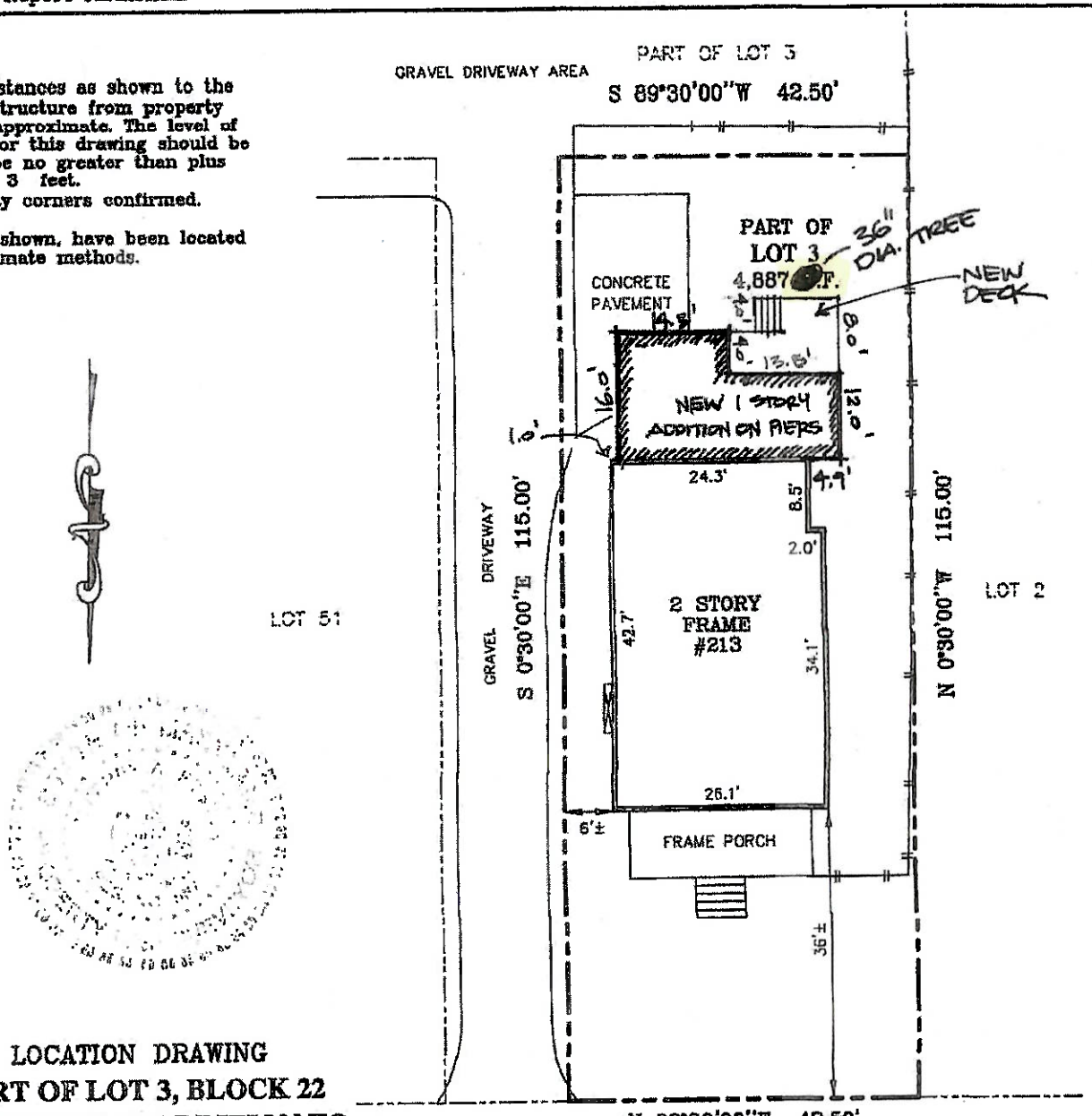
Enclosure

CONSUMER INFORMATION NOTES:

1. This plan is a benefit to a consumer insofar as it is required by a lender or a title insurance company or its agent in connection with contemplated transfer, financing or re-financing.
2. This plan is not to be relied upon for the establishment or location of fences, garages, buildings, or other existing or future improvements.
3. This plan does not provide for the accurate identification of property boundary lines, but such identification may not be required for the transfer of title or securing financing or re-financing.
4. Building line and/or Flood Zone information is taken from available sources and is subject to interpretation of originator.
5. No Title Report furnished.

Notes:

1. Setback distances as shown to the principal structure from property lines are approximate. The level of accuracy for this drawing should be taken to be no greater than plus or minus 3 feet.
   No property corners confirmed.
2. Fences, if shown, have been located by approximate methods.



LOCATION DRAWING
PART OF LOT 3, BLOCK 22
B.F. GILBERT'S ADDITION TO
TAKOMA PARK
MONTGOMERY COUNTY, MARYLAND

SURVEYOR'S CERTIFICATE

"THE INFORMATION SHOWN HEREON HAS BEEN BASED UPON THE RESULTS OF A FIELD INSPECTION PURSUANT TO THE DEED OR PLAT OF RECORD. EXISTING STRUCTURES SHOWN HAVE BEEN FIELD LOCATED BASED UPON MEASUREMENTS FROM PROPERTY MARKERS FOUND OR FROM EVIDENCE OF LINES OF APPARENT OCCUPATION."

Jeffrey A. Foster

MARYLAND PROPERTY LINE SURVEYOR REG. NO. 587
EXPIRES: 04-02-2013

REFERENCES	
PLAT BK.	A
PLAT NO.	2
LIBER	30324
FOLIO	613

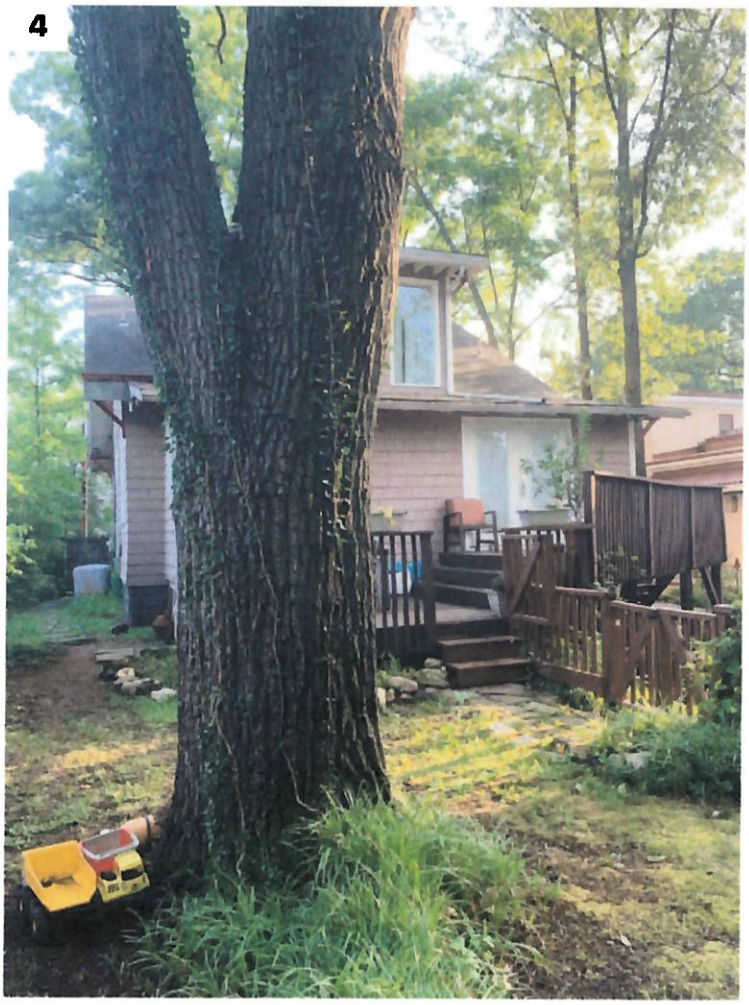
SNIDER & ASSOCIATES
LAND SURVEYORS
20270 Goldenrod Lane, Suite 110
Germantown, Maryland 20876
301/948-5100 Fax 301/948-1286

DATE OF LOCATIONS	SCALE: 1" = 20'
WALL CHECK:	DRAWN BY: E.H.
HSE. LOC.: 10-15-12	JOB NO.: 12-04203

APPLICANT: CHRISTOPHER MEIGHAN

Figure 1: Subject property marked by star

Figs. 2-4: Current condition/ location of tree



Kyne, Michael

From: Jan Van Zutphen <janvz@takomaparkmd.gov>
Sent: Tuesday, July 16, 2019 9:45 AM
To: Kyne, Michael
Subject: RE: 213 Ethan Allen Ave
Attachments: 213EthanAllenAv.JPG; LevelI,II,IIITreeAssessmet.pdf

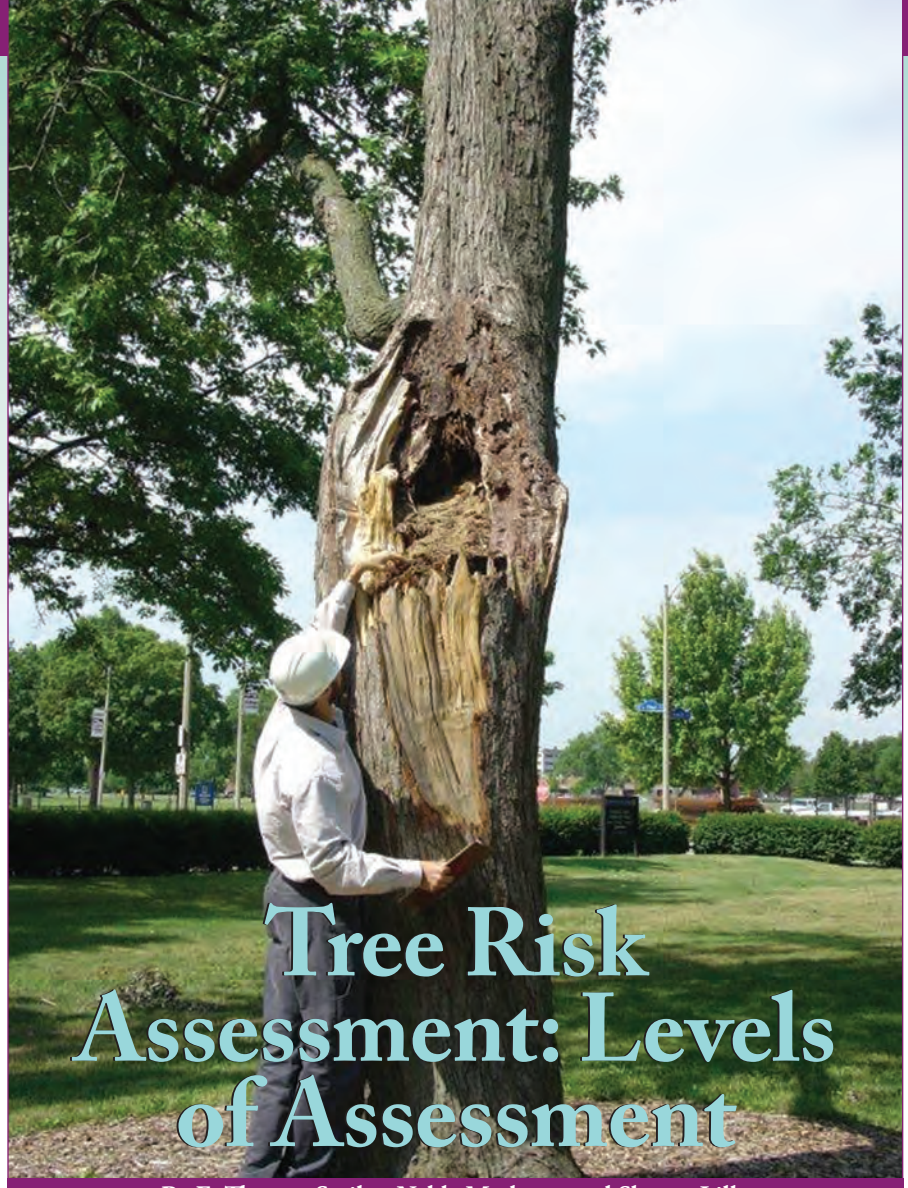
Good morning Michael,

Here is some info on the 35" chestnut oak (see attached picture) in the rear yard of 213 Ethan Allen Ave. I performed a level II assessment of the tree on 06/24/19. I found the following:
Decay at the base of the tree
Fungal fruiting bodies on one side of the tree trunk, some hollowness of the trunk in the same area
Decay in some part of the root system
The canopy of the tree is a bit thin, some branch die back.

I hope this helps.

Best Regards,

--
Jan van Zutphen
Urban Forest Manager
City of Takoma Park Department of Public Works
31 Oswego Avenue
Silver Spring, MD 20910
Ph: 301-891-7612
Fax: 301-585-2405
www.takomaparkmd.gov



Tree Risk Assessment: Levels of Assessment

By E. Thomas Smiley, Nelda Matheny, and Sharon Lilly

Editor's Note: The following article is the third in an extensive series of CEU items on tree risk assessment. Future articles will look at mitigation, reporting, and factors that affect likelihood of failure.

LEARNING OBJECTIVES

The arborist will be able to

- list and discuss elements that should be included in a Scope of Work statement.
- describe a limited visual (Level 1) assessment and explain when it would be used.
- describe a basic (Level 2) assessment and explain how it differs from a limited visual assessment.
- discuss under what circumstances an advanced assessment would be recommended.
- discuss the relative advantages and limitations of each assessment level.
- describe several advanced assessment techniques and explain how they might be used to gather specific information.
- explain why it is important for assessors to understand the possibilities and limitations of the techniques they employ.

CEUs for this article apply to Certified Arborist, Utility Specialist, Municipal Specialist, Tree/Worker Climber, and the BCMA management category.

◀ For all levels of assessment, if the tree risk assessor determines that a different type of assessment is needed, then that recommendation should be made to the client.

Defining the Scope of Work

Prior to beginning a tree risk assessment, the scope of work should be defined. The tree risk assessor and client must agree on the goals, limitations, and budget of the tree risk assessment. Any property boundaries that restrict access to the tree(s) should be identified. The local government or authority's requirements for inspection, reporting, and permitting should be considered. If a written report is to be presented to someone other than the person who contracts with the tree risk assessor, that person or agency should be identified.

The Scope of Work should include specifications for the following:

1. Identifying the tree(s) or area to be assessed. This may be the location of a tree (e.g., "the large oak tree in the front yard") or it may include selection criteria [e.g., "all trees greater than 12 inches (30 cm) diameter on Main Street"]. When assessing trees for a municipality or large property it may be important to have maps with definitive boundaries and a clear definition of how boundary trees will be treated.

2. The level and details of the assessment. One or more of the three levels of assessment (defined in this article) should be specified, as well as details that are to be included within the level. If the lowest level of inspection (Limited Visual) is selected, the assessor should describe how the inspection is to be done and what information is to be recorded. For example, "The inspection procedure is a "walk-by" from the sidewalk, looking for any obvious, aboveground defects."

Details of conditions to be assessed may also be included in the Scope of Work. For example, trees often have many small dead branches, but the tree risk assessor is only concerned about larger branches that can result in serious consequences if they fail. Specifications for assessment may state that only branches greater than two inches (5 cm) in diameter be noted. The same detail can be specified for the minimum degree of lean, live crown ratio, degree of taper, or other conditions of concern.

For all levels of assessment, if the tree risk assessor determines that a higher level of assessment or different type of assessment is needed, then that recommendation should be made to the client.

3. The method of reporting. The manner of reporting and any additional documentation should be defined. The preferred method is a written report. However, in some instances, the report may be verbal with a recommendation for mitigation, or a work order for the mitigation. In general, verbal reports are not recommended because of the potential for misinterpretation in the chain of communication.

4. Timetable for inspection and reporting. The time of the inspection and due date for the report should be specified.

5. Risk rating and mitigation. Risk assessments typically include a rating of the current tree risk, options and/or recommendations for mitigating risk, evaluation of the residual risk after mitigation, and recommended inspection interval, if applicable.

If a situation is encountered where tree failure is imminent and a high-value target is present and likely to be impacted, then the situation should be reported to the client as soon as possible. In addition, immediate action may be required to restrict access to target zone.

Levels of Tree Risk Assessment

Tree risk assessments can be conducted at different levels and may employ various methods and tools. The level selected should be specified in the Scope of Work established between the risk assessor and the client prior to conducting an assessment. The level(s) should be appropriate for the assignment. Three levels of tree risk assessment are defined and described here:

- Level 1: Limited Visual
- Level 2: Basic
- Level 3: Advanced

If conditions cannot be adequately assessed at the specified level, the assessor may recommend a higher level or different assessment. However, the assessor is not required to provide the higher level if it is not within the scope of the original assignment, without additional compensation, or without modifications to the agreement or contract.

In addition to specifying the level of inspection, tree risk assessors should also describe pertinent details regarding the method. For example, a Level 1 assessment can be done by walking by, driving past, or flying above the trees. The method used will greatly influence the cost and reliability of the results.

Level 1: Limited Visual Assessment

The Level 1 assessment is a visual assessment from a specified perspective of an individual tree or a population of trees near specified targets to identify obvious defects or specified conditions. A limited visual assessment typically focuses on identifying trees with an *imminent* and/or *probable* likelihood of failure. Level 1 assessments do not always meet the criteria for a "Risk Assessment" if they do not include analysis and evaluation of individual trees.

Limited visual assessments are the fastest but least thorough means of assessment and are intended primarily for large populations of trees. The assessment is often done on a specified schedule, and/or immediately after storms to rapidly assess a tree population. Tree inventories are usually considered Level 1 assessments unless a risk assessment is specifically included in the inventory.

The drive-by is a limited visual inspection of one side of the tree performed from a slow-moving vehicle.

Level 1 – Limited Visual Assessment Process

The process of limited visual assessment should include:

1. Identifying the location and/or selection criteria of trees to be assessed.
2. Determining the most efficient route and document the route taken.
3. Assessing the tree(s) of concern from the defined perspective (e.g., walk-by, drive-by).
4. Recording the location of trees that meet the defined criteria (e.g., significant defects or other conditions of concern).
5. Evaluating the risk (a risk rating is optional).
6. Identifying trees needing a higher level of assessment and/or prompt action.
7. Submitting recommendations or report.

The assessor performs a visual assessment by looking for *obvious* defects, such as dead trees, large cavity openings, large dead or broken branches, fungal fruiting structures, large cracks, and severe leans. The client may specify inspection for certain conditions of concern, such as lethal pests or symptoms associated with root decay.

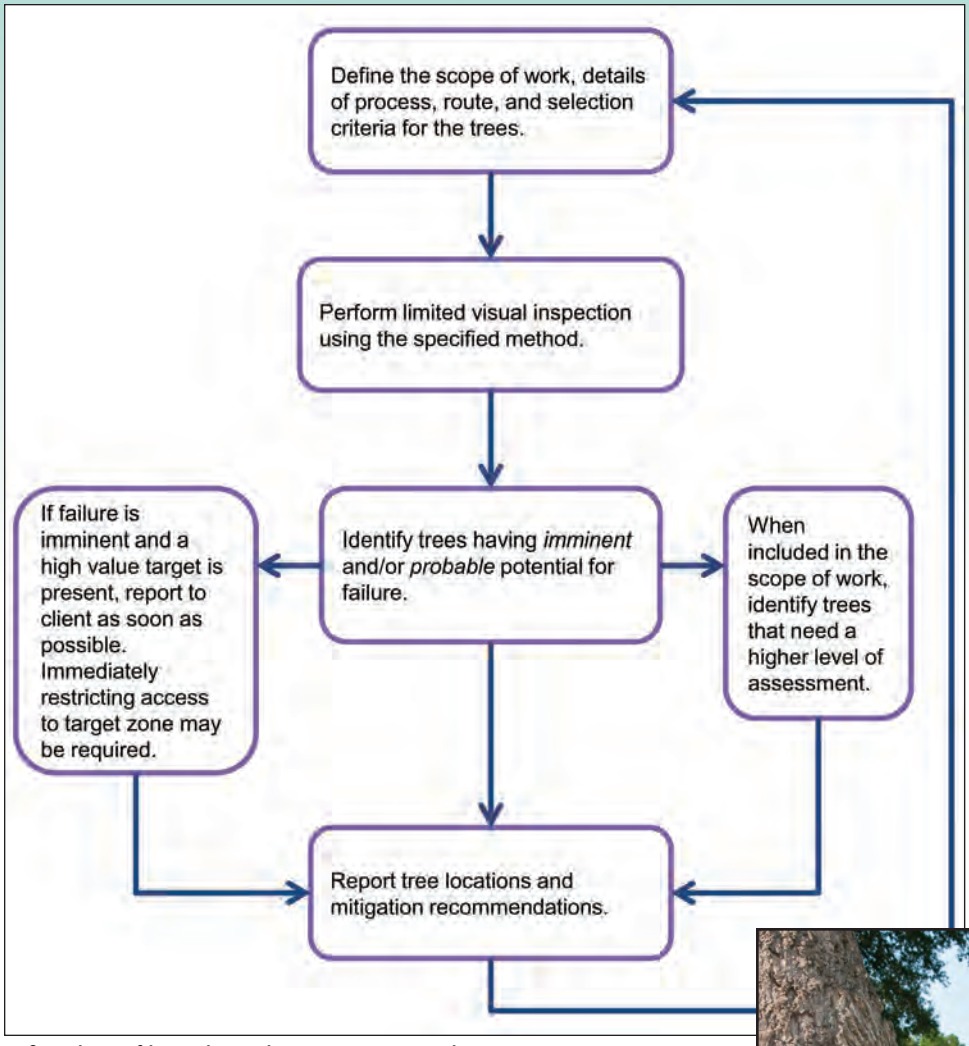
The Scope of Work should specify the perspective or type of inspection. The type of inspection may include one of the following:

- *Walk-by* is a limited visual inspection of one or more sides of the tree performed as the inspector walks past a tree. The inspector may need to stay on the sidewalk (footpath), on public property, or within a right-of-way. The Scope of Work may, in some cases, specify that the assessor to walk around certain trees to gain a more complete perspective.
- *Drive-by* (syn "windshield") is a limited visual inspection of one side of the tree performed from a slow-moving vehicle. The Scope of Work may also specify that the inspector walk around certain trees or record images to verify or document observations. This type of inspection is often performed by municipalities, utilities, or other agencies or landowners who have large populations of trees to inspect with a limited budget.
- *Aerial patrol* inspections are made from an aircraft overflying utility rights-of-way or other large areas. This type of inspection is conducted by some electric utility companies or their contractors to identify threats to the electric transmission system. Sometimes a more detailed, ground-based inspection may be specified to confirm observations. Images may be recorded to document observations.

When a tree of concern is identified, certain specified information about that tree is recorded. At a minimum, this information should include the tree location and recommended remedial action. In addition, the documentation may include the species name, tree size, defect or condition identified, and a work priority. A higher level of inspection may also be recommended when needed, if that option is included in the Scope of Work.

A constraint of limited visual inspections is that some conditions may not be visible from a one-sided inspection of a tree, nor are all conditions visible on a year-round basis. Also, a Level 1 risk assessment

▶



A flowchart of limited visual assessment procedures.

may not be adequate to make a risk mitigation recommendation. The assessor may use the Level 1 inspection to determine which trees require further inspection at the basic or advanced levels after which an appropriate mitigation can be recommended.

Level 2: Basic Assessment

A Level 2 or basic assessment is a detailed visual inspection of a tree and surrounding site, and a synthesis of the information collected. It requires that a tree risk assessor walk completely around the tree—looking at the site, buttress roots, trunk, and branches. A basic assessment may include the use of simple tools to gain additional information about the tree or defects. Basic is the standard assessment that is performed by arborists in response to a client's request for tree risk assessment.

Simple tools may be used for measuring the tree and acquiring more information about the tree or defects. However, the use of these tools is not mandatory unless specified in the Scope of Work. Measuring tools may include a diameter tape, clinometers, or tape measure. Other inspection tools include binoculars, magnifying glass, mallet, trowel, shovel, or a probe:

- Binoculars. Binoculars may be used to inspect the upper portions of a tree's crown to look for cavities, nesting holes, cracks, weak unions, and other conditions and tree responses.
- Magnifying glass. A magnifying glass (hand lens) may be used to help identify fungal fruiting bodies or pests that may affect the overall health of the tree.
- Mallet. The trunk may be sounded with a non-damaging instrument, such as a broad-headed mallet made of wood, rubber, leather, or resin. The tree risk assessor strikes the tree trunk in multiple places and listens for tone variations that may indicate hollows or dead bark.
- Probe. A probe is a small-diameter, stiff rod, stick, or wire that is inserted into a cavity to estimate its size and extent. Because there may be sections of non-functional wood adjacent to a cavity, this type of measurement should be considered only an approximation of the extent of decay.
- Trowel/Shovel. A trowel or shovel can be used to conduct minor excavations to expose roots or the root collar. Care should be taken to not damage roots during the excavation process. More extensive root collar excavations are considered an advanced assessment.

The primary limitation of a basic assessment is that it includes only conditions that are detected from a ground-based inspection; internal, belowground, and upper-crown factors may be impossible to see or difficult to assess and may remain largely undetected.

The trunk may be sounded with a non-damaging instrument, such as a broad-headed mallet, so as to indicate hollows or dead bark.

Level 3: Advanced Assessment

Advanced assessments are performed to provide detailed information about specific tree parts, defects, targets, or site conditions. They are usually conducted in conjunction with or after a basic assessment if the tree risk assessor needs additional information and the client approves the additional service. Specialized equipment, data collection and analysis, and/or expertise are usually required for advanced assessments. These assessments are therefore generally more time intensive and more expensive.

Probing may provide the risk assessor an approximation of the extent of decay.

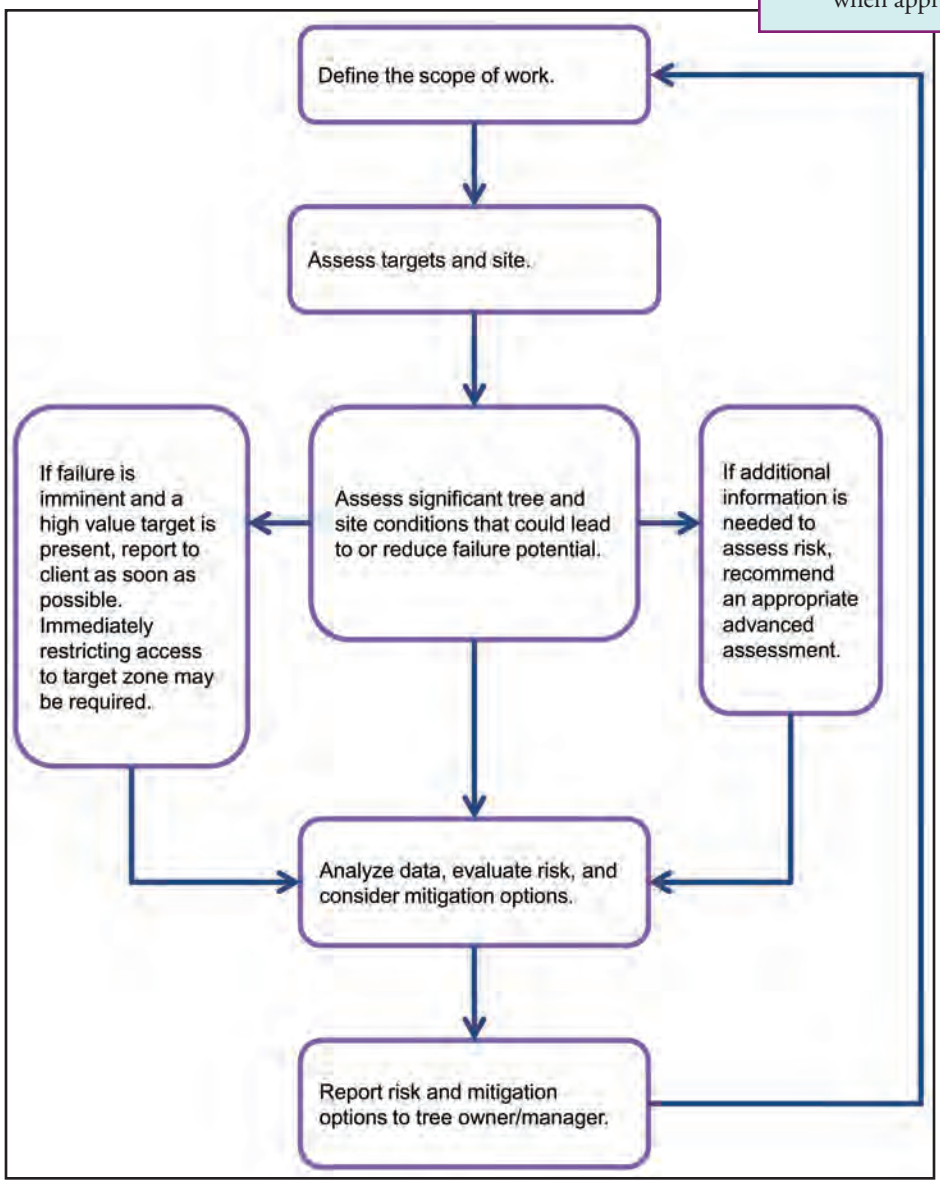
Procedures and methodologies should be selected and applied as appropriate, with consideration for what is reasonable and proportionate to the specific conditions and situations. The risk manager/property owner should consider the value of the tree to the owner and community, the possible consequences of failure, and the time and expense to provide the advanced assessment. Advanced assessments can provide additional information that may make the difference between recommending tree retention or removal. The tree risk assessor should identify what additional information is needed and recommend the technique to be used.

There are many types of advanced assessments that can be conducted, some of which are described in this article. Tree risk assessors are cautioned, however, that all technologies involve some uncertainty. Each technology has limitations; any evaluation of an individual tree or target will not be an accurate measure but a qualified estimation.

Standard safe work practices procedures should be applied in all instances.

Level 2 – Basic Assessment Process

1. Locating and identifying the tree or trees to be assessed.
2. Determining the targets and target zone for the tree or branches of concern.
3. Reviewing the site history and conditions, and species failure profile.
4. Assessing potential load on the tree and its parts.
5. Assessing general tree health.
6. Inspecting the tree visually and using binoculars, mallet, probes, or shovels, as desired by the arborist or as specified in the Scope of Work.
7. Record observations of site condition, defects, and outward signs of possible internal defects, response growth.
8. If necessary, recommending an advanced assessment.
9. Analyzing data to determine the likelihood and consequences of failure in order to evaluate the degree of risk.
10. Develop mitigation options and estimate residual risk for each option.
11. Develop and submit the report/documentation, including, when appropriate, advice on re-inspection intervals.



Flowchart of basic assessment procedures.

Examples of Advanced Tree Risk Assessments

Aerial Inspection

An aerial inspection (crown inspection) is the inspection of the aboveground parts of a tree not visible from a ground-based inspection, including the upper trunk, upper surfaces of stems, and branches. Aerial inspections usually include a visual assessment for defects, conditions, and response growth. Conditions of particular importance include inspection of significant branch junctions, cracks in branches, sunscald on the tops of branches, and bark damage from bird or animal feeding. In addition, aerial inspections may include evaluation of internal decay.

An aerial inspection can be performed from an aerial lift, adjacent building, ladder, or by

Level 3 – Advanced Assessment Techniques

There are many techniques that can be considered for advanced risk assessment.[z] Some situations may be assessed with several techniques. Advanced assessment techniques include, but are not limited to:

- Aerial inspection and evaluation of structural defects in branches
  - visual inspection
  - decay testing
  - load testing
- Detailed target analysis
  - property value
  - use and occupancy statistics
  - potential disruption of activities
- Detailed site evaluation
  - history evaluation
  - soil profile inspection to determine root depth
  - soil mineral and structural testing
- Decay testing
  - increment boring
  - drilling with small-diameter bit
  - resistance-recording drilling
  - single path sonic (stress) wave
  - sonic tomography
  - electrical impedance tomography
  - radiation (radar, x-ray, and gamma ray)
- Health evaluation
  - tree ring analysis (in temperate trees)
  - shoot length measurement
  - detailed health/vigor analysis
  - starch assessment
- Root inspection and evaluation
  - root and root collar excavation
  - root decay evaluation
  - ground-penetrating radar
- Storm/wind load analysis
  - detailed assessment of tree exposure and protection
  - computer-based estimations according to engineering standards
  - wind reaction monitoring over a defined interval
- Measuring and assessing the change in trunk lean
- Load testing
  - hand pull
  - measured static pull
  - measured tree dynamics

[z] Inclusion of specific products or techniques in this list does not necessarily imply that ISA endorses the use of that product or technique.

climbing the tree. The tree risk assessor should determine that the tree is safe to climb before entering the tree. Visual inspection from the ground using binoculars is not considered an advance assessment, but may be part of a basic assessment.

Assessment of Internal Decay

It is difficult to estimate or quantify the location and extent of internal wood decay during most basic assessments. When necessary to more accurately determine the location and extent of decay, it can be estimated with one of several decay-detecting techniques, including drilling and the use of sonic devices.

After estimates are made of the amount and location of solid wood present around a column of internal decay, several methods are available to evaluate the significance of the decay. Some methods are based on engineering models of pipe strength and recommended thresholds for minimum solid wall thickness. Modifications for species, location, amount of decay, dimensions of the tree, additional defects, and site conditions should be made by adapting the thresholds, but there is little guidance for such adaptations. Other methods adapt mechanical principles or engineering models in order to compare expected wind loads with the estimated load-bearing capacity of the tree.

The limitations of these models are that they are based on certain assumptions that may differ from actual trees. For example, unlike the common models for strength loss due to decay, tree trunks often are not circular in cross section and may have included bark, nonlinear fibers, and off-center decay. Wood in trees also does not have uniform strength throughout; some areas may be stronger and some weaker.

While high precision can be achieved during measurements, assumptions required to complete any evaluation carry some inherent error, which could be cumulative in the calculations. Nevertheless, mathematical models and calculations can be useful in some advanced tree risk assessments.

Several decay-detection devices are on the market but not all have been demonstrated through independent research to be effective tools, and there may be differences in precision, resolution, and reliability. This article will describe two well-established technologies currently available to risk assessors.

Drilling

Two types of drilling tools can be used to evaluate the extent of decay: a handheld electric drill or a resistance-recording drill. Both distinguish between solid and decayed wood by the drill's resistance to penetration as it moves through the wood.

It is important to carefully select testing locations so that the size and configuration of the decay column can be estimated. Before testing, sounding or visual assessment should be used to determine the best locations to test. The tree risk assessor should conduct sufficient testing to visualize the approximate extent of the decayed area. However, the tree risk assessor should take care to avoid unnecessary or excessive wounding. Tree risk assessors should also consider that drilling into decay can breach CODIT walls (especially wall 4), which may allow compartmentalized decay to spread. The number of drillings should be as few as possible, but as many as needed.

Compartmentalization of Decay in Trees (CODIT) is a model of tree response to wounding and decay. The model describes four responses, or walls, that the tree uses to exclude or compartmentalize decay fungi:

1. Plugging of the vessels or tracheids above and below the wound. The weakest wall.
2. The thick-walled cells of the latewood ring (temperate trees) and chemical responses.
3. Radial xylem parenchyma and chemical response of the ray cells. Strongest of the preexisting walls.
4. "Barrier zone" of new xylem formed after wounding. The biologically strongest of the four walls.

One type of drilling device is a handheld electric drill fitted with a long (8 to 18 inches, 20 to 45 cm), small-diameter (1/8 inch, 3 mm), full-fluted drill bit. Evaluation is primarily limited to the advanced stages of decay. Accuracy relies in large part on the experience and expertise of the operator.

A resistance-recording drill drives a small-diameter (1/8 inch, 3 mm), flat-tipped spade bit into the tree. As the bit penetrates the wood, the resistance to penetration is recorded. With training and experience, an inspector can distinguish solid wood from voids and decay. Incipient decay, effectiveness of compartmentalization, and response growth rates may be estimated from profiles created by some high-resolution resistance drills.

An inspector, with the proper training, can distinguish solid wood from decaying wood, with the use of a resistance-recording drill.

Sonic Assessment

Sonic wood assessment instruments send a sound (stress) wave through the wood and measure the time for the wave to travel from the sending point to the receiving point. If a crack, a cavity, or decay is present, the sound travels around the defect, increasing the transmission time (time-of-travel) from the sending to receiving point, as compared to the transmission time through wood with no defect. The device, however, cannot distinguish the *type* of defect (decay, cracks, embedded bark, or cavities) that increased the transmission time.

One type of device measures the transmission time between two points, which can be a quick test to reveal the presence of cracks or decay between the two points. Limitations, however, are that reference values are needed and that conducting only one test may miss even major defects. Tests at additional points are needed to provide a comprehensive inspection. Two sets of points, forming perpendicular lines, are considered the minimum by many operators in order to detect large, centrally located defects.

Sonic tomography instruments use measurements between many points to create a two- or three-dimensional picture (tomogram). By comparing the results of all time-of-travel measurements, it is possible to detect and map defects within the trunk. The tomogram illustrates the remaining load-carrying parts of the inspected cross section. The resolution of tomography is directly related to the number of sensors used on a tree. In contrast to drilling, sonic devices have substantially less risk of breaching CODIT wall 4.

Root Assessment

Root Inspection and Evaluation

The extent of damage or decay in tree butts, buttresses, and roots is difficult to evaluate in a basic inspection because most roots are beneath the soil surface and the root architecture is not visible. There are several types of evaluations that can be conducted on roots to inspect for decay. The simplest is the visual assessment of buttress roots at the basal flares, or when the top surfaces of the roots are exposed. When not exposed, the tree risk assessor will first need to excavate soil or other materials covering the root collar in order to conduct the assessment. This process is called root collar excavation. At a minimum, a root collar excavation should reveal the top of the buttress roots to the point where the root is nearly horizontal or follow roots a distance equal to or greater than the trunk diameter. Depending on the goal of the assessment, the excavation may need to continue farther out along the length of the root. The least injurious method of excavation available should be used. This may involve the use of high-pressure air or water. If necessary, hand tools can be used. Care must be taken not to damage the roots or trunk during the excavation process. After excavation, roots can be inspected for evidence of cutting, injury, decay, response growth, or other conditions.

Sonic tomography instruments use measurements between many points to create a two- or three-dimensional picture (tomogram).

Root Decay Evaluation

When evaluating root decay, the tree risk assessor should consider that decay in roots typically progresses from the bottom of the root upward. Drilling and sonic techniques can help determine the number of roots with decay and the extent of root decay within each root, but they are not designed to quantify the amount of strength loss in the root system. Tree risk assessors should also consider that drilling into decay in roots can also breach CODIT wall 4, which may allow compartmentalized decay to spread. The number of drillings should be as few as possible, but as many as needed.

Measuring Change of Lean

A changing angle of lean indicates a higher likelihood of failure. Sometimes it is difficult to determine if a tree's lean is changing. A digital level or other device can be used to monitor small changes in lean angle. When trunk angle measurements are made over time, it is important that they be taken at the same location each time. However, digital level readings taken during the dormant season cannot be directly compared with readings taken when the tree has foliage. The same is true during times of drought, rain, snow, or ice glazing.

Load Tests

Load tests are used by specially trained tree risk assessors to assist in evaluating the potential for failure. There are several types of load tests: hand pull, measured static pull, and measured dynamic. Load tests do not attempt to detect internal decay, but use deformation or deflection to detect weakness in the structure and assess the load required to initiate the failure process.

A *hand-pull test* involves installing a light-duty line in the tree, and pulling and releasing the line several times to move the tree or branch. When testing root and trunk stability, the line is placed high in the crown. When the line is pulled, trunk and root plate movement is observed. Excessive trunk, root, or soil movement may indicate instability. Branches may also be tested in this fashion. The line is run over the branch and pulled; the tree risk assessor looks for movement and crack openings. This technique is most commonly used in a pre-climbing inspection. Because the tree or branch reaction is monitored only visually, tree risk assessors are cautioned against overloading the tree or tree part and initiating failure. The tree risk assessor should be outside of the fall zone when conducting this type of test.

Pull test. Arrows: elastometers monitor fiber strain under the applied load and detect high strain areas in the wooden body of the stem. Circle: an inclinometer is positioned at the base of the stem to record root plate inclination during the load test.

In a *static pull test*, sensors are attached to the tree to measure marginal fiber strain (stretching and compressing) in the stem or branches, and/or inclination (change in angle) of the root flare in response to a controlled pull. The amount of deformation and inclination, measured by sensors, is compared to reference values to evaluate strength or stability. Working within specific thresholds for tolerable deformations is required to avoid overloading of the tree during the load test. The sensor readings after unloading should confirm that the tree has returned to its original position.

Dynamic load tests take place under natural wind conditions or with static pulls and are used to measure the movement of an individual tree. Sensors are placed on the trunk and/or near the base, to measure fiber strain and/or inclination of the root plate. Currently, this test is in the developmental stages and the availability of sensors is limited.

The next article in this series will discuss fundamental concepts in tree biomechanics.

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All photos and flowcharts are courtesy of the authors.

CEU TEST QUESTIONS

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Next, complete the registration information, ***including your certification number***, on the answer form and send it to ISA, P.O. Box 3129, Champaign, IL 61826-3129. Answer forms for this test, **Tree Risk Assessment: Levels of Assessment**, may be sent for the next 12 months.

If you do not pass the quiz, ISA will send you a retake answer sheet. You may take the quiz as often as necessary to pass. If you pass, you will **not** be notified; rather, you will see the credit on your CEU report (available online). Processing CEUs takes 4 to 6 weeks.

CEUs for this article apply to Certified Arborist, Utility Specialist, Municipal Specialist, Tree/Worker Climber, and the BCMA management category.

1. A limited visual assessment typically focuses on identifying trees with
   a. minimal defects or conditions that could lead to failure
   b. a imminent and/or probable likelihood of failure
   c. diameters greater than 40 inches (1 m) and at least one defect
   d. a close proximity to playgrounds or other high-target area
2. Which of the following is generally *not* a part of the inspection process in a basic visual assessment?
   a. review site history and conditions
   b. assess potential load on the tree and its parts
   c. assess the tree's general tree health
   d. climb the tree to inspect aerial portions
3. The reason three levels of assessment are defined is
   a. to accommodate municipal, utility, and commercial applications
   b. because arborists must look at aboveground, belowground, and interior portions of a tree
   c. because not all trees or situations require the same depth and breadth of assessment
   d. all of the above
4. The fastest, but least thorough means of assessment is
   a. Level 1
   b. Level 2
   c. Level 3
   d. Level 4
5. Limited visual assessments are intended primarily for
   a. standard visual assessments of individual trees
   b. assessments of trees in which interior decay cannot be seen
   c. large populations of trees
   d. assessments that use tools or electronic devices
6. Often, limited visual inspections are used as
   a. a screening step to identify trees that need further assessment
   b. an inexpensive way to avoid more thorough assessments
   c. a quick alternative to advanced assessment
   d. all of the above
7. Another name of a "basic" assessment is
   a. Level 1
   b. Level 2
   c. Level 3
   d. Level 4
8. A basic assessment requires that the assessor
   a. walk completely around the tree
   b. inspect visible buttress roots
   c. inspect the trunk and branches
   d. all of the above
9. Which of the following tools are commonly used in a basic visual assessment, but are not required?
   a. air excavation device
   b. mallet and probe
   c. decay detection device
   d. inclinometer
10. Advanced assessments are performed to provide
    a. risk evaluations on high-value trees, historic trees, or trees of significance to a community
    b. tree appraisal information to quantify a tree's value for insurance or litigation purposes
    c. detailed information about specific tree parts, defects, targets, or site conditions
    d. risk assessments of large populations of trees, such as in a municipality
11. A common method of limited visual inspection is
    a. a walk-by inspection of trees in a population
    b. a drive-by inspection of street trees in a city
    c. an aerial fly-over of utility transmission lines
    d. all of the above
12. A disadvantage of limited visual inspections is that
    a. some conditions may not be visible from a one-sided inspection of a tree
    b. not are all conditions are visible on a year-round basis
    c. they may not be adequate to make a risk mitigation recommendation
    d. all of the above
13. Another name of a "limited visual" assessment is
    a. Level 1
    b. Level 2
    c. Level 3
    d. Level 4
14. In a basic visual assessment, sometimes a trowel or shovel is used to
    a. take soil samples to send to the lab for fungal analysis
    b. dig decayed wood out of cavities
    c. perform minor soil excavation to inspect root collars
    d. all of the above
15. A limitation of a basic assessment is that it
    a. includes only conditions that are detected from a ground-based inspection
    b. provides a limited perspective, usually from only one side of the tree
    c. does not permit the use of any basic tools without becoming an advanced assessment
    d. all of the above
16. Advanced assessments are generally more time intensive and more expensive than basic visual assessments because
    a. they require specialized equipment, data collection and analysis, and/or expertise
    b. the potential consequences of tree failure are significantly higher than normal
    c. they involve trees with the highest likelihood of failure
    d. all of the above
17. Risk managers should consider the consequences of failure, tree value, and time and expense before committing to an advanced assessment because
    a. risk assessment measures should be reasonable and proportionate for the situation and circumstances
    b. only those trees with a high likelihood of failure can justify an advanced assessment
    c. only those trees with severe consequences of failure can justify an advanced assessment
    d. high-value trees warrant an advanced assessment regardless of the consequences of failure
18. Prior to beginning a tree risk assessment, it is important to define the scope of work in order to
    a. ensure that the tree risk assessor and client agree on the goals, limitations, and budget
    b. determine which advanced assessment techniques are needed to calculate risk
    c. determine whether a report will be needed to present the results of the assessment
    d. all of the above
19. In a basic visual assessment, the next step after recording observations of site condition, defects, outward signs of possible internal defects, and response growth is to
    a. develop mitigation options and estimate residual risk for each option
    b. analyze data to determine the likelihood and consequences of failure in order to evaluate the degree of risk
    c. develop and submit the report with all of the supporting documentation
    d. offer advice on re-inspection intervals based on the likelihood and consequences of failure
20. The problem with breaching wall 4 during decay detection procedures is that
    a. all four walls are necessary to sustain water transport
    b. the reaction zone may be killed
    c. compartmentalized decay may be allowed to spread
    d. all of the above
21. Drilling tools can help determine the number of roots with decay and the extent of root decay within each root, but they are *not* designed to
    a. quantify the amount of strength loss in the root system
    b. detect decay in horizontally oriented roots
    c. be used on any root that is fully or partially below the soil surface
    d. detect any interior flaws other than fungal decay
22. The Scope of Work should clarify
    a. any property boundaries that restrict access to the tree(s)
    b. local government or authority's requirements for inspection and permitting
    c. who the final report is to be submitted to
    d. all of the above

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23. For all levels of assessment, if the risk assessor determines that a higher level of assessment or different type of assessment is needed, then
    a. the additional assessment should be performed immediately
    b. that recommendation should be made to the client
    c. it should be undertaken only if the consequences of failure are severe
    d. all of the above
24. If a situation is encountered where tree failure is imminent and a high-value target is present and likely to be impacted, then
    a. the situation should be reported to the client as soon as possible
    b. mitigation should be an immediate priority
    c. immediate action may be required to restrict access to target zone
    d. all of the above
25. A limitation of using pipe-based models for residual strength of solid wood surrounding internal decay in trees is that
    a. mature tree trunks tend not to be circular in cross section
    b. decay may be off center
    c. decay may be irregularly shaped
    d. all of the above
26. A hand-pull test involves installing a light-duty line in the tree and pulling then releasing the line several times
    a. while timing the rate of deflection and return to vertical to measure wood flexibility
    b. to ensure that no hangers or dead wood is likely to fall from the crown
    c. to measure the maximum deflection at the top of the crown
    d. while watching for trunk or root plate movement that could indicate instability
27. What method of advanced assessment involves attaching sensors to a tree to measure marginal fiber strain (stretching and compressing) in the stem or branches, and/or inclination (change in angle) of the root flare in response to a controlled pull?
    a. dynamic load testing
    b. hand-pull test
    c. static pull test
    d. stress testing
28. A disadvantage of using drilling to estimate the extent of internal decay in trees is that
    a. it is not possible to estimate the decay in more than one plane of cross section
    b. drilling into decay can breach CODIT wall 4
    c. internal decay cannot be distinguished from internal cracks
    d. all of the above
29. Which of the follow describes the formation of the "reaction zone" in the CODIT model?
    a. plugging of the vessels or tracheids above and below the wound
    b. the thick-walled cells of the latewood ring (temperate trees) and chemical responses
    c. radial xylem parenchyma and chemical response of the ray cells
    d. all of the above
30. Which of the following constitutes the formation of the "barrier zone" in the CODIT model?
    a. plugging of the vessels or tracheids above and below the wound
    b. the thick-walled cells of the latewood ring (temperate trees) and chemical responses
    c. the new xylem formed after wounding
    d. radial xylem parenchyma and chemical response of the ray cells
31. Which of the following would *not* be considered an advanced assessment technique?
    a. developing a tomography of the stem
    b. drilling with a small-diameter drill bit
    c. performing a thorough root collar excavation
    d. using binoculars to better inspect a tree's crown
32. Which of the following would be considered and advanced assessment technique?
    a. load testing
    b. weather investigation
    c. drilling to detect decay
    d. all of the above
33. Sonic wood assessment instruments develop a tomogram representing internal wood decay based on
    a. detecting tonal differences among decayed wood, solid wood, and cracks
    b. measuring the time for sound waves to travel through the tree between points on the perimeter
    c. creating a "picture" of internal decay based on sonic differences of various decay organisms
    d. utilizing audio differences between internal cracks and decay to measure resistance
34. In contrast to drilling, sonic decay detection devices have substantially less chance of
    a. breaching CODIT wall 4
    b. breaching the reaction zone
    c. detecting off-center decay
    d. detecting a crack
35. The resolution of tomography is directly related to the
    a. thermal properties of the heartwood
    b. electrical impedance of the sensors
    c. number of sensors used on the tree
    d. all of the above
36. Binoculars may be used to inspect the upper portions of a tree's crown to look for
    a. cracks or weak unions
    b. cavities, nesting holes, or other signs of decay
    c. indications of response growth
    d. all of the above
37. When excavating roots for inspection, a guideline for the minimum amount to excavate is that the excavation should reveal
    a. all roots greater than two inches in diameter that are within a radius equal to three times the diameter of the trunk
    b. the top of the buttress roots to the point where the root is nearly horizontal or follow roots a distance equal to or greater than the trunk diameter
    c. all of the root collar and buttress roots such that the underneath side of the buttress roots can be inspected
    d. the top side of all roots within the dripline of the tree or a diameter of three times the trunk, whichever is less
38. In the Scope of Work, the identification of trees to be assessed may take the form of
    a. the location of a tree (e.g., "the large oak tree in the front yard")
    b. selection criteria [e.g., "all trees greater than 12 inches (30 cm) diameter on Main Street"]
    c. maps with definitive boundaries and a clear definition of how boundary trees will be treated
    d. all of the above
39. The primary reason for performing a root excavation in tree risk assessment is to look for
    a. evidence of decay, cutting, or other factors that may compromise stability
    b. the concentration of fine, fibrous roots essential to "hold" the tree
    c. signs of soil cracking or lifting due to bending moment reaction
    d. insects, mites, or nematodes in the soil that will disturb water uptake
40. An increasing angle of lean indicates a
    a. strong phototropic response
    b. corrective response growth
    c. higher likelihood of failure
    d. decay problem on the compression side

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