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**Introduction**

The process of evaluating tree health and condition involves gathering information in the field, determining the significance of that information and producing a report of the fieldwork findings. As many reports are the product of periodic ongoing monitoring of a developing situation, over time, some repetition in explanatory information is inevitable.

In producing and explaining the findings, each report is intended to be readily understood and able to stand alone, with no further reference being required by the reader.

Each report contains the following sections;

- **Overview** Describes the events that precipitated the initial evaluation and identifies the subject, owner and location.
- **Tree Inspection** Containing an explanation of the field work techniques and an outline of methods and instruments used in analysis.
- **Observations** Gives site and tree specific information and commentary.
- **Conclusions** An interpretation of the field work observations, testing and analysis, with recommendations for treatment.

## Overview

The Red Hawk Community has several areas of woodland that comprise the Native Growth Protection Areas (NGPA). The trees which form buffer set asides between the homes in have been the subject of periodic Tree Inspection. The process of evaluating the trees began following a tree failure which occurred during a severe storm in December of 2006 causing damage to a home within the community. The area where the failure occurred was inspected as an isolated issue on the edge of one of the NGPA's. Subsequent to that inspection, the homeowner's association called for an expansion of the Tree Inspection to include two other NGPA's. That inspection took place in the spring of 2007 with a follow-up inspection occurring in 2010. After a span of four years, the community representative requested that the areas undergo a further Tree Inspection. The field study for this year's work took place during the latter part of January, 2015.

## Tree Inspection

To develop an accurate picture of tree health and condition, information must be gathered about the multiple, changeable, factors which influence tree vitality and stability. Vital, healthy tree growth is the result of a complex association of internal and external influences and to consider each tree as an isolated entity is to fall short in understanding the whole picture. As a practical matter, information must be gathered and structured in the best way to communicate the results of the observations and to impart any recommendations for treatment.

Individual tree inspection begins at ground level; tree genus and species is determined and soil quality, rooting conditions, soil level, irrigation and drainage characteristics are observed. Soil is a living micro-system that relies on an active working relationship between structural and living organic components. In an urban setting the structural condition of the soil is most commonly adversely affected. Alterations to physical soil structure will have an effect on the functions of the living soil components.

The quality of the soil may be assessed in its ability to contain and disperse available moisture and the level of soil compaction may be tested to evaluate the aeration capacity of the soil. Some soil types are easily compacted and although they are high in nutrient quantity, little nutrient is available to the growing tree. Compact soils also cause problems by restricting the trees ability to discharge the gasses produced as part of the growth cycle.

The visible parts of the tree, the trunk, branches and leaves live in balance with the unseen roots. Damage to the soil leads to inhibited root growth and causes a lack of vitality and decline within the tree as a whole. Soil compaction may be the result of short term heavy or long term frequent traffic in the root zone. The effects of soil compaction may not become apparent in the tree for decades following the initial compaction event.

If signs of stress are present, a soil test may be made to assess the fertility of the soil. Testing establishes the presence and degree of vital nutrients and micro-flora.  Vital soil is essential to vital tree growth, the presence of nutrients and organisms within the soil mean that growth can continue. An imbalance of nutrients can cause poor vitality; often exhibited by leaf discoloration, distortion or lack of annual growth. Poor nutrition will slow growth can diminish the trees natural defense mechanisms and expose the tree to disease.

In nature, few tree species grow alone; the forest is their natural and protected setting. Whether native or introduced, regardless of a trees' origin, trees in a landscape setting demand special attention. Although bound by the genetic code of its predecessors each tree is also the product of its local environment in terms of health and structural form.

Looking at the overall picture, the health and condition of the soil, turf and other plants and trees can reveal the cause of disease, or indicate potential problems. The presence of certain species of fungus can indicate decay. Decay fungi may destroy support tissues and leave conductive tissues unharmed. The tree may appear healthy and continue to grow until the internal decay outpaces the new outer growth whole tree collapse can result.

A root crown examination may be necessary if root decay is suspected. By removing the soil at the base of the tree, the location, health and condition of the absorbing and support roots can be determined.

In the primary examination of the root crown and trunk a mallet is used to test for loose bark. Bark lifting can indicate dead or hollow areas and give signs of the presence of decay in the root crown zone and at the base of the trunk. The mallet may be used to "sound" for decay but has limited reliability. If decay is suspected the tree will be tested using the Resistograph. Where Resistograph tests were made a more detailed explanation and an interpretation with illustrations is given later in the text.

The type of decay and its effect on the stability of the wood depends on the species of fungus involved. Soil and root tissue samples may be taken to determine the cause of disease by laboratory testing.

The inspection continues with an evaluation of the tree crown, first by eye or with the use of binoculars then, if necessary, by climbing into the canopy of the tree. The color, size and condition of the leaves, trunk, branches and twigs are assessed. The shape and formation of all the trees components give information about health, vitality and structural strength. The crown density, the number of leaves on each stem, and past and current growth extension, indicate current health and reveal previous problems. Changes in growth rate in past growth may indicate prior disease or injury.

An evaluation of the general growth habit will reveal any problems related to vigor, or the genetic component of tree growth. Previous treatments such as pruning or cabling are observed, the quality of the work, and its effect on the tree is assessed. Any growth abnormalities are noted: weak limbs, discolored or missing bark, cracks or cavities in branches or trunks. Indications of disease are observed within the canopy of the tree, disease may be indicated by leaf blight, leaf loss, poor vitality, stem canker, fungal growth or insect and bird activity.

Trees produce adaptive growth to compensate for the stress related to growth and injury. The shape and formation of limbs and trunks can reveal the ability of the tree to compensate for weakness or may indicate internal problems that could lead to limb or trunk breakage. The interpretation of these changes in form is part of a growing body of knowledge pioneered in Europe and adopted across the globe. The knowledge is not new but the application of that knowledge in risk assessment is in the forefront of progress in understanding how trees compensate for stress. Research into stress-loading of trees and materials testing of wood structure has led to the development of systems of structural evaluation based on the principals of bio-engineering.

## Observations

The NGPA's within the Red Hawk community are separated into three distinct locales and are shown on the included sketch plan as Areas A, B, and C. The areas are distinguished by location and by the make up of the tree population. Tree species within the buffers include:

- Douglas fir (*Pseudotsuga menziesii*)
- Western redcedar (*Thuja plicata*)

- Bigleaf Maple (*Acer macrophyllum*)
- Red Alder *(Alnus oregona)*
- Western Hemlock (*Tsuga heterophylla*)

Of primary concern is the condition of the larger older Douglas fir. Where tree failure has happened in the past the majority of trees that failed have been Douglas fir. Failure has occurred at the root crown during high wind incidents. Examination of tree remains has determined that Laminated Root Rot is the primary agent of decay.

Laminated Root Rot also known as yellow ring rot affects conifers in Japan, Manchuria, and Western North America, from Southern Oregon, to British Columbia. In North America two distinct forms exist; in Washington State one form occurs through the Eastern Cascades and Eastern Washington. The second form is found here in Western Washington. Different species are affected by the different strains. The eastern form primarily affects Western Redcedar (*Thuja plicata*) and the western form affects the Douglas fir (*Pseudotsuga menziesii*).

The disease occurs mainly in forests that are managed for timber production but is often found in landscaped settings where stands of trees remain following the clearing of a wooded area. Trees highly susceptible to the disease in Western Washington include; Mountain Hemlock (*Tsuga mertensiana*), Douglas fir (*Pseudotsuga menziesii*), Grand Fir (*Abies grandis*), Pacific Silver Fir (*Abies amabilis*), and White Fir (*Abies concolor*).

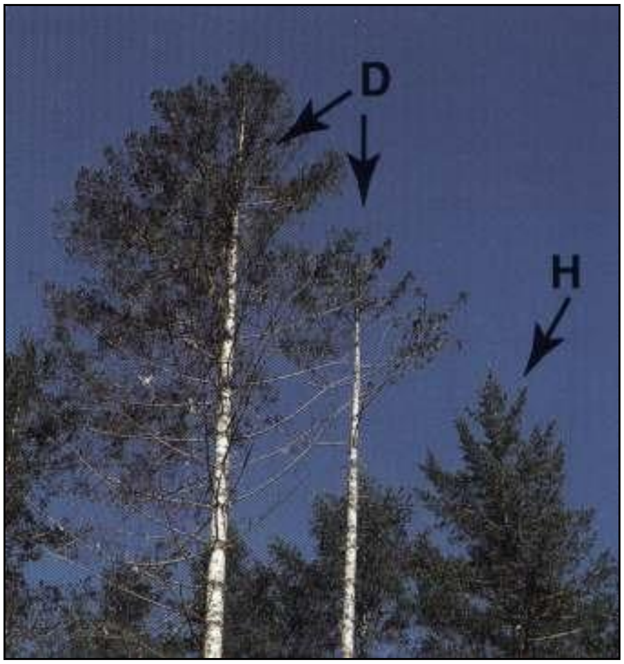
***Symptoms and Diagnosis***

Trees may be infected at a young age but the disease is seldom noticed until the trees are at least ten years old. Most destruction occurs in trees between 25 and 125 years old. The majority of the trees are blown down while still alive. Failure is due to root decay caused by the fungus, *Phellinus weirii*, which digests the woody support roots while absorbing root activity continues. New growth continues while older root and trunk tissues are decayed. The typical pattern of decay, shown in the photograph above, leaves only stubs of support roots showing following failure.

Laminated Root Rot spreads on site by growing through the soil via root contacts. Diseased trees and the stumps of fallen trees should be considered infection sites and the fungus is capable of surviving on decaying stumps for over 50 years. An area of fifty feet around a diseased stump is a potential infection zone; all susceptible trees that fall within this area may be infected.

The tree in the photograph on the previous page is located in Area C. Laminated Root Rot was diagnosed (see following section) and several fruiting bodies of the Brown Rot fungus *Phaeolus schweinitzii* were also present indicating that the tree was subject to decay by at least two different pathogens.

However it appears that Laminated Root Rot is the primary cause of failure. The




growth within the upper canopy of some trees is reduced; this can cause a “rounding of the crown” shown as **D** in the photograph at left. Conifers typically have a dominant central leader shown as **H.** When the disease slows growth the leader is first affected, the surrounding limbs continue to grow forming the rounded crowns as shown above. A disease center may be indicated by a group of trees with rounded crowns surrounded by trees with strong central leaders.

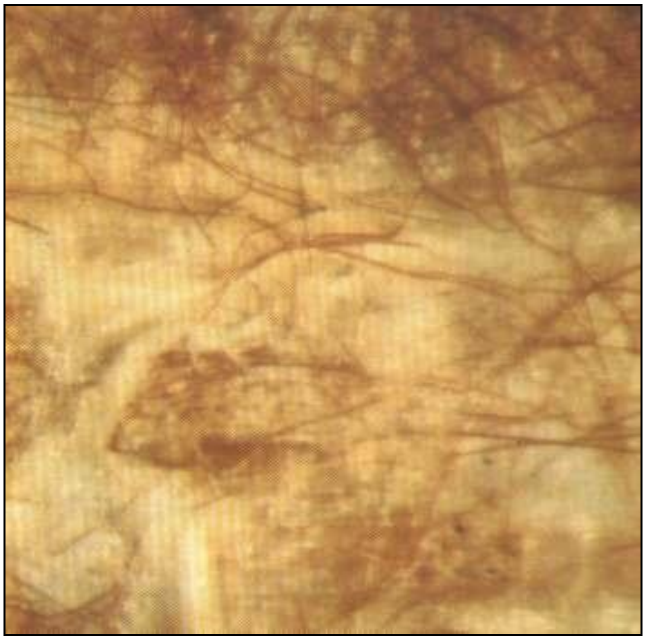
The base of some trunks may be decayed at the root crown level close to the ground. This decay can be detected in standing trees with the use of the Resistograph.

The symptoms described above may also be attributed to a number of other forms of disease

above ground symptoms of the disease are often subtle. The and further examination is necessary to determine that *Phellinus weirii* is at work.

Positive diagnosis of Laminated Root Rot is made through the microscopic examination of root tissues.

Shown below, the hair-like growth is known as setal hyphae and is a fungal structure which shows that *Phellinus weirii* is present. Extensive de-lamination of wood tissues and decay are to be expected where setae are present.



The risk of whole tree failure increases significantly where Laminated Root Rot exists. Furthermore the risk of additional failure increases with incidence of failure. As individual trees fall the remaining trees become exposed as previously described. The new exposure can cause additional failure in both diseased trees and healthy trees with poor structural form.

To better understand the implications of the site disease the disease sites were located on the plans. All susceptible trees with increased risk of failure were identified by plotting their location in relation to the known disease sites. In addition to the failure in conifers a Bigleaf Maple was noted to have several dead leaders and large broken hanging deadwood. Shown at right this tree is located toward the north end of Area A. There is also a Douglas fir growing up through the center of the

Maple; the base of the fir is constricted by the Maple. With the trunk growth of the Maple acting like an encircling root which will eventually constrict the growth of the fir causing decline, death and probable failure at the base.

## Conclusions

Since the last Tree Inspection, five years ago, there have been three significant tree failures. The locations of the tree failures are shown on the sketch plan. Two of these failures were directly attributable to Laminated Root Rot which was diagnosed using the method described earlier in the report.

The third failure is shown at left. This fir tree was composed of two stems. The photograph shows the base of the tree and one of the stems. The photo shows bark that was growing between the stems. It seems that during the failure of a neighboring fir this tree was struck and caused the weak co-dominant union between the two stems to fail. Both trees fell in opposite directions within Area C which is a buffer with no formal trails or access.

A Douglas fir located in Area A on the edge of the buffer failed at the root crown. Examination showed the presence of Laminated Root Rot. The tree collapsed toward the transmission line ROW; an area that receives only occasional use. No harm occurred.

One situation is of concern at this time. The Bigleaf Maple shown on the following page and described previously should be addressed. There are

indications that the area around the base of this tree is regularly accessed. The condition of the Maple is very poor. The canopy of the tree contains very large dead branches  and leaders. Some of the deadwood has broken off and is hanging; other deadwood is still attached. The Douglas fir discussed in the previous section will become increasingly prone to failure with time. Failure would likely occur at the base and would have a significant probability of causing harm. These trees should be pruned to remove the deadwood and to create a wildlife snag by reduction of both the Maple and the Fir to high stumps approximately 20' tall. The photo showing the Fir and the Maple is indicated by yellow flagging.

Given the presence of disease and the increasing size of the trees within the buffers monitoring is highly recommended with the next inspection to be scheduled for 2017.

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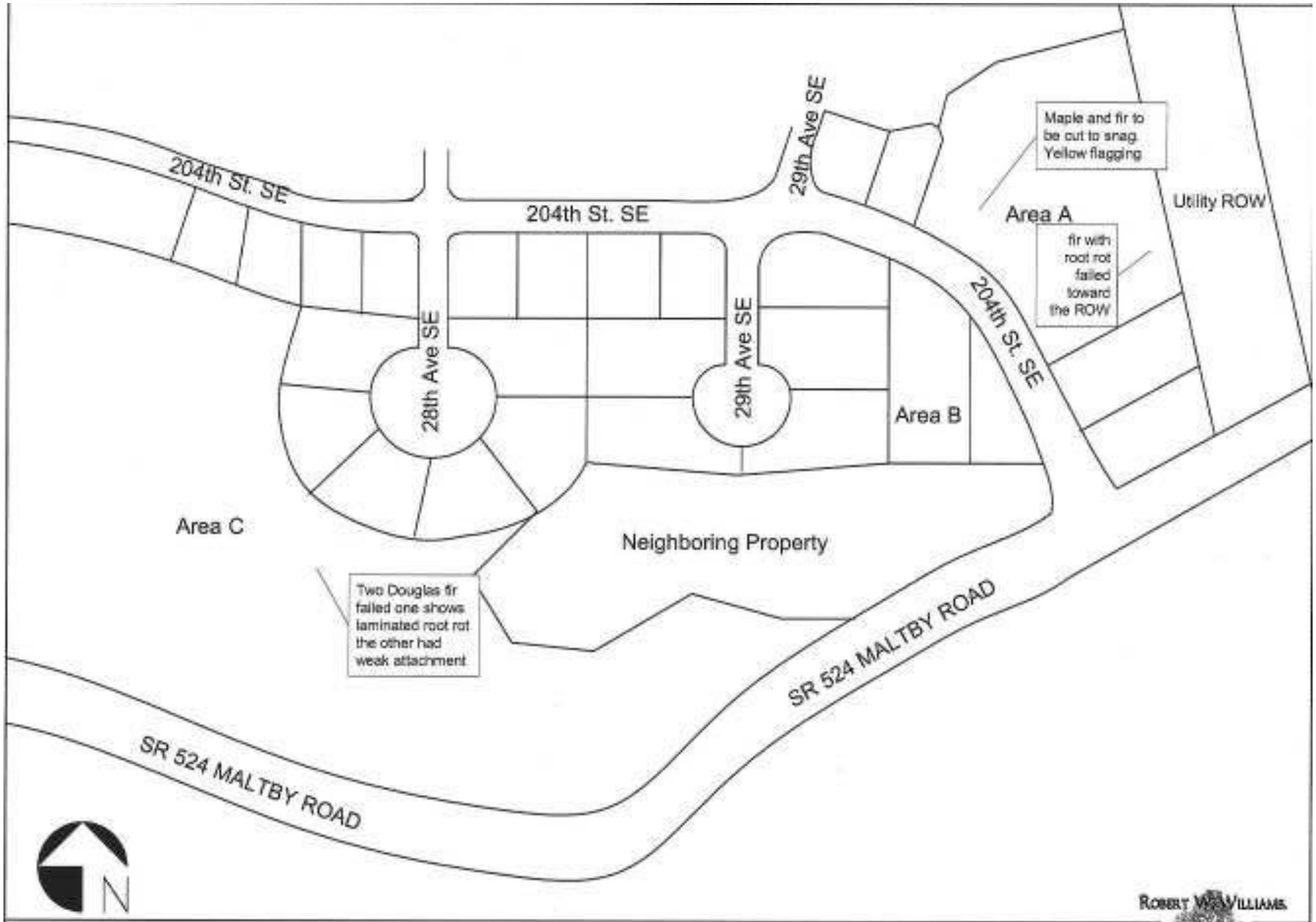

Sketch Showing the Areas identified in the Arborist's report 2015 for the Red Hawk community