



March 24, 2022

Project: Vegetation management plan for select trees at 4645, 4649, and 4651 Forest Avenue SE, Mercer Island. Parcel Numbers 404500-0075, -0080, and -0085.

Contact: Scott Sinclair – Tree Harmony Arborists, LLC
PO Box 1261, Mercer Island, WA 98040
Phone - 206 275 0991 Email – paulscottsinclair@gmail.com

Objective: Evaluate risk for trees in range of houses, entry drives, walking paths, and parking. Make recommendations for removal, mitigation, and preservation. Promote health, correct structure, and insure longevity of those to remain. Create scenario for any mitigation planting required by the City.

Description: The three properties sit interlocked on a one acre section between Forest Avenue and Lake Washington on the west side of Mercer Island (Figure 1). The 4645 house was the first of the three present on the section having been built in 1936. It was heavily remodeled in 1998 and the current owners have lived there for six years. They have made few if any substantial changes to the property.

The 4651 house was constructed next in 1961 and renovated in 1989. The current owners purchased it twenty-five years ago. They have made few noticeable changes to their property since. The center, and upper, 4649 house was constructed in 1977 on a lot which was carved in between, and likely out from, the earlier established properties.

The current home owners of the 4649 property purchased it in July of 2021. Over the course of meeting the neighbors the topic of trees arose. The other two home owners have grown concerned with some of the trees overhanging their homes and shared driveway. Several large limbs have failed over their tenure, a couple struck the homes and damaged the hardscape, and a number came close to causing damage to their homes and vehicles.

The 4649 home owners contacted Tree Harmony Arborist who in turned reached out to Superior NW and a preliminary site visit was made in December of 2021 during which many trees were pointed out as being in need of preventative maintenance. Several had safety concerns.

After a pause to think through their options the three home owners requested that a formal vegetation management plan be created, including risk assessments, for several of the trees within reach of the various houses, driveways, parking areas, and the walking paths. They asked that the report include a plan for remediation based on the numbers of trees recommended for removal. They also wanted suggestions for more desirable species and locations for any replacement tree in order to enhance the area, provide for better bio-diversity and longevity, and aid in long term slope stability.

Three more site visits were made during the spring of 2022. The trees of concern were documented as to size, species, and locations. Their diameters were measured at the standard height of 54" above grade (DSH). Caliper measurements were taken at 6" above grade per industry standard. Heights were estimated. Other trees in their vicinity were also noted. The trees were tagged with 1" circular bright green markers unless otherwise noted. The following itemized list begins at the lakeside in the small area between the 4645 and 4651 properties. The trees' rough locations and numerical designations are shown in Figure 2 (an aerial image from 2019 was used for the tree plot as it illustrated the clearest placements).

1. Big Leaf maple (*Acer macrophyllum*) 26" DSH, 75' tall, 24' spread mainly to the west side standing between the 4649 boat house and the lakeside and docks (Figure 3). The upper half of the canopy is dead (Figure 4). There is a section extending to the northwest in the mid canopy that is live but dying back. The only truly viable portion of the tree is the set of six scaffolds below the halfway point growing to the west. Tree is in advanced decline and likely infected with the newly identified disease that is killing the maples.

2. Western Red cedar (*Thuja plicata*) 34" DSH, reaches into 80' range on some sections, no more than 60' tall on others. The tree stands with the south side of its base touching a large stone retaining wall for the 4651 house (Figure 5). A concrete pillar corner support for the raised driveway parking area is 30" E of the tree (Figure 6). A second stone wall supports the stairs that lead down to the lake (Figure 7). The area between the two retaining walls is quite narrow and runs 12' out to the east side of the tree. The stairs are formed from Keystone blocks that appear to be set over a concrete and brick framework and run down the north side of the tree 3' off its base. Another concrete block retaining wall system runs east to west 10.5' N of the tree.

The cedar was topped or damaged near the 40' level and separates into a main stem and a 16" caliper subordinate that heads east at a 30 degree angle. The subordinate turns more upright, 15-18' out from the central column, and continues into the 65' range. A pair of smaller subordinates comes off the main stem above the separation point. Another large subordinate grows almost horizontal to the north and extends over the 4645 neighbor's roof. This upper area is where a large section of the tree broke out and struck the 4645 home a number of years ago. There are multiple subordinate spars coming off low on the column. The largest is an 18" caliper coming off the east side that goes out 5' and turns up at a 45 degree eventually reaching the 55' level. A handful of large subordinates come off low in the NW quadrant. They are crooked, droop down, and then turn upward reaching out as much as 30' and up into the 40' level. They are carrying quite a bit of weight and at least two broke off in the past. Tree exhibits decent new growth and color in the lower half of the canopy. New growth is somewhat stunted, color is less vibrant, and the canopy is more sparse above the separation point.

3. Western Red cedar 22.5" DSH, 70' tall, standing 8' E of the east side gutter line on the 4651 house near its NE corner. It is growing on a raised embankment and leans slightly to the west as it rises. A 5' tall stone retaining wall crosses 18" W of cedar's base and curves to intersect with the main retaining wall that starts 6' SW of the tree (Figure 8). The entry drive is 15' E of the tree and there is another small stone retaining wall that starts 5' NE of the tree (Figure 9). The cedar appears to be in fair condition. The majority of its canopy is off the west side.

4. Western Red cedar 18" DSH, 55' tall, standing 4.5' W of the entry drive next to a storm drain catch basin (Figure 10). The edge of the basin is 6" off the tree's base and the vault is at least 24" deep. The catch Basin measures 5.5' square and intersects connects with a low stone retaining wall 30" W of the base of the tree (Figure 11). The combination takes out nearly half of the rooting space for this tree on its north side. The cedar exhibits fair health in the lower half of canopy. Epicormic growth is present in the upper half.

5. Douglas fir (*Pseudotsuga menziesii*) 20.5" DSH, 70' tall standing 6.5' W of the entry driveway and 20' S of the #4 cedar. It was topped or damaged near the 35' foot level and has a single large spar, offset to the west, rising above that point. There are a couple of subordinate spars coming off to the north side. One of the subordinates turns back on itself. It was not possible to determine if decay is present at the damage point. The majority of the live canopy is on the large spar and fairly dense. Exhibits fair health and a suboptimal structure.

6. Big Leaf maple, 26" caliper, bifurcates fully at 4' mark, the stems measure 16" and 18" DSH. Close to a third of the canopy is dead. The majority of the viable canopy extends to the west. There is large caliper breakage in the upper canopy. Tree stands 24' S a little west of the #5 and almost even with the SE corner of the 4651 house. There is a nice little madrone at the maple's base that could be maintained to help hold the bank here

7. Leyland cypress (*Cupressus x leylandii*) 32" DSH, 70' tall standing on the east side and above the entry drive. The east edge of the asphalt is 7' off the base of the tree at the closest. The driveway curves into the southeast quadrant of the tree and into a small stone retaining wall (Figure 12). It has a curve north of the tree that swings out to come near a keystone block retaining wall that runs north (Figure 13). Tree has a multitude of subordinate spars growing up and out from low on the column. They are carrying a lot of weight on the west side and over the driveway. There is evidence of a several breakouts and the clients report that the tree has lost limbs every year of the last eight. Most recent failure occurred in mid-March when two large limbs broke loose and fell across the driveway for the properties. Above the halfway point the spars start to angle more to the vertical but multiple are sprung and going horizontal through the others. Majority of the biomass, nearly 70%, grows to the west side (Figure 14). The tree leans slightly to the west from the base increasingly so in the upper reaches. The east side of the tree is interfering with the canopy from the #10 tree. This tree is Exceptional by definition.

8. Western Red cedar 10.5" DSH, topped or damaged near the 9' level and now has three leaders above this point. A 3.5" caliper goes to about the 20' level and bends to the northwest, a 5" caliper goes to about 50' and all of its branches reach north, and then a 6.5" caliper that goes to about 60' tall with branches spreading evenly. Some of its branches are rubbing against the mid-sized one causing abrasions and weak points. The cedar stands 12' E slightly north of the #7 tree. Weak condition.
9. Western Red cedar 19.5" DSH, 70' tall standing 12' E and slightly south of #8. Exhibits good new growth and color and its canopy comes down to the 8' level.
10. Dawn Redwood (*Metasequoia glyptostroboides*) 19.5" DSH, 70' tall, stands 7.5' SW of #9, 8.5' SE of #8, and 10' W of the #11 tree. It is in good condition. Canopy has been raised and probably the deadwood was removed in the lower part of the tree.
11. Western Red cedar 14" DSH, topped or damaged near the 12' mark, has three stems coming off this point in an offset formation. West side stem is 6" caliper and reaches 50' tall. The north side stem is 7.5" caliper and reaches 60' tall. The south side is 9" caliper and reaches 60' tall. Branches from each stem cross against the other two creating abrasions and weak points. Tree is standing 10' E of #10 and 8' SSE of the #9. It is in below average condition. Its canopy reaches primarily east and west and the east side interferes with the Dawn Redwood. Poor structure and weak condition.
12. Western Red cedar 19" DSH, bifurcates at the 15' mark, and the two stems continue up to the 45' level. The separation is north to south and there is a noticeably active fracture plane showing fresh reaction wood (Figure 15). Tree stands 2' N of the entry drive and about 30' SW of the SW corner of the 4649 house.
13. Douglas fir 19" DSH, 70' tall standing 2' N of the north fence line and 8' N of the concrete stairs coming down from the 4649 house. Another set of concrete stairs are 20" off the north side of the tree's base and lead to the 4645 house (Figure 16). The landing pad for the stairs comes even to the midline of the tree and extends north at a right angle. There is a large structural root running off to the northeast that is probably the fir's major support structure. The tree leans slightly west from its base and 85% of its canopy is on the west side. It jinks back to vertical above the 45' level. Its branches are overextended on the west side and come down to within 18' of grade. Several overhang the house.
14. Scots pine (*Pinus sylvestris*) 17" DSH, 50' tall standing 15' E of #13, 3' N of the stairway leading down from the 4649 house, and 14' S of a concrete staircase that leads down to the 4645 house from its garage. The SW corner of the garage is 19' E and about 3' N of the base of this tree. The pine is in below average condition with viable canopy only in the upper reaches. It exhibits considerable needle loss.
15. Western Red cedar 21" DSH, 65' tall, stands 3' E of the 4645 garage, 11' W of a large stone retaining wall, 16' S of a concrete staircase coming down along the retaining wall and curling toward the garage (Figure 17). Nearly 80% of the cedar's canopy extends to the west and over the garage. The tree bifurcates near the 45' mark and has two subordinate spars that rise above the 40' level. Fair health but not the best placement. Tree only has structural roots evident to the south side. The north side has no flare present (Figure 18).

16. Douglas fir 22.5" DSH, 65' tall, has subordinate spar on the west face near the 18' mark. Fairly heavy canopy comes down to this level. It is evenly distributed and the tree exhibits fair health. The large stone retaining wall crosses through the NE quadrant of the tree's rooting space 3' from its base. The wall runs east and north away from the fir. It stands 14' E of the 4645 garage foundation. Heavy buttress roots run out to the east side.

17. Big Leaf maple stump sprout with two current stems 12" and 13" DSH coming off of a large decaying base (Figures 19-21). The stems lean slightly until they reach 16-18' mark where they were either topped or damaged (Figure 22). Multiple scaffolds are crossing through each other as they reach into the 50' level. There is sun scald and associated decay on the surfaces of the larger scaffolds. Weak structure with heavy canopy high on the columns over a compromised support system. The base of the tree is 3' S of the stone retaining wall and 5' N of a concrete block retaining wall for the stairs leading down the side of the 4649 house.

18. Big Leaf maple 11" DSH coming off of a compromised base (Figure 23). The tree is 'balanced' on two large structural roots going nearly due east and west. There is little root development to the north and south. The base is hollowed with some decay present. The tree only reaches about 45' tall and appears to have been maintained actively below that height. It is standing 17' W of the NE corner of the 4649 house, 11' N of the house foundation, and 4' S of the big stones at the beginning of the retaining wall lining the entry driveway to the 4645 house. It leans slightly south and only about half of the canopy seems to be viable.

Numerous other trees grow throughout the three properties. Only the large cottonwood standing on the south side of the driveway was deemed as being more than a low risk. It will be removed as part of the 4661 construction project.

Methods: Tree risk assessment is both an art and a science. To properly perform, an arborist must have an extensive background in biology, tree mechanics, and tree structure that is equal parts academic and field knowledge. It takes years of study to recognize and correctly diagnose the subtle signs trees exhibit before their failure, whether it be partial or total. The process begins with a visual inspection that is followed as necessary with soundings, core testing, and/or other detection means. Each tree is examined and evaluated according to species, size, vigor, injuries present, root and grade disturbance, deadwood, location and extent of decay, stem taper, exposure, and targets in range.

The International Society of Arboriculture (ISA) spent a number of years developing a Best Management Practices bulletin to aid in their tree risk assessment program. Their methodology supersedes any and all other systems which may be currently in use. While focusing on a qualitative analysis the program is still based on the three primary aspects of tree risk; failure potential, size of part failing (potential of damage from impact), and target rating.

The aspects are scaled as follows. Failure potential (FP) can be imminent, probable, possible, or improbable. Target rating (T) is based on frequency of occupancy and is listed as very low, low, medium, or high. Selections are made in each of the first two categories and a likelihood of target impact found. It can be rated as unlikely, somewhat likely, likely, or very likely as shown in Figure 24. Obviously a level of null risk does not exist if a tree is present. For practical purposes however, arborists assume that if there is no target, the tree poses no risk.

The consequences of the failure, directly related to the part size, are listed as negligible, minor, significant, or severe. Crossing the likelihood of a failure with the resulting consequences results in one of four risk categories; Low, Moderate, High, or Extreme. The highest level, extreme, can only be assigned when the likelihood of failure and impact is very likely and the consequences are severe (Figure 25).

Risk Analysis: The targets within range of a tree differ according to the failure types. A branch falling out of a tree generally does not reach much farther out than the diameter of the canopy itself. Heavy winds may carry a branch sideways for some distance but the range is directly correlated to the height of the break in the tree. Scaffold failures reach out to no more than 20% past their length. Hence the end of a 20' leader has the potential to hit something 24' away. A failure occurring mid stem can reach targets up to 10% beyond its length with factors for wind velocity and fall height modifying this range. Trees which uproot or have basal failures cannot strike targets outside their own height in anything less than hurricane force winds.

The #1 maple has a **probable likelihood of large stem or scaffold failure** based on the degree of dead material present and the species' propensity to crack off when in this condition combined with its location on the shore being exposed to the strong winds coming off of Lake Washington on a regular basis. The docks bracket the tree on the lake side and the boat shack sits close to its east side. This leaves little space available for material falling out of the tree to land without hitting a valuable target which results in the maple having a **high likelihood** of striking. The tree is thus categorized as **likely to fail and impact**. The consequences would be **significant** making the hemlock a **high risk** for stem or large scaffold failure.

The #2 cedar will experience greater force loads from storm winds because of its height and stature. The protection it is afforded by the large evergreens on the 4661 property to the south will be lost in the next year or so as they will be removed to allow the redevelopment of the lot. It has multiple large elements with weak attachments that are over extended. It is characterized as having a **probable likelihood of large stem or scaffold failure**. It sits tightly between the 4651 parking area and the 4645 home and has a **high likelihood** of striking. This puts it in the **likely to fail and impact** row in the second matrix. Consequences will be **significant to severe** depending on the exact size of the failed section. The cedar is thus labeled as a **high risk** for stem or large scaffold failure.

The #3 and #4 cedars, even though they have grown up in place, have significantly constrained rooting spaces preventing the formation of full Structural Root Plates expected for trees their size. The cedars will also be suddenly exposed to wind loading because of the removal of the much large evergreens in the stand to their south. They have to be considered as having **possible likelihoods of catastrophic failure**. They are both tall enough to reach the 4645 house or its garage, would definitely crash across and block the driveway, and would take out the fence. They could also strike the #13 and/or the #14 trees causing them to fail or break apart and hit the home or garage. Putting all the scenarios together the two cedars are slated as having **medium likelihoods of failure and impact**. It would likely result in **severe** damage and the two trees are rated as being at **moderate risk** of catastrophic failure.

The #5 fir will also have a **possible likelihood of stem failure** because of its compromised structure and being suddenly exposed. If there is decay at the damage point the likelihood would increase to **probable**. Under a storm induced failure the top section would land on the driveway but would not hit any of the homes. If, however, there is decay and the top cracks out to the west it would likely hit the 4651 home. So depending on the strength of attachment of the upper spar the fir would be categorized as **unlikely to fail and impact** or **likely to fail and impact**. The fir is either a **low risk** (decent attachment) or **high risk** (weak/decayed attachment). Only an aerial inspection will allow a definitive categorization.

The #6 maple has a **probable likelihood of large scaffold failure** based on the degree of dead material present and the over extension to the west side combined with the species' propensity to crack off when in this condition. The tree overhangs the 4651 house and has a **high likelihood** of striking. The maple is thus **likely to fail and impact**. The consequences would be **minor** because only the end portion of the material will hit the roof. This results in the maple being rated as a **moderate risk** for stem or large scaffold failure.

The #7 Leyland cypress has been experiencing scaffold and limb failure for the last few years. It has numerous over extended and overweight elements. It is characterized as having a **probable likelihood of large limb or scaffold failure**. Nearly all the elements that have failed and all those most prone to failure are on the west side of the tree and overhang the driveway. One of the limbs that broke out just missed a car coming down the driveway and another landed a couple of yards behind one of the home owners walking up the driveway. While normally the probability of persons or vehicles being struck by tree parts is quite low in magnitude repeatedly placing them in close proximity increases the chance of meeting in space and time considerably. The limbs are also coming lose more than one at a time which increases the struck-by probability. These combination of these factors puts the Leyland in the **high likelihood of hitting** column in the first matrix. This makes the breaking limbs and scaffolds **likely to fail and impact**. Consequences will be **significant to severe** depending on the exact size of the failed section and whether it hits a vehicle or person. The cedar is thus labeled as a **high risk** for limb or large scaffold failure.

The #8 cedar has a **probable likelihood of stem failure** due to the compromised attachment at the low topping point and the significant abrasions along the columns of the three stems. They are just as likely to crack off in a mild weather event as under heavy winds. The two larger stems are well within range of the 4645 garage and will cross the fence and the path leading down to the lake. It is listed as having a **high likelihood** of striking and placed in the **likely to fail and impact** row. The two stems are large enough to cause **significant** damage making the tree a **high risk** for stem failure.

The #9 cedar presents little risk. The same is true for the #10 Dawn Redwood.

The #11 cedar has the same issues as the #8 tree. It has three stems long enough to hit either the 4645 garage or the 4649 house. It is categorized as a **high risk** for stem failure.

The #12 cedar has an active fracture plane below its two stems which are close to broadside to the wind. The tree is not large enough currently to experience too great of wind loading. It is placed in the **possible likelihood of stem failure** row in the first matrix and, because the stems are not quite long enough to reach the 4649 house, in the **low likelihood of impact** column. This makes the tree **unlikely to fail and impact** and automatically a **low risk**.

The #13 fir exhibits a rather contradictory structural profile. Its Structural Root Plate is compromised because of the concrete stair landing in its NW quadrant but it has a massive structural root extending into the NE quadrant. The sidewalk was built in 1999 during the extensive remodel of the 4645 house and its construction likely cut roots on the north side of the tree when it was young. The fir leans slightly west but returns to vertical above the 45' level. The canopy is rather one sided to the west but is fairly full and comes down low on the column providing for a center of gravity below the halfway point. Thus the fir is considered as having a **possible likelihood of stem or catastrophic failure**.

The tree is most likely to rotate over the NE root and either fall across the 4645 house or if it slides by that house's NE corner it will land on the 4639 house. If the tree has not developed enough structural root holding power on the south side it could be lifted over its base by a strong storm wind coming off the lake. If that occurs the tree will land on the 4645 garage. Whichever case happens in a catastrophic failure the tree has a **high likelihood** of striking.

If the stem snaps on the #13 fir it will be equally likely to land on one of the buildings as to land in the center area between them. That gives it a **medium likelihood** of hitting.

So, under a catastrophic failure the #13 fir is **somewhat likely to fail and impact** and with a stem failure it is **unlikely to fail and impact** according to the first matrix. The consequences would be **severe** in either scenario. Therefore the #13 tree is slated into the **moderate or low risk** boxes in the second matrix.

The #14 pine presents little risk.

The #15 cedar was present when the 4645 garage was built in 2000. The garage sits 3' W of the tree and the excavation for it could have been as close as 6" off the base of the cedar cutting all the roots to that side. Post construction the cedar only developed structural roots to the south side and was obviously prevented from doing so to the west. The short stature of the cedar and the pronounced developed of the two subordinate spars are highly indicative of the tree reacting to destabilization. It will be listed as having a **possible likelihood of catastrophic failure**. Because it has the two large subordinates weighted to the west it will be listed as having a **possible likelihood of stem failure**.

If the #15 cedar fails catastrophically it will land against the driveway retaining wall but isn't tall enough to hit the house to the northeast. Hence the cedar is **unlikely to fail and impact** catastrophically. If either of the two stems crack over they have a **high likelihood** of striking the garage making the tree **somewhat likely to fail and impact** in regards to stem failure. It would likely result in **significant** damage and the two stems are rated as **moderate risks**.

The #16 fir was also impacted by the construction event in 2000 but had more room to establish a decent Structural Root Plate over the last twenty years. It has the one small subordinate that likely was due to a reaction to the initial impact. It is deemed to have an **improbable likelihood of failure** and is automatically categorized as **low risk**.

The #17 and #18 maples have nearly the same profiles. The current trees grew from the stumps of maples likely removed during the 1998-2000 construction events. Any north side roots would have been severed when the driveway was constructed. Post construction root development to the north side would have been severely hampered because of the retaining wall and driveway.

The maples currently present are significantly compromised due to the extent of atrophy and decay in their bases and structural roots. Both have been topped low on the column, perhaps a couple of times, and both have poor canopy formations with high densities above the damage points. The two maples are listed as having **probable likelihoods of catastrophic, stem, or large scaffold failure.**

In cases like these, failures are more related to weight loads than to storm events. Generally the sections fall to the direction in which they are orientated or are weighted towards. The canopies of both the #17 and #18 maples have grown more to the south than in the other directions and the trees as a whole are weighted in that direction. When they fail, catastrophically or partially, either maple will have a **high likelihood** of hitting the 4649 house. This categorizes the two trees as **likely to fail and impact.**

Because the maples are close to the house they will not build up much momentum when they fail and because of their dense canopy formations the branches will likely ‘cushion’ the impact. Even if the maples crack off at the base the **consequences** of their failure should only be **minor.** This categorizes each maple as a **moderate risk** for catastrophic or stem/scaffold failure.

Discussion: Maples which have been topped or damaged can still live for long periods and reach large stature if maintained. If they are not pruned on a regular basis to regulate their dimensions however the epicormic shoots can grow overly large. The tree can end up with too great of weight loads on its scaffolding and too high in its canopy, creating a scenario for early failure.

Fir, hemlock, and cedar trees generally live into their sixties and seventies in this region. Many can live much longer and reach impressive size. When apical dominant species such as evergreens have been topped or damaged their normal response is to create new upper leaders. The multiple shoots that grow up from the damage points are often weakly attached. The cuts themselves often develop areas of decay. If the tree in question is not regularly pruned situations are created where the tree puts all its energy into dense vertical growth at the expense of the vitality of the lower canopy. The tree becomes top heavy with its density gradient reversed leading to instability.

Topping negatively affects the root structure of the tree also. For the most part trees have a one to one correspondence between their canopies and their roots. If the canopy is suddenly reduced there is inadequate energy to sustain the roots and atrophy occurs. When the roots dieback they cannot provide enough resources for the tree to thrive and disease, insect infestations, and poor compartmentalization occur.

Mechanical root damage, which mainly occurs during construction, creates issues for the tree that can manifest up to ten years later. In hard woods canopy dieback is the most evident result (besides catastrophic failure). Poor color, low new growth volume, anemia, disease, and insect predation also are also commonly seen.

In softwoods root rots are the most drastic consequence of root disturbance in the Pacific NW. Often by the time the symptoms of these fungal diseases manifest the tree is in dire straits. Poor new growth and color, dieback, and subordinate spars originating low on the column are common outcomes also.

The majority of the readily identifiable issues with the trees in this study result from topping or other types of mid stem damage. The rest are direct aftereffects of construction impact.

Crown reduction techniques are used to train trees to lower statures, to promote stronger structure, and to maintain trees at desired sizes. Larger trees may have to be treated on an annual basis for three to five years in order to establish viable lower canopies.

Thinning techniques can also be used to control dimensions of plants. Trees that grow in clumps, groves, or other amorphous shapes can benefit from selective removal of older stems in order to invigorate the plant and maintain its size. Thinning out dense thickets will encourage stronger growth patterns and reduce competitive stress.

Proper stewardship of an urban forest can provide ongoing benefits for generations. But if urban trees are not actively managed they can create hazardous situations requiring expensive removal and loss of benefits. Investing time and resources into maintaining a healthy and diverse ecosystem will pay off now and for the future.

When tree removal is necessitated they have to be replaced to ensure the longevity of the canopy cover. Choosing a mix of species helps with biodiversity and increasing the depth of the ecological web. Picking the correct tree for the placement makes sure that it will be able to mature without creating future issues.

Recommendations: While preserving green spaces and the resulting biological diversity is important, trees that pose threats to persons or property must be managed so that safety is the highest priority. Being able to increasing the overall strength and resilience of a neighborhood canopy whenever possible is another important consideration.

The entire upper dead section of the #1 maple has to be removed along with the larger dead limbs. A case can be made to remove the tree entirely but it could result in an environmental review and/or extensive restoration because of the tree's lakeshore location. It may make the most sense to just monitor the tree and continue to remove the dead material over time. The maple may live for another five to ten years.

The risk present in the #2 cedar can be mitigated by using reduction pruning techniques. The over-extended spars should be pruned back and down throughout this tree. The uppermost spars cannot be allowed get taller because of their propensity to shear off in storm winds. It may be necessary to remove one or more if there is not a means to prune them correctly because of their formation. The tree seems to have adjusted to the space and conditions under which it lives so could be maintained long-term.

The #3 and #4 cedars will have to be monitored closely once construction begins on the 4661 property. They have less than adequate rooting space and are somewhat stunted but have been adjusting to their space.

It probably makes the most sense to just reduce the larger upper spar on the #5 fir and then monitor the tree long term. Leaving it exposed when the trees on the 4661 lot are removed just puts the tree at too great a likelihood of failure.

The #6 maple should have the large dead material excised. It should also be pruned to reduce the weight on the over-extended elements on the house side to prevent breakage.

Unlike the #2 cedar, the #7 Leyland cypress does not lend itself well to corrective pruning. Leylands do not have well developed laterals so there is no place along the length of a spar to make a proper pruning cut. Hence there is no means of doing the weight reduction pruning that is required to mitigate the risk present in the tree correctly. If nothing is done the limbs and spars will continue to over-extend in competition for light and breakage will keep happening. The broken elements open holes in the Leyland's canopy through which the storm winds can hit other elements that had been somewhat protected. The tree will just continue to delaminate. The most correct option is to remove and replace this tree.

The #8 and #11 cedar should be removed because of their compromised structures and risk profiles. There is no way to mitigate the risk in a way that allows the cedars to be functional trees long term. Their removals will also create space for the much more desirable Dawn Redwood.

The #12 cedar can be retained as is but it needs to be monitored annually. If the fracture plane continues to be active then installation of a brace rod will be required.

The #13 fir is a good candidate for removal in the short term based on its circumstances and location. It looms over the 4645 home and will be induced to continue to extend over it because of phototropism. It has a non-ideal structure for the species. Just pruning the lower branches to create proper clearance for the house will shift the tree's center of gravity significantly higher on the column. As the tree grows it will increase the lever force on its compromised root base exponentially.

The #14 pine should be monitored. It may recover or continue to decline mostly depending on the weather over the next few years. It could have the dead material removed which would make it easier to determine whether additional elements are dying in the short term.

The #15 cedar needs to have the two subordinates removed and the lower branches raised and/or pruned back to create proper roof clearance for the garage. The point of separation needs to be inspected to determine whether there is an active fracture plane present. If the joint is weak it may require reinforcement braces and/or reduction of the main stems.

The #16 tree does not require intervention at this time.

The #17 and #18 maples need to be removed in the short term. There is not a reasonable way to mitigate their risk otherwise.

The City of Mercer Island has guide for tree replacement that requires a 1:1 replacement for healthy removed trees less than 10" DSH, a 2:1 replacement for trees 10-24" DSH, a 3:1 replacement for those in the 24-36" range, and 6 trees planted for every healthy removed tree larger than 36" DSH or designated Exceptional.

Because the #17 and #18 maples are being condemned for their quite poor conditions, they should only have to be replaced on a one for one basis.

The #13 tree is going to be considered as a removal at this time because it makes the most sense to do so and it will give its two replacements a head start on replenishing the firs lost biomass.

The #7 Leyland needs to be removed. It has significant risk issues, no redeeming qualities (besides just being large), and no feasible way to mitigate the risk. Because of being condemned only four, rather than six, trees will be planted as replacements.

Ideally any blackberries and ivy will be removed from the areas entirely.

The exposed spaces of the embankments where the #17 and #18 maples will be removed are excellent places to install eight or ten ferns along with two vine clumps (*Acer circinatum*) to take their places as shown in Figure 26.

There is enough space east of the 4645 garage and north of the 4649 house to install a pair of Weeping Alaska Cedars (*Cupressus nootkatensis*) that will take the place of the #13 fir.

It would be ideal to plant a pair of Dawn Redwoods in the area of the #10 to match it in the landscape. If the home owners would rather keep the #10 as a focal point then a pair of Serbian Spruce (*Picea omorika*) could be set anywhere north or south of the big Dawn that makes sense in the landscape.

Planting two Shore pines (*Pinus contorta*) in the area south of the driveway and east of the #6 maple might make the most sense for the second pair of replacements for the #7 removal. The two trees would create decent anchors for the landscaping in that area, provide a visual break between the new 4661 home and the 4649 residence, and their root systems would lock down the soil at the top of the slope preventing it from eroding down the hillside.

Because of how spread out the plantings will be water bags will make more sense than trying to run irrigation all over. They will probably have to be used for at least the first three years. Ten gallon Gator bags would be good choices but there are a number of different sizes and brands. The soil around the trees just has to be kept moist during the short local dry season.

All the trees should be monitored on an annual basis to account for any changes in their health or structure.

Depending on the growth response of the pruned trees and the consideration taken during the original care cycle, the trees will likely need to be pruned again two or three years later. The second round may include further reduction type pruning if deemed necessary by the arborist in charge.

As an end note, laying down arbormulch, the chips that are created by the grinding of the pruning debris, has been found to be the number one best treatment for long term plant health care. Keeping a 3-4" layer out to the drip line has been shown to create more robust, disease resistant, and even fungal resistant plants. It is recycling at its best. Chip mulch has also been proved to be one of, if not the best, topical erosion control material.

Waiver of Liability: Because the science of tree risk assessment is constantly broadening its understanding, it cannot be said to be an exact science. Every tree is different and performing tree risk assessment is a continual learning process. Many variables beyond the control, or immediate knowledge, of the arborist involved may adversely affect a tree and cause its premature failure. Internal cracks and faults, undetectable root rot, unexposed construction damage, interior decay, and even nutrient deficiencies can be debilitating factors. Changes in circumstance and condition can also lead to a tree's rapid deterioration and resulting instability. All trees have a risk of failure. As they increase in stature and mass their risk of breakdown also increases, eventual failure is inevitable.

While every effort has been taken to provide the most thorough and accurate snapshot of the trees' health, it is just that, a snapshot, a frozen moment in time. These findings do not guarantee future safety nor are they predictions of imminent events. It is the responsibility of the property owner to adequately care for the tree(s) in question by utilizing the proper professionals and to schedule future assessments in a timely fashion.

This report and all attachments, enclosures, and references, are confidential and are for the use of Scott Sinclair, Tree Harmony Arborists, LLC, the owners of the properties listed, and their representatives only. It may not be reproduced, used in any way, or disseminated in any form without the prior consent of the clients concerned.

Anthony Moran, BS
Certified Arborist
Qualified Tree Risk Assessor
ISA #PN-5847A

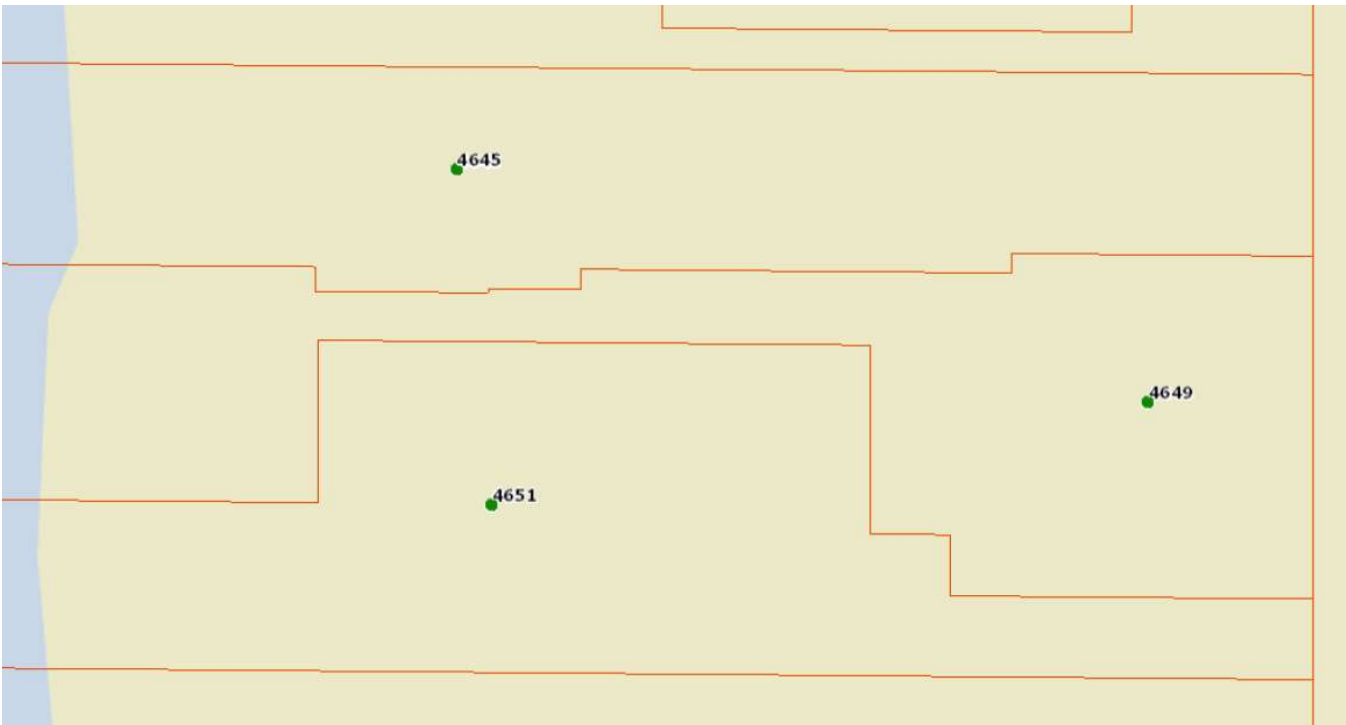


Figure 1. Showing how the three properties interlock and why the households decided to work together with the trees.

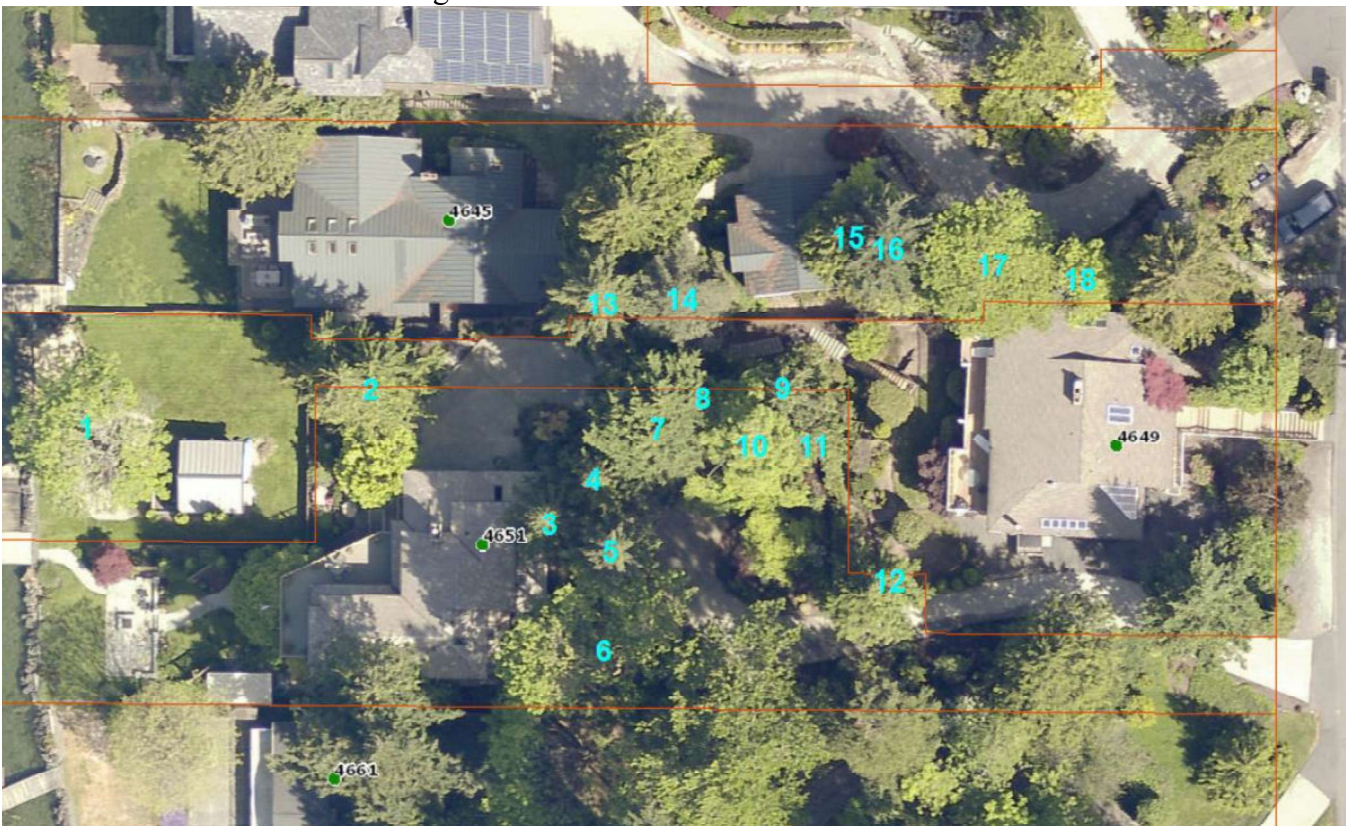


Figure 2. Aerial imagery from 2019 with the subject tree numbers shown in teal at the rough locations of the trees. Only the trees of interest were studied. Note how the yards overlap (faint red lines) making it difficult determine which tree belonged to whom.



Figure 3. Looking WSW at the location of the 31 maple. The branches shown are mostly viable. Note how close the docks and boat house are to the tree.



Figure 4. Looking up and SW and showing the large dead section that needs to be excised. It accounts for close to 2/3 of the upper canopy. The lowest limb showing is mostly viable. The ones between it and the dead section are about half viable.



Figure 5. Looking SE at the base of the #2 cedar. Note the level of the parking slab for the 4651 house.



Figure 6. Concrete support post for the 4651 parking area.



Figure 7. Looking east at the stairs leading up on the north side of the #2 cedar. Note the retaining wall on the left (north) side of the image).



Figure 8. Looking south at the base of the #3 cedar.



Figure 9. Looking SE past the base of the #3 cedar. Note the retaining wall.



Figure 10. Looking down and north at the base of the #4 cedar above the stairs and small stone wall.



Figure 11. Looking south at the storm drain plate at the base of the #4 cedar. Note proximity of the driveway and stone wall.



Figure 12. Looking SSE at the driveway curve and stone walls on the south side of the #7 Leyland cypress.



Figure 13. Looking NNW at the driveway and retaining wall north of the base of the #7 Leyland.



Figure 14. Looking up and NNW at the canopy of the #7 Leyland.



Figure 15. Looking SW at the separation point on the #12 cedar.



Figure 16. Looking west and down at the base of the #13 fir. Note the proximity of the landing for the stairs on the north side of the tree. The large structural root is circled. There is little to no root crown flair evident in the other sectors of the base.



Figure 17. Looking down and north at the base of the #15 cedar. Note the wall of the garage at the left side of the image.

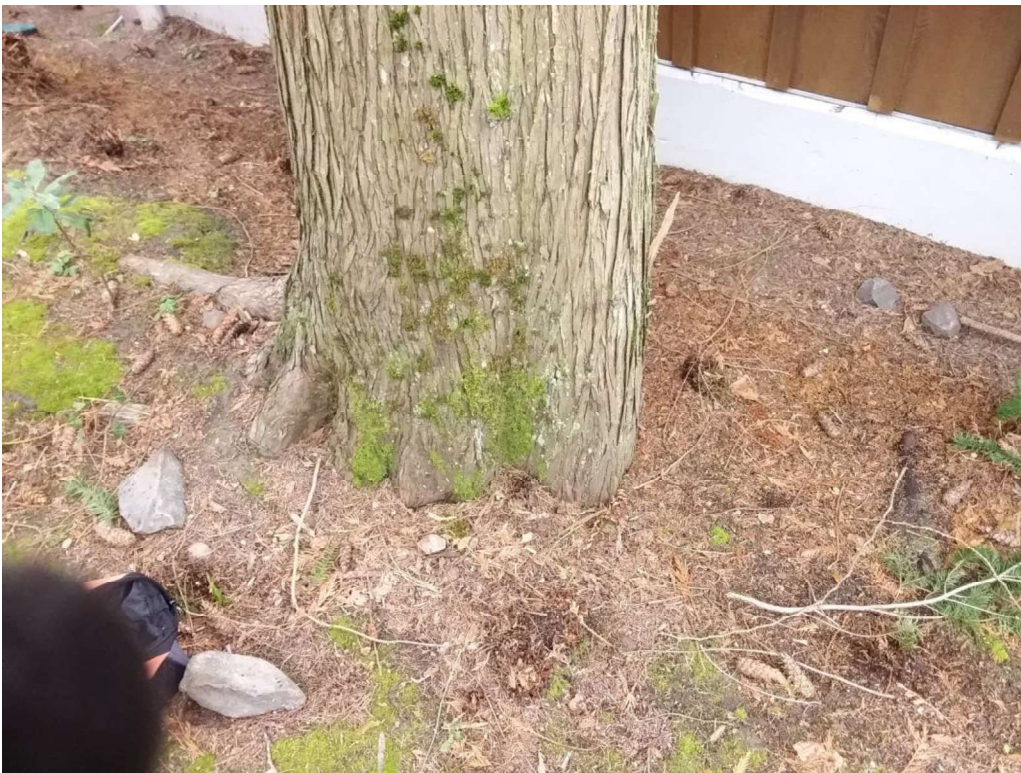


Figure 18. Looking down and west at the base of the #15 cedar. Note the complete lack of structural root development on the north side of the tree. The 4645 garage wall is in the background.



Figure 19. Looking NW at the base of the #17 maple and showing the open decay pocket on the south side (circled). Note the slight lean of the two stems.



Figure 20. Looking east at the base of the #17 maple. The decayed remnant of the original stump is circle. This is what the two lignotuberous sprouts originated from.



Figure 21. Looking east at the base of the #17 maple from a bit further back. Note the advanced decay in the main structural root.



Figure 22. Looking up and ESE at the canopy formation of the #17 maple.



Figure 23. Looking north at the base of the #18 maple showing the open decay. Note the formation of the large structural roots to the east and west upon which the tree seems to balance.

Figure 24. The matrix used to estimate the likelihood of a tree failure impacting a specific target.

Likelihood of Failure	Likelihood of Impacting Target			
	Very Low	Low	Medium	High
<i>Imminent</i>	Unlikely	Somewhat Likely	Likely	Very likely
<i>Probable</i>	Unlikely	Unlikely	Somewhat Likely	Likely
<i>Possible</i>	Unlikely	Unlikely	Unlikely	Somewhat Likely
<i>Improbable</i>	Unlikely	Unlikely	Unlikely	Unlikely

Figure 25. Risk rating matrix showing the level of risk as the combination of likelihood of a tree failing and impacting a specific target, and severity of the associated consequences.

Likelihood of Failure and Impact	Consequences			
	Negligible	Minor	Significant	Severe
<i>Very likely</i>	Low	Moderate	High	Extreme
<i>Likely</i>	Low	Moderate	High	High
<i>Somewhat likely</i>	Low	Low	Moderate	Moderate
<i>Unlikely</i>	Low	Low	Low	Low



Figure 26. Rough replanting plan showing good locations and species.

SP – Shore Pine

DR – Dawn Redwood (Serbian Spruce could be substituted)

AW – Weeping Alaska Cedar

VM – Vine Maple

f – fern, Sword or otherwise or mix

Exact placement can be established once the plants are on site and can be set in place in the containers to make sure the spacing is adequate.