FINAL REPORT

An Evaluation of Potential Effects on Old-Growth Redwoods from Implementation of the Richardson Grove Operational Improvement Project

TREE DECISIONS

August 14, 2015

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TREE DECISIONS

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I. EXECUTIVE SUMMARY

My professional opinion is that implementation of the Richardson Grove Operational Improvement Project would not have any substantial detrimental effect on individual old-growth redwoods *(Sequoia sempervirens)* or the overall health of the stand of redwoods in Richardson Grove. This opinion is based on:

- 3 decades of experience evaluating redwoods as a practicing and consulting arborist (see Appendix A);
- extensive review of the scientific literature on coast redwood biology, ecology, and resilience;
- multiyear examination of old-growth redwoods at Richardson Grove State Park, including a helicopter overflight session to evaluate tree crowns;
- consultation with California Department of Transportation (Caltrans) engineers and biologists;
- a site review to evaluate potential impacts on every old-growth redwood tree affected by the project, using revised maps, detailed descriptions, and cross sections of work supplied by Caltrans; and
- review of the final environmental impact report/environmental assessment (FEIR/EA) (Caltrans 2010).

II. DISCUSSION

A. Origins of the Redwood Highway

The Redwood Highway is a 350-mile section of U.S. Highway 101 (U.S. 101) that runs from San Francisco to Crescent City, California, and passes through stands of old-growth coast redwoods. The approximately one-mile section of the Redwood Highway that winds through Richardson Grove State Park was constructed around 1915 and was first surfaced around 1927, probably using gravel and oil (Caltrans 2010a; Hawk 2004). The road was narrow, with challenging curves, and was not paved until the 1930s (Hawk 2004). Sections of U.S. 101 along the Eel River in Humboldt County were destroyed in 1964 by severe floods and then were rebuilt (see Appendix B, photographs 5 and 6).

Richardson Grove State Park is one of the oldest redwood state parks in the North Coast area and borders the South Fork of the Eel River. Visitors can hike among majestic old-growth redwood trees that are more than 1,000 years old; some of the trees are more than 300 feet tall. The park is open year round and offers hiking, camping, swimming, seasonal fishing, and wildlife viewing (California State Parks 2011a).

B. Scope of the Richardson Grove Operational Improvement Project

The Richardson Grove Operational Improvement Project (project) requires modifications along a 1.1-mile length of U.S. 101 that runs through Richardson Grove State Park. Old-growth redwoods grow close to the highway on both sides. Proposed roadway improvements to U.S. 101 include minor realignments and shoulder widening to create smoother curves, including superelevations ("banking") to minimize large-vehicle off-tracking conflicts (Caltrans 2010b, 2010c).

The project's primary modifications to the existing landscape would include a triangular cut slope and a crescent-shaped fill slope near the south end of the grove, new foundations for a bridge barrier rail, and a cut slope near the north end of the project limits that is outside Richardson Grove State Park (Appendix C; Caltrans 2010d).

The project includes changes to five existing drainage culverts beneath the highway. Four culverts would be extended, and one that is outside of the park at the northern end of the project area would be replaced in conjunction with a drain installation. In addition, a soldier pile wall would be constructed outside of the park at the northern end of the project area, with a section of gabion wall at each end. The piles for the soldier pile wall require 30-inch-wide holes, placed 8 feet apart and up to 20 feet deep. The bottom of the soldier pile wall may be buried between 2 and 9 feet.

The design of the project took the protection of trees into account. Effects on adjacent trees have been minimized by creating small increases in road height rather than severing roots, and by selecting a thinner roadbed layer to minimize the depth of soil replacement (Caltrans 2010e). U.S. Department of Transportation design exceptions include reduced requirements for line of sight, road shoulder widths, and minimum horizontal clearance to fixed objects, so that no old-growth redwoods would be removed. This project would add less than 5% of hardened surface (roadbed) to the existing hardened surface within the structural root zone (Caltrans 2010f, 2010g, 2010h).

C. Arborist Review of the Project

I reviewed the following resource materials provided by Caltrans:

- "Old-Growth Redwoods in Project," a set of revised 24-inch x 36-inch layout drawings of U.S. 101 as it progresses through the length of the project area, which includes all the trees whose root zones are within the project's disturbed soil area (Appendix C).

- "Individual Tree Details," an updated description of the proposed work, with updated graphics depicting the work, for each old-growth redwood within the project limits (Appendix D).

- The FEIR/EA (Caltrans 2010).

I visited the project site in May 2009 on behalf of the Save-the-Redwoods League and submitted a brief evaluation to that organization in June 2009. I conducted site visits again on behalf of Caltrans in September 2011, October 2011, November 2011, and January 2012, reviewing tree mapping, reviewing construction plans, and evaluating trees in consultation with Caltrans personnel. On December 27, 2011, I executed a verified declaration of my opinion of project effects that was filed the following day with the United States District Court. Most recently, in February 2013 and April 2015, I walked with a Caltrans biologist and Caltrans engineer through the section of U.S. 101 that is included in the proposed project and evaluated individual trees again in the context of revised mapping.

D. Characteristics of Coast Redwoods

1. Genetic Architecture

The coast redwood is a hexaploid—each of its cells contains six sets of chromosomes, with 66 chromosomes total. By contrast, many conifers are diploid, with only two sets of chromosomes. Being a hexaploid is not unusual in the plant kingdom, but it is rare among trees, as the coast redwood is the only known hexaploid conifer. The opportunity for adaptive mutation is higher, which could allow greater adaptability to changing environmental conditions (Rogers 1997; Guynup 2000).

2. Root Systems

a. General Characteristics of Tree Root Systems

Tree roots can provide anchorage, absorption and conduction of water and minerals, storage of carbohydrates, production of hormones, and sites for resprouting. They are opportunistic and will proliferate where environmental conditions such as water, soil oxygen, and nutrient availability are favorable (Perry 1982). Root growth patterns vary widely between trees of different species growing under diverse environments. Lateral woody roots extend outward from the tree base and provide anchorage and support for the tree (Schnelle et al. 1989).

Depending on tree size or species, the lateral roots often decrease in diameter at a distance within 2 meters of the trunk base at sites called "zones of rapid taper" (Helliwell 1989). Lateral roots branch into smaller secondary roots that continue to bifurcate. More than 90% of the root mass will be found in the top meter of soil (Gasson and Cutler 1990; Harris et al. 2004).

Lateral roots can extend far beyond the dripline (the circumference of the tree crown) to a distance of two or three times the radius of the canopy. Open-grown tree roots can spread generally to about three times the distance to the dripline and perhaps farther for forest trees (Gilman 1990). Roots frequently encompass a generally circular area about four to seven times the area beneath the tree's crown (Perry 1992; Hagen 2001). Sinker roots extend straight or obliquely downward from primary and secondary lateral roots and increase stability (Mattheck 1994).

Fine roots originate along the basic root framework. They advance outward, down, and most frequently up toward the soil surface (Perry 1982), and greatly increase the tree's underground surface area for acquiring water and dissolved minerals from the soil. Fine absorbing roots are found primarily beyond the dripline (Schnelle et al. 1989). The surface area of a tree's roots can be greater than the surface area of its leaves, and when roots are associated with beneficial symbiotic fungi called mycorrhizae, the effective absorptive surface of the finer roots can be amplified 100 times or more (Perry 1992).

Self-grafting between separate roots of a single tree occurs in most, and probably all, of the forest tree species of commercial importance (Graham and Bormann 1966). Roots may grow across each other and continue to grow radially until pressure develops at the point of contact. Each root develops a ridge of tissue, the intervening bark is eventually broken down, and vascular continuity is established (Graham and Bormann 1966).

The shape of an individual root system is also heavily influenced by site conditions (Costello 2012; Stokes and Mattheck 1996). The downward extent of tree roots can be limited by site-specific influences such as mechanical impedance, low oxygen levels, and dry subsoils (Stone and Kalisz 1991).

Frequent injury to and death of roots from many agents is ongoing throughout the life of a healthy tree, and new roots often form rapidly after injuries (Perry 1992). Root pruning stimulates roots to regenerate at or just behind the cut (Wilson 1970).

When a tree's root, trunk, or branch tissue is disrupted by pruning cuts or other wounds, microorganisms begin to infect the site. The tree responds by forming chemical and physical "walls" (barriers) around the wound to slow or prevent the spread of disease or decay. This process is called compartmentalization (Shigo 1977, 1986).

In a study of the effects of root severance on four species of deciduous hardwoods, different roots were severed at one of four locations: at the root flare or at distances of 1, 2, or 3 meters from the trunks. The roots were excavated and examined 5 years later, and severed roots of all sizes showed only minimal decay. The author concluded that, unlike in branches where leaving a stub can lead to more extensive decay, severing the roots did not cause substantial deterioration from root decay, and the minimal decay after 5 years posed no threat to the long-term health and stability of these four species (Watson 2008). Roots are strong compartmentalizers (Shigo 1986; Watson 2008).

b. Coast Redwood Root Systems

Coast redwoods are surprisingly capable of compensating for disruptions to their root systems, as described by several researchers in the excerpts shown below.

Stone and Vasey (1962a:13) comment that "The mature redwood is apparently able to overcome the loss of a large portion of its root system by rapidly regenerating a new root system. What continues to surprise us is that so much of the root system can be removed without any noticeable reduction in vigor."

Sturgeon (1964:8, 11, 16, 17, 18) comments as follows about coast redwoods:

> The coast redwood species *(Sequoia sempervirens)* is rather remarkable in its ability to adapt to soil conditions, to sprout profusely, to respond to increased light, and to survive and grow under certain stresses imposed by man. …

> Coast redwood resists well attack by natural agents and adjusts remarkably well to changes in the environment, especially by growing of new roots and new foliage. …
>
> Roads of various qualities have been built through stands of redwoods...all in Humboldt County. A few trees along these roads and highways have had portions of their bases removed for road development over the past 40 years or more. Asphalt or concrete paving, which obviously is laid over the root zone of many trees adjoining the roadways, has not generally affected the vigor of these trees. A very few trees bordering the paved highway have defects that could be attributable to loss of effective root area. However, in most instances there are other apparently contributory factors to reduced vigor, such as fire effects and poor site quality. …
>
> Trees marginal to unpaved roads must suffer loss of effective root zone. Redwood trees have fibrous feeder roots at levels of one to two feet below the soil surface. Compaction caused by road building would reduce the effectiveness of such roots. However, redwood trees are remarkably aggressive and seem to compensate for such depreciating factors and maintain an outward appearance of vigor. In fact, trees on highway margins in relatively dense stands develop deeper crowns on the side where the opening for the highway provides more light than on forested sides. …
>
> Judging from the absence of significant loss of vigor in trees bordering the highways, coast redwood is evidently not seriously affected by paving where it does not cover more than half the trees' root zone.

Standish (1972:53, 54) adds:

> Meinecke's work in 1929 conclude(d) that the continued high visitor use of Coast Redwood areas should eventually lead to a decline in the tree's general health. If the tree's annual ring increments are a good indication of the tree's health, then this present study has failed to confirm Meinecke's theory. …
>
> Essentially there was no significant difference between the different areas in the growth of Coast Redwood, and there is no evidence that shows any correlation of visitor use to growth pattern changes.

McBride and Jacobs (1978:22, 33) comment as follows:

> The comparison of radial growth differences failed to show a significant difference between the two groups of trees. The results of this experiment did not provide any evidence that tourist trampling and subsequent soil compaction have caused reduced radial growth or lowered tree vigor. …
>
> Soil compaction was not demonstrated to reduce radial growth of redwoods. No correlation between the proximity of trails to individual trees and the vigor of

> these trees as expressed in ring width could be established. Trail construction should not be limited by a fear of adversely influencing the trees.

Stone and Vasey (1962b:2–3) described the effects of soil removal that disturbed redwood roots at Humboldt Redwoods State Park:

> Old-growth redwoods on alluvial flats in Humboldt Redwoods State Park had two feet of soil mechanically removed by a bulldozer over a radius of 40 feet around each of 4 redwoods with diameters ranging from 28 to 84 inches, and heights of 150 to 300 feet. …
>
> The soil was spread back in place immediately after removal, thus creating a two-foot-deep layer of soil entirely free of live roots. The treatment destroyed 30 to 40 per cent (by volume) of the existing root system of each tree including most of the 'feeder' roots. Root re-entry into the 'new layer' of soil was rapid. (Two years later), 40 per cent had been replaced at the zero to three inch depth, while at the 6 to 9 inch depth, 52 per cent had been replaced. All these roots were healthy and growing vigorously. Thus, redwood roots are able to reoccupy the soil mass rapidly with new roots, despite the loss of as much as 40 per cent of their old root systems. …
>
> Crowns of the treated trees were examined. No apparent change took place. Dieback did not occur and the crowns remained green and healthy. Radial growth of the treated trees was also examined. Using root growth, diameter growth, and crown condition as criteria of tree health, no noticeable decline in health was apparent two years after root removal.

Lastly, Stone (1965:8) comments:

> We found that within four years after removal of 90% of the feeder root system a replacement root system comparable to the original one had been regenerated by vertical upward growth of roots from below.

3. Stability and Anchorage

Relatively few tree species rely on a strengthened primary central root called a taproot to achieve long-term anchorage and stability. Coast redwoods do not have taproots (Fritz 1934). Resistance to windthrow can be increased substantially by small increases in rooting depth (Fraser 1962). Tree stability generally depends on the shape and size of aboveground parts, and especially on the type of root system. To prevent mechanical failure of a tree, external loading forces such as wind must be distributed down the tree and into the ground (Mattheck 1994). Strong and widespread lateral roots, as employed by coast redwoods (Fritz 1929; Olson et al. 1990; USFS 1908), disperse aboveground loading forces to soil and provide traction to resist uprooting (Coutts 1983; Ennos 1993; Mattheck 1994; Stokes and Mattheck 1996). One California forestry professor wrote that "I followed one major root some 150 feet from the main trunk till it disappeared and often 100 foot lengths are not uncommon with roots of 1–2 inch diameter at that point," and that "redwood roots graft onto other redwood roots and grow strongly together creating therefore a matrix like steel reinforcing bars in concrete. This means that pressures are distributed over the entire forest floor" (Becking 1979).

4. Buttress Flares and Lignotubers

Many trees effectively increase basal trunk diameter by creating buttresses (Ennos 1994). The coast redwood has developed a specialized organ of regeneration and carbohydrate storage called a lignotuber, which can develop into a massive swelling at or just below ground level. It continues to expand throughout the life of the tree and is generally covered with shoot buds. If the trunk is injured, the lignotuber can release shoots and generate new roots to increase the vigor and stability of young and old trees (Del Tredici 1998, 1999). Sequoia lignotubers also store carbohydrates and mineral nutrients, and can function as a kind of "clasping organ" to anchor trees growing on steep slopes (Del Tredici 1998, 1999).

5. Recovery from Periodic Flooding

In 1933, a coast redwood more than 1,200 years old fell in Richardson Grove State Park. Emanuel Fritz, a professor from the School of Forestry at the University of California, Berkeley, examined the tree's massive rootball and confirmed the extraordinary ability of this species to respond to heavy siltation by creating new root systems that grow upward into new sediment. In his own words (Fritz 1934):

> The main grove stands on a “flat” or high river bench built up by past floods. Seven great floods and a number of minor ones occurring during the life of this tree deposited enough silt to raise the ground level more than 11 feet. Each time the base of the tree was partially buried but was able to adapt itself to the new level by originating a newer and higher root system.
>
> A heavy flood, a thousand or more years ago, left a heavy deposit of silt, perhaps 30 inches deep. The root system continued to function but a new system was eventually formed to fit the higher ground level. …Each time a new set of roots was formed and the trunk below ceased its diameter growth. …Roots pointing outward occur as aftermath of floods. They are an attempt by the tree to readjust its root system to the new soil level. …The 1933 root system is approximately 300 years old.
>
> Other trees in Richardson Grove have similar subsurface trunks, as may be noted by examining the trees that have large fire scars. The exposed central trunk in each case exhibits straight grain at the ground line instead of the usual outward flare of the butts.

6. Pruning Response

Coast redwoods are very effective at compensating for disruptions to their branch systems and their root systems. Sturgeon (1964:8, 11) comments that “[c]oast redwood resists well attack by natural agents and adjusts remarkably well to changes in the environment, especially by growing of new roots and new foliage."

Recent studies of the effects of coast redwood pruning confirm that this species responds with extraordinary resilience after severe pruning treatments. O'Hara and Berrill (2009:6) comment:

> Several studies report increasing sprout production with increasing pruning severity. These are evolutionary adaptions that allow trees to quickly rebuild crowns after disturbances such as defoliations and branch damage. …Sprouting was unaffected by pruning severity except at the most severe pruning treatments. Sprout numbers and sizes were nearly constant from the control trees to trees receiving treatments that left only approximately 40% live crown.

In addition, O'Hara (2012:532) states that "In summary, pruning apparently has relatively minor effects on increment in coast redwood as represented by basal area increment, height increment, and volume increment."

O'Hara (2012:537) further comments:

> The response of coast redwood to pruning varies from typical responses of conifers. The typical decreasing increment with increasing pruning severity pattern was not observed in these study plots despite the inclusion of very severe pruning treatments. Instead, redwood growth is less sensitive to pruning and reductions in crown size than other conifers.

7. Ability to Withstand Low-Light Conditions

Small redwoods in an old-growth forest may have been suppressed by massive overstory trees for more than 400 years, but still maintain the ability to accelerate growth rates when older trees fail and light becomes available (Fritz and Averill 1924; Olson et al. 1990).

8. Fire History and Effects

Native Americans are reported to have used periodic burning to increase the efficiency of food gathering and to clear the understory for easier travel (Fritz and Averill 1924; Gilligan 1966). Fire history researchers have reached widely varying estimates of fire return intervals in different old-growth coast redwood forests (Veirs 1982; Finney and Martin 1989). Wide disparities in fire return interval estimates have been attributed to several causes:

- Changes in past land uses before and during settlement of the redwood region (Stuart 1987)

- Variation in forest type from mesic (relatively moist) coastal forests to drier inland stands (Veirs 1982)

- The difficulty of accurately assessing and cross-dating fire scars because of indistinguishable and discontinuous annual growth rings that are commonly encountered in coast redwoods (Fritz and Averill 1924; Fritz 1940)

The basal bark of a coast redwood trunk is thick and fire resistant, but periodic fires can decrease fire resistance sufficiently to kill the cambium layer (living tissue beneath the bark) (Fritz 1931; Isenberg 1943). Redwoods can live for many centuries with substantial fire scars, as evidenced by charring and fire cavities on old-growth trees throughout Richardson Grove.

9. Resistance to Insects and Decay

Coast redwoods have no important tree-killing insect or disease enemies (Fritz 1931). Fire injuries become entrance courts for infection by wood-rotting fungi (Finney and Martin 1989; Fritz 1931; Kimmey and Lightle 1955; Kimmey 1958). Two major types of decay have been identified: a brown cubical rot caused by *Poria sequoiae* and a white ring rot caused by *Poria albipellucida* (Kimmey and Lightle 1955). *Poria sequoiae* is not a "tree-killing" disease, but is a very important factor when it contributes to structural weakening of a tree (Fritz 1931).

Most decay in coast redwoods is associated with fire wounds in the lower portion of the bole and dead or broken treetops (Fritz and Bonar 1931; Kimmey and Lightle 1955). Entrance courts appear to be the same for both fungi. Broken branches were not identified as entry points for decay-causing fungi (Kimmey and Lightle 1955).

Old-growth coast redwoods are valued for their decay resistance. Highly decay-resistant wood has been found to be about five times more prevalent in old-growth redwoods than in young-growth coast redwoods, mainly in the butt log heartwood nearest the sapwood (Clark and Scheffer 1983; Piirto 1985).

In tests to determine decay resistance to ground contact, about 94% of old-growth coast redwood trees had outer heartwood that was either resistant or very resistant to decay. Differences in the decay resistance of coast redwood can be attributed to differences in extractive content (the nonstructural compounds in wood) (Anderson 1961; Clark and Scheffer 1983).

10. Development of Spike Tops

Earlier fires sometimes swept up the trunks of coast redwoods on weathered bark shreds and killed the tops of trees that had thinner layers of insulating bark than their lower trunks (Fritz 1931). A contributing cause of spike tops is the partial destruction of basal cambium from fire and the consequent reduction of water-conducting sapwood, which reduces the availability of moisture to keep the top of the tree alive (Fritz 1931). Injury to the tops of coast redwoods is sometimes traceable to girdling by rodents (Fritz and Averill 1924).

Moisture stress can account for many of the spike tops that are visible in older coast redwoods (Stone 1965). During transpiration (water loss through needles), water moves upward through the xylem (water-conducting tissue) under negative pressure. When tension becomes too great, the water conduit is vulnerable to cavitation (formation of an air pocket that disrupts the continuity of a water column) (Sperry 1989; Zimmermann 1983).

Coast redwoods are relatively inefficient at regulating the rate of transpiration through their needles (limited stomatal control) (Burgess and Dawson 2004). With increasing tree height, gravity and friction exert potentially greater disruptive effect on a water column (Ambrose et al. 2009). Nonetheless, redwoods apparently have large safety margins within their xylem structure to protect against cavitation even under severe drought conditions. This is a successful adaptive strategy for a species growing in an environment with abundant winter rainfall, summer fog, and coast-moderated temperatures throughout the year (Ambrose et al. 2009).

11. Fog Drip and Direct Foliar Absorption

Redwood roots obtain water from the water table, precipitation, and fog drip; needles (redwood leaves) obtain moisture directly from rain, dew, or fog. In one study, between 8% and 34% of the water used by coast redwoods in coastal forests of northern California during the summer months was attributable to fog precipitation that had dripped from foliage into the soil (Dawson 1996).

Another study demonstrated that tree crown fog interception by coast redwoods compensated for the negative effect of gravity on upward water conduction that accompanies increasing tree height (Simonin et al. 2009). The abundant and closely arranged needles can take in a great deal of moisture directly from fog, dew, and rain, which supplements water that is obtained from roots (Limm et al. 2009; Simonin et al. 2009).

12. Specialized Xylem Structure for Effective Uptake of Water

The spiraling of water-conducting elements in trees can be analyzed to determine the pathways of water ascent. Dyes injected into conifers, including coast redwoods, will ascend by way of tracheids (specialized water-conducting cells) in a path similar to the arrangement of the tracheids (Hendrickson and Vité 1960; Kozlowski and Winget 1963).

In coast redwood trees, aqueous dyes ascend in zigzag patterns, which indicate that tree roots lift water and dissolved minerals (sap) in a diffuse manner that serves all of the branches and leaves (Perry 1992). This pattern of sap ascent is called "interlocked." Water in the various layers of sapwood is transported alternatively from one direction to the opposite. Injected dye will spread out as it ascends the tree, and can be identified in cross-sectional wood "wafers" that are obtained from the tree above the site of dye injection (Rudinsky and Vité 1959).

This pattern of sap ascent gives the coast redwood two ecological advantages: moisture is distributed completely over the upper crown, and the tree has great adaptability to environmental changes (Rudinsky and Vité 1959). Death or injury to individual roots of a coast redwood does not lead to corresponding one-sided trunk or branch death in the crown of the tree (Perry 1992). (See Appendix E.)

E. Condition of Old-Growth Redwoods in the Project Area

No more eloquent and unbiased source of knowledge about old-growth redwood resilience exists than the trees alongside U.S. 101 in Richardson Grove. More than 90 years of highway traffic, including the passage of more than 15 million cars and trucks over the redwoods' root zones during the past decade (Caltrans 2010a, 2010i), has had no discernible substantial detrimental effect on the trees. Any fair critique of the Richardson Grove Operational Improvement Project must address and account for the absence of discernible decline.

During my field visits to Richardson Grove over the past 5 years, including an aerial evaluation of the canopy by helicopter in 2011, I have observed that the old-growth redwoods alongside U.S. 101 appear to be in vigorous health. Only three old-growth trees along the highway in Richardson Grove (Tree No. 20 at Postmile 1.37 and Tree Nos. 89 and 90 at Postmile 1.69) show evidence of substantial prior detrimental impacts attributable to root destruction. During construction work on U.S. 101 decades ago, these three trees were subjected to extreme severance of multiple large-diameter buttress roots. The scars from this destruction are still visible at the bases of the trees. Although spikes (dried-out treetops) still extend above the crowns of these three trees as evidence of severe moisture stress from decades ago, their canopies appear to be vigorous and healthy today (see Appendix B, Photographs 7, 8, 9, and 10).

None of the proposed highway modifications in the Richardson Grove Operational Improvement Project require severing any buttress roots on old-growth redwoods.

Vigorous old-growth redwoods have vast, multilayered root systems that extend well beyond their canopies. Roots proliferate where the resources of life are available (Perry 1992). The roots of mature redwoods extend in all directions and well beyond the structural root zone. The issue is not just whether roots would be disturbed to some extent, but whether old-growth redwoods can successfully adapt, compensate, and remain in vigorous health despite disturbance to roots. Research on coast redwoods has demonstrated the extraordinary resilience of old-growth redwoods in response to externally induced changes to their root systems (see above discussion under “D. Characteristics of Coast Redwoods”). The vigorous condition of the old-growth redwoods in Richardson Grove alongside U.S. 101 is an external manifestation of their successful resiliency.

F. Tree Assessment Methodology

1. Trees Examined

Caltrans provided an updated description of the proposed work, with updated graphics depicting the work, for each old-growth redwood within the project limits (Appendix D, "Individual Tree Details"), which I reviewed most recently on August 9, 2015.

Old-growth redwood trees (i.e., trees with a diameter at breast height equal to or greater than 30 inches, as measured and mapped) were evaluated if their root health zones were within the project’s disturbed soil area (Appendix C).

We examined the areas around all old-growth redwood trees (totaling 109, six located outside the park boundaries) where some part of their root health zone fell within areas of proposed project activity. (The root health zone is a circular area with the tree trunk at the center and a radius equal to five times the tree trunk diameter measured 4.5 feet above ground level [Smiley et al. 2002].) Of these 109 trees, 78 would be subject to project activity within their structural root zone (a circular area with the tree trunk at the center and a radius equal to three times the tree trunk diameter measured 4.5 feet above ground level) (California State Parks 2011b).

2. Tree Assessment Criteria

The following factors were used to assess potential project effects on individual trees:

- Visual examination of tree condition
- Proximity of the tree to U.S. 101
- Proximity of proposed work to the base of the tree
- Extent of proposed work as depicted in the Individual Tree Details and project cross section diagrams
- Extent of new soil compaction

The structural root zone contains the majority of the tree's large supporting structural roots that provide stability (Costello et al. 2003; Helliwell 1989; Mattheck 1994; Smiley at al. 2002; Smiley 2009; Urban 2008). A change within the structural root zone does not equate to a substantial detrimental impact. For purposes of evaluating the potential effect of construction activity, a substantial detrimental impact would be a change to a tree's structure or environment that significantly diminishes a tree's ability to carry out one of its essential physiological activities—movement of water and nutrients; growth of new wood, leaves, and roots; exchange of gases; and seed production. Structural roots within the structural root zone would have to be severely disrupted or destroyed for the health or stability of a vigorous old-growth redwood to be substantially compromised.

Project activities occurring in the root health zone but not in the structural root zone (that is, in the area between three and five times the distance from the center of the trunk) would be farther from the large supporting roots, the buttress flare, and the trunk of the tree, and would affect only a very small percentage of nonstructural roots. Research on root regeneration by coast redwoods has demonstrated the extraordinary ability of coast redwoods to regenerate new roots even after up to 90% of the "feeder" (absorbing) roots have been destroyed (Stone 1965; Stone and Vasey 1962a, 1962b). Therefore, disruption or destruction of a small percentage of nonstructural roots in this outer area of the root health zone would have no substantial effect on tree health or stability.

3. Tree Ratings

a. Fluctuations in the Needle Density of Coast Redwoods

Fluctuations in needle density occur even when coast redwoods are growing under natural conditions away from human activities. The life span of a coast redwood needle (leaf) varies, but ranges from 2 to 5 years, or 7 years at most (Snyder 1992). Periodic seasonal "flushes" of new chartreuse-colored needles will be followed several years later by the browning and release of the same needles as they reach the end of their useful life (senescence). Thus, the "evergreen" appearance of a coast redwood persists through every season despite continuous changes in the number, location, and density of needles.

If root disruption caused by construction effects were to disrupt a root system's ability to absorb moisture, the tree may not be able to sustain the volume of needles present during construction activities. Continuing evapotranspiration of water from the tree's foliage could exceed the root system's ability to acquire enough water to maintain needle density.

b. The Effect of Root Zone Disturbance on Tree Health

The rating categories shown below in Table 1 were developed to illustrate the potential effect of the project on individual trees. They are based on my education, training and experience as an arborist, field review, consultation with Caltrans personnel, and a review of the scientific literature as noted by references in this report.

Table 1: Effect of Root Zone Disturbance on Tree Health

Rating	Effect
0	Root zone disturbance would have no effect on tree health.
1	Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.
2	Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.
3	Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.
4	Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.
5	Effect of root zone disturbance may be a reduction in root health sufficient to cause lasting visible dieback of wood in the uppermost crown; tree survival is not threatened.
6	Effect of root zone disturbance may be severe enough to threaten survival of the tree.

Each tree was rated according to the predicted effects of root disturbance on tree health, as may be evidenced by a change in the appearance of needles (leaves). Differences in rating categories reflect the degree of predicted root disturbance as affected by location, depth, and type of excavation (if any); proximity of the work to individual trees; and the amount and depth of added soil or roadway (if any).

Ratings of 1–3 are relative to each other, and reflect minor differences in the extent of root disturbance as illustrated in the updated Appendix D and in cross-sectional depictions (Caltrans 2015). In each of these three categories, the root disturbance would be so inconsequential to tree health that any decline in needle density would be imperceptible and unquantifiable.

A tree rated as a 4 could conceivably experience a perceptible reduction in needle density as an effect of construction activity. If any perceptible decline in foliage were to occur, the effect would be minor, temporary, and likely indistinguishable from normal cyclical fluctuations in needle density attributable to climatic variation and natural leaf senescence.

A rating of 5 would indicate that the effect of root disturbance could temporarily interrupt the ascent of water sufficiently to cause dieback of the top of the redwood (a spike top).

A rating of 6 would indicate extreme and lasting disruption such as the destruction of major supporting buttress roots or severe and widespread compaction throughout the tree's circumference that could threaten the survival or stability of a tree.

c. Evaluation of the Effect of Root Zone Disturbance on Tree Health

There is no way to quantify the exact extent or percentage of root disturbance because there is no way to observe or calculate the breadth and depth of each tree’s functioning root mass. As an example of the impossibility of ascertaining total root mass, when a 1,200-year-old redwood fell in 1933 in Richardson Grove, the estimated age of just the most recent iteration of seven levels of roots was 300 years—five lower levels of roots had regenerated after repeated flooding had deposited 11 feet of silt over the original basal root system of the tree (Fritz 1934; see Appendix B, Photograph 11).

Root structure and mass cannot be ascertained without excavating entire root systems. Therefore, some use of informed judgment is necessary and unavoidable in the assessment of root zone disturbance on individual tree health. Any professional assessment of potential effects of root disturbance must include, at a minimum, a thorough review of published research on the biological and ecological characteristics of coast redwoods, and must address and account for the absence of discernible decline of the old-growth redwoods alongside U.S. 101 in Richardson Grove after nearly 100 years of highway traffic and highway maintenance activities.

G. Tree Assessment Results

1. Effects of the Project on Old-Growth Redwoods

a. Excavation

Excavation for roadway construction by conventional methods would include the use of heavy equipment such as excavators, backhoes, grinders, loaders, and concrete saws. Conventional road alteration procedures would not make any provision for protection of roots encountered during construction. Roots in the excavation area could be damaged, and damage could extend beyond the limits of excavation because pulling and tugging by equipment could tear roots.

b. Compaction

Extreme soil compaction can be one of the most critical threats to the health and survivability of trees. Soil compaction can reduce oxygen diffusion and moisture availability to roots, limit drainage, encourage the proliferation of undesirable soil microorganisms, and reduce a tree’s capacity to respond favorably to many kinds of biotic and abiotic stress.

Although old-growth redwoods are resilient trees with multiple adaptive capabilities, their resilience can be overwhelmed by extreme environmental stress. The minor increase in compacted area created by these limited highway modifications would not create such stress.

U.S. Department of Transportation design exceptions for this project allow roadway shoulders to taper with steeper slopes to reduce the area of coverage on native soil.

Research has consistently demonstrated that soil compaction over a small percentage of a vigorous old-growth redwood's root structure would not, in itself, have any substantial detrimental or life-threatening effects (Gothier 1980; Hartesveldt et al. 1975; McBride and Jacobs 1978; Standish 1972; Stone 1965; Stone and Vasey 1962a, 1962b; Sturgeon 1964). The small amount of additional compaction resulting from implementation of this project would be insignificant to the health and stability of the old-growth redwoods.

c. Design

As designed, the project includes the following features which are more protective of trees than standard roadway design:

- Design exceptions were obtained to reduce shoulder widths and steepen embankment slopes, allowing for a narrower project footprint.

- An aggregate mix called Cement-Treated Permeable Base would be used as a base for new pavement in the roadway. This material was selected for this project because it requires approximately 6 inches less in application depth than other common road aggregates, is permeable, and requires only consolidation (a lesser degree of compaction) adjacent to roots within the structural root zone. Cement-Treated Permeable Base allows for greater oxygen diffusion and water percolation than a conventional subbase material (Caltrans 2010j, 2010k, 2010l).

- Excavation would go no deeper than 12 inches below the roadway for nearly every location in this project. Fewer roots would be affected by excavation than if a standard roadway design were used. Exceptions would be in the areas planned for culvert extension, two cut slopes, new barrier rail foundations, culvert replacement, new drainage, and installation of retaining walls.

d. Rating of Redwood Effects

Each tree was examined and rated for potential effects in light of the design features which are part of the project, and assuming the use of conventional construction equipment and conventional road construction procedures.

Based on the examination and rating, I reached the following conclusions, shown in Table 2:

- For five of the trees (rated 0), the project would have no effect (Tree Nos. 44, 45, 76, 108, and 114).

- For 29 trees (rated 1), the project activity would have an extremely minor effect, with no decline in foliage density or tree health (Tree Nos. 1, 6, 23, 27, 29, 31, 40, 47, 48, 57, 60, 66, 71, 74, 78, 79, 80, 84, 85, 88, 91, 93, 94, 95, 98, 102, 116, 118, and 119).

- For 25 trees (rated 2), the effect of the project would be very slight, with no decline in foliage density or tree health (Tree Nos. 2, 7, 8, 10, 14, 15, 16, 18, 19, 22, 24, 26, 28, 54, 58, 86, 89, 90, 92, 96, 99, 101,103,109, and 117).

- For 31 trees (rated 3), the effect would be slight, with no decline in foliage density or tree health (Tree Nos. 3, 9, 11, 12, 20, 21, 30, 32, 33, 34, 35, 36, 39, 41, 42, 51, 52, 53, 56, 62, 63, 64, 70, 72, 75, 77, 81, 82, 83, 97, and 112).

- For 18 trees (rated 4), the effect may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree (Tree Nos. 4, 5, 13, 25, 37, 38, 46, 49, 55, 59, 61, 67, 68, 69, 87, 104, 105, and 106).

- For two of the above 18 trees (Tree Nos. 104 and 105), one culvert would be replaced within their structural root zones, and a new drain would be installed near Tree No. 105. The culvert would be backfilled with Portland Cement Concrete slurry, which is similar to the backfill already in place around existing culverts. Using Portland Cement Concrete slurry halves the width of the trench normally required to lay a 24-inch culvert, reducing it from 2 feet on either side to 6 inches, and thereby limiting the area of root disturbance. Because of the limited total area of root disturbance and the resilience of coast redwoods, culvert replacement and drain installation would not threaten the trees' health or stability.

- For one of the trees (rated 5), the effect of root zone disturbance may be a reduction in root health sufficient to cause lasting visible dieback of wood in the uppermost crown, although tree health and survival are not threatened (Tree No. 73).

- No trees were rated 6, because in no instance would the survival or stability of any old-growth redwood be threatened by implementation of construction activities as proposed in the Richardson Grove Operational Improvement Project.

The old-growth redwoods will successfully respond and adapt to the new roadway conditions. In each case, disturbances would be confined to a small percentage of the area occupied by roots. None of the proposed highway alterations, using conventional highway construction techniques with the design features and exceptions incorporated into this project, is of sufficient magnitude to threaten the health or stability of any old-growth redwood.

2. Effects of the Project on Old-Growth Redwoods using Minimization Measures

a. Recommended Minimization Measures

The minimization measures described below would reduce the minor effects of the project on old-growth trees. However, as explained above, even in the absence of these minimization measures, this project would not jeopardize the health or survival of any of the old-growth redwoods in Richardson Grove State Park.

Table 2: Ratings of Construction Effects on Trees*

Tree	Rating
1	1
2	2
3	3
4	4
5	4
6	1
7	2
8	2
9	3
10	2
11	3
12	3
13	4
14	2
15	2
16	2
18	2
19	2
20	3
21	3
22	2
23	1
24	2
25	4
26	2
27	1
28	2
29	1
30	3
31	1
32	3
33	3
34	3
35	3
36	3
37	4
38	4
39	3
40	1
41	3
42	3
44	0
45	0
46	4
47	1
48	1
49	4
51	3
52	3
53	3
54	2
55	4
56	3
57	1
58	2
59	4
60	1
61	4
62	3
63	3
64	3
65	
66	1
67	4
68	4
69	4
70	3
71	1
72	3
73	5
74	1
75	3
76	0
77	3
78	1
79	1
80	1
81	3
82	3
83	3
84	1
85	1
86	2
87	4
88	1
89	2
90	2
91	1
92	2
93	1
94	1
95	1
96	2
97	3
98	1
99	2
100	
101	2
102	1
103	2
104	4
105	4
106	4
107	
108	0
109	2
110	
111	
112	3
113	
114	0
115	
116	1
117	2
118	1
119	1

*Note: On the walk-through of Richardson Grove for the Richardson Grove Operational Improvement Project conducted February 11-12, 2013, individual old-growth redwoods in the project area were assigned an identifying number if any soil-disturbing activities were to be conducted within the tree's root health zone. Since that time, changes in proposed project footprint have reduced the area of root disturbance. As a result, 10 trees (indicated in gray) will no longer have any disturbed soil in their root health zone, and 3 trees have been added (Tree Nos. 30, 118, and 119) that will have soil-disturbing activities in their root health zone.

1. Hand Tools and Pneumatic Soil Excavation

Soil within the structural root zone of old-growth redwoods would be removed using hand tools such as picks and shovels, using hand-held pneumatic devices, or a combination of the two (Caltrans 2010e, 2010j, 2010m).

Pneumatic excavators are hand-held devices that are connected by hoses to air compressors. A high-pressure stream of air is tunneled through a nozzle that breaks dense soil into finer particles and effectively removes soil without causing substantial damage to roots. If soil moisture is adequate, even compacted soils can be removed from root systems with virtually no damage (Smiley 1999). The use of a pneumatic excavator (such as an Air Spade®) or hand-held tools is assumed to protect roots 2 inches or larger from being cut during excavation (Gross and Julene 2002; Smiley 1999). When root preservation is a key objective for "high-value" trees, use of the pneumatic soil excavation technique is recommended (Gross and Julene 2002).

Pneumatic excavators would prevent damage to tree roots and enable roots to be incorporated into the structural section of the roadway (Caltrans 2010n, 2010o). Pneumatic excavators would not be used in the two areas where slopes must be excavated (Appendix C, Sheet 5, Station Marker 71; and Sheet 11, Station Marker 87.3), where the new barrier rail foundations must be constructed (Appendix C, Sheet 10, Station Marker 84.5) and where culverts are extended or a drain inlet is added (near Tree Nos. 12, 13, 15, and 96). Pneumatic excavators also would not be used north of the park boundary where retaining walls would be installed below U.S. 101 (near Tree Nos. 104, 105, and 106), and one culvert would be replaced in conjunction with a drain installation (Appendix C, Sheet 19, Station Markers 110.4 through 112.3).

2. Clean Severance of Roots

Locations in the park where roots larger than 2 inches in diameter would be severed, if encountered, are limited to the same sites indicated in the previous paragraph, where excavation could not be done by use of a pneumatic excavator or with hand tools.

Roots that are damaged or severed will create physical and chemical barriers (compartmentalization) to limit the spread of decay (Shigo 1977, 1986; Watson 2008). Roots would be most successful at limiting decay if they are cleanly severed with a sharp instrument to encourage rapid compartmentalization (Watson 2008). Clean cuts offer a smaller surface for drying and compartmentalization (Urban 2008).

If a root 2 inches or larger in diameter must be severed, it would be severed cleanly with a sharp instrument.

3. Avoiding Unnecessary Compaction

Unnecessary soil compaction would be avoided. Designated parking and material storage locations are incorporated into the requirements of the project (Caltrans 2010p). Heavy equipment for road excavation, trenching, and construction would operate from the paved roadway and would not park on undisturbed soil beneath the canopies of old-growth redwoods.

4. Supplemental Irrigation

During the drier months of June to September, a tanker truck would spray water weekly to a distance of 25 feet from the roadway in an amount equal to a one-half-inch depth in areas where excavation has occurred within the structural root zones of redwoods 30 inches or greater in diameter (Caltrans 2010l).

Root disturbance occasioned by this project would be insubstantial. Nonetheless, this supplemental irrigation would be available to wide areas of absorbing roots. The prescribed supplemental irrigation would not have any detrimental effects and would be of some benefit to trees during the drier months, even without road construction activity.

5. Monitoring and Quality Control

A designated monitor would be on-site during construction to ensure that minimization measures are implemented during soil excavation, culvert work, and placement of aggregate mix within structural root zones (Caltrans 2010q, 2010r).

b. Rating of Redwood Effects using Minimization Measures

Each tree was reexamined and rated again using the information used in the first evaluation and taking into account the minimization measures that could be applied during construction of the project.

Proposed activity within the root health zone was evaluated closely for potential effects on health or stability. The benefits of applying specific minimization measures (as reflected in improved ratings for individual trees) are listed in Table 3 below.

Based on the reexamination and rating with minimization measures, I reached the following conclusions:

- For seven trees (rated 0), the project would have no effect (Tree Nos. 29, 31, 44, 45, 76, 108, and 114).

- For 35 trees (rated 1), the project activity would have an extremely minor effect, with no decline in foliage density or tree health (Tree Nos. 1, 6, 18, 19, 23, 26, 27, 28, 40, 47, 48, 54, 57, 58, 60, 66, 71, 74, 78, 79, 80, 84, 85, 88, 91, 92, 93, 94, 95, 98, 102, 109, 116, 118, and 119).

- For 53 trees (rated 2), the effect of the proposed project would be very slight, with no decline in foliage density or tree health (Tree Nos. 2, 3, 7, 8, 9, 10, 11, 12, 14, 15, 16, 20, 21, 22, 24, 30, 32, 33, 34, 35, 36, 37, 38, 39, 41, 42, 51, 52, 53, 56, 59, 61, 62, 63, 64, 67, 68, 69, 70, 72, 75, 81, 82, 86, 89, 90, 96, 97, 99, 101, 103, 112, and 117).

- For 11 trees (rated 3), the effects would be slight, with no decline in foliage density or tree health (Tree Nos. 4, 5, 13, 25, 46, 49, 55, 73, 77, 83, and 87).

- For three trees (rated 4) the effect may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree (Tree Nos. 104, 105, and 106).

Table 3 indicates that project effect ratings for 52 of the old-growth redwoods would be reduced if hand tool/pneumatic soil excavation techniques were used where soil removal is a necessary procedure. Project effect ratings for three of the old-growth redwoods would be reduced if roots are encountered and they are cut cleanly with a sharp instrument.

Table 3: Tree Ratings: Comparison of Project Effects Without and With Minimization Measures*

Tree	Project Effect Rating	Project Effect Rating with Minimization Measures	Minimization Measure(s)[1] to be Applied
1	1	1	N/A
2	2	2	N/A
3	3	2	H
4	4	3	H
5	4	3	H
6	1	1	N/A
7	2	2	N/A
8	2	2	N/A
9	3	2	H
10	2	2	N/A
11	3	2	H
12	3	2	H
13	4	3	H, R
14	2	2	N/A
15	2	2	N/A
16	2	2	N/A
17			
18	2	1	H
19	2	1	H
20	3	2	H
21	3	2	H
22	2	2	N/A
23	1	1	N/A
24	2	2	N/A
25	4	3	H
26	2	1	H
27	1	1	N/A
28	2	1	H
29	1	0	H
30	3	2	R
31	1	0	H
32	3	2	H

Tree	Project Effect Rating	Project Effect Rating with Minimization Measures	Minimization Measure(s)[1] to be Applied
33	3	2	H
34	3	2	H
35	3	2	H
36	3	2	H
37	4	2	H
38	4	2	H
39	3	2	H
40	1	1	N/A
41	3	2	H
42	3	2	H
44	0	0	N/A
45	0	0	N/A
46	4	3	H
47	1	1	N/A
48	1	1	N/A
49	4	3	H
51	3	2	H
52	3	2	H
53	3	2	H
54	2	1	H
55	4	3	H
56	3	2	H
57	1	1	N/A
58	2	1	H
59	4	2	H
60	1	1	N/A
61	4	2	H
62	3	2	H
63	3	2	H
64	3	2	H
66	1	1	N/A
67	4	2	H
68	4	2	H
69	4	2	H
70	3	2	H
71	1	1	N/A
72	3	2	H
73	5	3	H
74	1	1	N/A
75	3	2	H
76	0	0	N/A
77	3	3	N/A
78	1	1	N/A

Tree	Project Effect Rating	Project Effect Rating with Minimization Measures	Minimization Measure(s)[1] to be Applied
79	1	1	N/A
80	1	1	N/A
81	3	2	H
82	3	2	H
83	3	3	N/A
84	1	1	N/A
85	1	1	N/A
86	2	2	N/A
87	4	3	R
88	1	1	N/A
89	2	2	N/A
90	2	2	N/A
91	1	1	N/A
92	2	1	H
93	1	1	N/A
94	1	1	N/A
95	1	1	N/A
96	2	2	N/A
97	3	2	H
98	1	1	N/A
99	2	2	N/A
100			
101	2	2	N/A
102	1	1	N/A
103	2	2	N/A
104	4	4	N/A
105	4	4	N/A
106	4	4	N/A
107			
108	0	0	N/A
109	2	1	H
110			
111			
112	3	2	H
113			
114	0	0	N/A
115			
116	1	1	
117	2	2	N/A
118	1	1	N/A
119	1	1	N/A

*Note: On the walk-through of Richardson Grove for the Richardson Grove Operational Improvement Project conducted February 11-12, 2013, individual old-growth redwoods in the project area were assigned an identifying number if any soil disturbing activities were to be conducted within the tree's root health zone. Since that time, changes in proposed project footprint have reduced the area of root disturbance so that 10 trees (indicated in gray) will no longer have any disturbed soil in their root health zone and 3 were added (Tree Nos. 30, 118, and 119) that will have soil disturbing activities in their root health zone.

[1] Hand tools/pneumatic soil excavation (H); roots cut cleanly (R); not applicable (N/A)

If these two minimization measures are applied, only three trees in the project area would retain a project effect rating of “4” (a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree); not a single tree would have enough activity within its root health zone to cause lasting visible dieback of wood in the uppermost crown. In no case, with or without minimization measures, would root zone disturbance have a substantial detrimental effect on the health or stability of any old-growth redwood.

Not all minimization measures would be applied in each tree’s root health zone. For example, if the top 3 inches of roadway are to be removed for road surface replacement, it makes no sense to scrape away the existing roadway asphalt with hand tools; similarly, no roots would be present to be cut with sharp instruments.

Some of the minimization measures would be beneficial but would not reduce project effect ratings for each tree. These include supplemental irrigation, avoidance of compaction and monitoring for quality control. None of the proposed highway alterations is of sufficient magnitude to threaten the health or stability of any old-growth redwood. In each case, disturbances would be confined to a small percentage of the area occupied by roots and would be well within the adaptive capabilities of the tree.

III. CONCLUSION

The life of any redwood is a succession of adaptations to environmental changes. The old-growth coast redwoods along U.S. 101 in Richardson Grove show no discernible decline after tens of millions of vehicles have crossed over their structural root zones for nearly 100 years.

This proposed construction project would add less than 5% of hardened surface (roadbed) to the existing hardened surface within the structural root zones of individual trees (Caltrans 2010f, 2010g, 2010h). Research has consistently verified that coast redwoods are extraordinarily resilient, provided that their roots and needles obtain adequate moisture from the water table, precipitation, and fog. Nothing in the Richardson Grove Operational Improvement Project would substantially diminish the ability of these old-growth redwoods to obtain water.

This conclusion represents my professional opinion based on the consistent research findings on redwood resilience, the current vigorous health of the subject trees, the confined areas of root disturbance, and the design of the roadway modifications to reduce the effects on trees.

The use of minimization measures during roadway improvement activities would further reduce the minor effects of the project on old-growth trees, and should be implemented. However, even if the minimization measures were not incorporated into this project, the limited root disturbance would be inconsequential to the appearance, stability, and continued health of the old-growth redwoods in Richardson Grove.

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APPENDIX A

Qualifications of the Arborist

APPENDIX B

Photographs

APPENDIX C

Old-Growth Redwoods in Project

APPENDIX D

Individual Tree Details

APPENDIX E

Interlocked Sap Ascent in Coast Redwoods

(from Rudinsky and Vité 1959)

QUALIFICATIONS OF THE ARBORIST

I. EDUCATION AND PROFESSIONAL LICENSES

UNIVERSITY OF CALIFORNIA AT BERKELEY

Doctor of Jurisprudence, Boalt Hall School of Law, 1981

Master of Social Welfare, School of Social Welfare, 1981

Bachelor of Arts, School of Psychology and School of Social Welfare, 1976

ASCA Registered Consulting Arborist #362

California Attorney at Law #108156

Certified Arborist #WE-130A

California State Contractor #679621

ISA Tree Risk Assessment Qualified

In 1984 I became a Certified Arborist and in 1995 I became a Registered Consulting Arborist. These designations together require examinations, hundreds of hours of qualifying and continuing education requirements in arboriculture, and peer evaluation of professional reports. I have also been an active member of the State Bar of California for over 25 years and have completed courses in alternative dispute resolution through the Center for Law and Mediation and the University of California at Berkeley. I do not maintain a law practice, but I am often retained as a consulting arborist in the resolution of tree-related controversies.

I have 15 years of experience climbing, pruning, restoring, and removing trees, and 17 years of experience providing consulting services in connection with tree health and risk assessment, tree species selection, appraisal of tree value, tree preservation for land development, forensic examinations, and resolution of tree-related disputes.

I have given arboricultural presentations at about 50 local, state, regional, and national arboricultural and forestry conferences.

I have been admitted in court as an arboricultural expert in six California counties and have testified at trial about 35 times.

I have engaged in many hundreds of arboricultural consultations and investigations. Several dozen assignments included evaluation of coast redwoods for health and structural stability, including evaluation of root systems and tree responses to root disturbance.

More than 10 years ago I was retained by Sanctuary Forest, a forest preservation association, to examine Luna, a renowned old-growth redwood in Humboldt County that had been severely vandalized. This assignment required a deep review of the literature of old-growth redwoods, including structural stability, moisture dynamics, and species response to severe trunk destruction and root severance. The tree was successfully braced and cabled by a team of arborists, foresters, and forest ecologists. I have continued to visit the site to evaluate Luna's resilience and have stayed current with research on redwood resilience.

I am a past president of the American Society of Consulting Arborists (ASCA) and have served on the faculty of the national ASCA Consulting Academy for the past 12 years, teaching such subjects as Forensic Arboriculture and The Role of the Consultant in Dispute Resolution.

II. ROLE

In May 2009 I was contacted by Land Projects Manager Christine Ambrose and retained by the Save-the-Redwoods League as a consultant to evaluate this project's potential for detrimental effects on old-growth redwoods.

In October 2010 I was contacted by Caltrans Project Manager Kim Floyd and retained by Caltrans to consult further about the project and about old-growth redwoods.

In September 2011 I was contacted by Caltrans attorney Janet Wong and retained by Caltrans to serve as a consultant and expert witness.

In August 2012 I was contacted by Caltrans Project Manager Kim Floyd and retained by AECOM to consult further about the project and about old-growth redwoods.

III. SITE AND DOCUMENT REVIEW

When I was initially retained by the Save-the-Redwoods League, I reviewed the Draft Environmental Impact Report (DEIR). In May 2009 I met with a group at Richardson Grove State Park to question Caltrans personnel about materials, techniques, and possible effects on old-growth redwoods. The Caltrans staff reviewed project plans, alternatives, fill composition, culvert repair, and mitigation measures. I did not measure and map each tree because tree diameters and locations had already been established by surveyors.

When I was retained as a consultant by Caltrans in October 2010, I examined the Final Environmental Impact Report, reviewed comments and answers, and met on site with the project manager and project engineer for further review of project plans.

When I was retained as an expert witness for this litigation in September 2011, I conducted additional field visits, and reviewed technical articles, project documents, and legal documents.

When I was retained as a consultant for this project in February 2013, I conducted additional field visits with the project manager, project biologist, and project engineers, and reviewed technical articles, Caltrans documents, and legal documents.

1. **August 1913:** Humboldt County redwoods. (Caltrans Transportation Library and History Center, Sacramento)

2. **March 1916:** Building U.S. 101 near San Rafael, California. (Caltrans Transportation Library and History Center, Sacramento)

3. **1920s(?):** Automobile in the redwoods. (Caltrans Transportation Library and History Center, Sacramento)

4. **June 1953:** U.S. Highway 101 north of Myers Flat in Humboldt County. (Caltrans Transportation Library and History Center, Sacramento)

5. **December 1964:** U.S. Highway 101 flood washout in Richardson Grove reveals the depth of road material. (Courtesy of California State Parks, 2011, Catalog #090-17559)

6. **January 1965:** U.S. Highway 101 flood washout near Myers Flat in Humboldt County reveals the depth of road material. (Caltrans Transportation Library and History Center, Sacramento)

7. **2012:** Tree No. 20 alongside U.S. Highway 101 in Richardson Grove. Very large buttress roots were severed for highway construction, causing the top of the tree to dry out and form a "spike top." No buttress roots of old-growth redwoods would be severed during the Richardson Grove Operational Improvement Project.

8. **2012:** Top of Tree No. 20, showing a "spike top" most likely caused by severance of major buttress roots several decades ago during highway construction. No buttress roots of old-growth redwoods would be severed during the Richardson Grove Operational Improvement Project.

9. **2012:** Trees No. 89 and 90 alongside U.S. Highway 101 in Richardson Grove. Several decades ago, very large buttress roots of these redwoods were severed for highway construction, causing the topmost part of the trees to dry out and form a "spike top." No buttress roots of old-growth redwoods would be severed during the Richardson Grove Operational Improvement Project.

10. **2012:** The tops of Trees No. 89 and 90 showing "spike tops" apparently caused by severance of major buttress roots during highway construction. No buttress roots of old-growth redwoods would be severed during the Richardson Grove Operational Improvement Project.

11. **1933:** This redwood was more than 1,200 years old when it fell in Richardson Grove in 1933. During its lifetime, the depth of soil at its base had increased by about 11 feet because of silt deposited by periodic floods. As soil accumulated, seven distinct layers of roots had formed. (Courtesy of the Marian Koshland Bioscience and Natural Resources Library, University of California, Berkeley: lib.berkeley.edu/BIOS/)

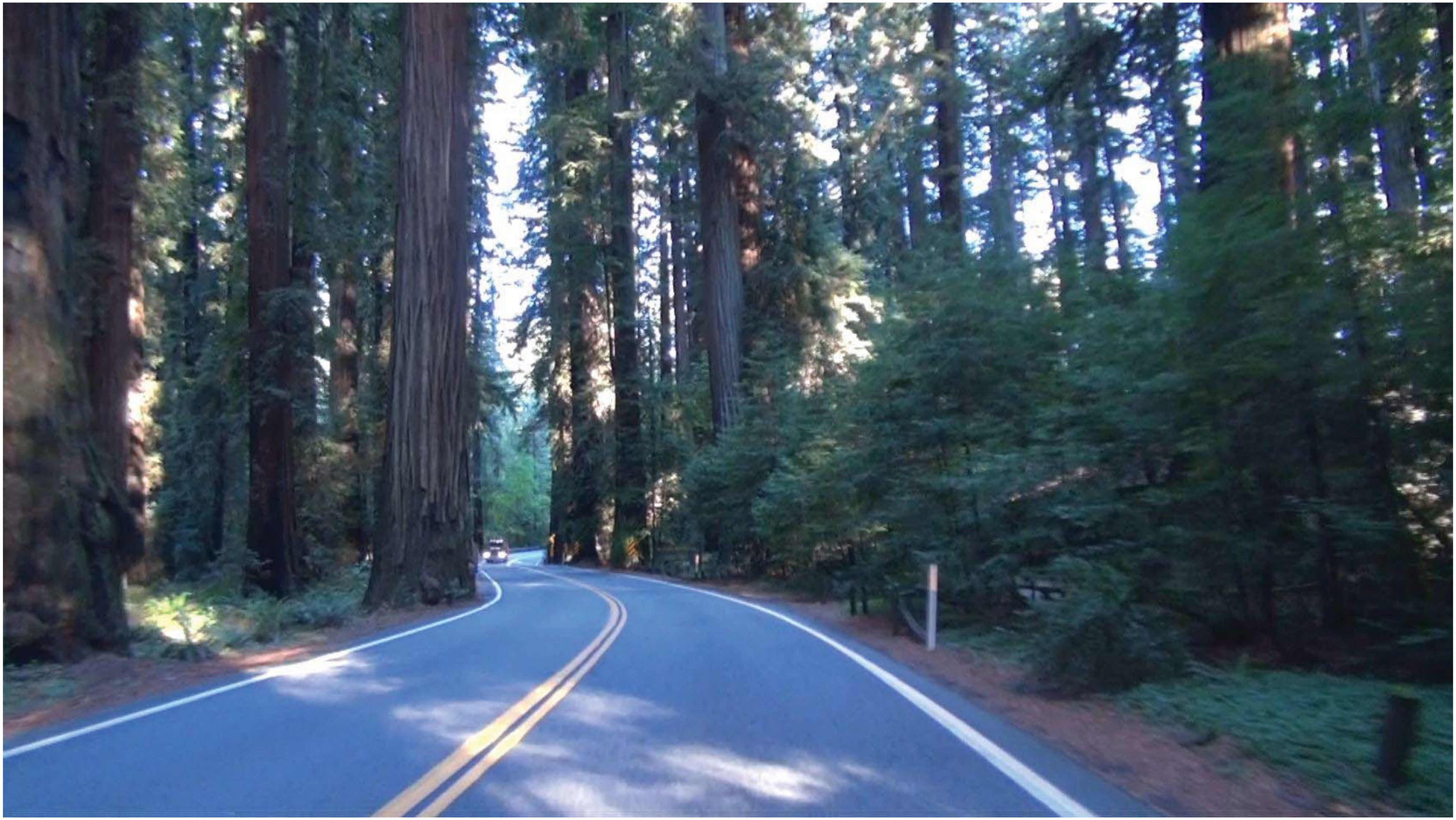
12. **2011:** Natural silt deposits alongside coast redwoods adjacent to Bull Creek, in the Rockefeller Grove in Humboldt County. Redwood trunks form new layers of roots below accumulated soil.

13. **2011:** This old-growth coast redwood toppled in the 1950s or 1960s during an extreme flood in Bull Creek. Soil had accumulated alongside the standing tree and new roots had formed from buried trunk tissue. This successful survival tactic enables redwoods to survive repeated flooding and sedimentation.

14. **2011:** Fibrous redwood roots growing alongside Bull Creek in the Rockefeller Grove in Humboldt County. Old-growth redwoods have very wide-spreading structural roots that form massive quantities of fibrous roots that help absorb water and minerals.

15. **1926:** View of Richardson Grove facing north near the current Visitor Center. (Courtesy of the Marian Koshland Bioscience and Natural Resources Library, University of California, Berkeley: lib.berkeley.edu/BIOS/)

16. **July 1950:** View of Richardson Grove facing north near the current Visitor Center. (Courtesy of California State Parks, 2011, Catalog #090-17352)



17. **2011:** Current view of Richardson Grove, facing north. The Visitor Center is obscured on the right by young trees growing in a former parking area.

18. **1950s:** Redwoods alongside U.S. Highway 101 as viewed facing west from the current site of the Visitor Center. (Courtesy of California State Parks, 2011, Catalog #090-17293)

19. **2013:** Redwoods alongside U.S. Highway 101, as viewed facing west from the current site of the Visitor Center. A parking area and museum have been replaced by young redwoods, ferns, and duff.

20. **2012:** Heading north on U.S. Highway 101 and entering the redwood grove adjacent to Richardson Grove State Park.

21. **2011:** A helicopter view of Richardson Grove and the Eel River, looking north.

22. **2011:** A helicopter view of Richardson Grove and the Eel River, looking south. U.S. Highway 101 can be seen through the trees.

Attachment A

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	HUM	101	1.10 / 2.20	1	20

This map has been prepared under the direction of the following registered civil engineer. The registered civil engineer attests to the engineering data contained herein.

Eric Lund

REGISTERED CIVIL ENGINEER

August 13, 2015

DATE

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REGISTERED PROFESSIONAL ENGINEER
Eric Lund
No. 58092
Exp. 6/30/16
CIVIL
STATE OF CALIFORNIA

Old growth redwood tree with number (red) is analyzed for potential root health zone effects.

55"*

Old growth redwood tree without number has root health zone outside of project's disturbed soil area.

55"*

* Tree size: diameter at breast height (DBH)

Old growth redwood tree eliminated from analysis because root health zone is now outside of project's disturbed soil area.

Limit of Proposed Excavation

Limit of Proposed Embankment

Existing Edge of Pavement

Proposed Edge of Pavement

62

Proposed Centerline

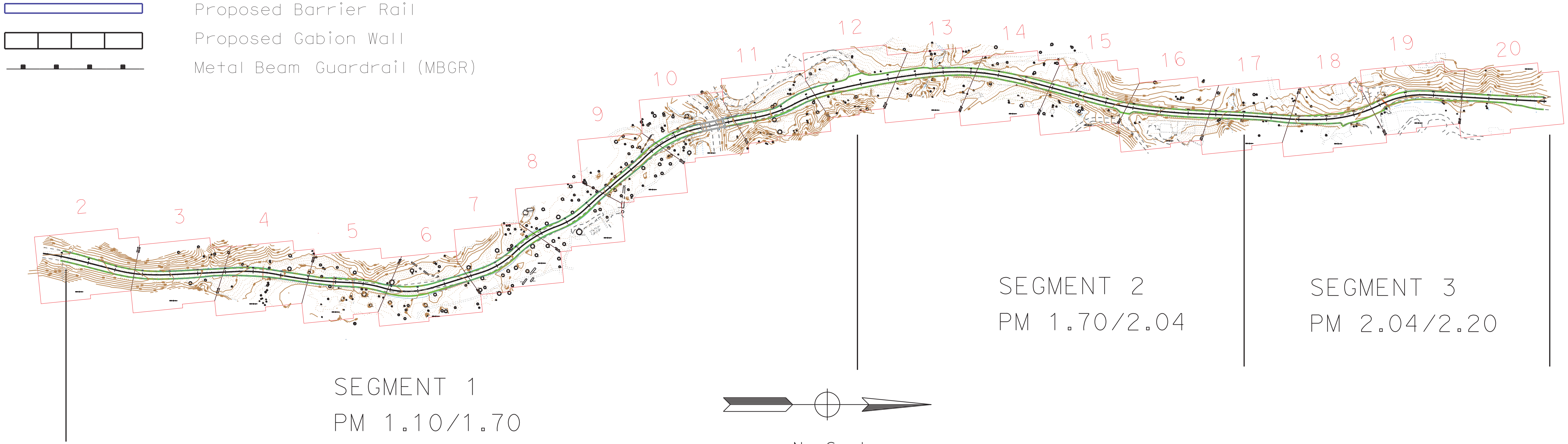
Proposed Culvert Extension

Proposed Soldier Pile Wall

Proposed Barrier Rail

Proposed Gabion Wall

Metal Beam Guardrail (MBGR)



No Scale

Note:

Detailed information on numbered trees presented in Individual Tree Details

Attachment A
Old Growth Redwoods** in Project

** Diameter greater than or equal to 30"

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

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EA 01-46480

LAST REVISION 08/12/15

DATE PLOTTED => 12-AUG-2015
TIME PLOTTED => 15:41

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	HUM	101	1.10 / 2.20	2	20

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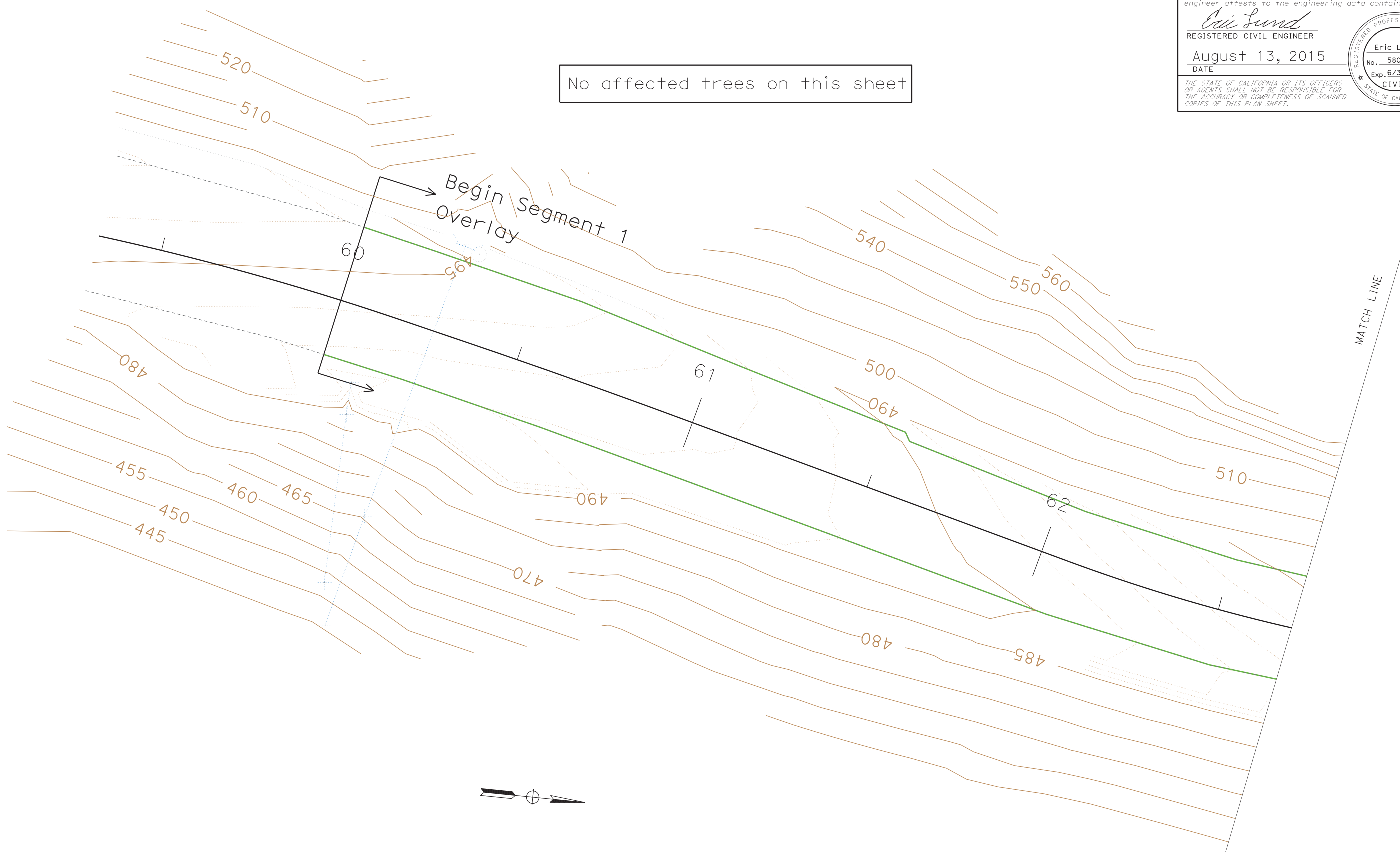
No affected trees on this sheet



Old Growth Redwoods in Project

1"=25'

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

Attachment A

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	HUM	101	1.10 / 2.20	3	20

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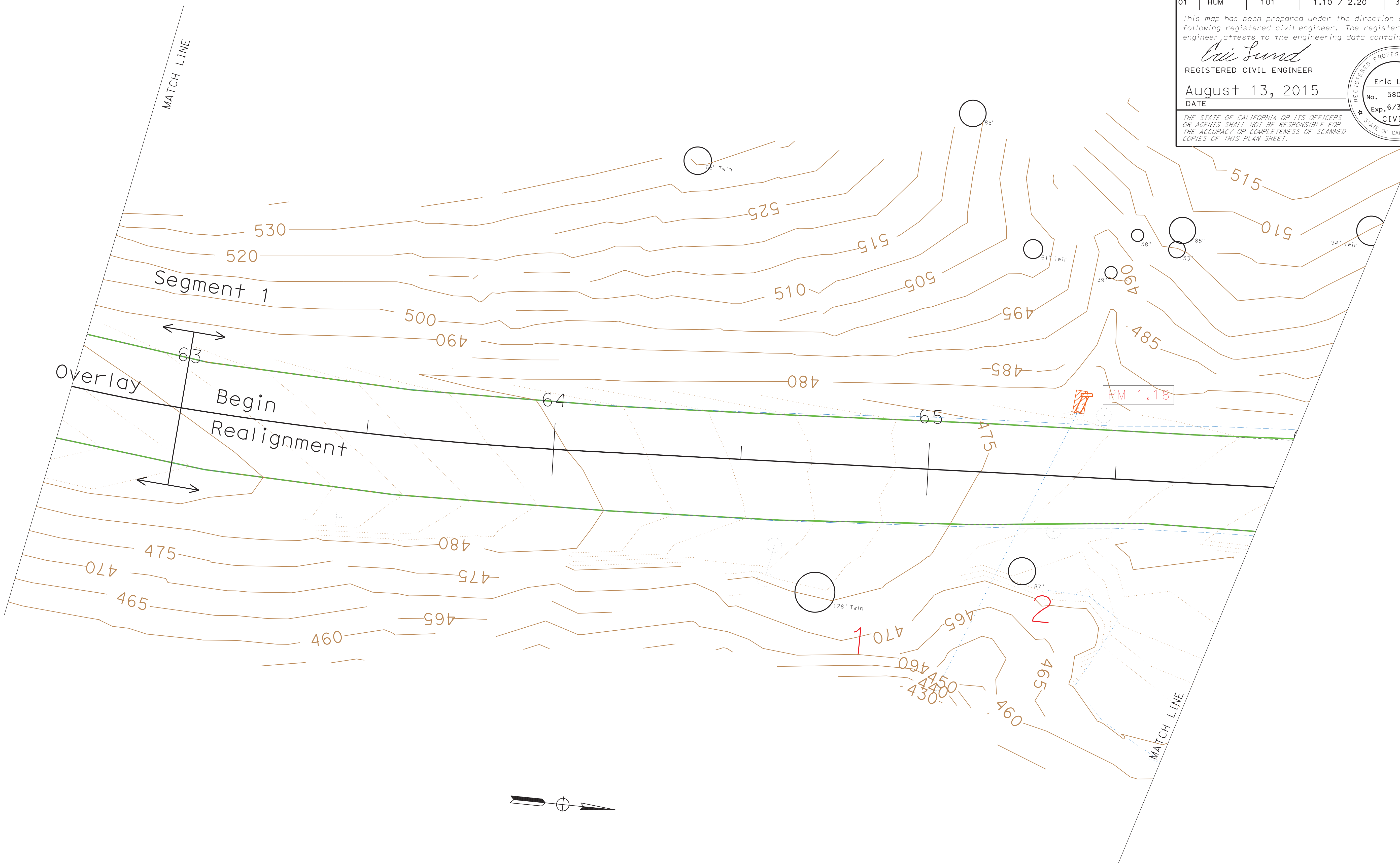

Old Growth Redwoods in Project

1"=25'

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

Attachment A

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01	HUM	101	1.10 / 2.20	4	20

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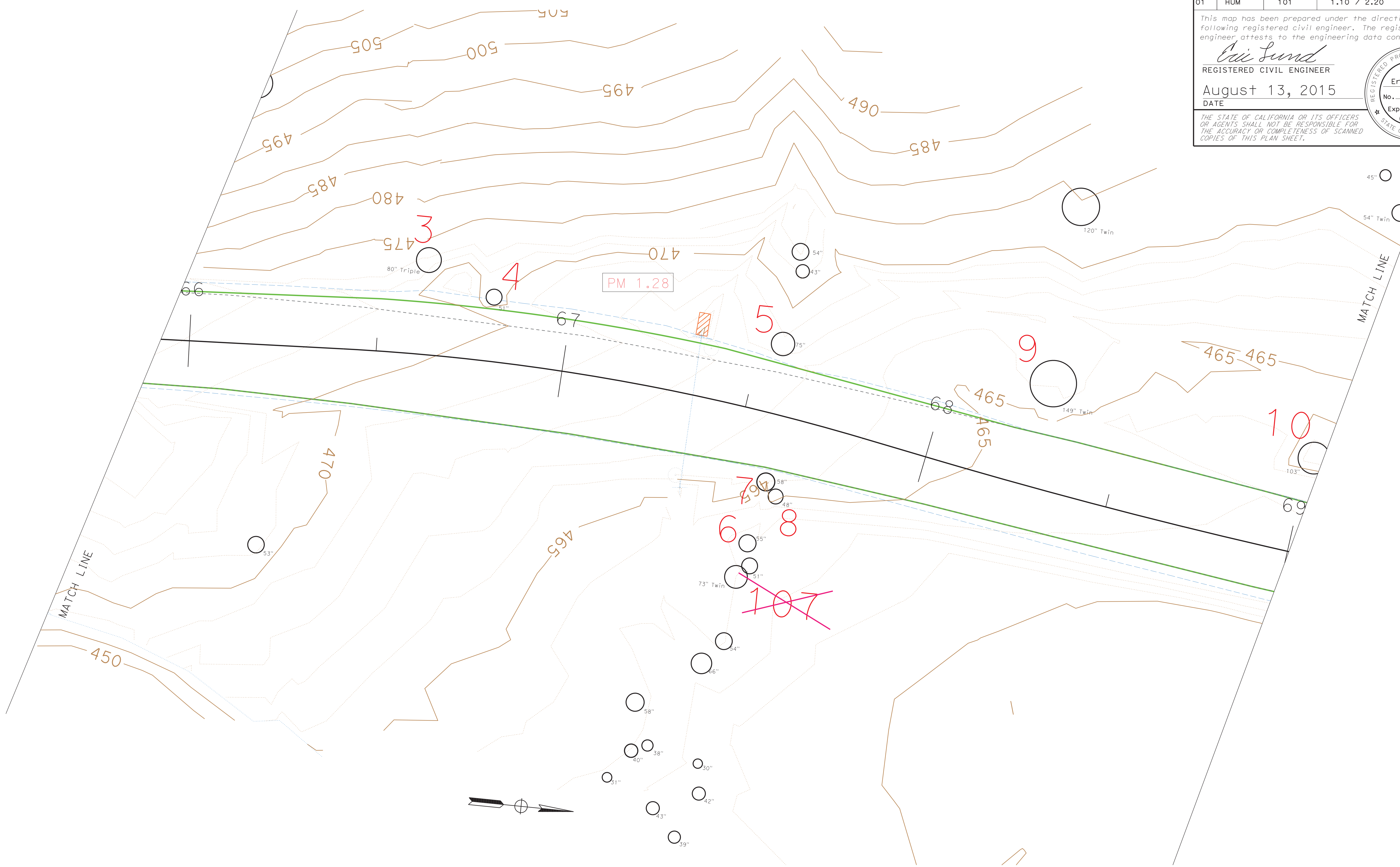

Old Growth Redwoods in Project

1"=25'

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

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Attachment A

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01	HUM	101	1.10 / 2.20	5	20

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Eric Lund
REGISTERED CIVIL ENGINEER

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Eric Lund
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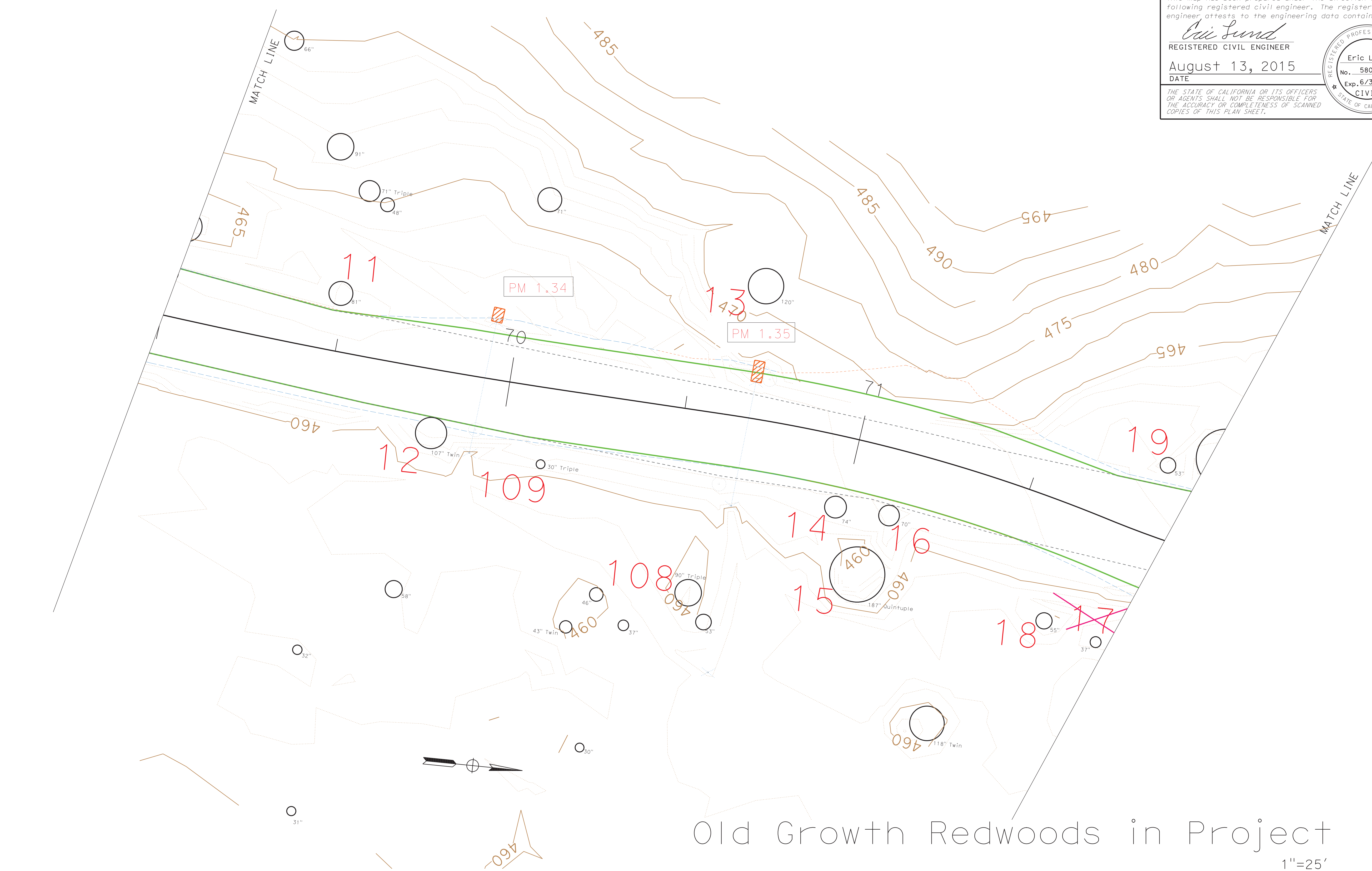

Old Growth Redwoods in Project

1"=25'

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Attachment A

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	HUM	101	1.10 / 2.20	6	20

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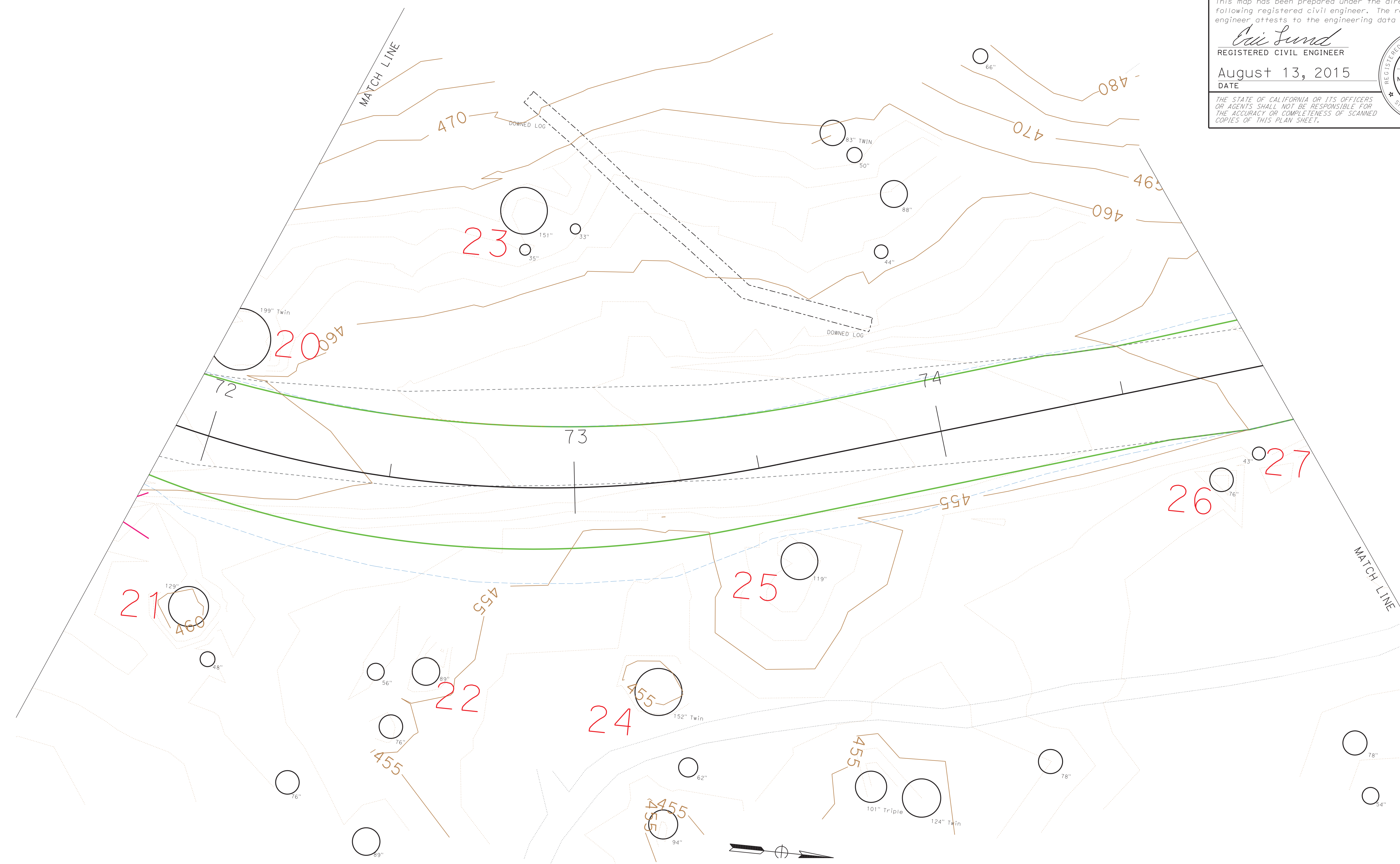
Eric Lund
No. 58092
Exp. 6/30/16
CIVIL
STATE OF CALIFORNIA



Old Growth Redwoods in Project

1"=25'

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

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LAST REVISION 02/18/15

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EA 01-46480

Attachment A

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	HUM	101	1.10 / 2.20	7	20

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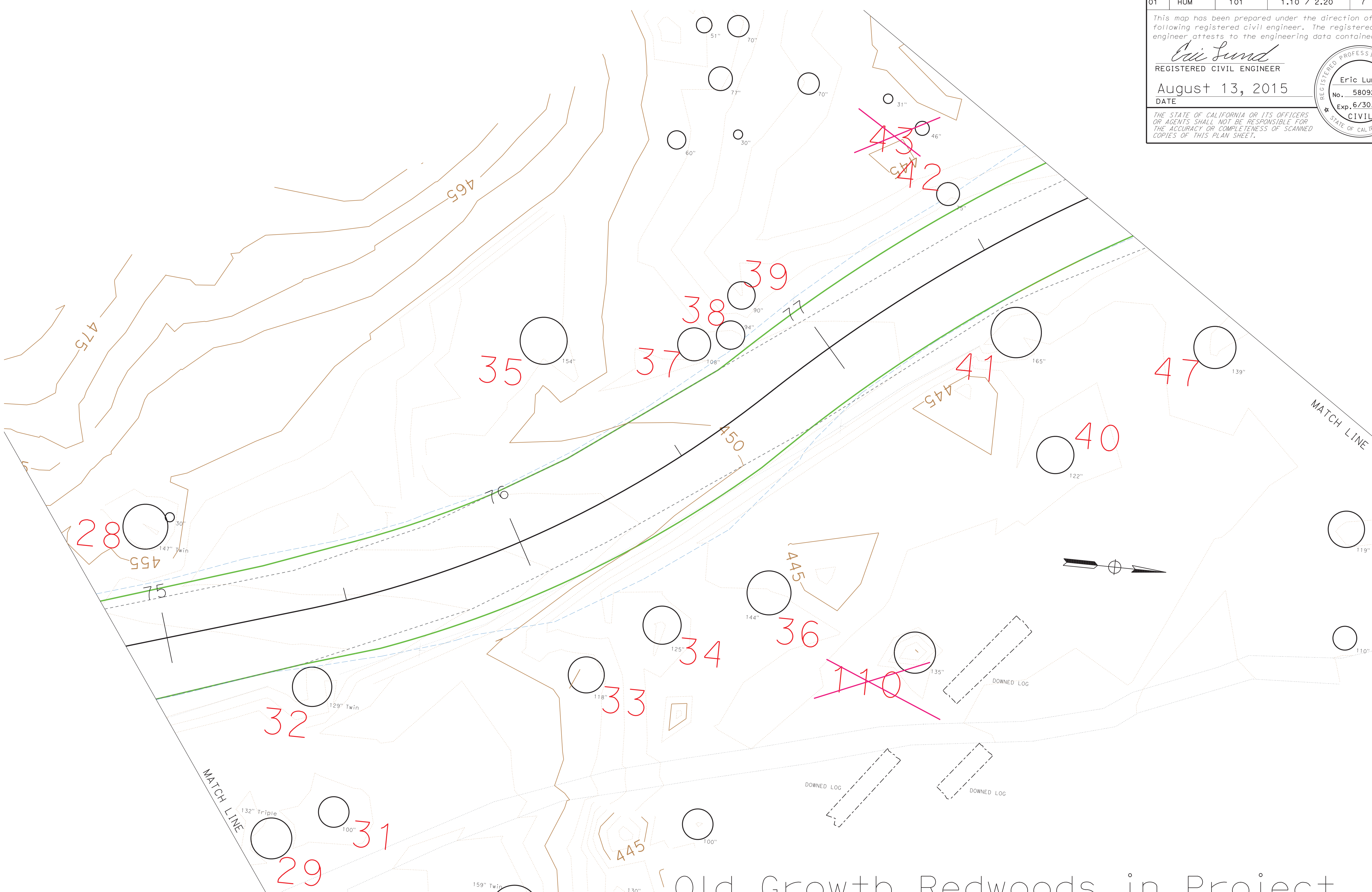
Eric Lund

REGISTERED CIVIL ENGINEER

August 13, 2015

DATE

REGISTERED PROFESSIONAL ENGINEER
Eric Lund
No. 58092
Exp. 6/30/16
CIVIL
STATE OF CALIFORNIA



Old Growth Redwoods in Project

1"=25'

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

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TIME PLOTTED => 15:41

LAST REVISION 02/18/15

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EA 01-46480

Attachment A

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	HUM	101	1.10 / 2.20	8	20

This map has been prepared under the direction of the following registered civil engineer. The registered civil engineer attests to the engineering data contained herein.

Eric Lund

REGISTERED CIVIL ENGINEER

August 13, 2015

DATE

REGISTERED PROFESSIONAL ENGINEER
Eric Lund
No. 58092
Exp. 6/30/16
CIVIL
STATE OF CALIFORNIA

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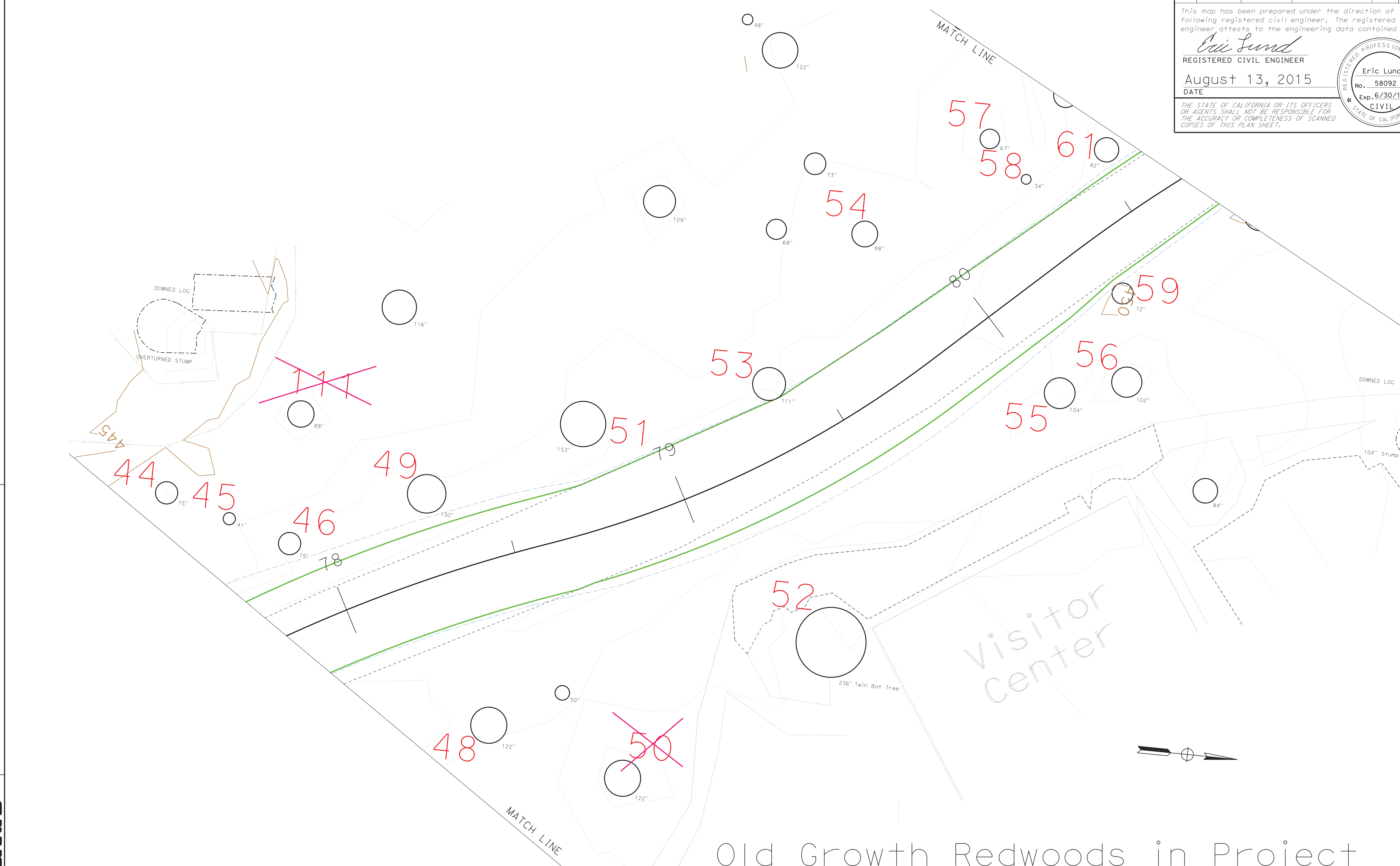
STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans



Old Growth Redwoods in Project

1"=25'

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

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CU 00000

EA 01-46480

DATE PLOTTED => 12-AUG-2015
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LAST REVISION 02/18/15

Attachment A

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	HUM	101	1.10 / 2.20	9	20

This map has been prepared under the direction of the following registered civil engineer. The registered civil engineer attests to the engineering data contained herein.

Eric Lund

REGISTERED CIVIL ENGINEER

August 13, 2015

DATE

REGISTERED PROFESSIONAL ENGINEER
Eric Lund
No. 58092
Exp. 6/30/16
CIVIL
STATE OF CALIFORNIA

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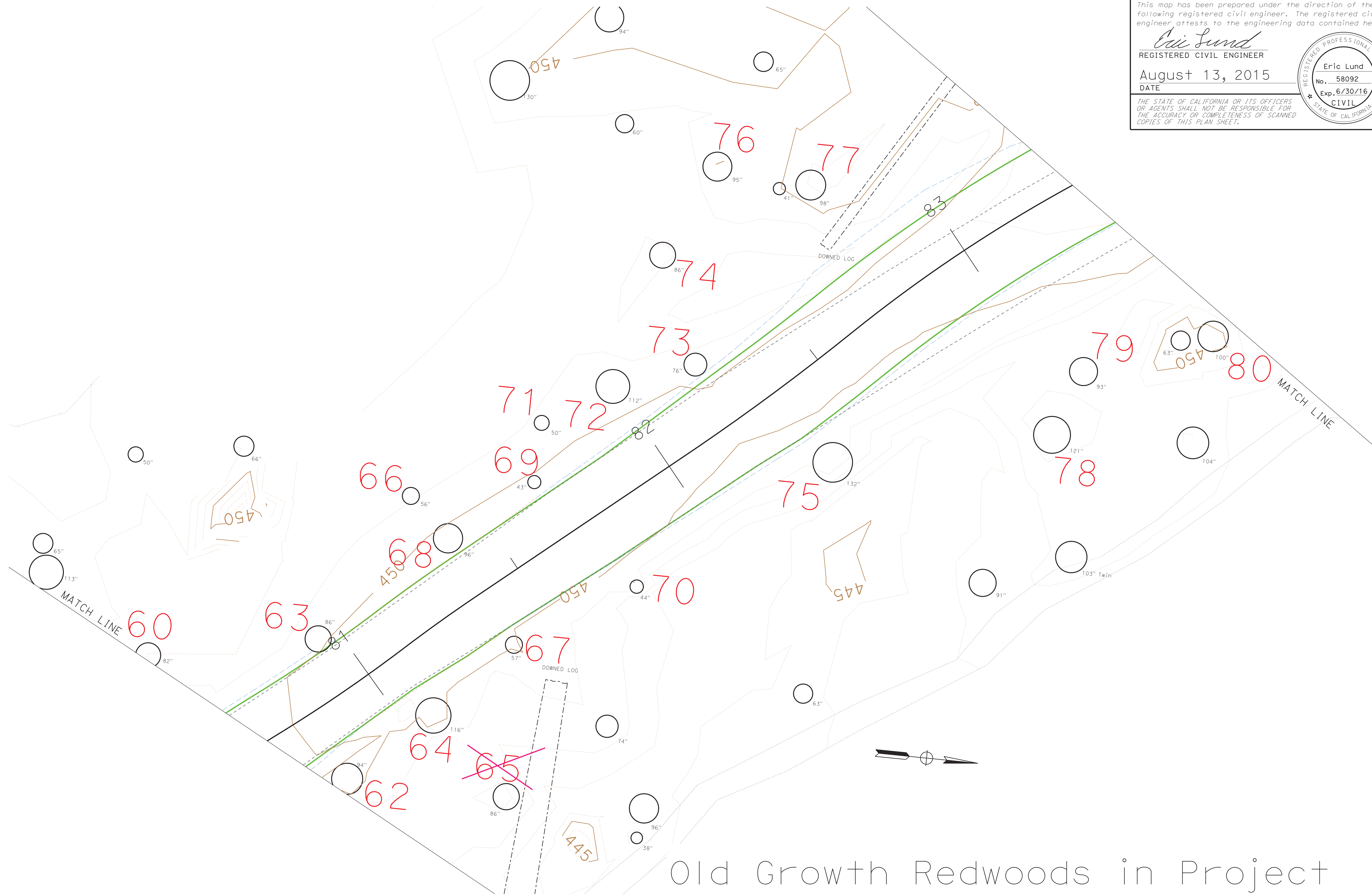

Old Growth Redwoods in Project

1"=25'

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

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RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

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DGN FILE => sheet9.dgn

CU 00000

EA 01-46480

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TIME PLOTTED => 15:41

LAST REVISION 02/18/15

Attachment A

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	HUM	101	1.10 / 2.20	10	20

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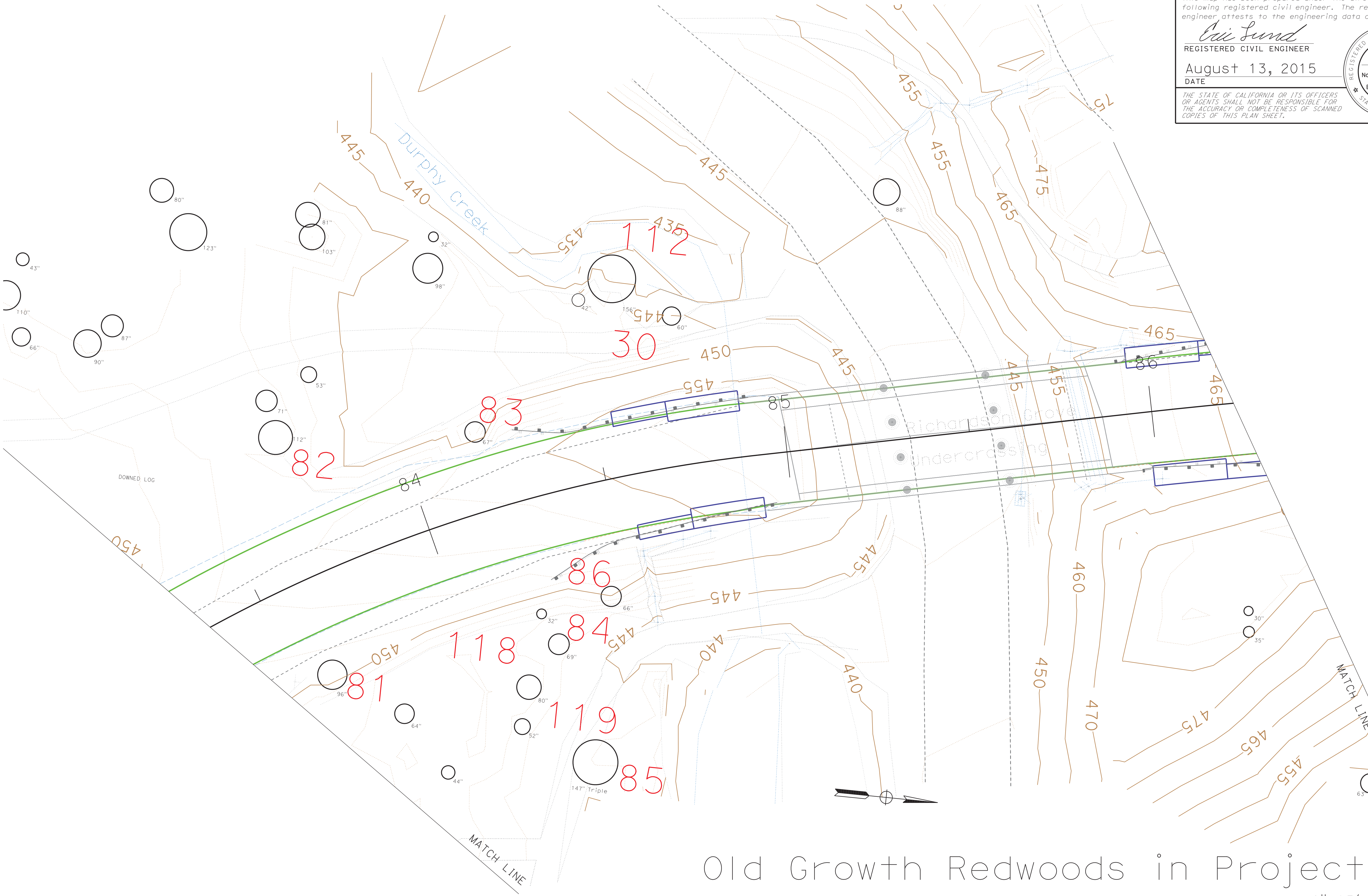

Old Growth Redwoods in Project

1"=25'

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

RELATIVE BORDER SCALE IS IN INCHES

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DGN FILE => sheet10.dgn

CU 00000

EA 01-46480

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LAST REVISION 07/3/15

Attachment A

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	HUM	101	1.10 / 2.20	11	20

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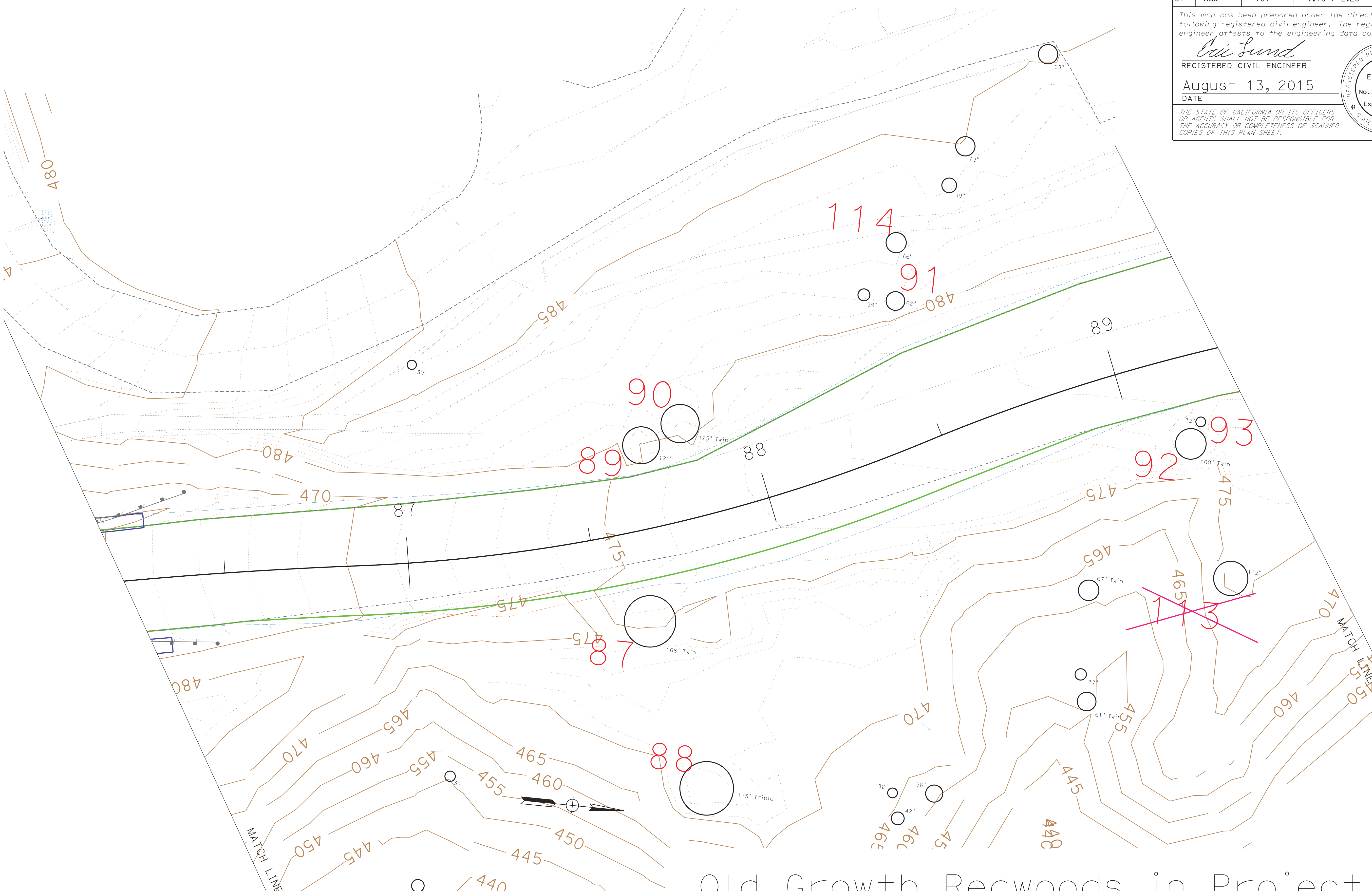

Old Growth Redwoods in Project

1"=25'

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

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TIME PLOTTED => 15:41

LAST REVISION 02/18/15

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => s122576
DGN FILE => sheet11.dgn

CU 00000

EA 01-46480

Attachment A

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	HUM	101	1.10 / 2.20	12	20

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August 13, 2015
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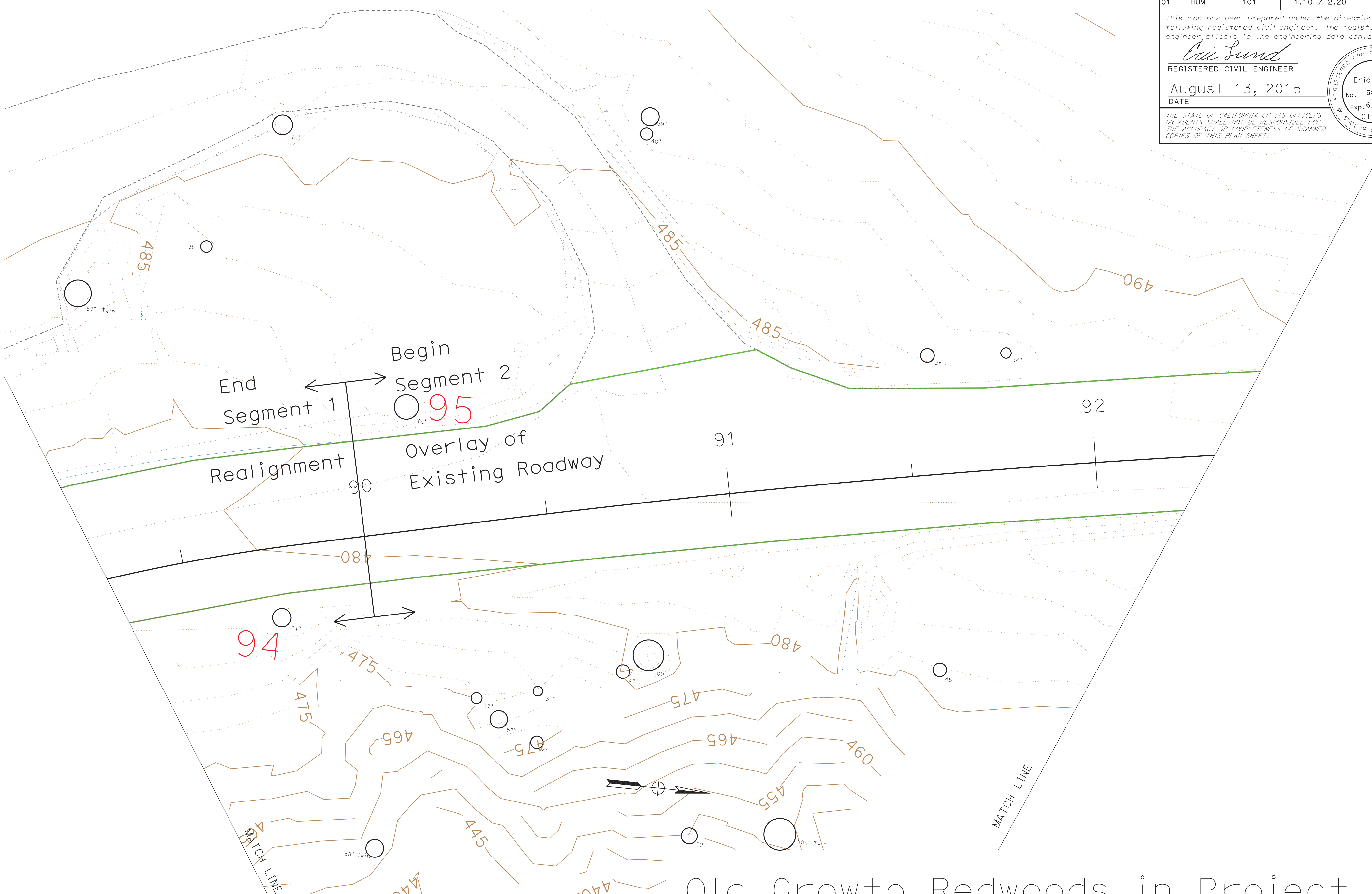

Old Growth Redwoods in Project

1"=25'

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

Attachment A

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	HUM	101	1.10 / 2.20	13	20

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STATE OF CALIFORNIA

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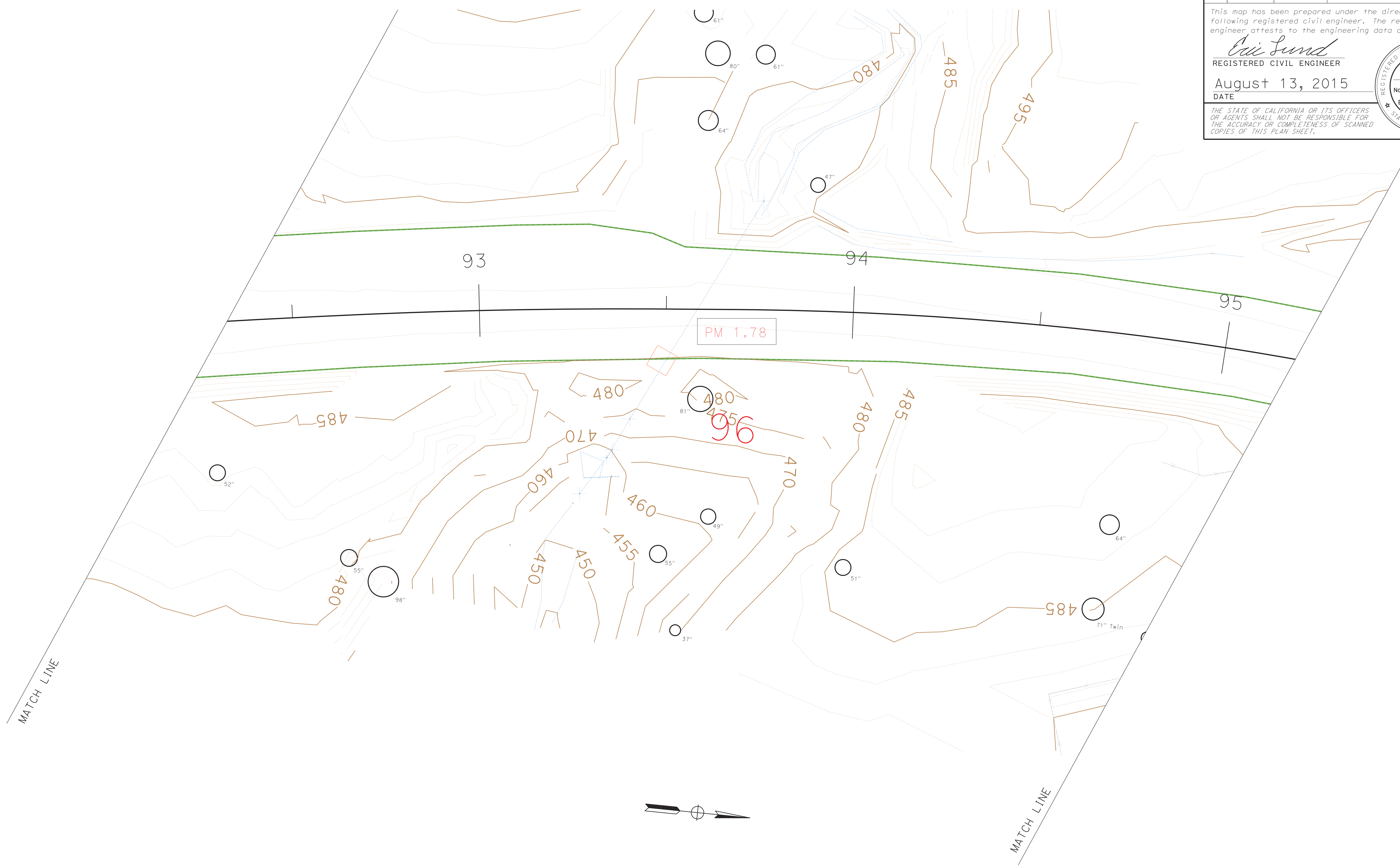

Old Growth Redwoods in Project

1"=25'

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

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LAST REVISION 05/29/13

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USERNAME => s122576
DGN FILE => sheet13.dgn

CU 00000

EA 01-46480

Attachment A

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	HUM	101	1.10 / 2.20	14	20

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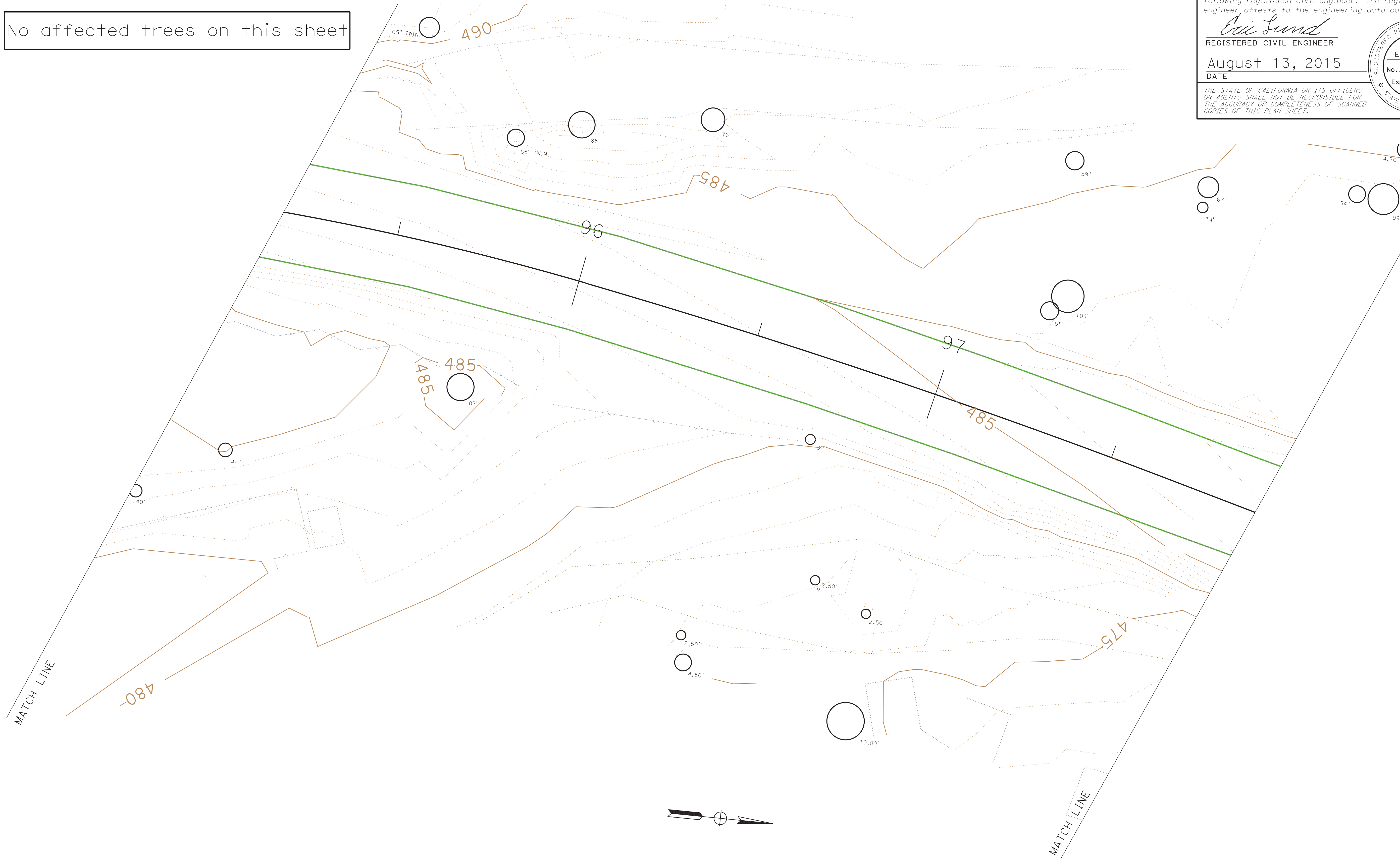
No affected trees on this sheet



Old Growth Redwoods in Project

1"=25'

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

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CU 00000

EA 01-46480

LAST REVISION 05/29/13

DATE PLOTTED => 12-AUG-2015
TIME PLOTTED => 15:42

Attachment A

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	HUM	101	1.10 / 2.20	15	20

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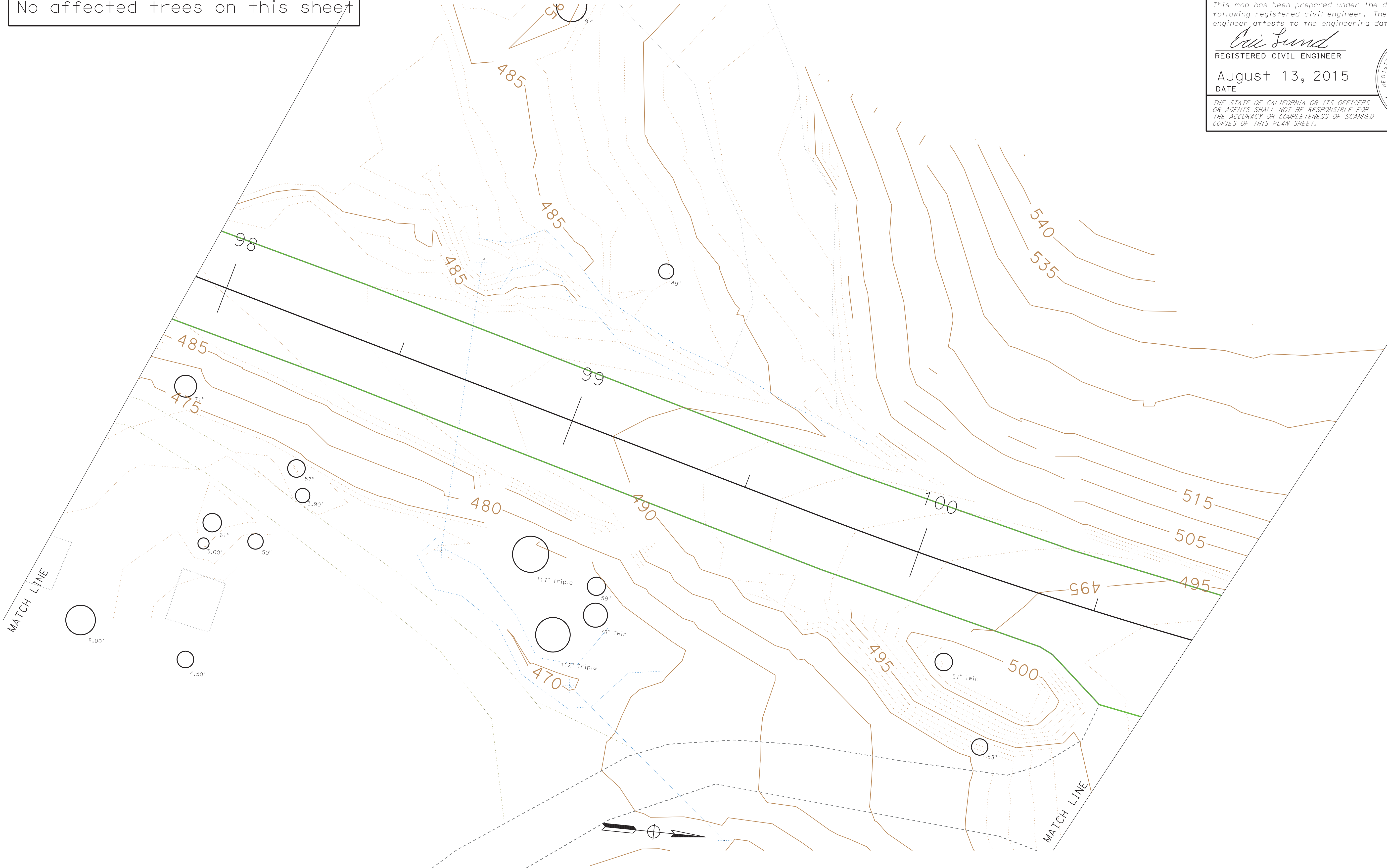
No affected trees on this sheet



Old Growth Redwoods in Project

1"=25'

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

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DATE PLOTTED => 12-AUG-2015
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RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => s122576
DGN FILE => sheet15.dgn

CU 00000

EA 01-46480

Attachment A

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	HUM	101	1.10 / 2.20	16	20

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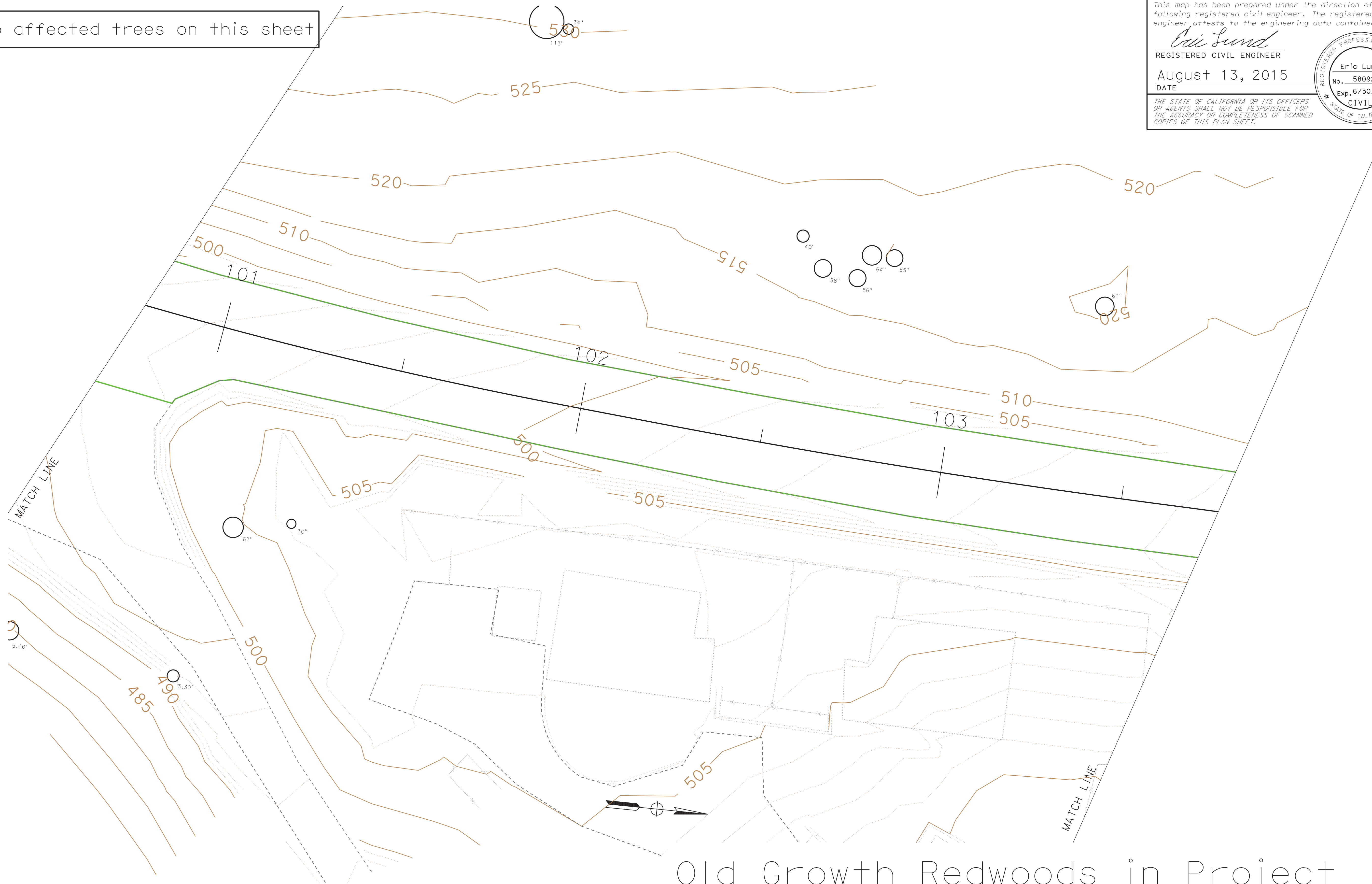

Old Growth Redwoods in Project

1"=25'

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USERNAME => s122576
DGN FILE => sheet16.dgn

CU 00000

EA 01-46480

Attachment A

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	HUM	101	1.10 / 2.20	17	20

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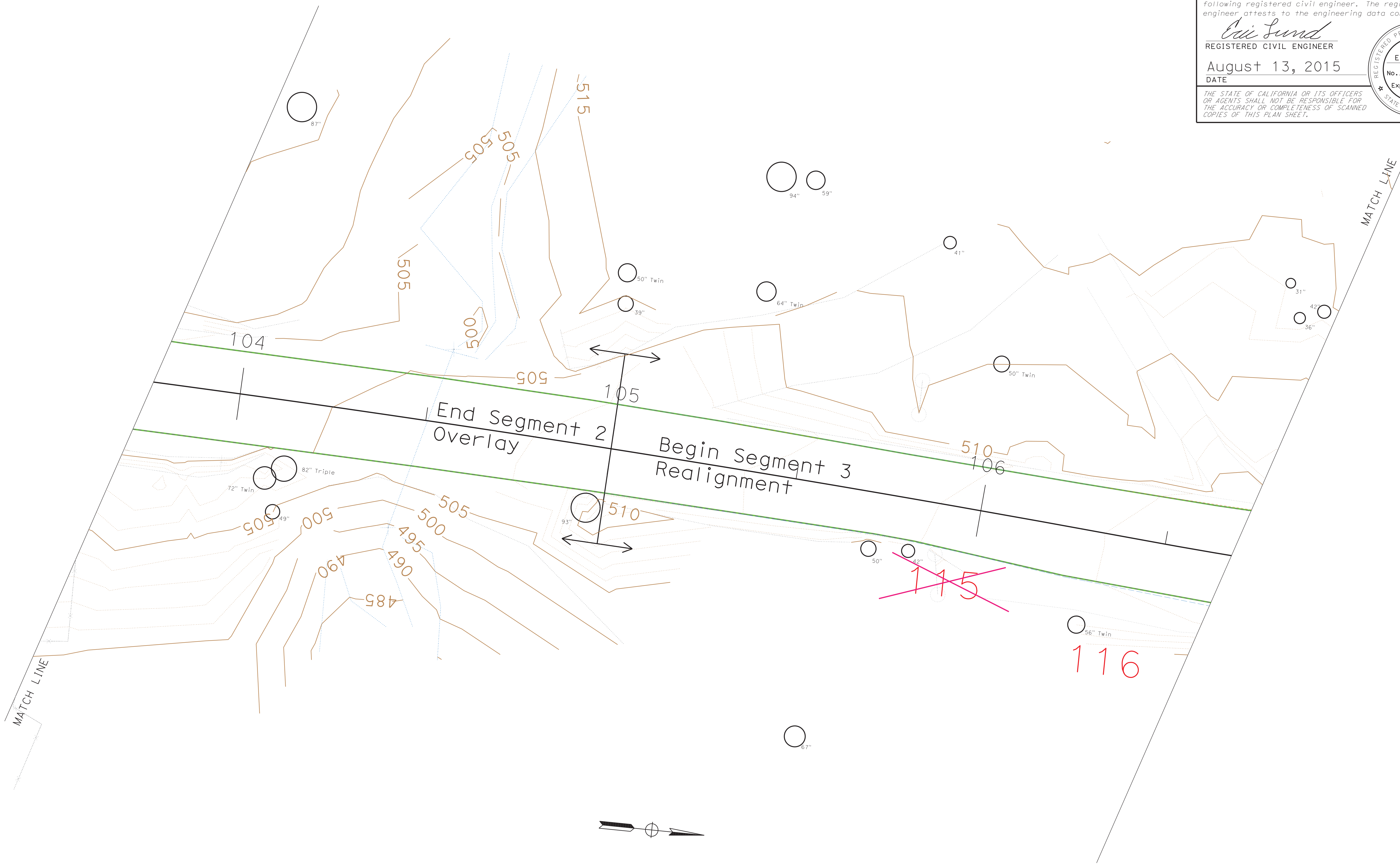

Old Growth Redwoods in Project

1"=25'

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

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USERNAME => s122576
DGN FILE => sheet17.dgn

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Attachment A

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	HUM	101	1.10 / 2.20	18	20

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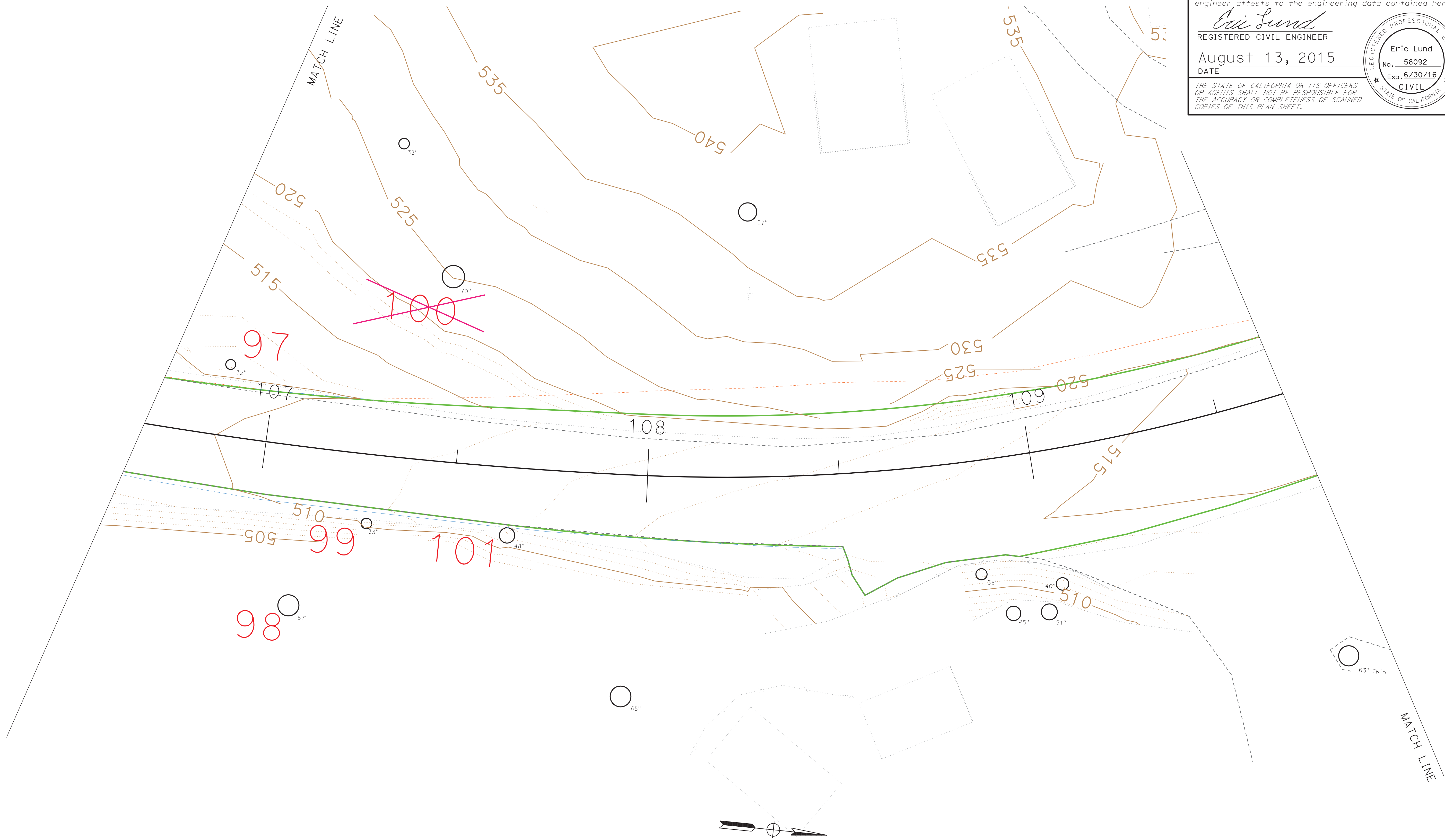

Old Growth Redwoods in Project

1"=25'

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Attachment A

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	HUM	101	1.10 / 2.20	19	20

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August 13, 2015
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Exp. 6/30/16
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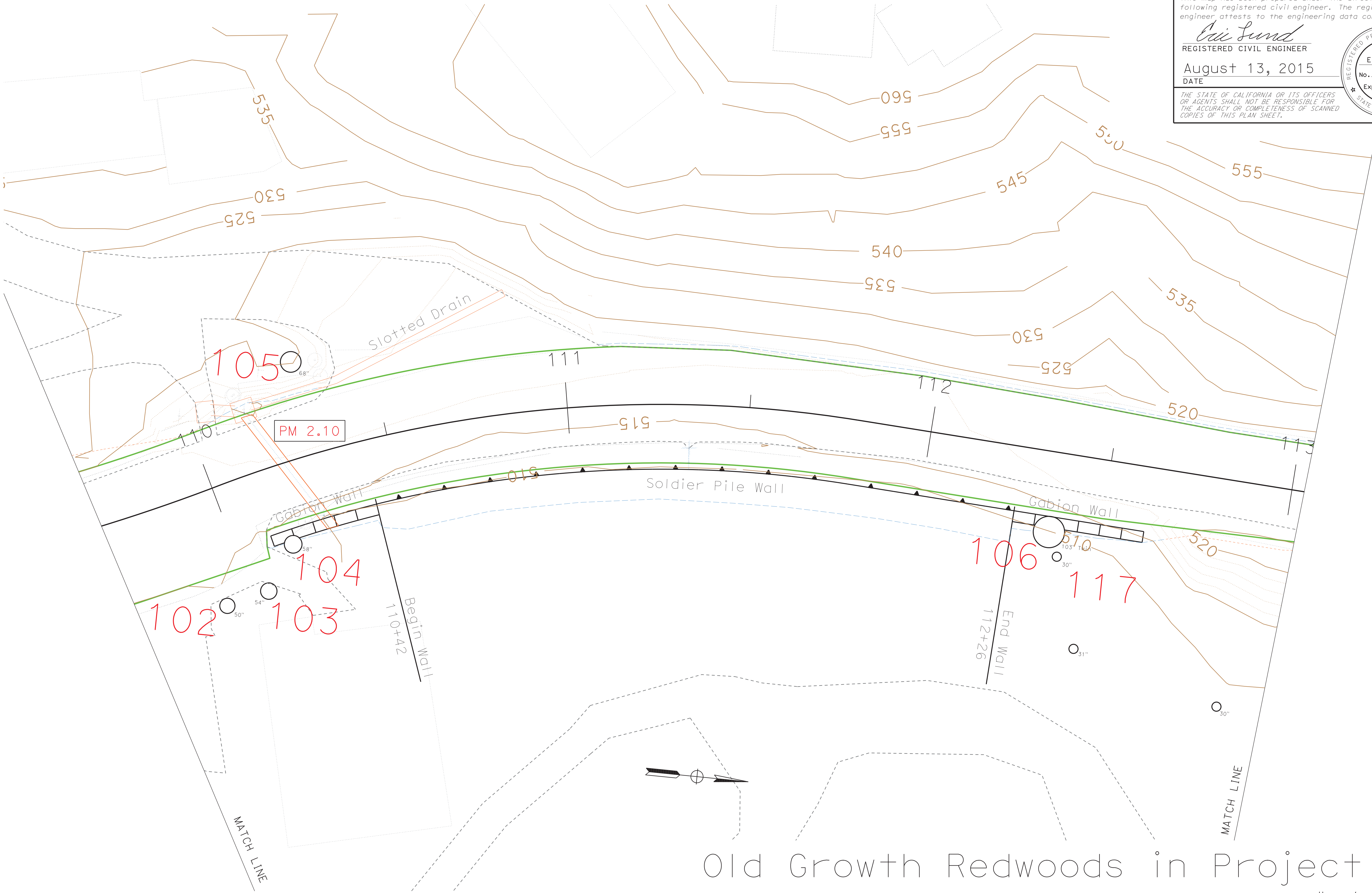

Old Growth Redwoods in Project

1"=25'

Attachment A

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	HUM	101	1.10 / 2.20	20	20

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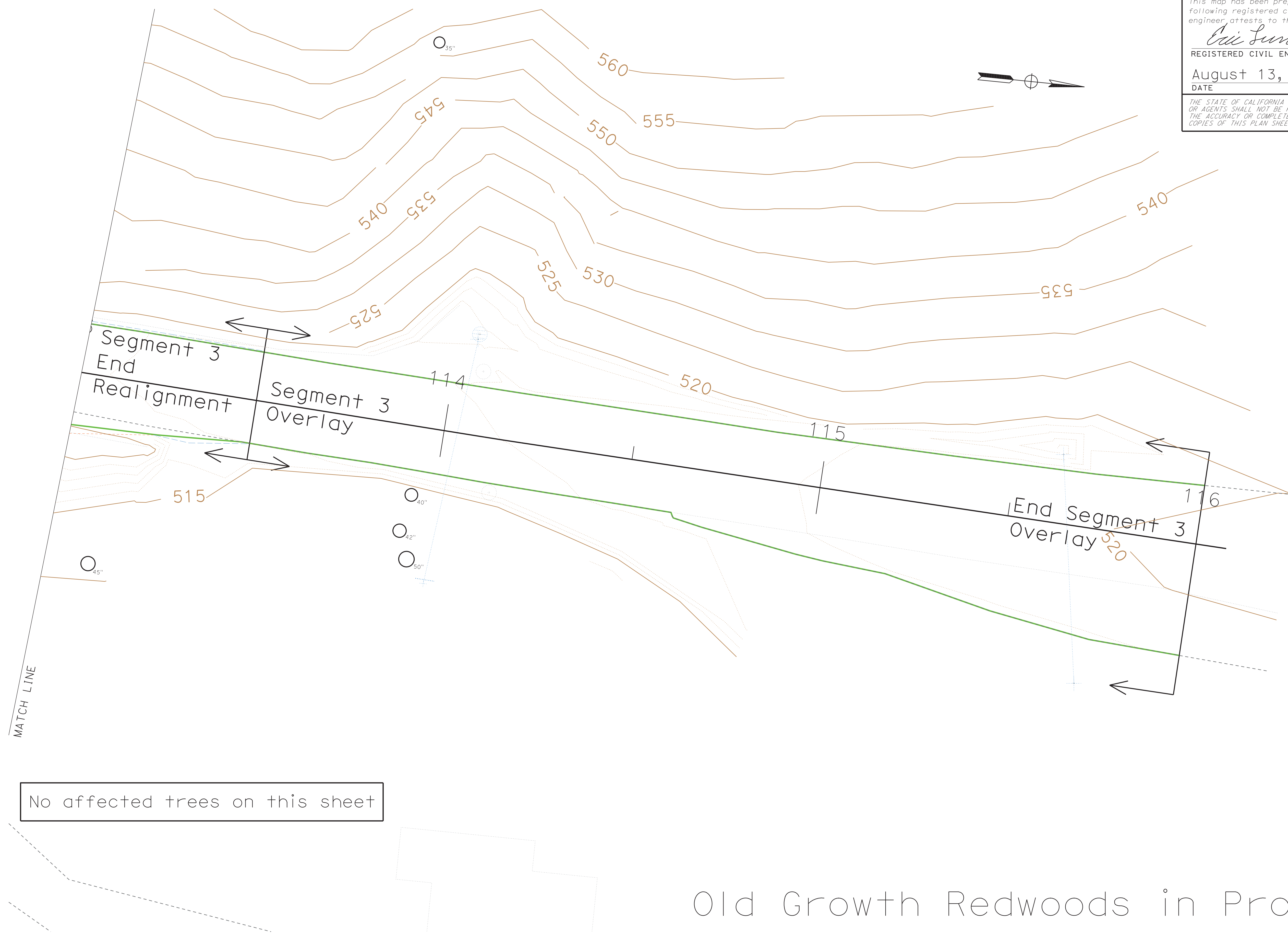


No affected trees on this sheet

Old Growth Redwoods in Project

1"=25'

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

Final
Individual Tree Details

For the Richardson Grove Operational Improvement Project

Humboldt County, California

District 1-HUM-101, PM 1.1/2.2

EA 464800

August 12, 2015

STATE OF CALIFORNIA
Department of Transportation
District 1, Eureka

Prepared By: Valerie Gizinski, Senior Environmental Planner
North Region Environmental Management

Eric Lund, Project Engineer
North Region Design

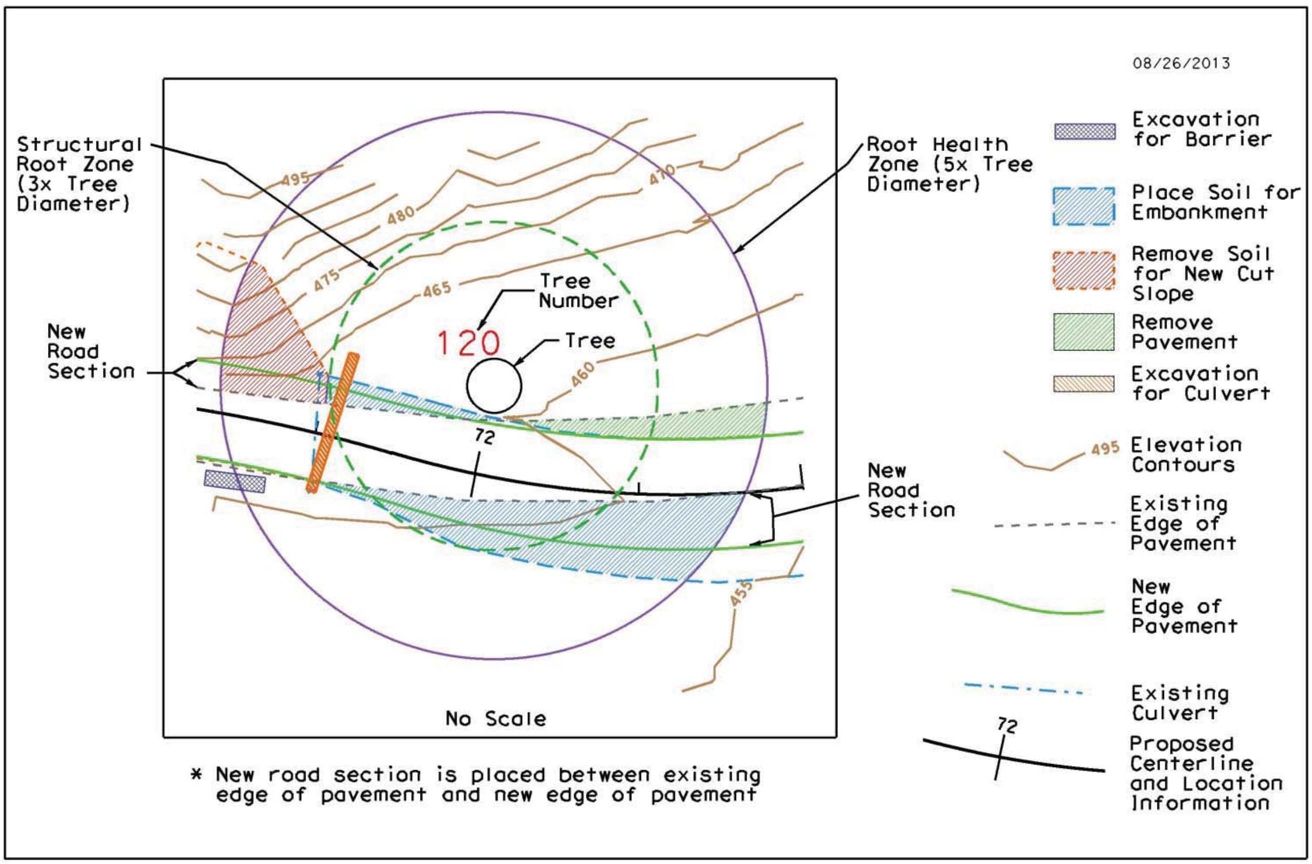
Julie East, Environmental Planner
North Region Environmental Management

Individual Tree Details

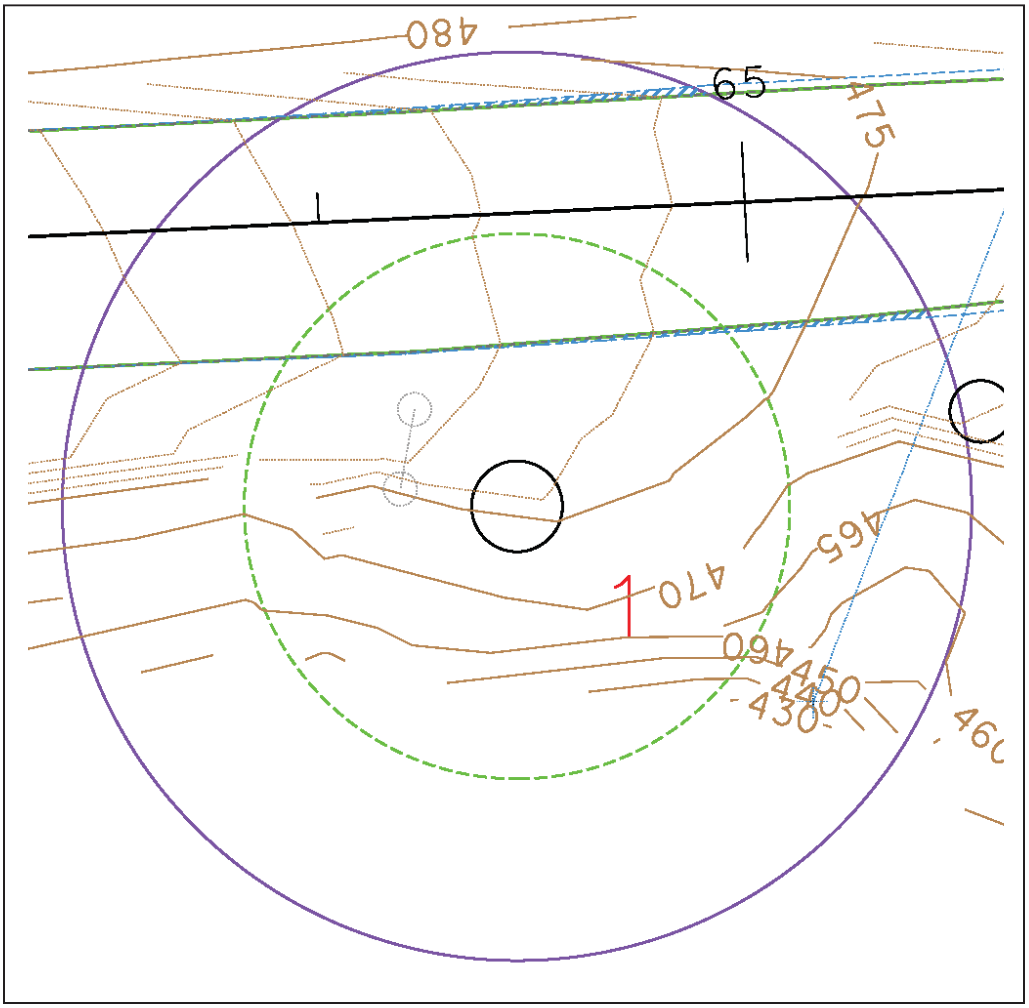
This document presents updated information on every old growth redwood tree potentially affected by the project, a description of the proposed work around each tree, and a summary of potential tree impacts using conventional construction methods without minimization or avoidance measures.

Additionally, an illustration is included for each tree that shows the root health and structural root zones as well as a depiction of proposed work within these areas of the tree. Figure 1 below is a legend for the illustrations.

Figure 1 Tree Work Legend



Individual Tree Details

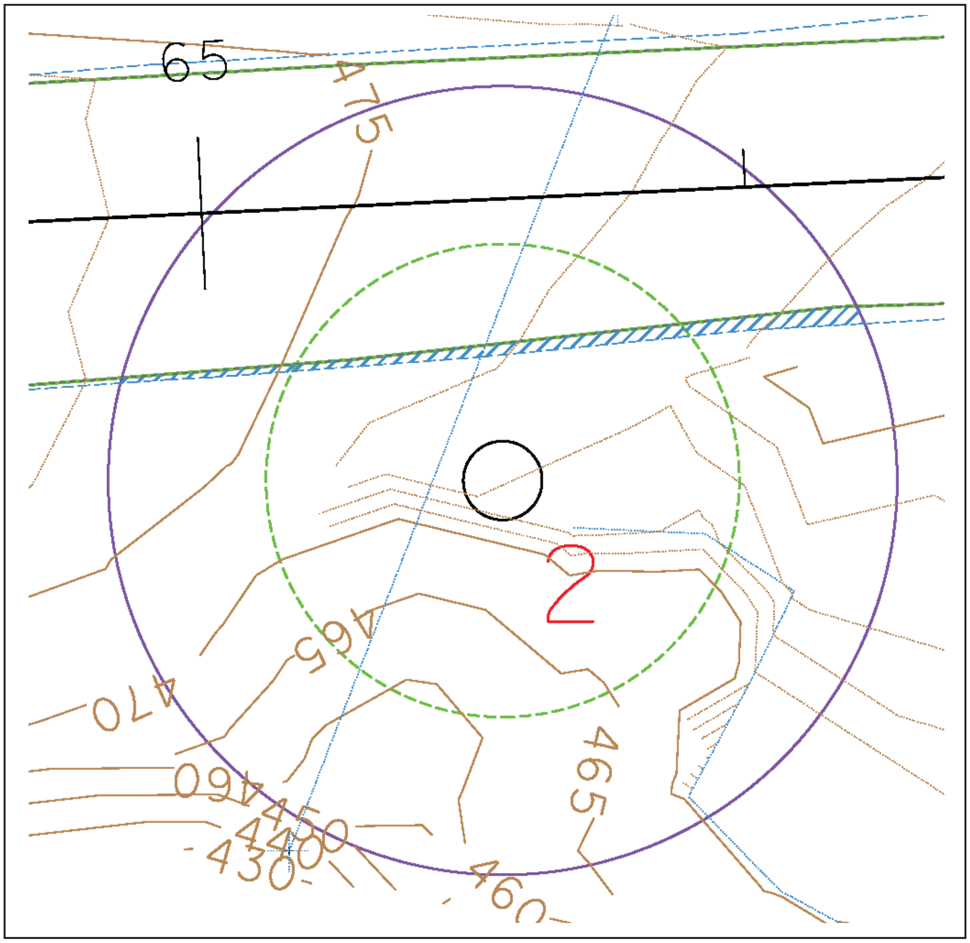


Description: Tree #1, 128 inches DBH (depicted in Attachment A, Sheet 3).

Work in structural root zone? Yes

Details of work: New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

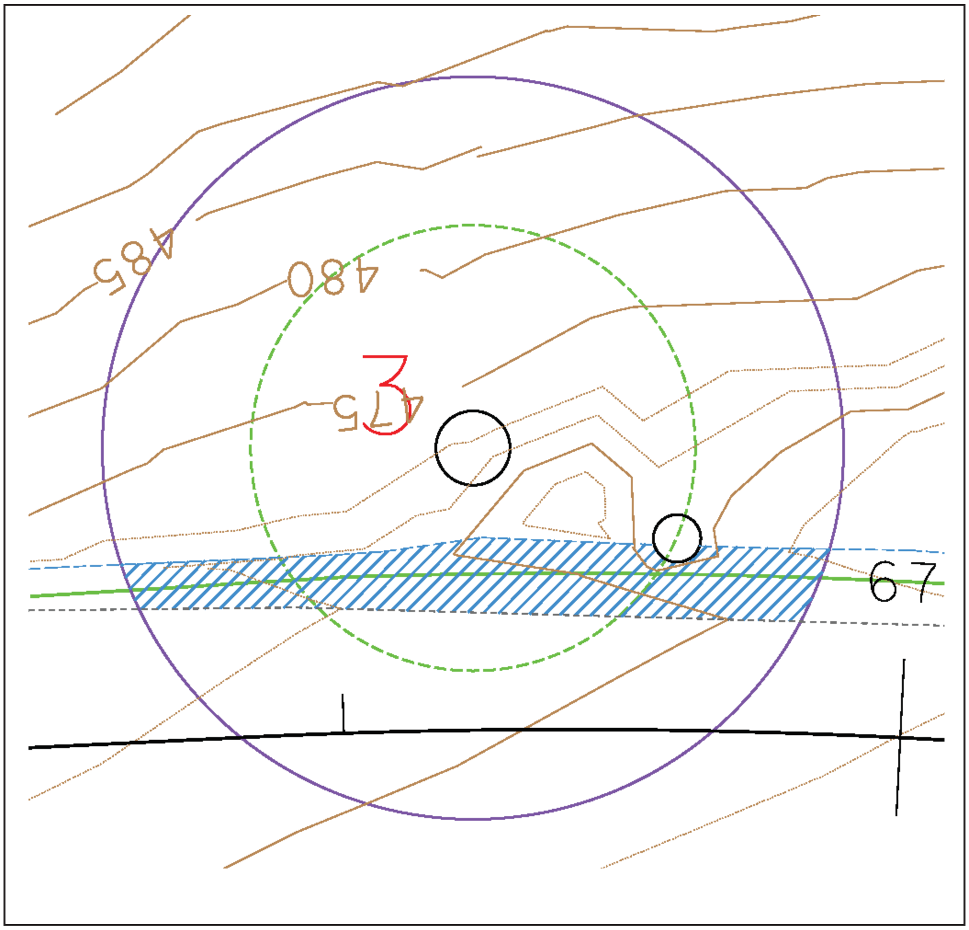


Description: Tree #2, 87 inches DBH (depicted in Attachment A, Sheet 3). Tree base appears to have been struck by a vehicle, and the root flare is not visible.

Work in structural root zone? Yes

Details of work: New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

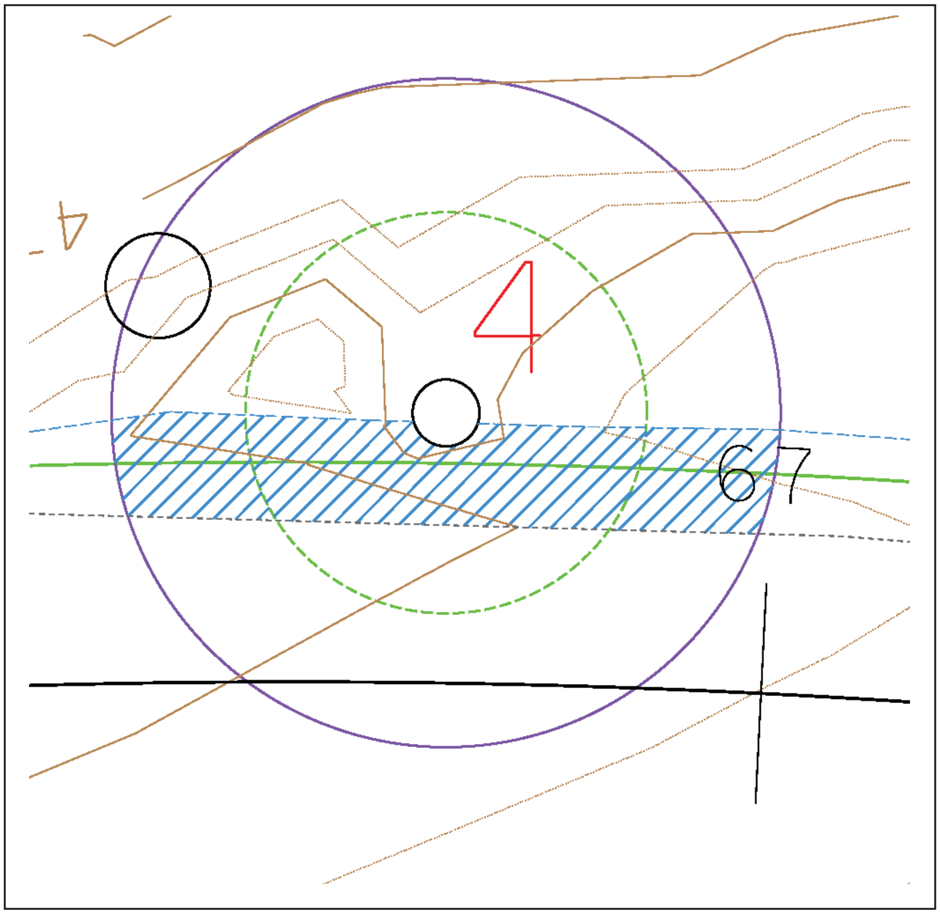


Description: Tree #3, 80 inches DBH (depicted in Attachment A, Sheet 4). Tree has three trunks.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 4 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

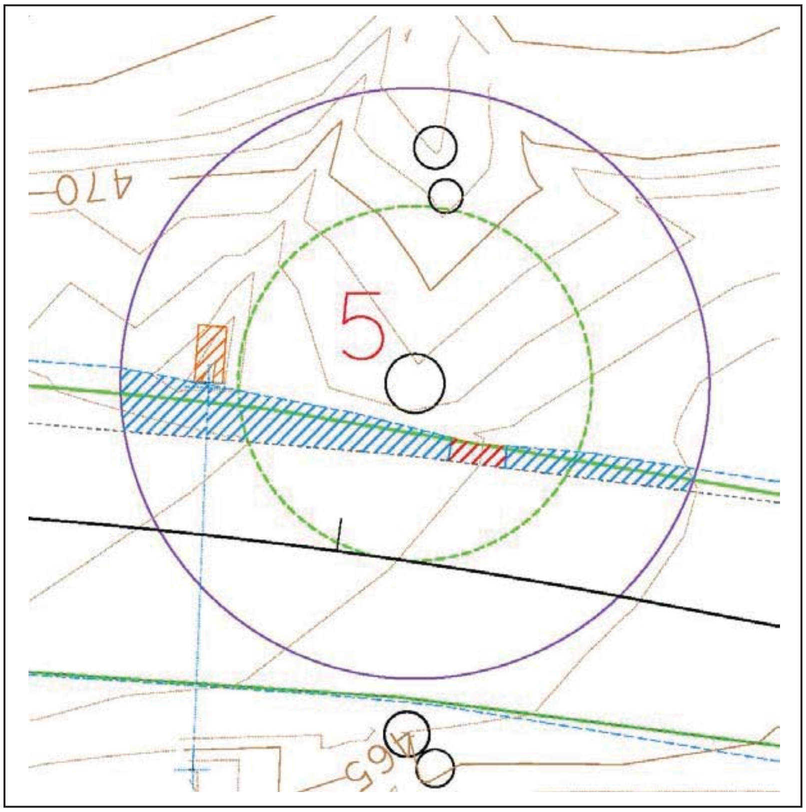


Description: Tree #4, 51 inches DBH (depicted in Attachment A, Sheet 4). Base of tree is elevated from road.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 4 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.

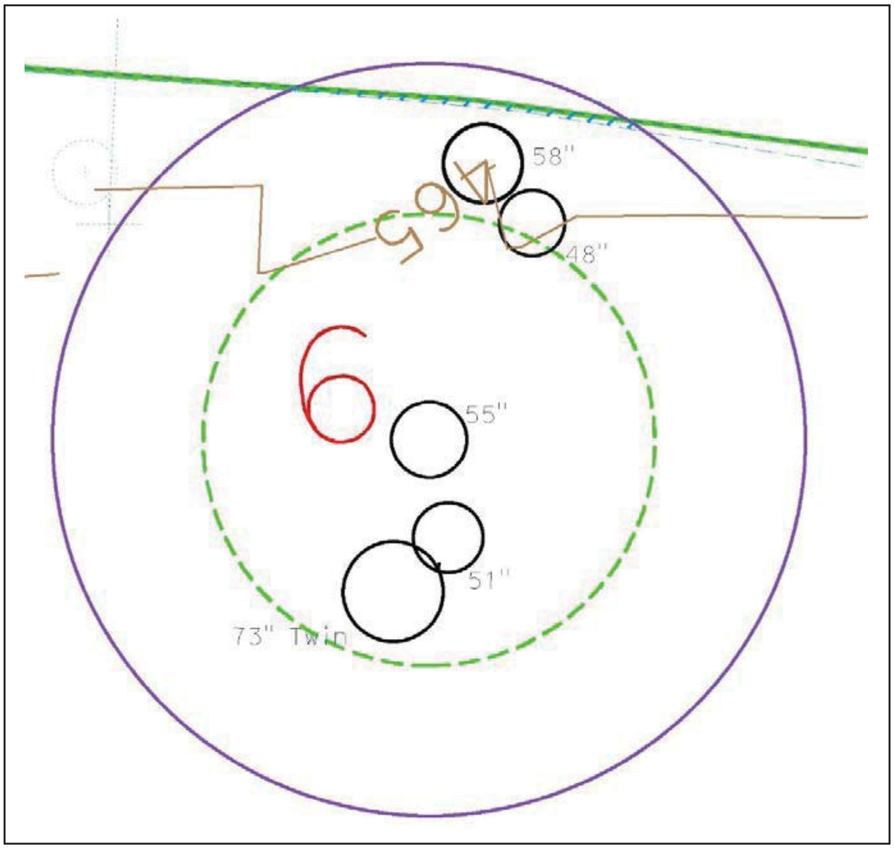


Description: Tree #5, 75 inches DBH (depicted in Attachment A, Sheet 4). Tree has numerous sprouts at the base.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 4 feet toward the tree. Where road would be widened, sprouts would be carefully cut from the tree base; soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt. Outside of structural root zone an 18-inch diameter culvert would be extended approximately 6 feet with a new inlet structure.

Evaluation: Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.

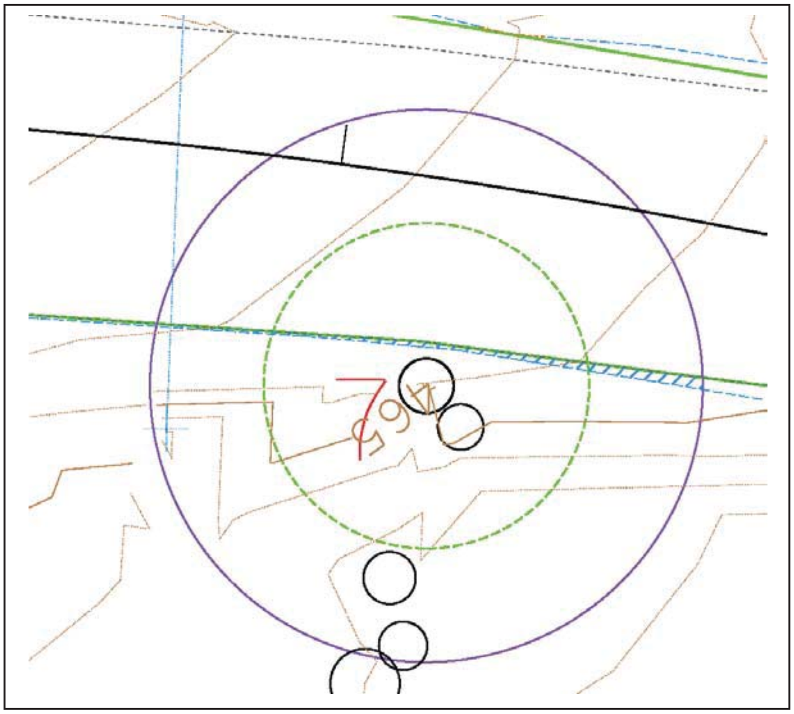


Description: Tree #6, 55 inches in diameter at breast height (depicted in Attachment A, Sheet 4).

Work in structural root zone? No

Details of Work: New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

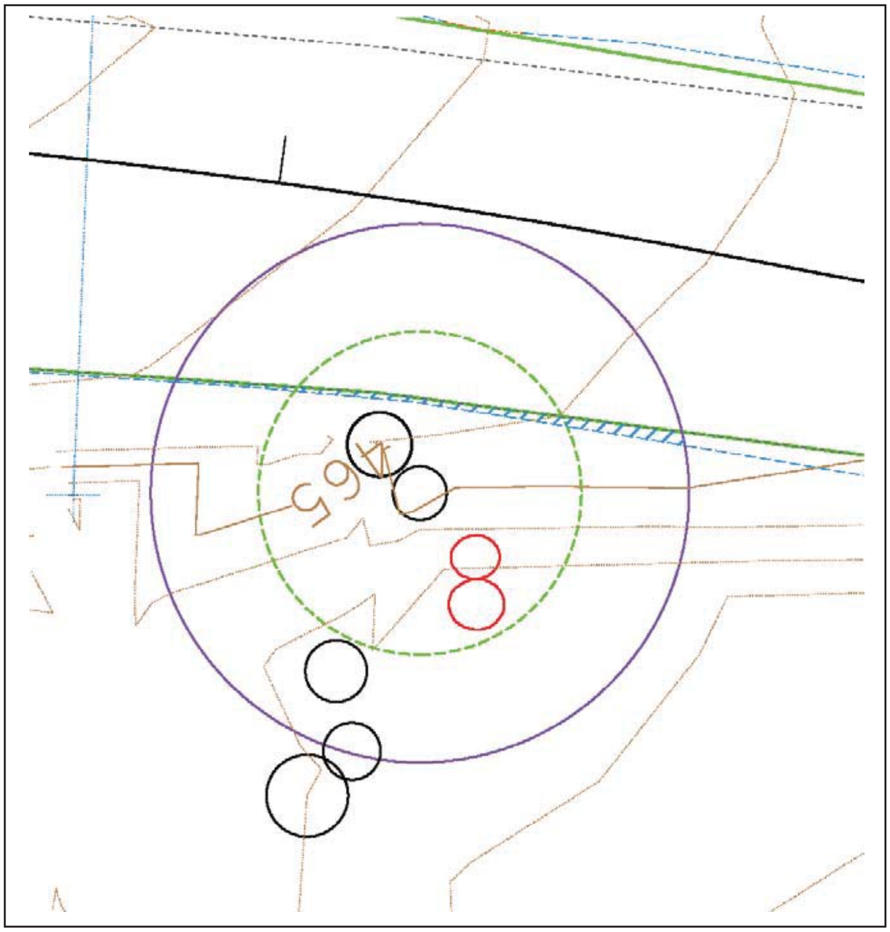


Description: Tree #7, 58 inches DBH (depicted in Attachment A, Sheet 4). Tree appears to have been struck by a vehicle on road side of trunk. Closer to the road than tree #6.

Work in structural root zone? Yes

Details of Work: New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

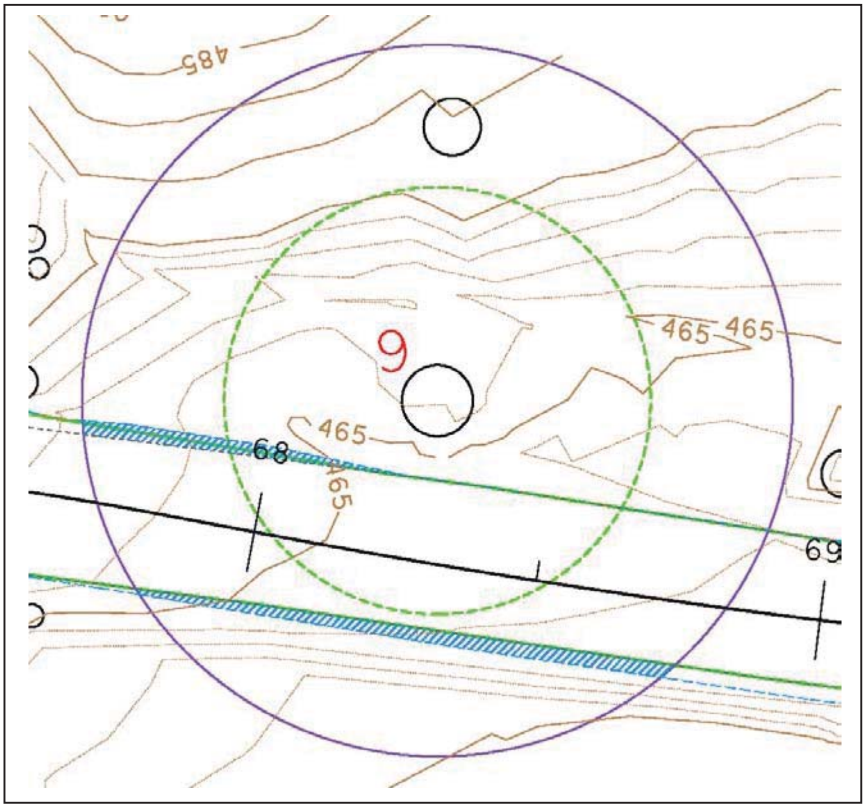


Description: Tree #8, 48 inches DBH (depicted in Attachment A, Sheet 4).

Work in structural root zone? Yes

Details of Work: New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

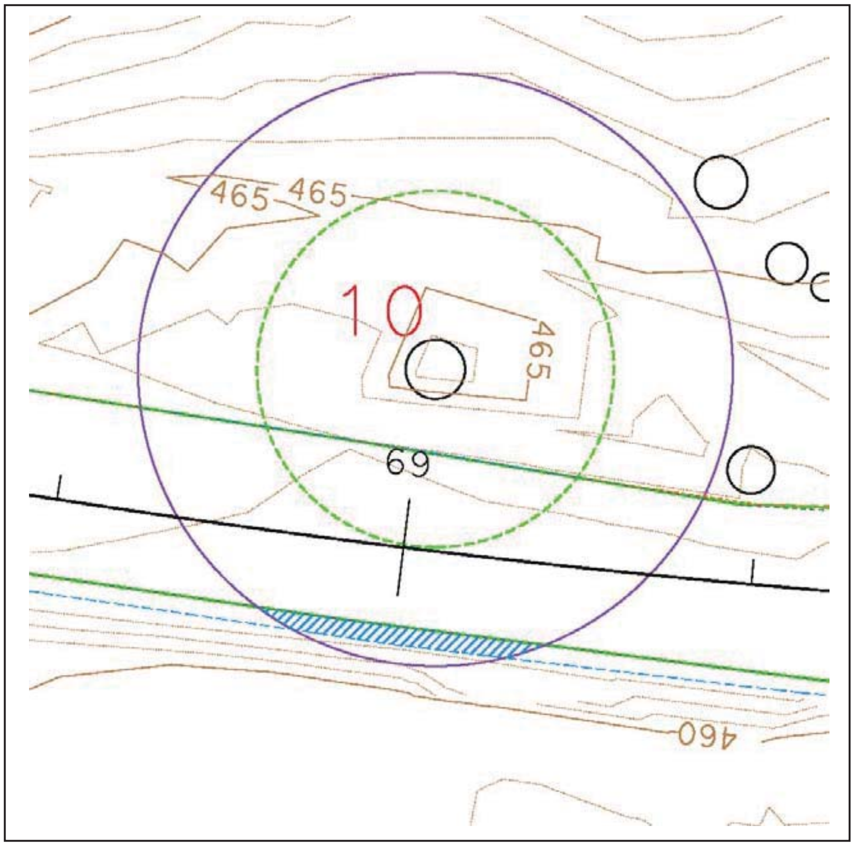


Description: Tree #9, 149 inches DBH (depicted in Attachment A, Sheet 4). Tree has two trunks.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 1 foot toward the tree; across the road it would be widened up to 1 foot. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 18 to 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

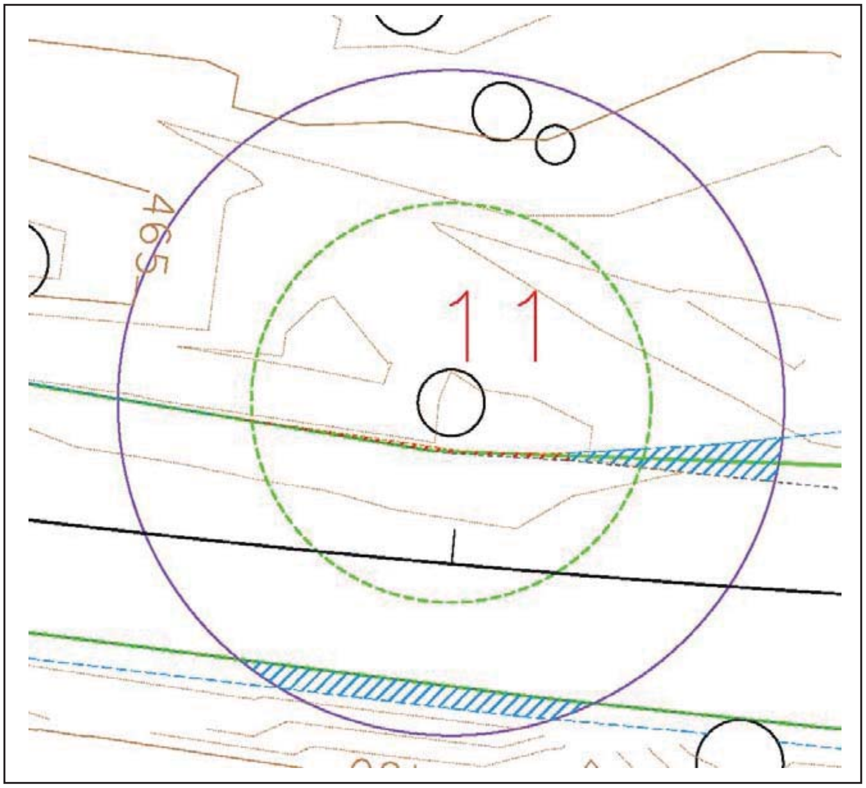


Description: Tree #10,103 inches DBH (depicted in Attachment A, Sheet 4).

Work in structural root zone? Yes

Details of Work: Across the road from the tree, the road would be widened up to 1 foot. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 18 to 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

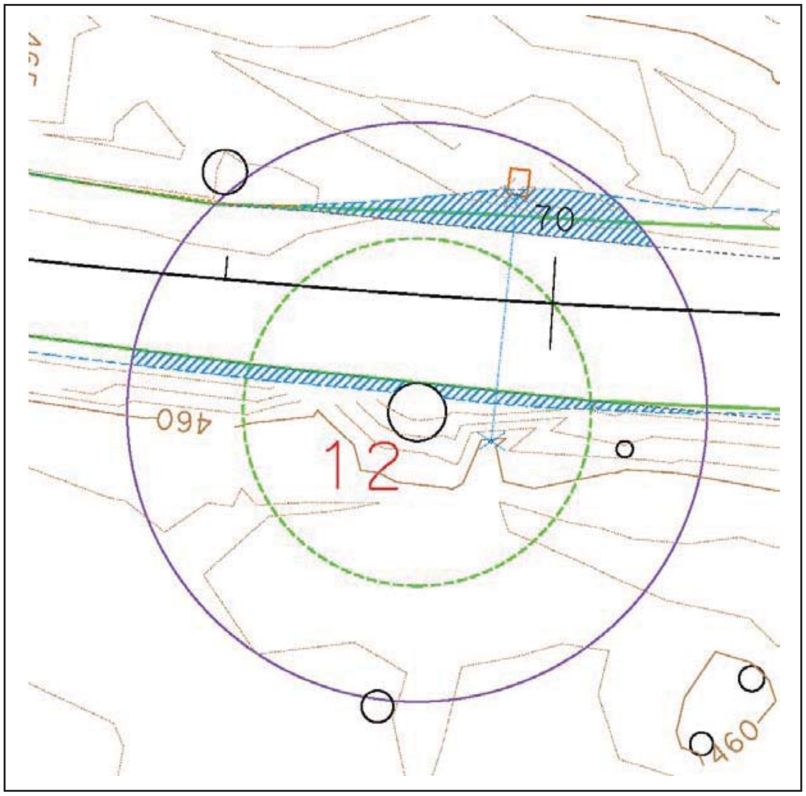


Description: Tree #11**,** 81 inches DBH (depicted in Attachment A, Sheet 5).

Work in structural root zone? Yes

Details of Work: The road would be widened up to 3 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.



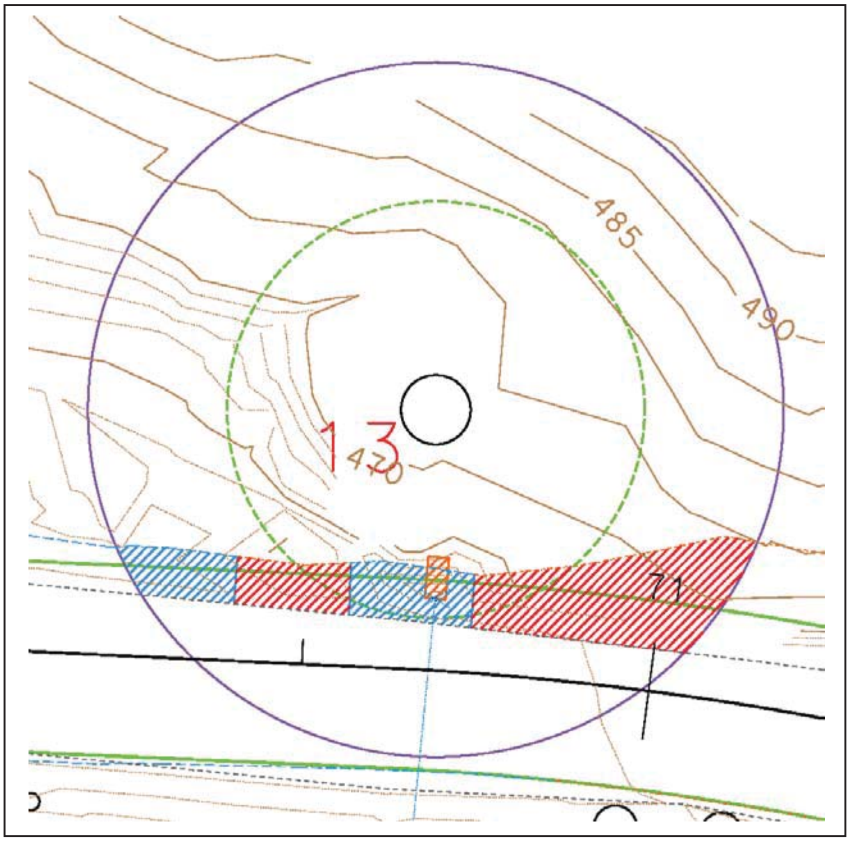
Description: Tree #12**,** 107 inches DBH (depicted in Attachment A, Sheet 5). Tree has two trunks. It appears to have been struck by a vehicle and has formed a callus roll.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 1 foot toward the tree; across the road it would be widened up to 4 feet. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt. An 18-inch culvert would be extended across road from tree.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

Individual Tree Details

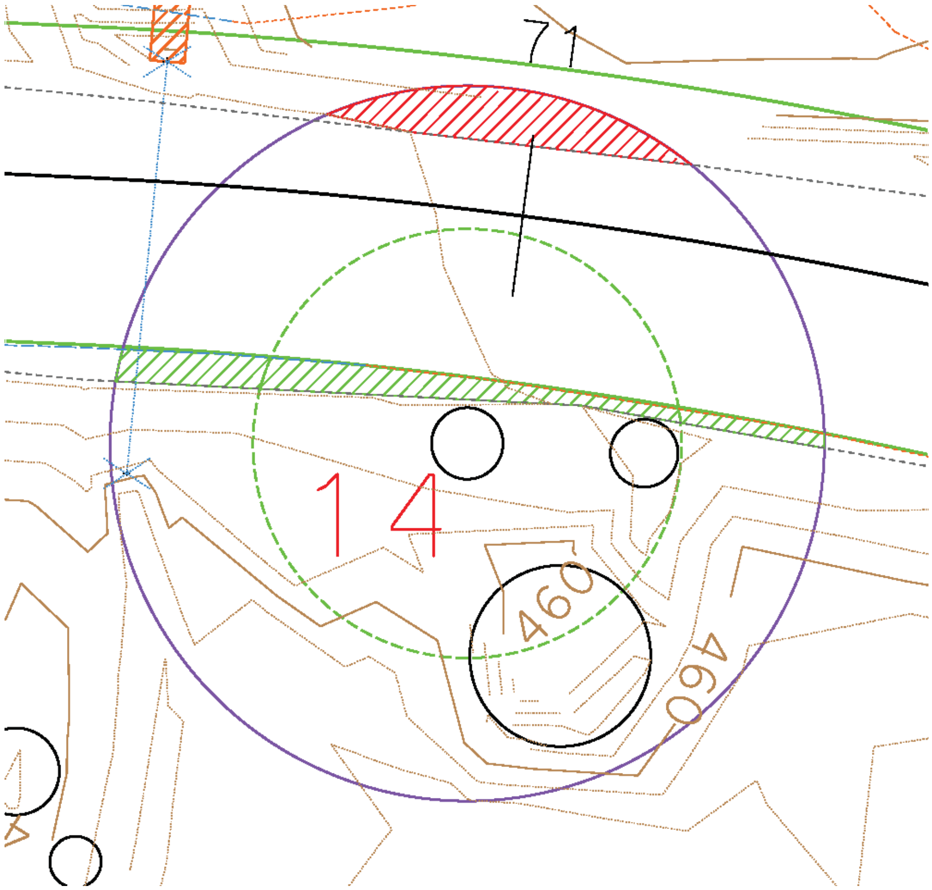


Description: Tree #13, 120 inches DBH (depicted in Attachment A, Sheet 5).

Work in structural root zone? Yes

Details of Work: The road would be widened up to 8 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). Soils would be removed for new roadside cut slopes (average depth greater than 36 inches). The top layer of roadway would be ground off and replaced with new asphalt. An 18-inch culvert would be extended.

Evaluation: Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.

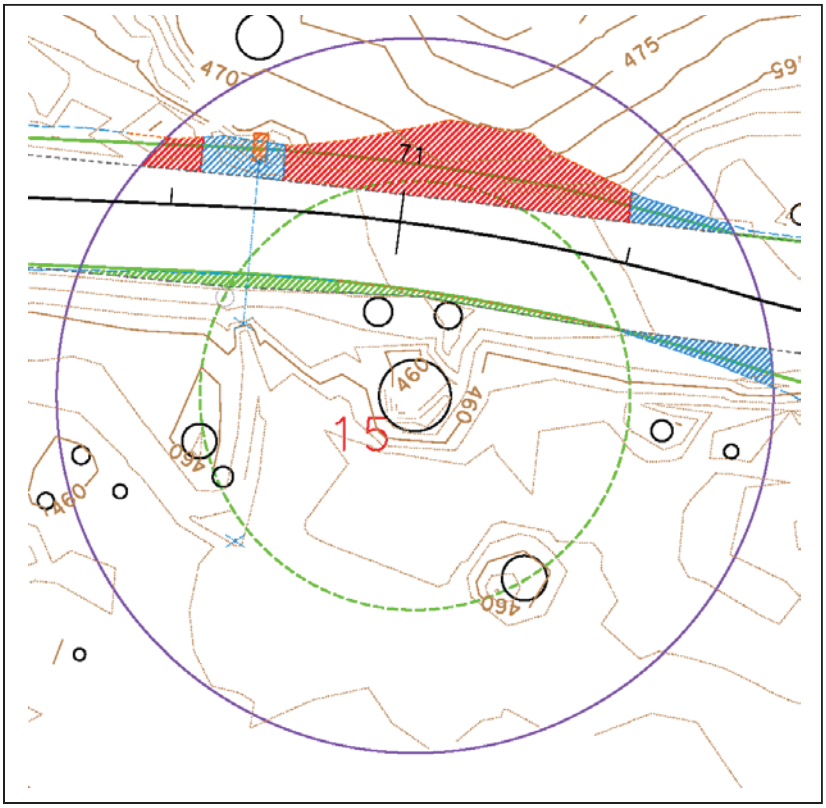


Description: Tree #14, 74 inches DBH (depicted in Attachment A, Sheet 5). Tree appears to have been struck by a vehicle, and a small portion of the base appears to have been cut back.

Work in structural root zone? Yes

Details of Work: The road would be moved up to 3 feet away from the tree. Across the road from the tree, the road would be widened up to 8 feet. Where pavement would be removed, road materials would be replaced with gravel at the road edge and native soils and duff beyond. Where road would be widened, soil and old road materials would be dug out and replaced with new materials. Soils would be removed for new roadside cut slopes (average depth greater than 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

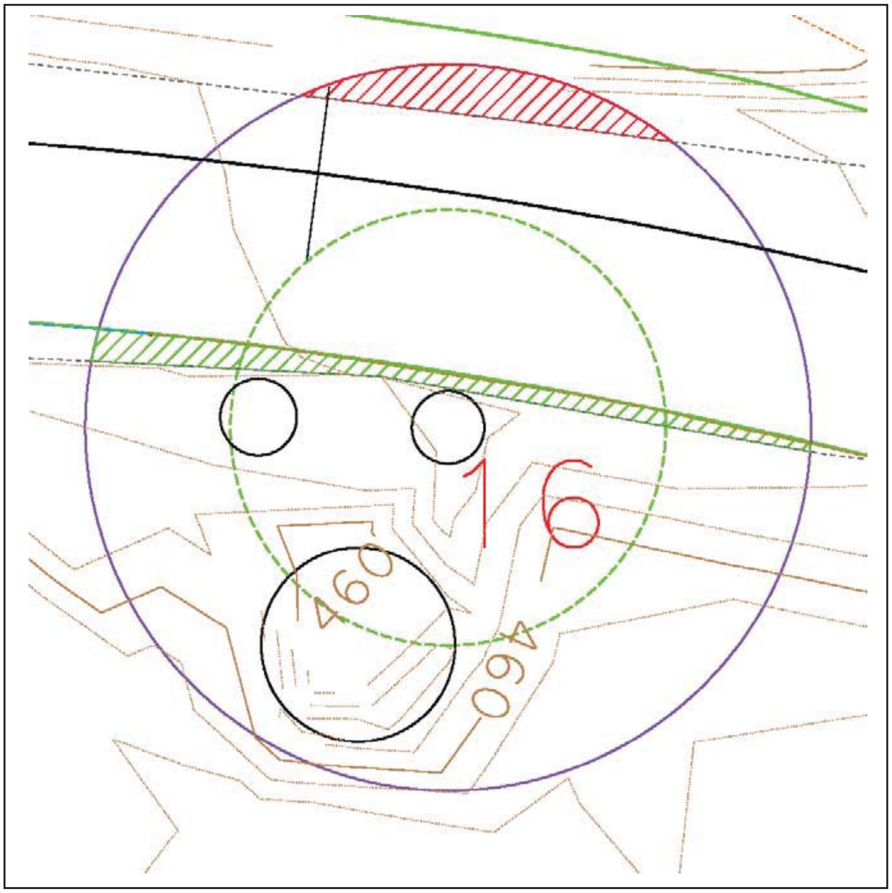


Description: Tree #15, 187 inches DBH (depicted in Attachment A, Sheet 5).Tree has multiple stems and a large central cavity.

Work in structural root zone? Yes

Details of Work: The road would be moved up to 3 feet away from the tree. Across the road from the tree, the road would be widened up to 8 feet. Where pavement would be removed, road materials would be replaced with gravel at the road edge and native soils and duff beyond. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). Soils would be removed for new roadside cut slopes (average depth greater than 36 inches). The top layer of roadway would be ground off and replaced with new asphalt. An 18-inch diameter culvert would be extended. The extended culvert would conform to the new topography.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.



Description: Tree #16, 70 inches DBH (depicted in Attachment A, Sheet 5). Tree appears to have been struck by vehicles; basal flare has been cut back.

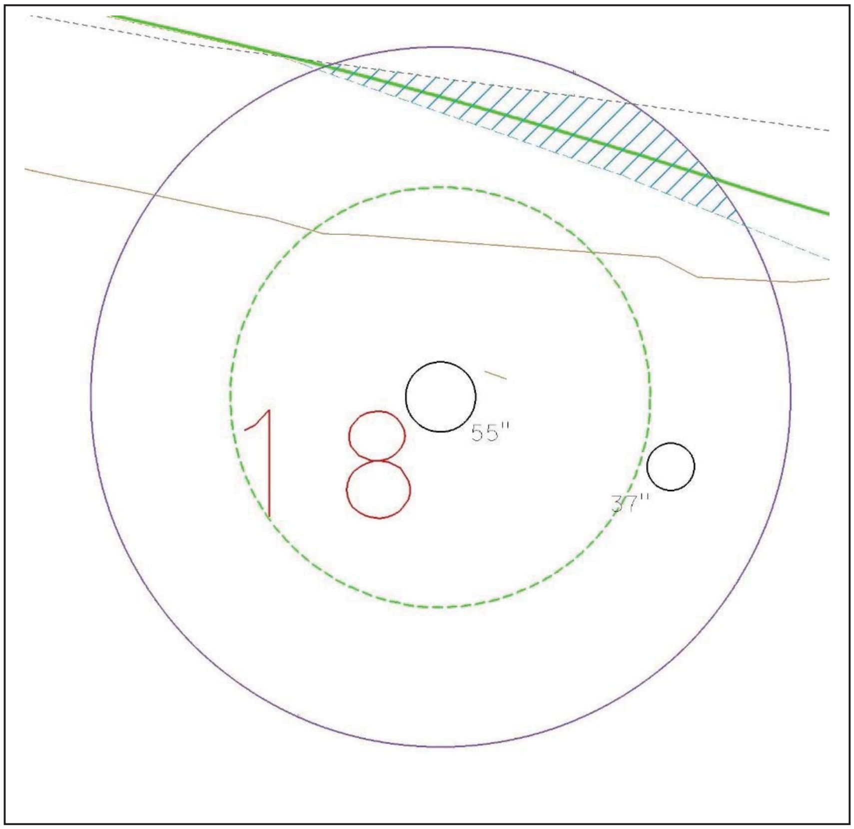
Work in structural root zone? Yes

Details of Work: The road would be moved up to 3 feet away from the tree. Across the road from the tree, the road would be widened up to 8 feet, outside of the structural root zone. Where pavement would be removed, road materials would be replaced with gravel at the road edge and native soils and duff beyond. Where road would be widened, soil and old road materials would be dug out and replaced with new materials. Soils would be removed for new roadside cut slopes (average depth greater than 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

#17 Eliminated. Previously mapped; project work not within root health zone.

Description: Tree #17**,** 37 inches DBH (depicted in Attachment A, Sheet 5).

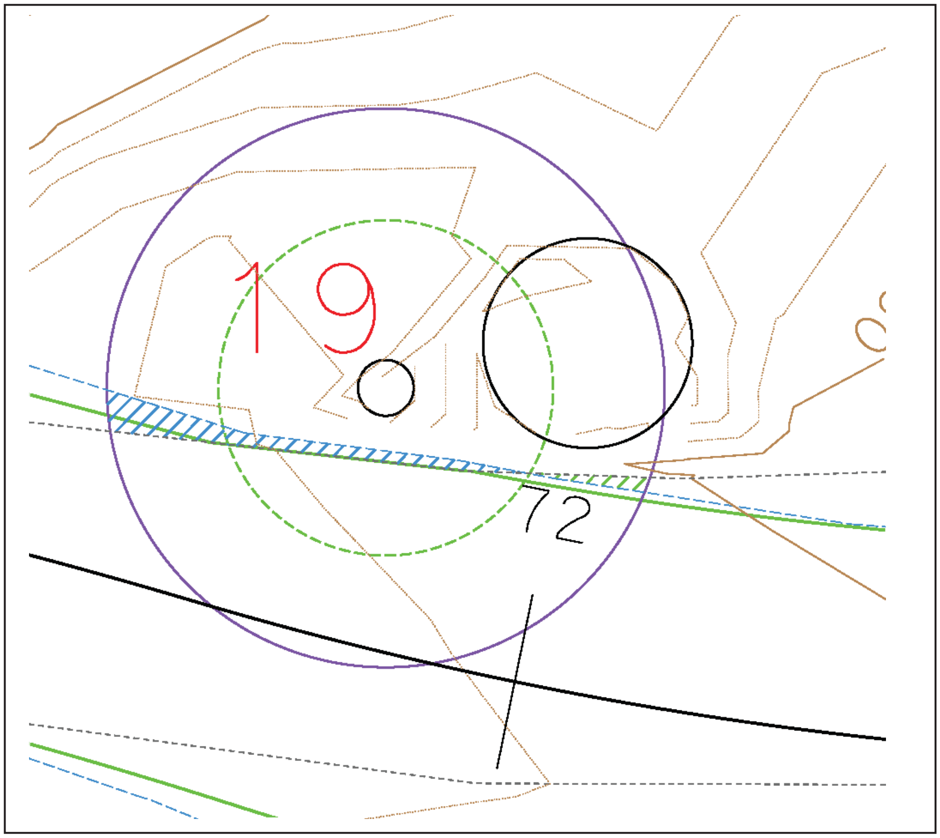


Description: Tree #18, 55 inches DBH (depicted in Attachment A, Sheet 5).

Work in structural root zone? No

Details of Work: The road would be widened up to 3 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

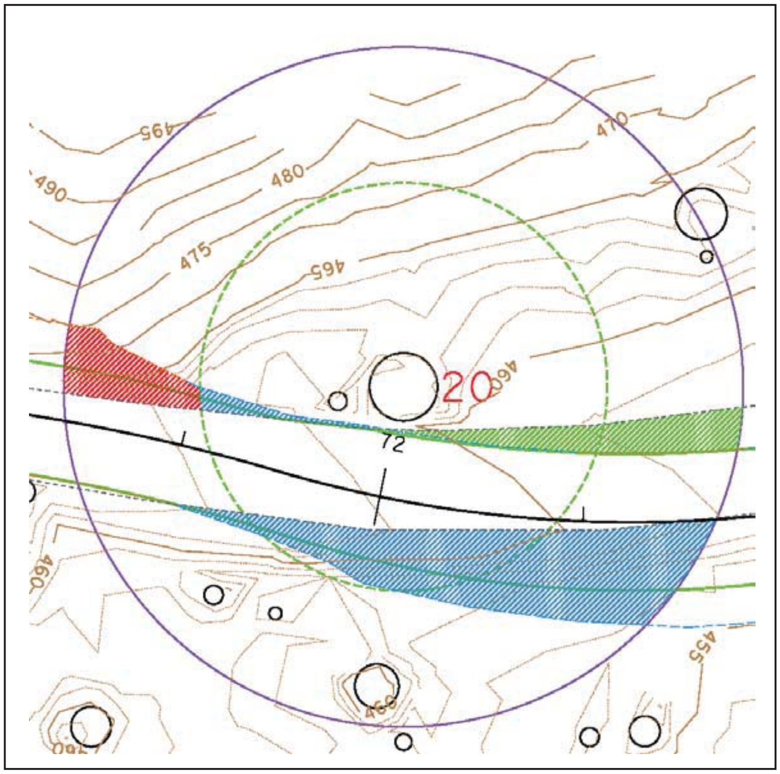


Description: Tree #19, 53 inches DBH (depicted in Attachment A, Sheet 5).

Work in structural root zone? Yes

Details of Work: The road would be widened up to 2 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

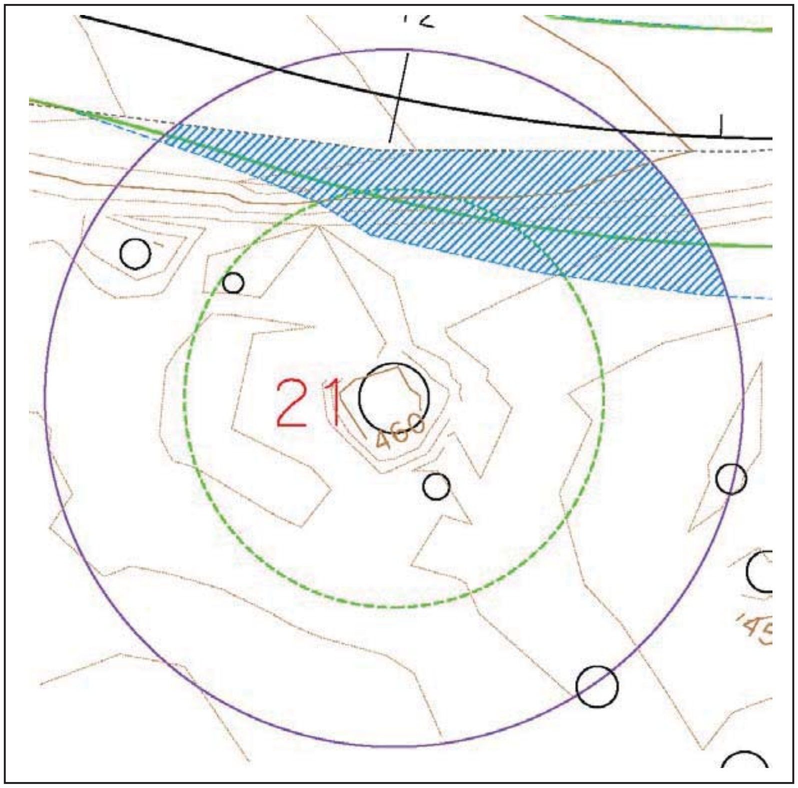


Description: Tree #20, 199 inches DBH (depicted in Attachment A, Sheet 6). Tree has two trunks and uppermost top of tree is dead (a “spike” top). A core sample of paving in this area revealed that asphalt material is 1.5 feet deep. Large-diameter buttress roots were cut, probably during construction of highway.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 5 feet toward the south side of the tree and narrowed up to 7 feet on the north side; across the road it would be widened up to 12 feet. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth greater than 36 inches). Soils would be removed for new roadside cut slopes outside of structural root zone (average depth greater than 36 inches). Where pavement would be removed, road materials would be replaced with gravel at the road edge, and native soils and duff beyond. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

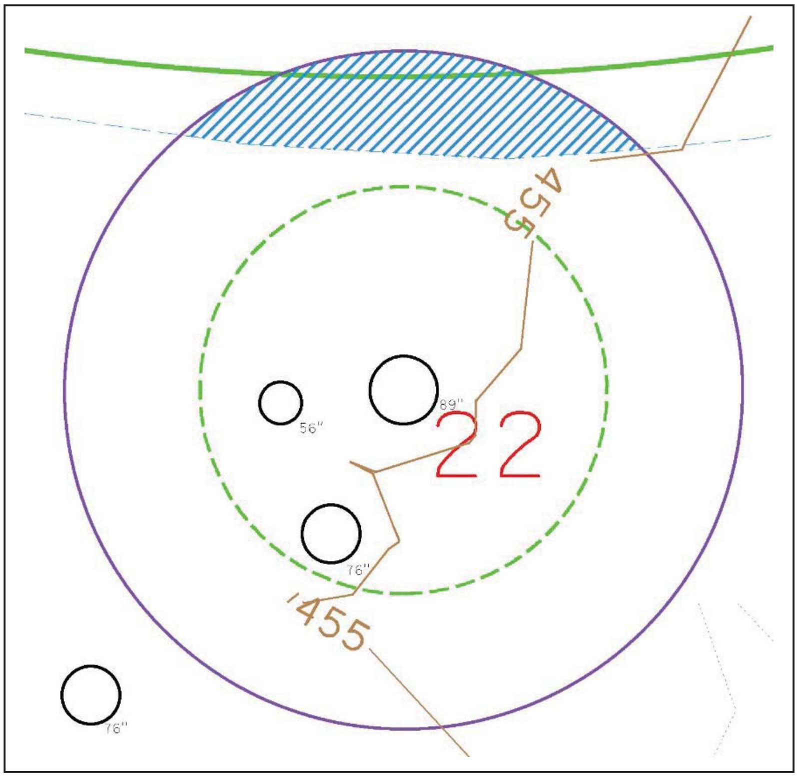


Description: Tree #21, 129 inches DBH (depicted in Attachment A, Sheet 6).

Work in structural root zone? Yes

Details of Work: The road would be widened up to 14 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth greater than 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

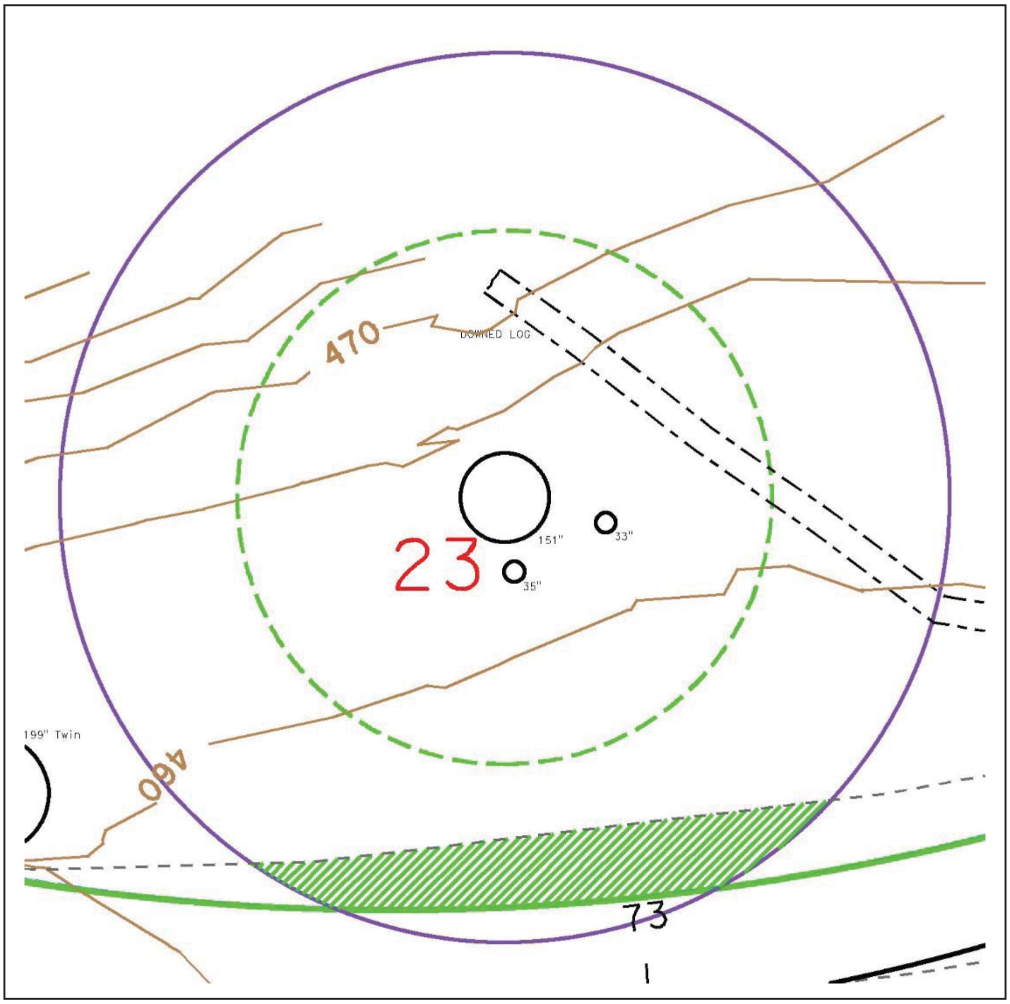


Description: Tree #22, 89 inches DBH (depicted in Attachment A, Sheet 6).

Work in structural root zone? No

Details of Work: The road would be widened up to 17 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new materials. New soils would be placed to construct embankment (average depth greater than 36 inches).

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

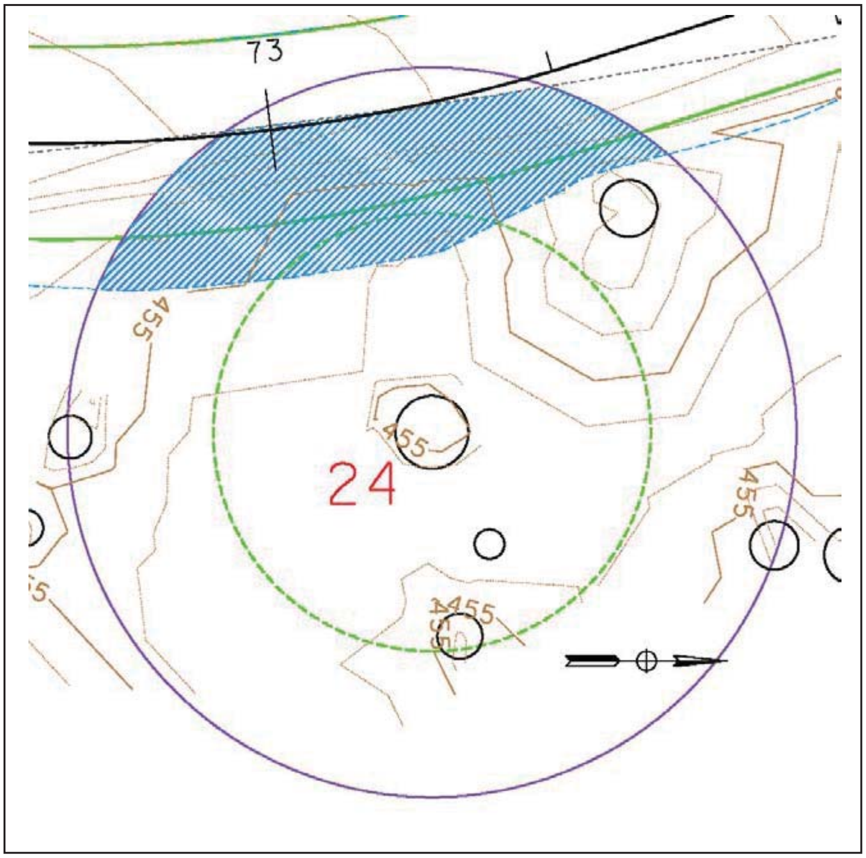


Description: Tree #23, 151 inches DBH (depicted in Attachment A, Sheet 6).

Work in structural root zone? No

Details of Work: The road would be moved up to 10 feet away from the tree. Where pavement would be removed, road materials would be replaced with gravel at the road edge and native soils and duff beyond. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

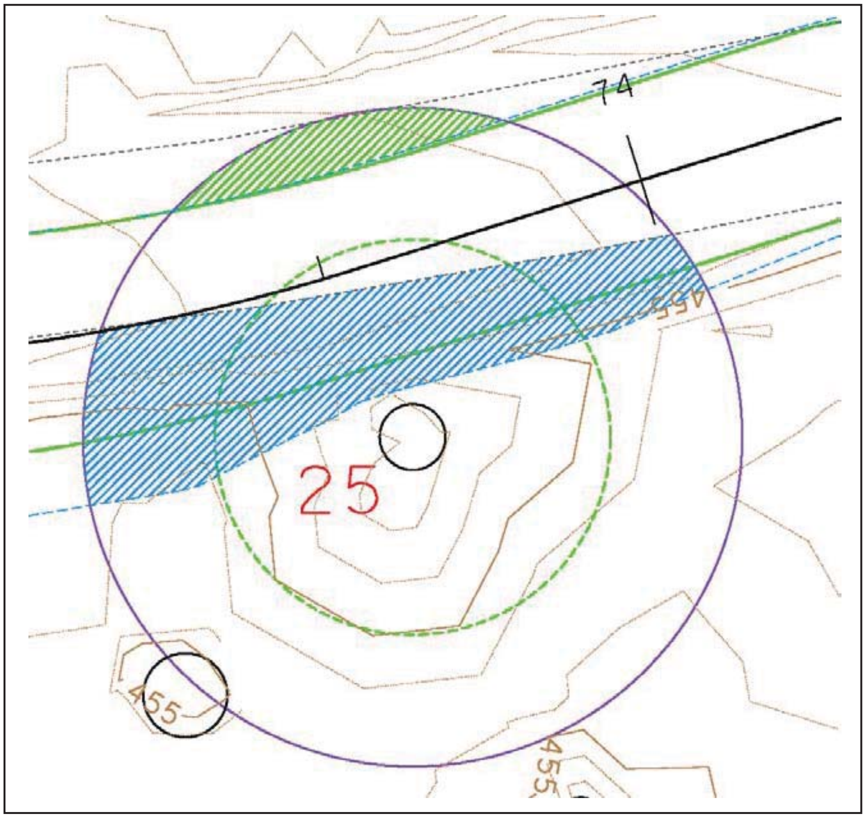


Description: Tree #24,152 inches DBH (depicted in Attachment A, Sheet 6). Tree has two trunks.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 17 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth greater than 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

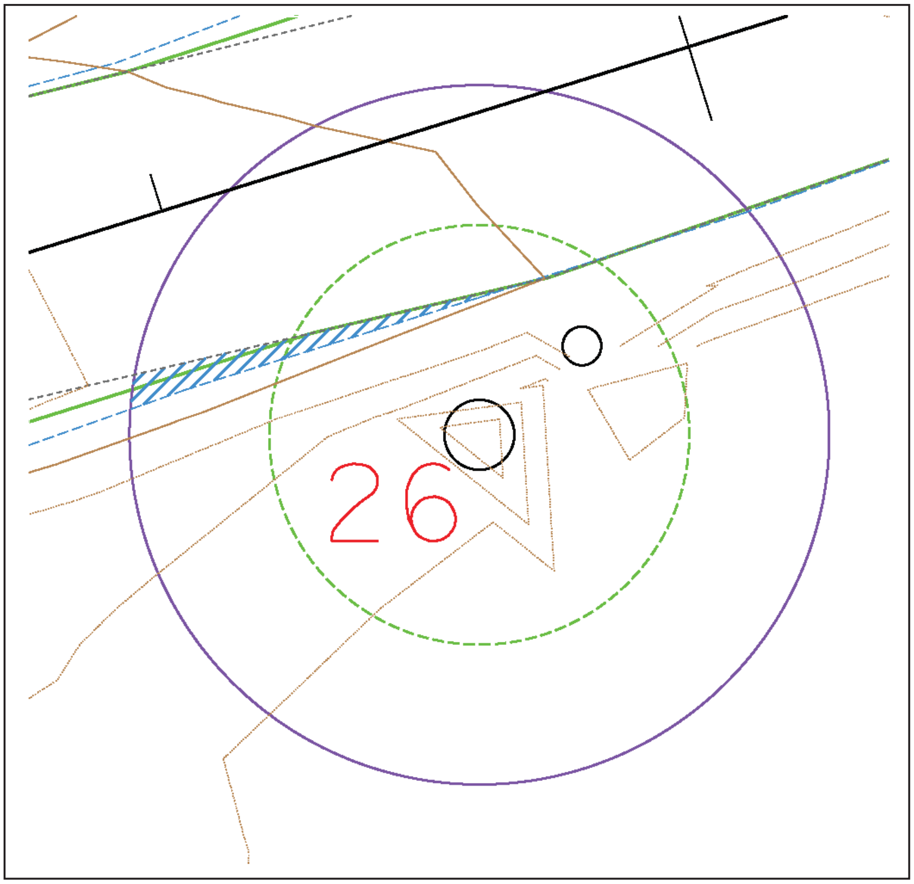


Description: Tree #25, 119 inches DBH (depicted in Attachment A, Sheet 6).

Work in structural root zone? Yes

Details of Work: The road would be widened up to 17 feet toward the tree; across the road it would be narrowed by up to 9 feet. Where road would be widened, soil and old road materials would be dug out and replaced with new materials. New soils would be placed to construct embankment (average depth greater than 36 inches). Where pavement would be removed, road materials would be replaced with gravel at the road edge, and native soils and duff beyond. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.

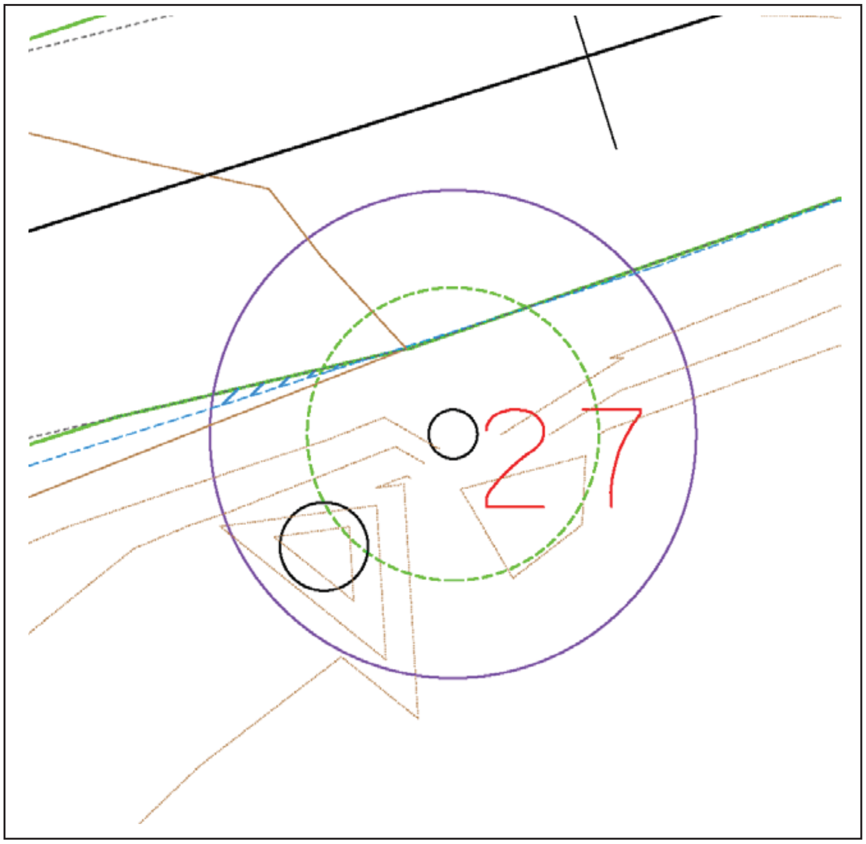


Description: Tree #26, 76 inches DBH (depicted in Attachment A, Sheet 6). Tree has a large basal scar that is callusing over.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 2 feet toward the tree. New soils would be placed to construct embankment (average depth 1-2 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

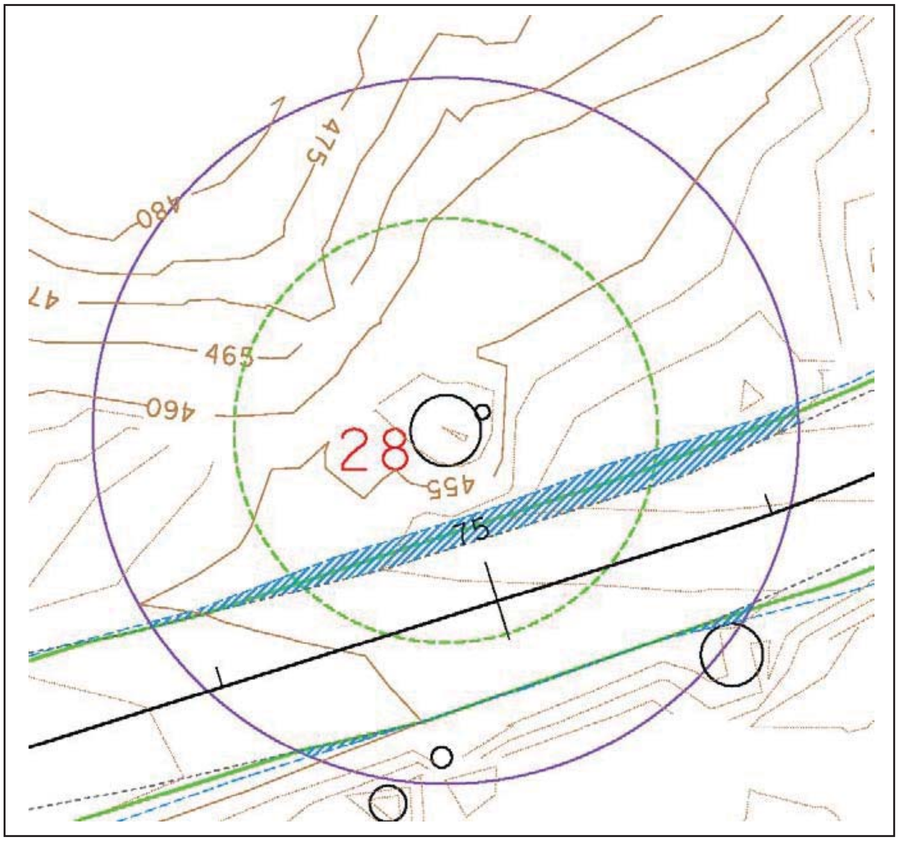


Description: Tree #27, 43 inches DBH (depicted in Attachment A, Sheet 6). Tree is adjacent to road and appears to have been struck by vehicles.

Work in structural root zone? Yes

Details of Work: New soils would be placed to construct embankment (average depth 1-2 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

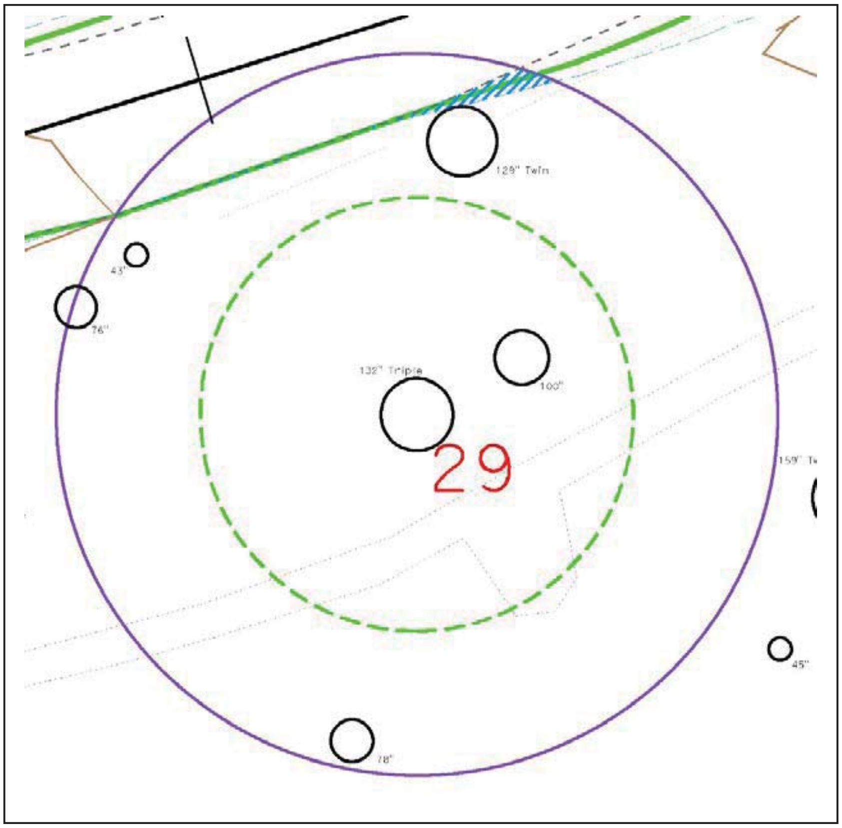


Description: Tree #28, 147 inches DBH (depicted in Attachment A, Sheet 7). Tree has two trunks with a large basal hollow, and is growing on a mound of earth above the road.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 3 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.



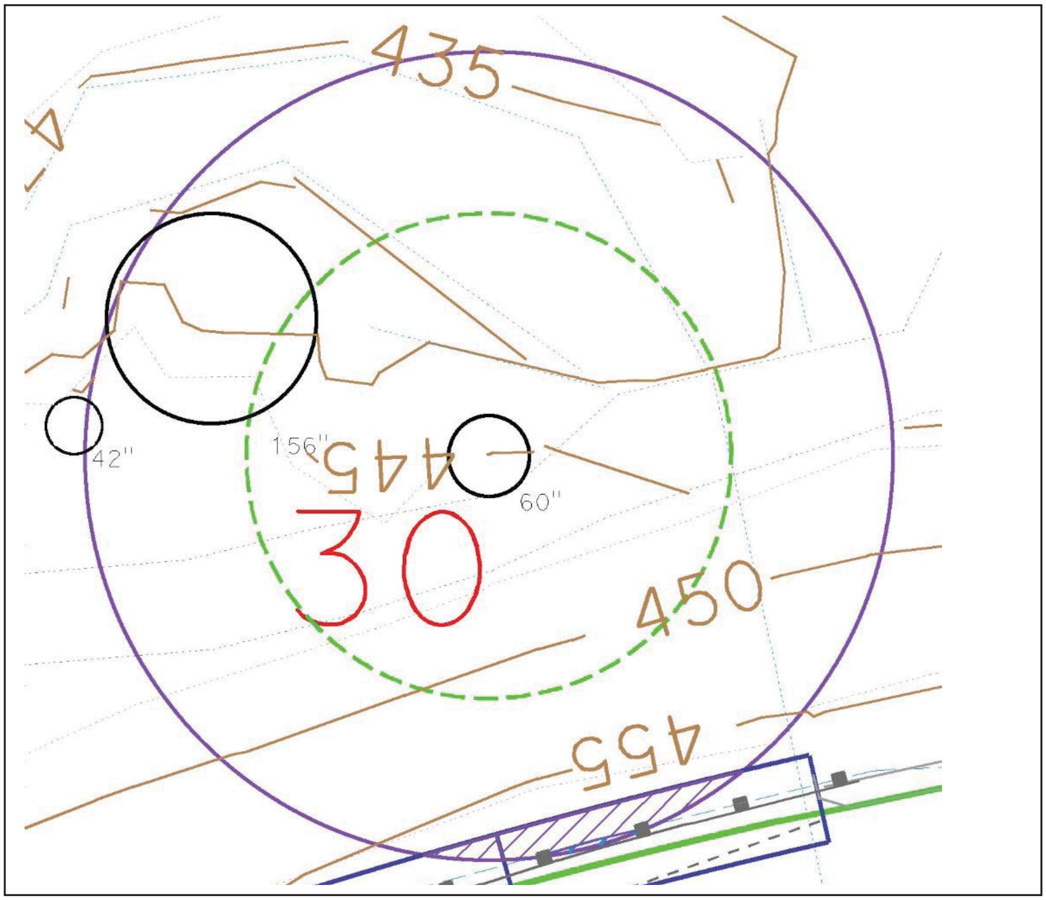
Description: Tree #29, 132 inches DBH (depicted in Attachment A, Sheet 7). Tree has three trunks.

Work in structural root zone? No

Details of Work: The road would be widened less than 2 feet toward the tree. Where the road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

Individual Tree Details

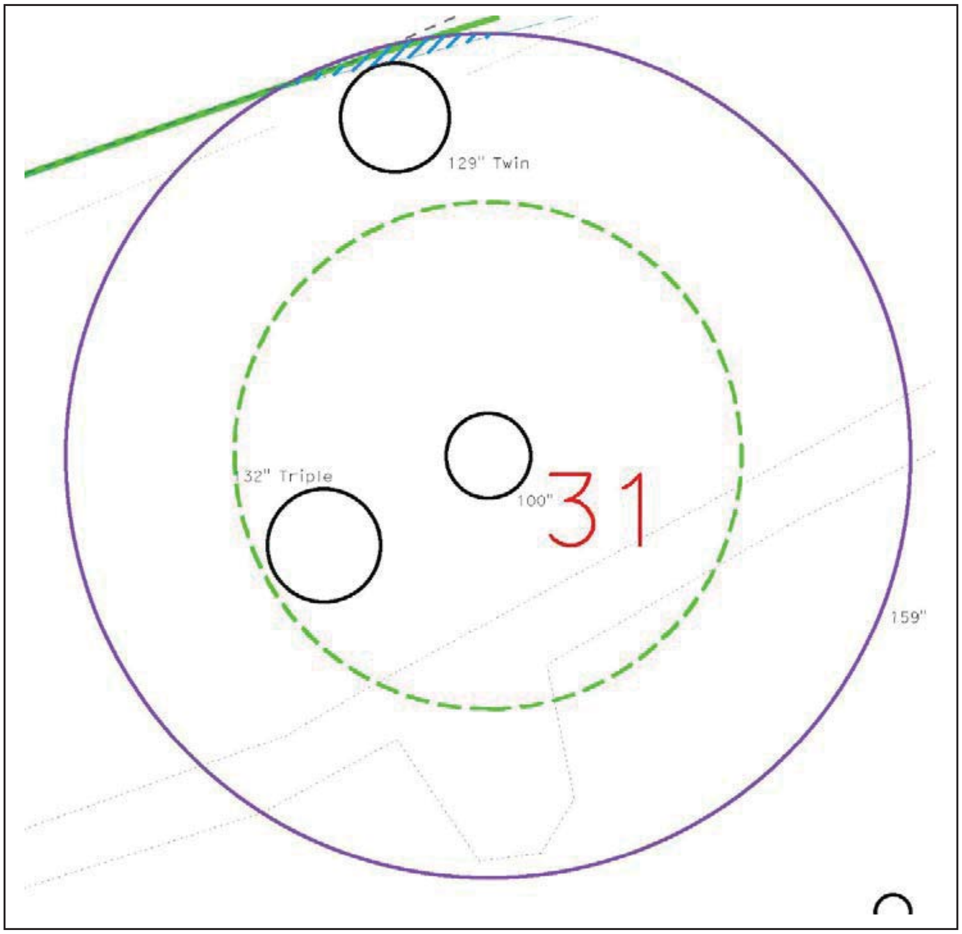


Description: Tree #30, 60 inches DBH (depicted in Attachment A, sheet 10). On slope below bridge.

Work in structural root zone? No.

Details of Work: Metal beam guardrail would be removed and soil would be placed in the post holes; a transition barrier and crash cushion would be installed in its place. For the transition barrier, soil would be removed to a depth of 4 feet, a width of 5.5 feet, and a length of 20 feet and filled with concrete. For the crash cushion, soil will be removed to a depth of 1 foot, a width of 4 feet, and a length of 15 feet, and filled with concrete. Crash cushion to be installed on slab.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

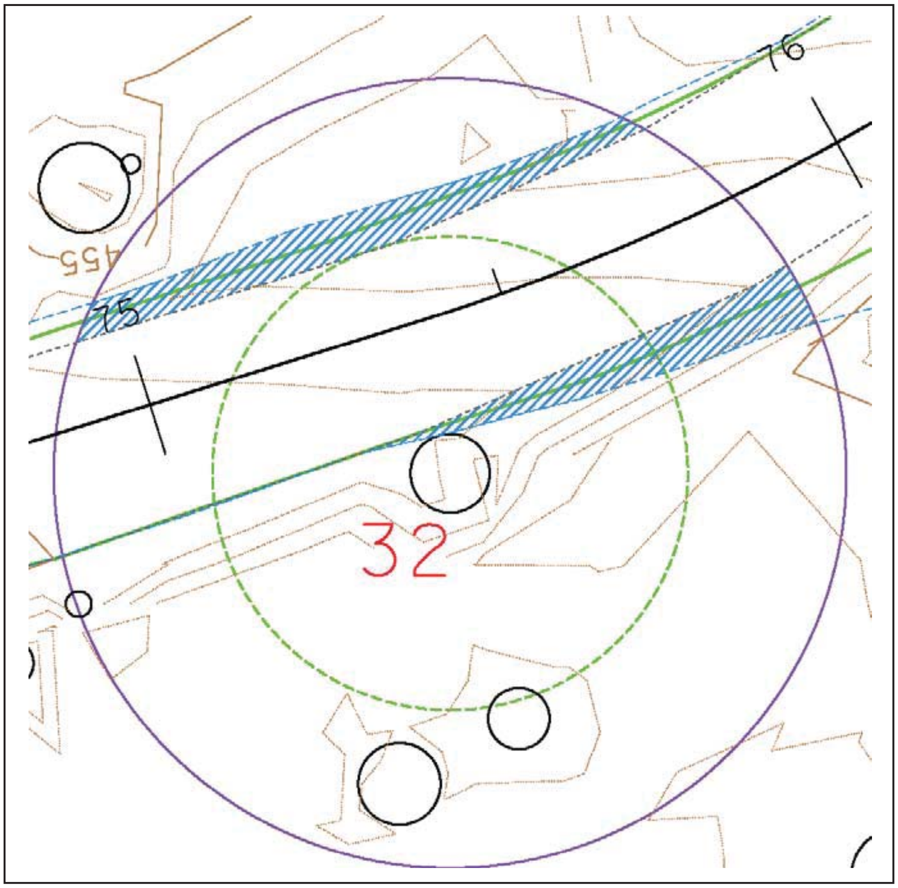


Description: Tree #31, 100 inches DBH (depicted in Attachment A, Sheet 7).

Work in structural root zone? No

Details of Work: The road would be widened less than 1 foot toward the tree. Where the road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment outside of structural root zone (average depth 6 to 18 inches).

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

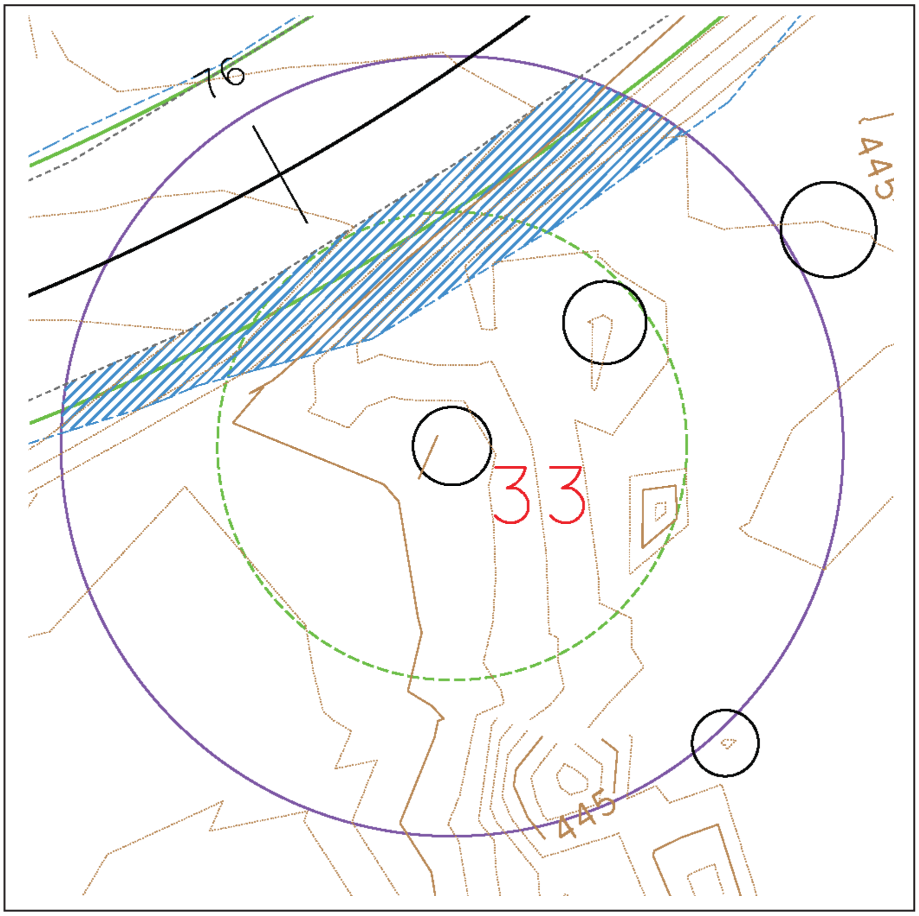


Description: Tree #32, 129 inches DBH (depicted in Attachment A, Sheet 7). Tree has two trunks. The base of tree is at the edge of road; root flare has never been cut.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 3 feet toward the tree; across the road it would be widened up to 3 feet. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

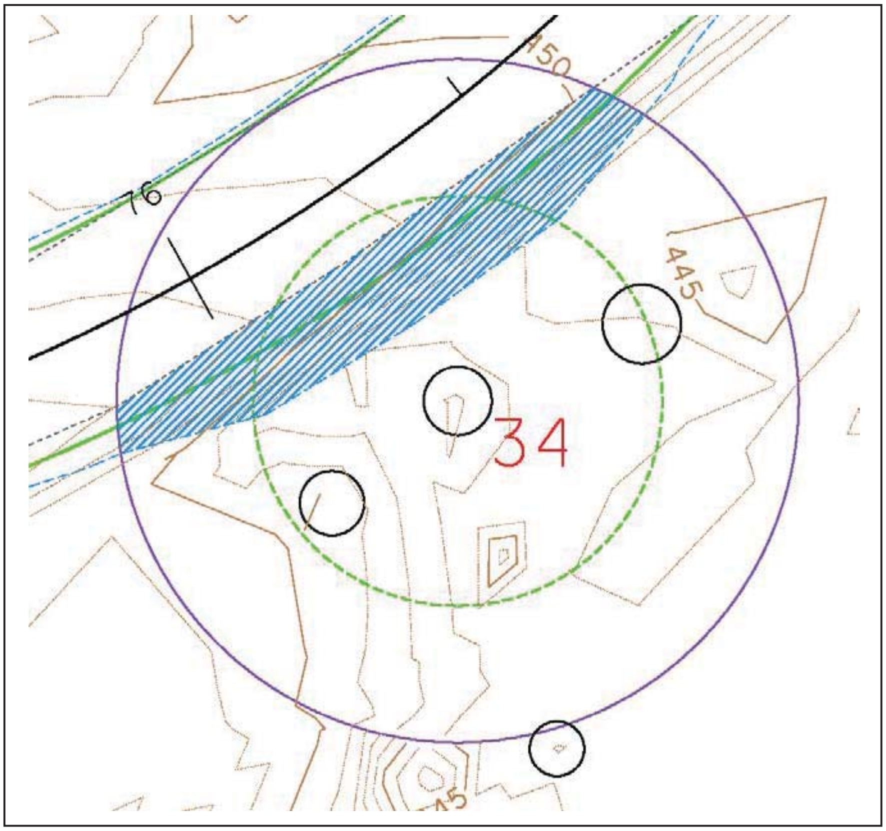


Description: Tree #33**,** 118 inches DBH (depicted in Attachment A, Sheet 7).

Work in structural root zone? Yes

Details of Work: The road would be widened up to 6 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 18 to 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

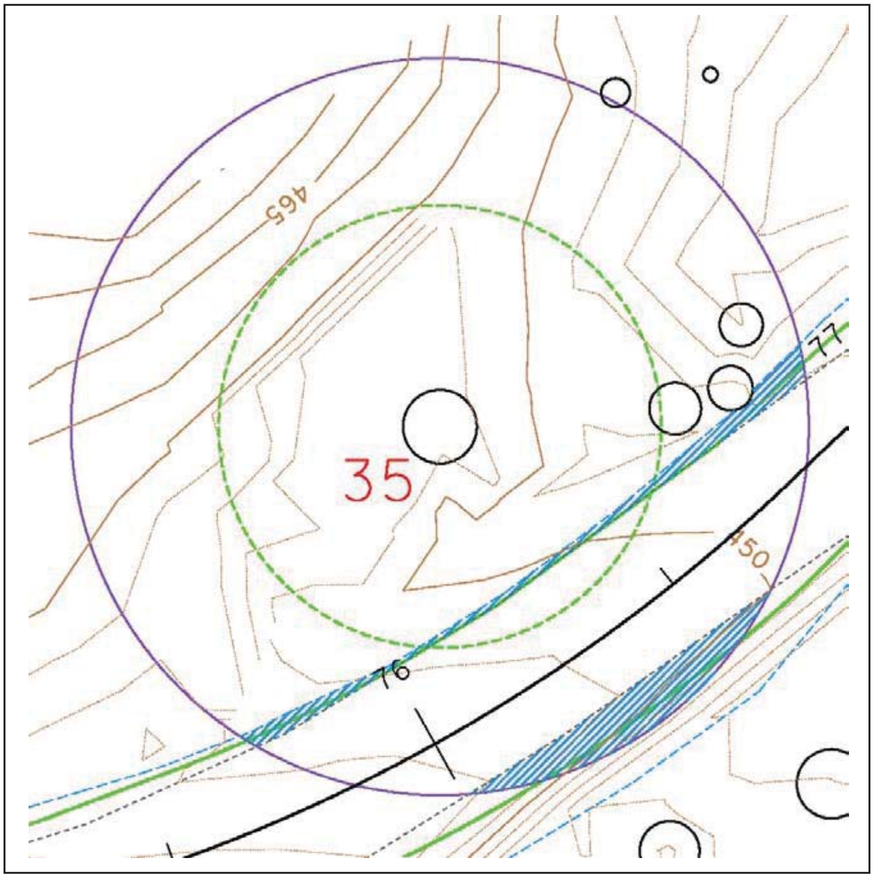


Description: Tree #34, 125 inches DBH (depicted in Attachment A, Sheet 7).

Work in structural root zone? Yes

Details of Work: The road would be widened up to 5 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth greater than 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

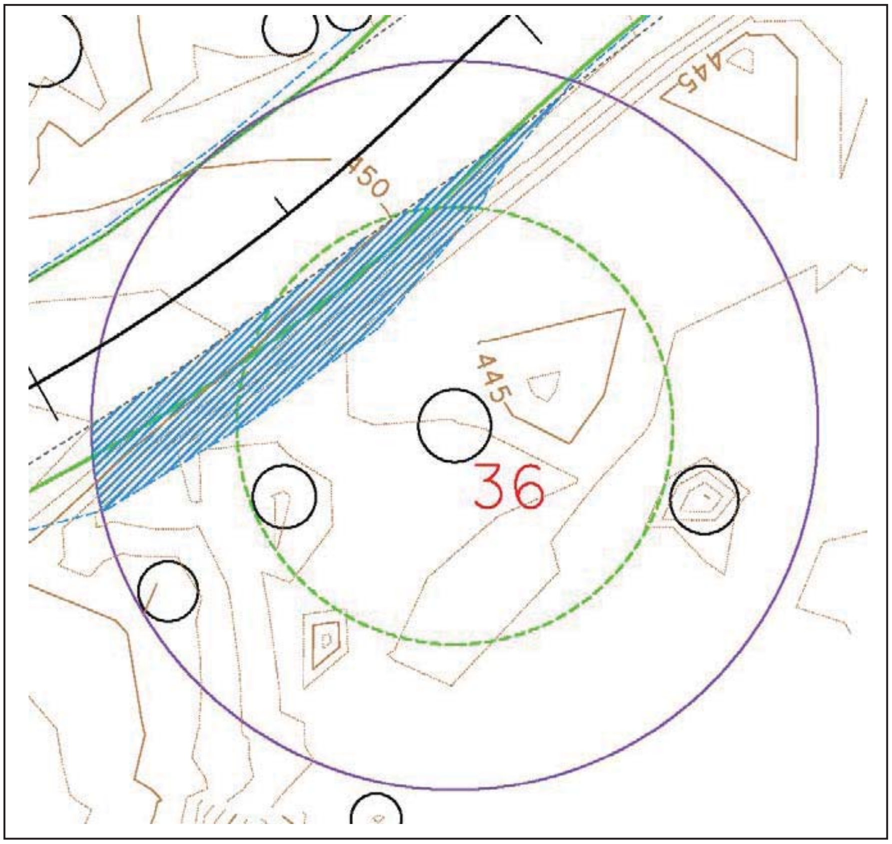


Description: Tree #35, 154 inches DBH (depicted in Attachment A, Sheet 7). Tree has a full crown and a fire scar on one side of trunk.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 2 feet toward the tree; across the road it would be widened up to 6 feet. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

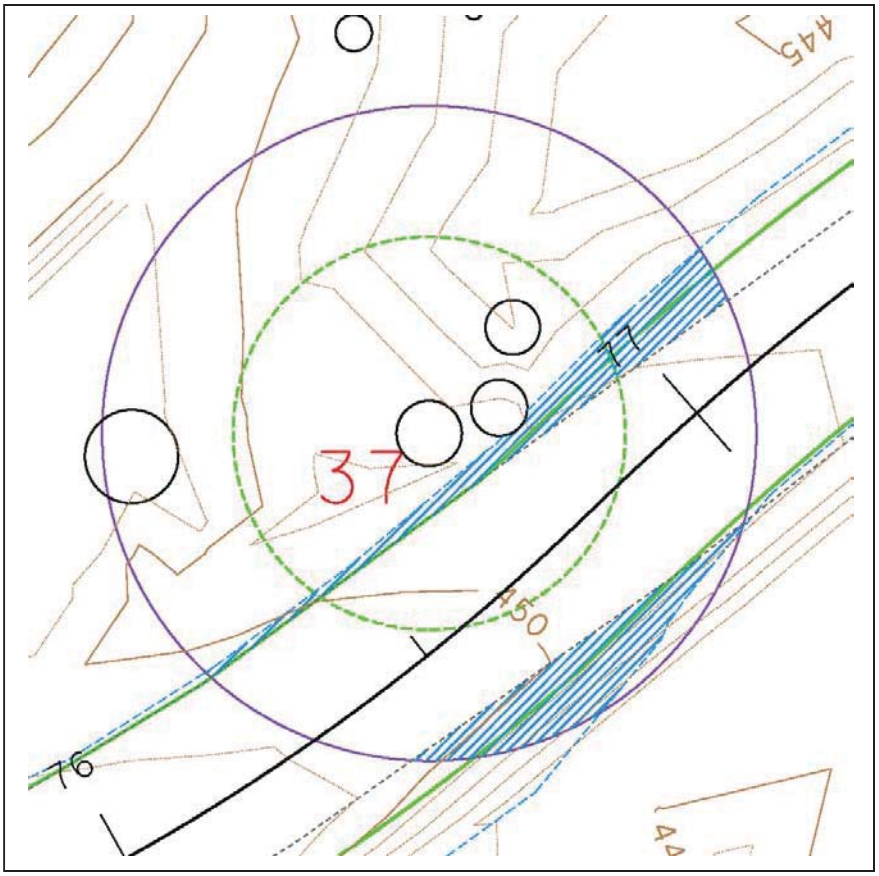


Description: Tree #36, 144 inches DBH (depicted in Attachment A, Sheet 7).

Work in structural root zone? Yes

Details of Work: The road would be widened up to 5 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth greater than 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

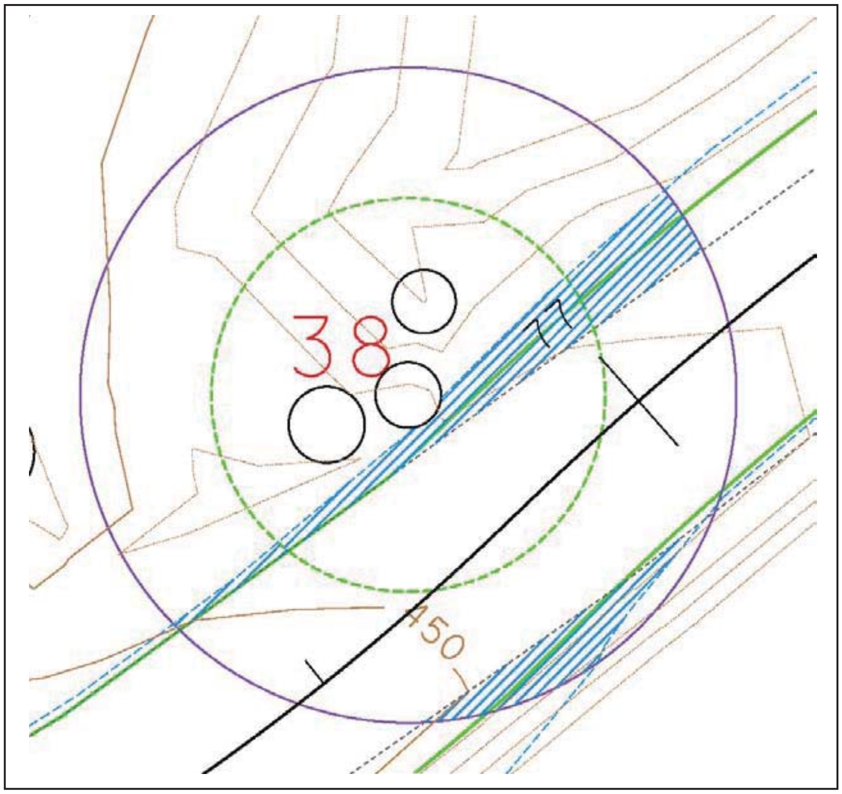


Description: Tree #37**,** 108 inches DBH (depicted in Attachment A, Sheet 7).

Work in structural root zone? Yes

Details of Work: The road would be widened up to 5 feet toward the tree; across the road it would be widened up to 5 feet. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.

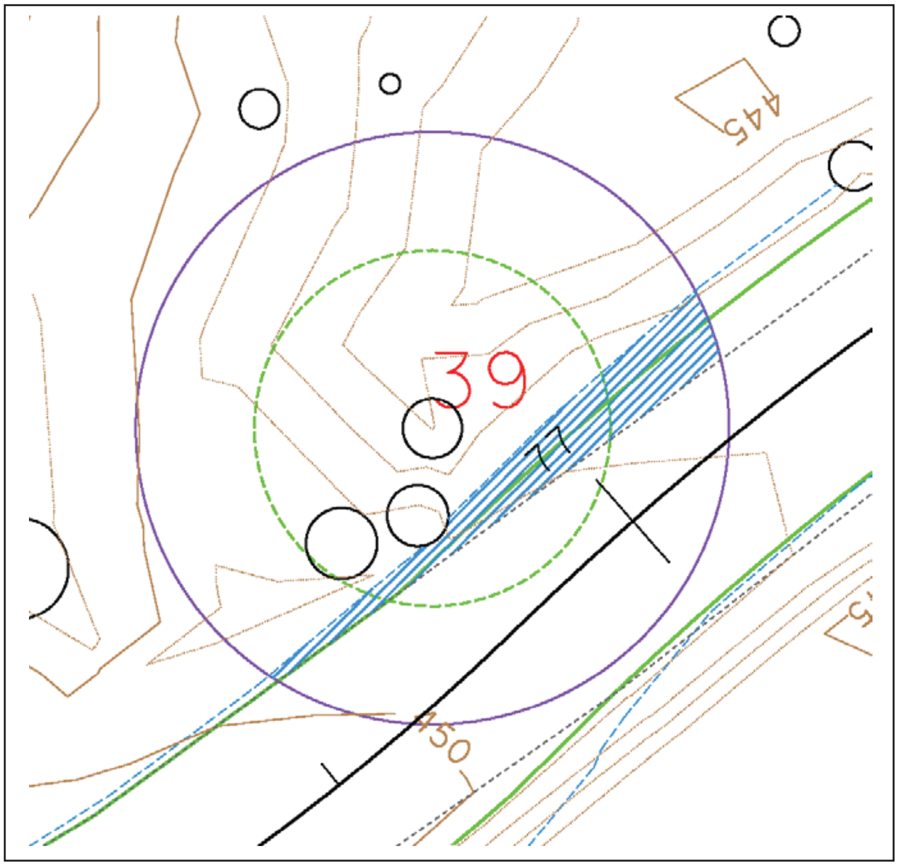


Description: Tree #38**,** 94 inches DBH (depicted in Attachment A, Sheet 7).

Work in structural root zone? Yes

Details of Work: The road would be widened up to 5 feet toward the tree; across the road it would be widened up to 4 feet. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.

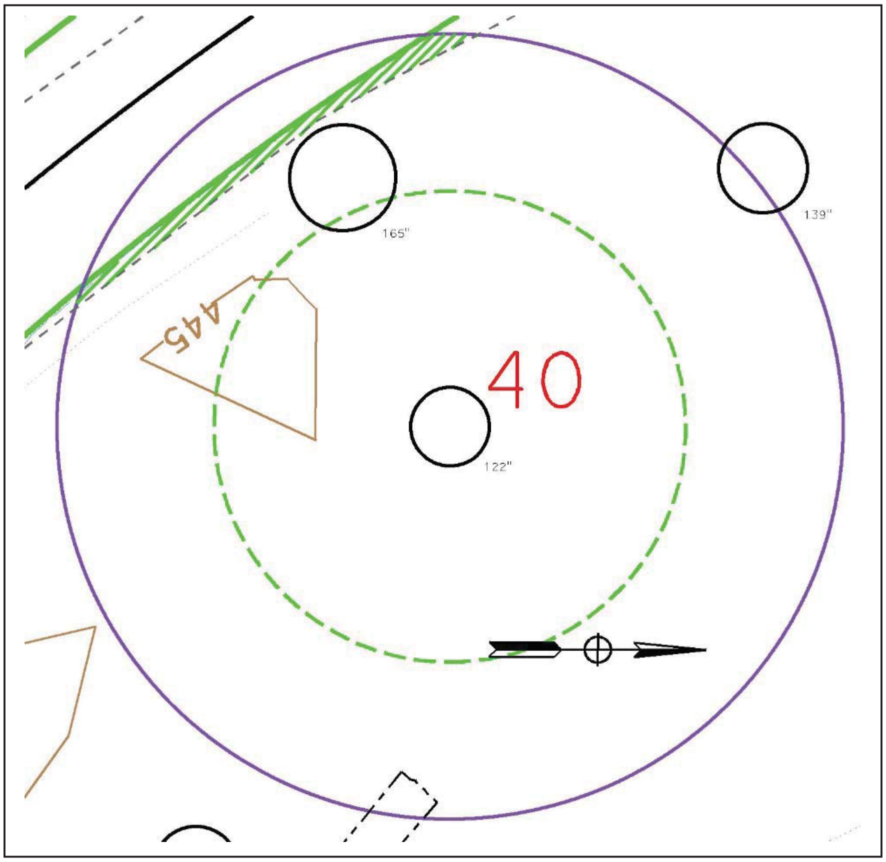


Description: Tree #39**,** 90 inches DBH (depicted in Attachment A, Sheet 7).

Work in structural root zone? Yes

Details of Work: The road would be widened up to 5 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

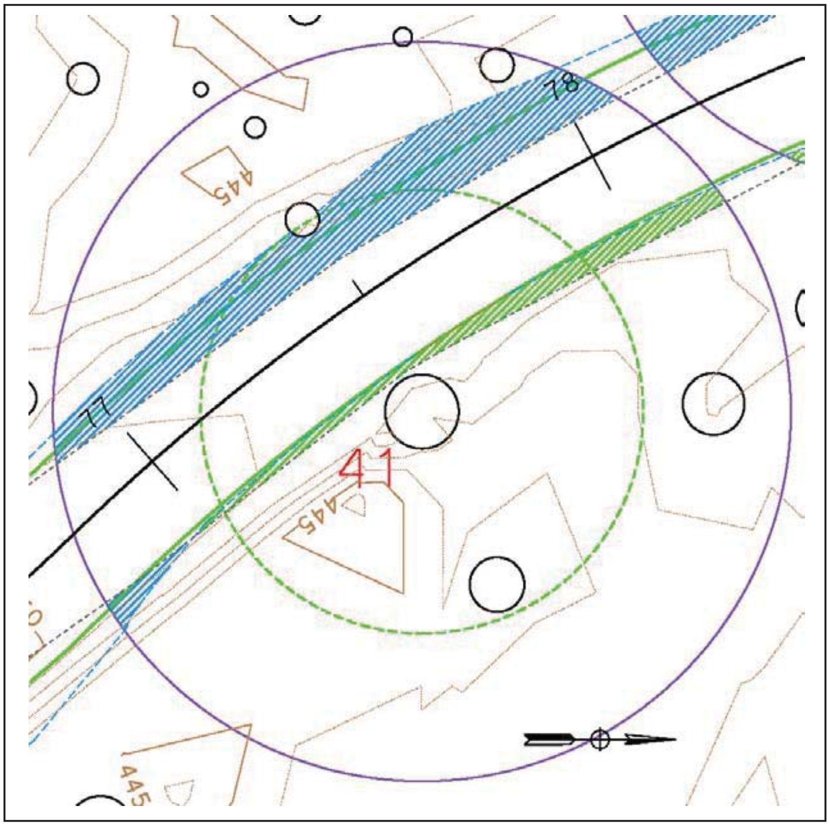


Description: Tree #40, 122 inches DBH (depicted in Attachment A, Sheet 7).

Work in structural root zone? No

Details of Work: The road would be moved approximately 3 feet away from the tree. Where pavement would be removed, road materials would be replaced with gravel at the road edge, and native soils and duff beyond. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

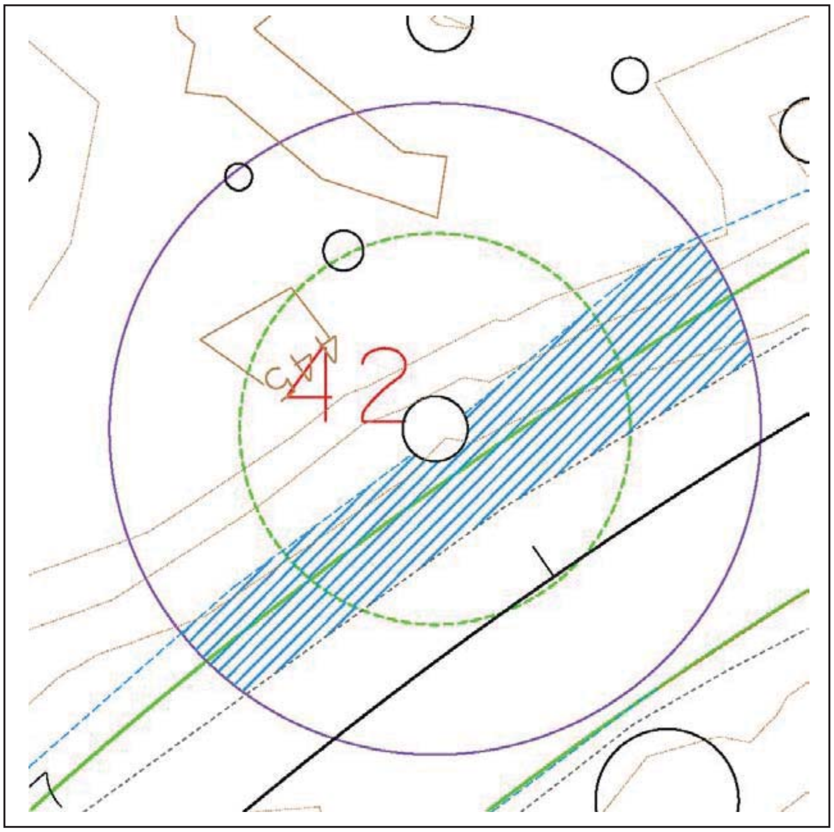


Description: Tree #41**,** 165 inches DBH (depicted in Attachment A, Sheet 7). Tree is next to road, and base and lower trunk appear to have been struck by a vehicle.

Work in structural root zone? Yes

Details of Work: The road would be moved up to 5 feet away from the tree. Where pavement would be removed, road materials would be replaced with gravel at the road edge, and native soils and duff beyond. Across the road from the tree, the road would be widened up to 7 feet. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 18 to 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.



Description: Tree #42**,** 75 inches DBH (depicted in Attachment A, Sheet 7).

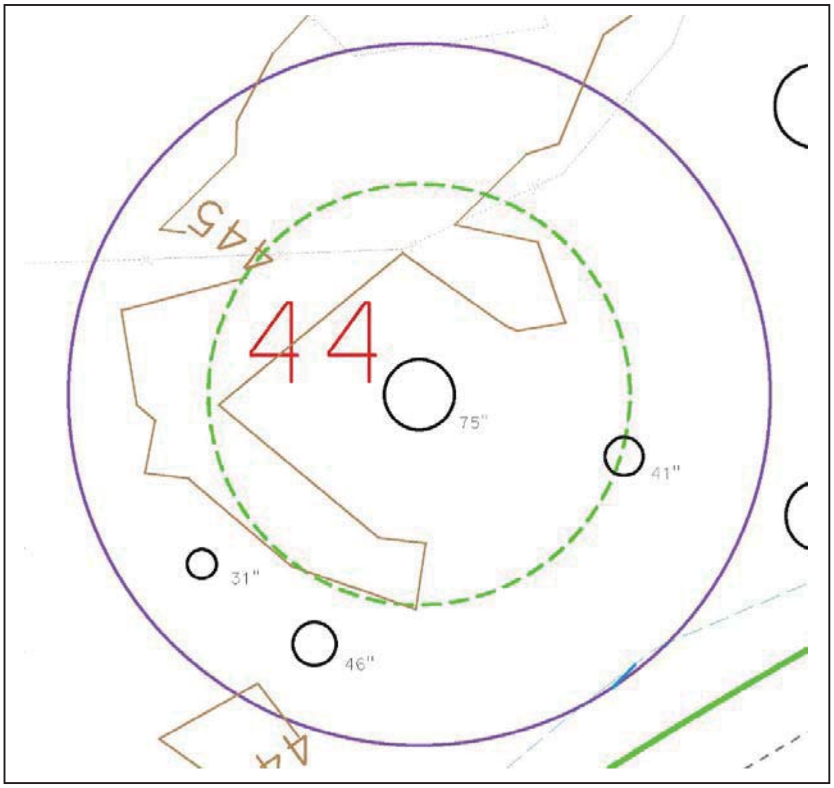
Work in structural root zone? Yes

Details of Work: The road would be widened up to 7 feet toward the tree. Where the road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 18 to 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

#43 Eliminated. Previously mapped; project work not within root health zone.

Description: Tree #43**,** 46 inches DBH (depicted in Attachment A, Sheet 7).

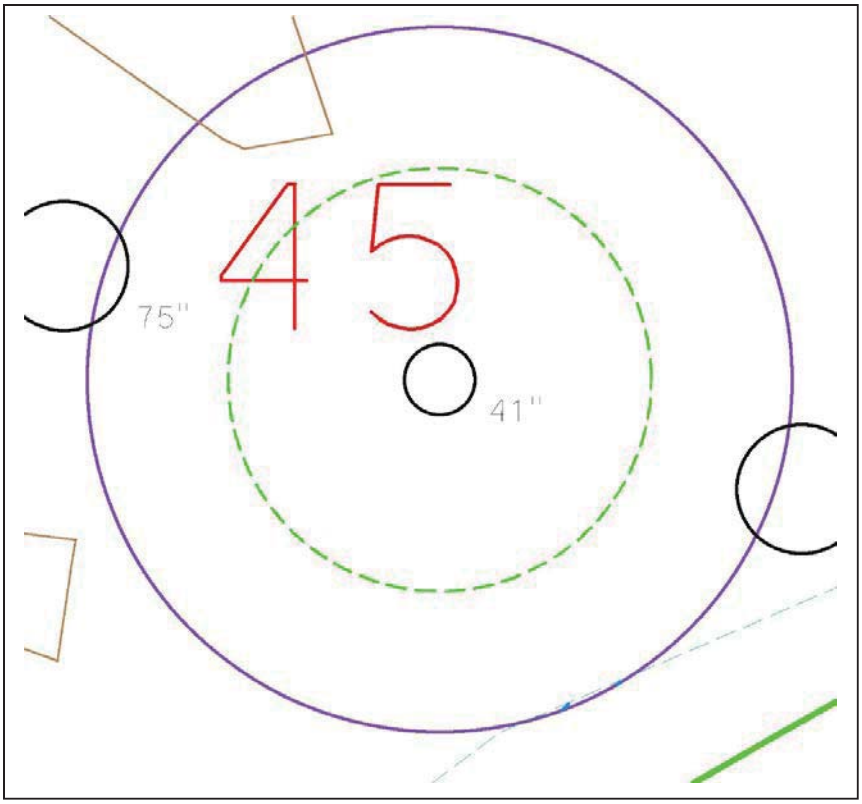


Description: Tree #44, 75 inches DBH (depicted in Attachment A, Sheet 8).

Work in structural root zone? No

Details of Work: New soils would be placed to construct embankment (average depth 6 to 18 inches).

Evaluation: Root zone disturbance would have no effect on tree health.

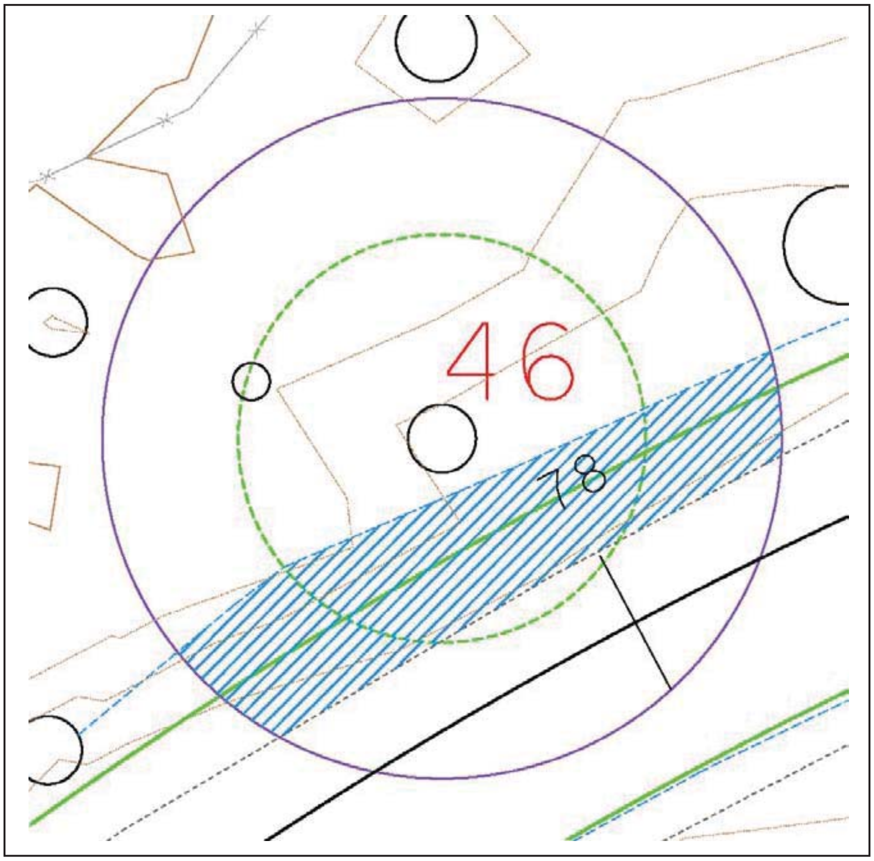


Description: Tree #45, 41 inches DBH (depicted in Attachment A, Sheet 8).

Work in structural root zone? No

Details of Work: New soils would be placed to construct embankment (average depth 6 to 18 inches).

Evaluation: Root zone disturbance would have no effect on tree health.

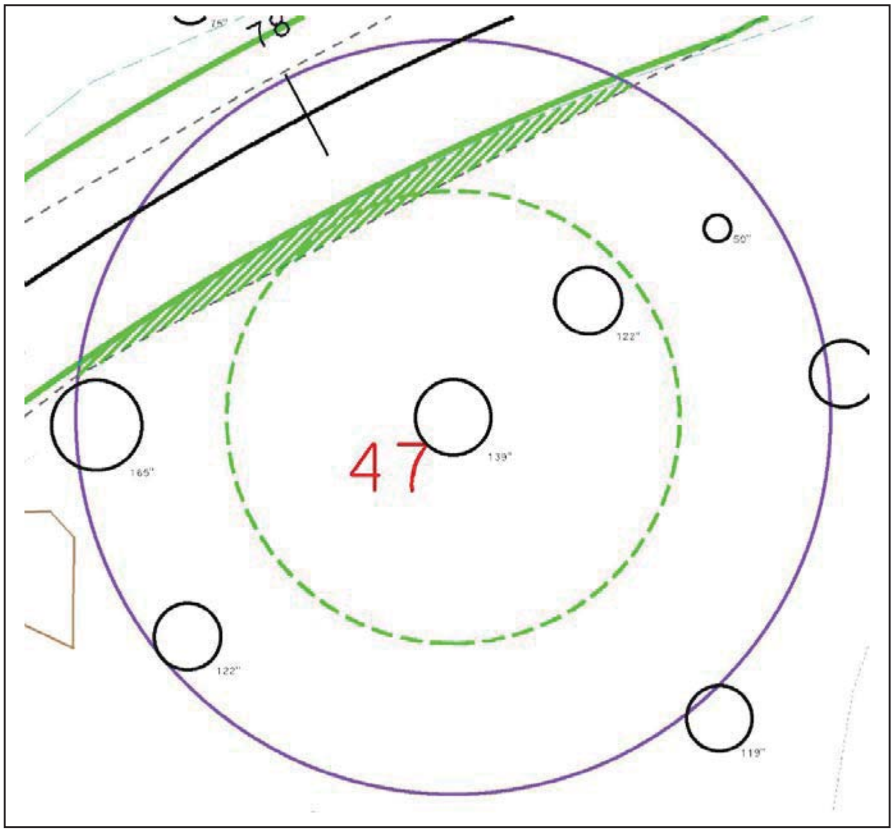


Description: Tree #46, 75 inches DBH (depicted in Attachment A, Sheet 8). (Listed as Tree #46 in Table 9 and #34 in Table 10 of Final EA.)

Work in structural root zone? Yes

Details of Work: The road would be widened up to 7 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 18 to 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.

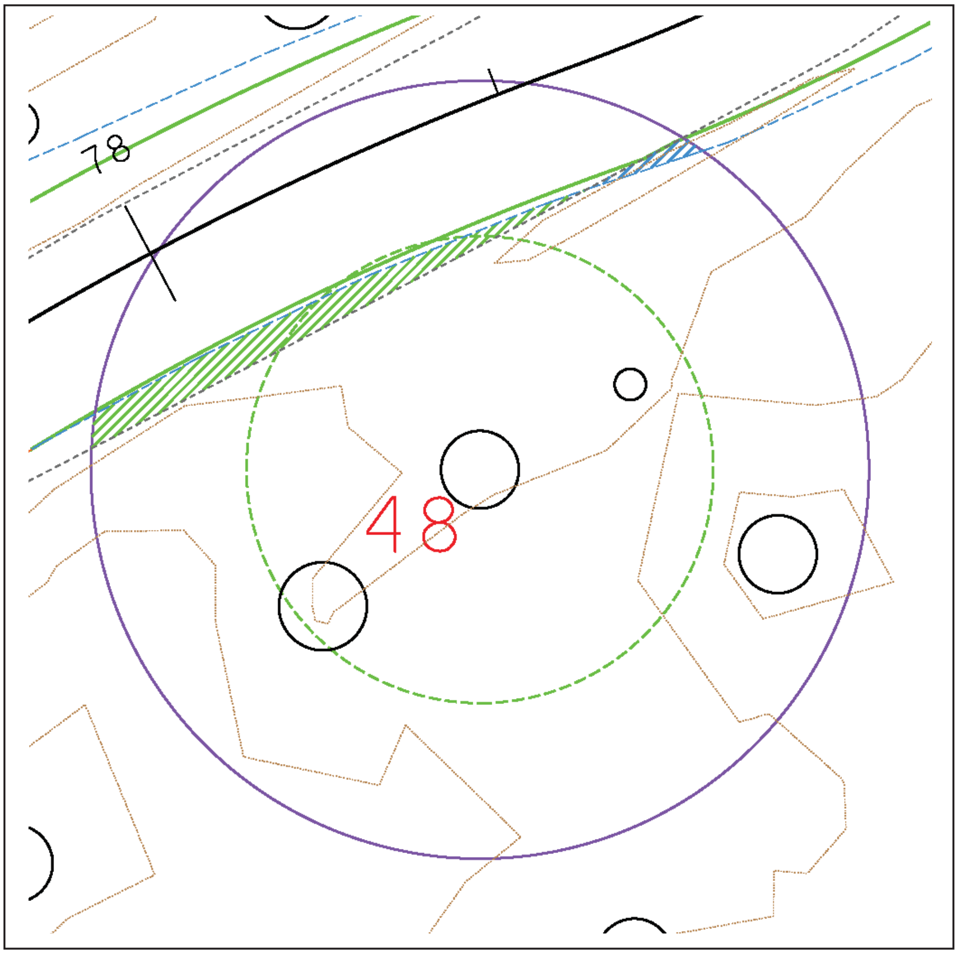


Description: Tree #47, 139 inches DBH (depicted in Attachment A, Sheet 7).

Work in structural root zone? Yes

Details of Work: The road would be moved approximately 5 feet away from the tree. Where pavement would be removed, road materials would be replaced with gravel at the road edge, and native soils and duff beyond. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

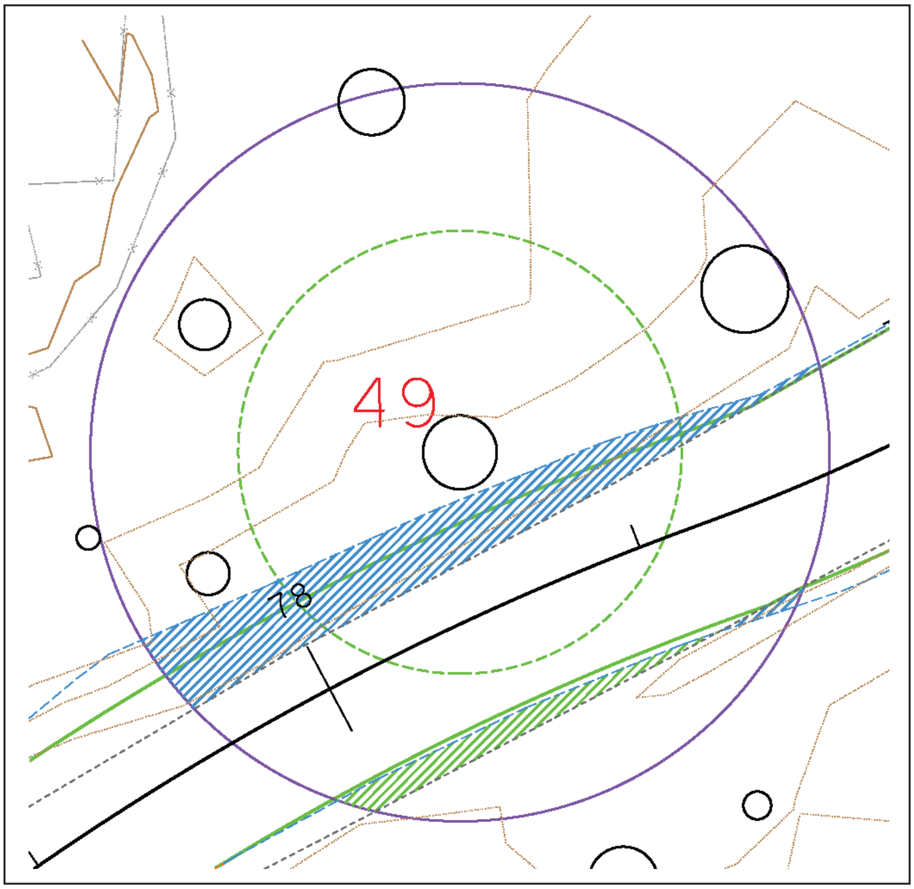


Description: Tree #48, 122 inches DBH (depicted in Attachment A, Sheet 8).

Work in structural root zone? Yes

Details of Work: The road would be moved approximately 5 feet away from the tree. Where pavement would be removed, road materials would be replaced with gravel at the road edge, and native soils and duff beyond. New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.



Description: Tree #49, 130 inches DBH (depicted in Attachment A, Sheet 8).

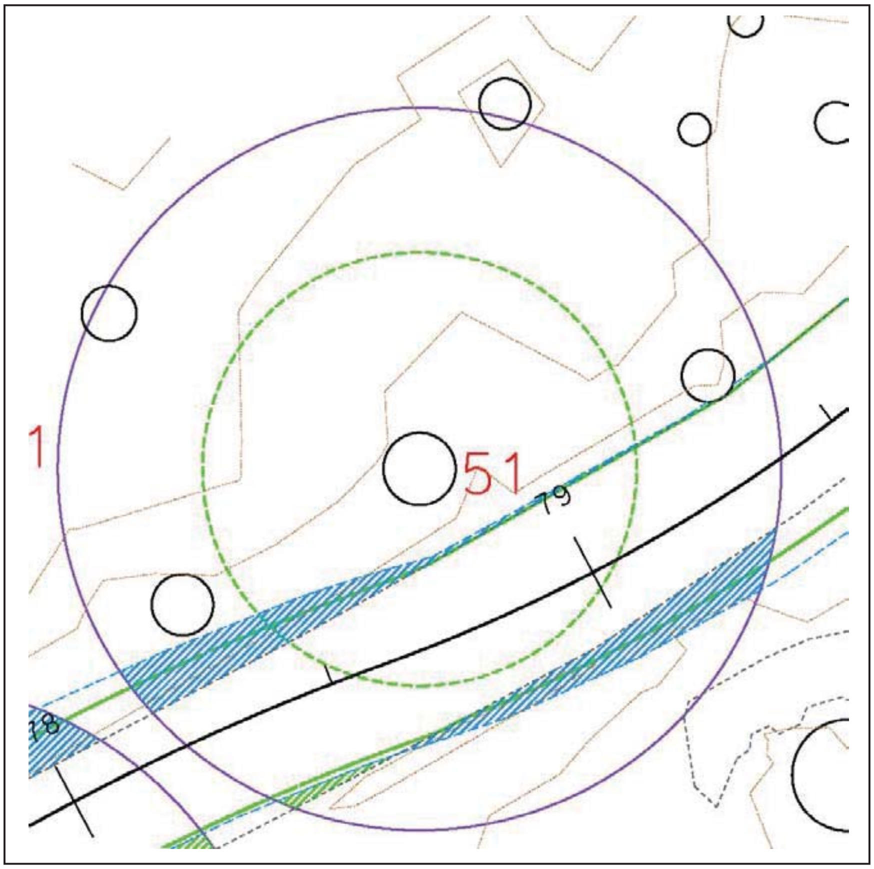
Work in structural root zone? Yes

Details of Work: The road would be widened up to 7 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. Up to 5 feet of pavement across the road would be removed and replaced with gravel at the road edge, and native soils and duff beyond. New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.

#50 Eliminated. Previously mapped; project work not within root health zone.

Description: Tree #50, 122 inches DBH (depicted in Attachment A, Sheet 8).

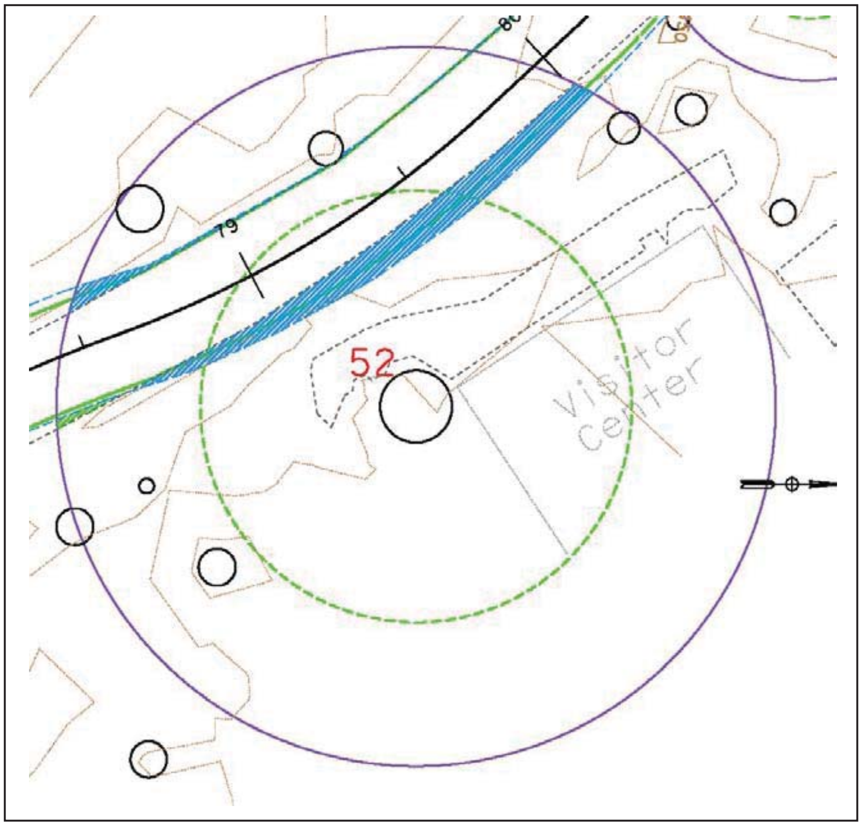


Description: Tree #51, 153 inches DBH (depicted in Attachment A, Sheet 8). Tree has a cavity with fire scar, though not extensive. Area around the tree had historically been used for vehicle parking.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 6 feet near the tree; across the road it would be widened up to 4 feet to the north. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. Across the road to the south, approximately 4 feet of pavement would be removed and replaced with gravel at the road edge, and native soil and duff beyond it. New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

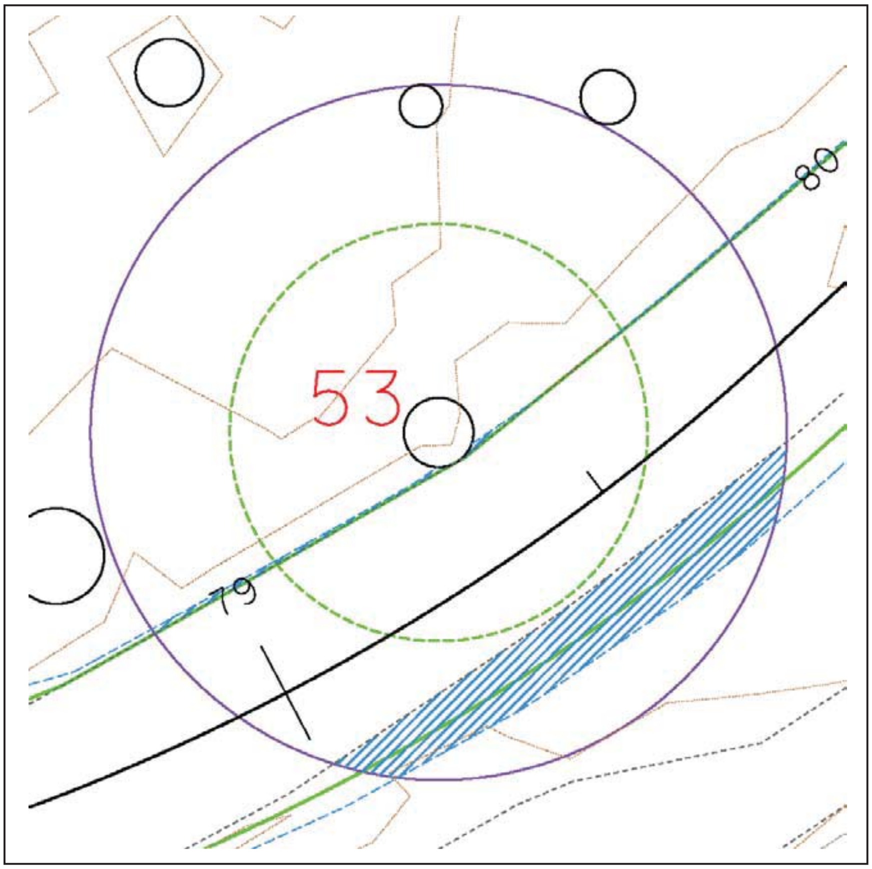


Description: Tree #52, 236 inches DBH (depicted in Attachment A, Sheet 8). Tree has two trunks. It is next to the park Visitor Center and is known as the “bat” tree. The ground around the trunk and through the hollow of the tree is completely paved.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 5 feet toward the tree; across the road it would be widened up to 3 feet. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 18 to 30 inches), gravel at the road edge and native soils and duff beyond. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

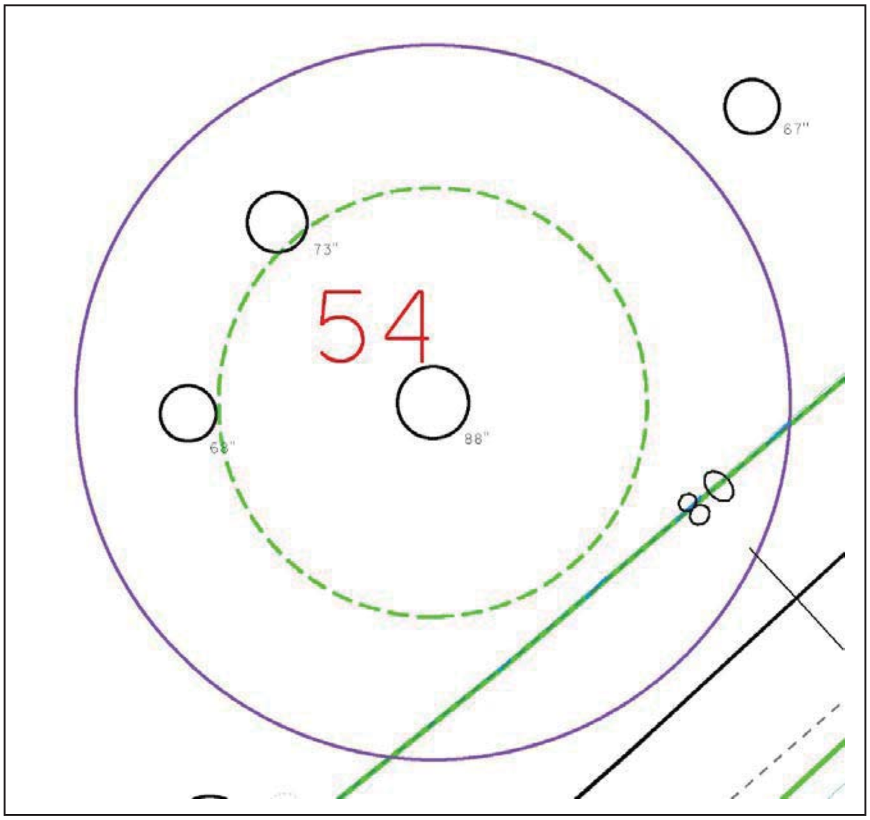


Description: Tree #53, 111 inches DBH (depicted in Attachment A, Sheet 8). Tree appears to have been struck by vehicles; basal flare was apparently cut for road installation, but crown is in very good condition.

Work in structural root zone? Yes

Details of Work: Across the road from the tree, the road would be widened approximately 5 feet, outside of the structural root zone. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 18 to 36 inches) both within and outside of structural root zone. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

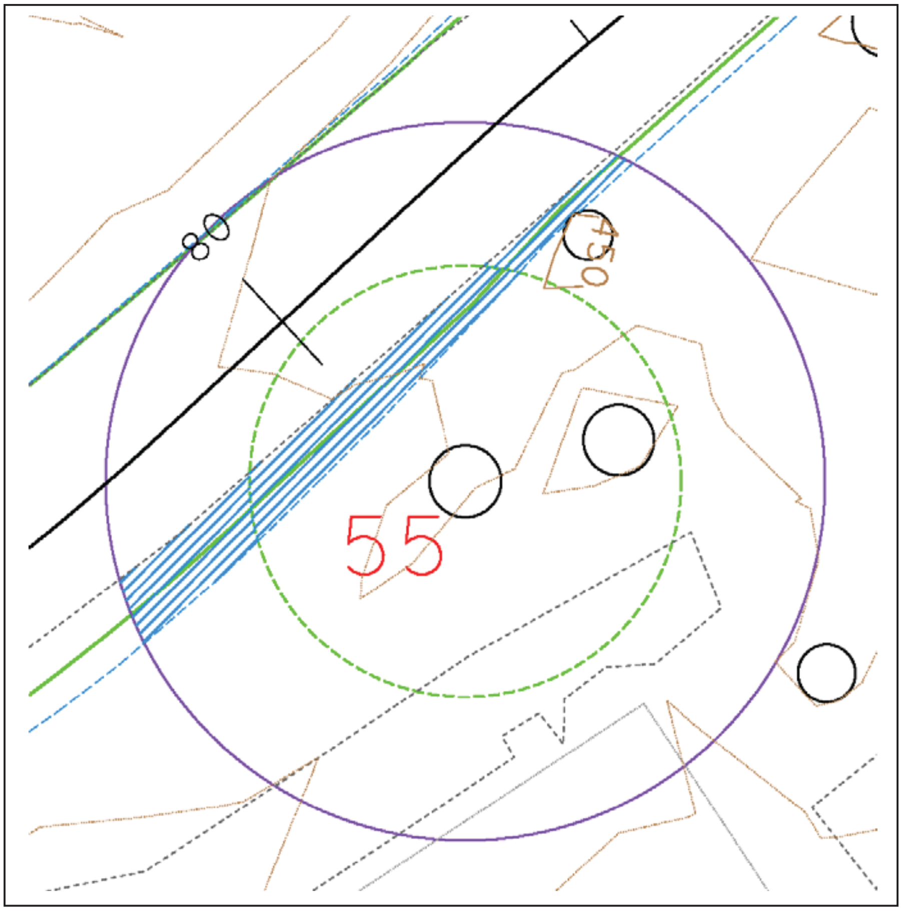


Description: Tree #54, 88 inches DBH (depicted in Attachment A, Sheet 8).

Work in structural root zone? No

Details of Work: The road would be widened less than 1 foot toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials; new soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

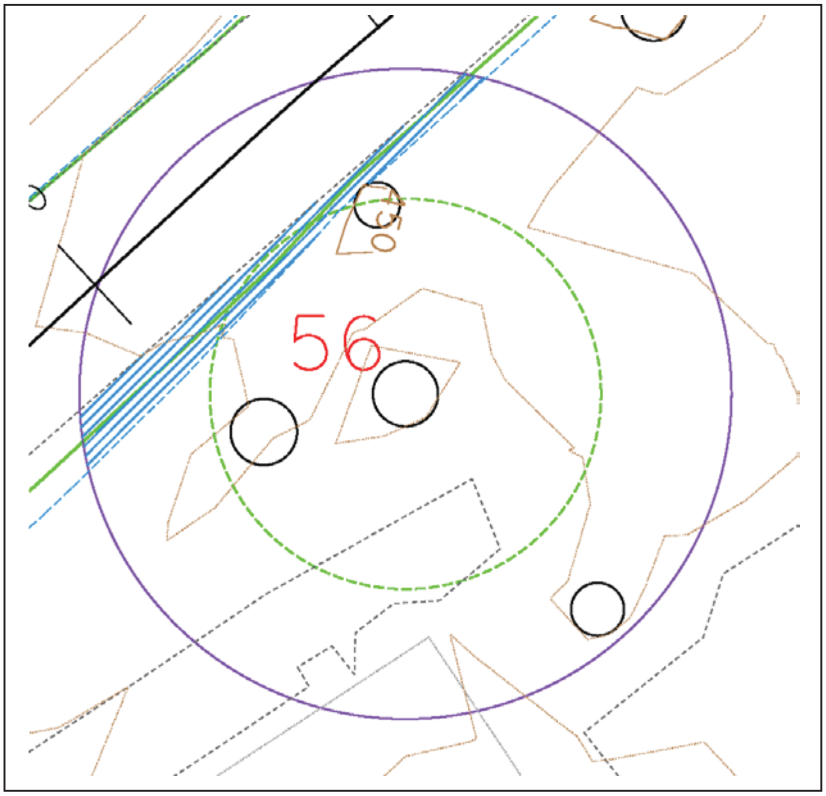


Description: Tree #55, 104 inches DBH (depicted in Attachment A, Sheet 8).

Work in structural root zone? Yes

Details of Work: The road would be widened up to 5 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 18 to 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.

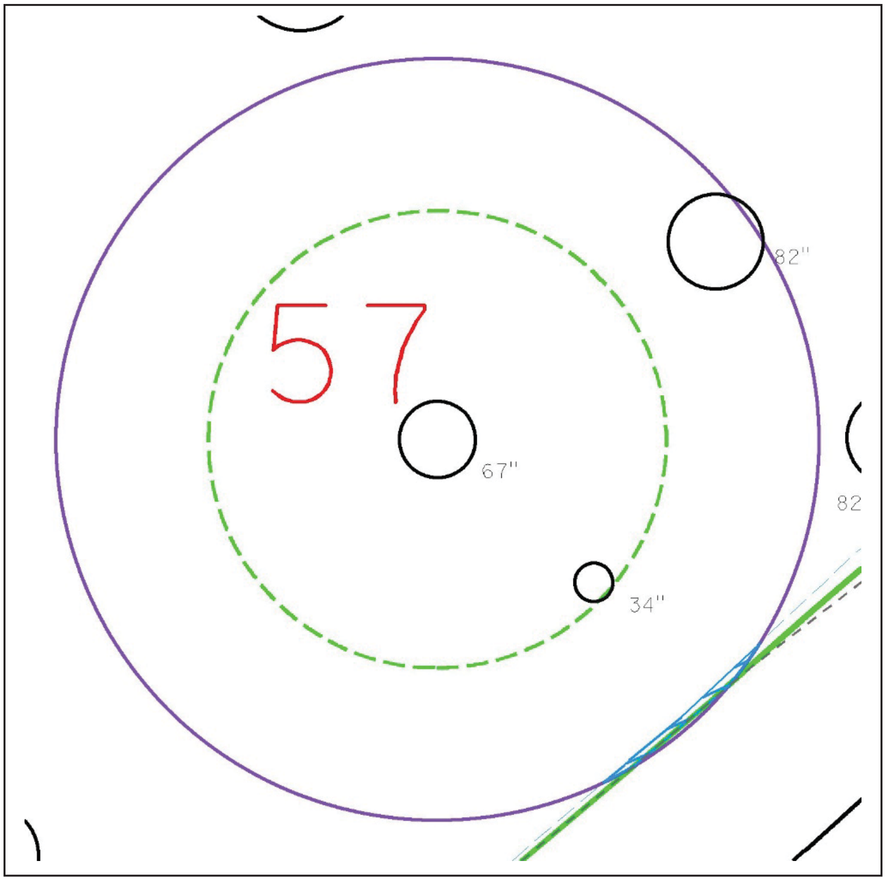


Description: Tree #56, 102 inches DBH (depicted in Attachment A, Sheet 8). Tree is by the large park entrance sign at the Visitor Center.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 3 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 18 to 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

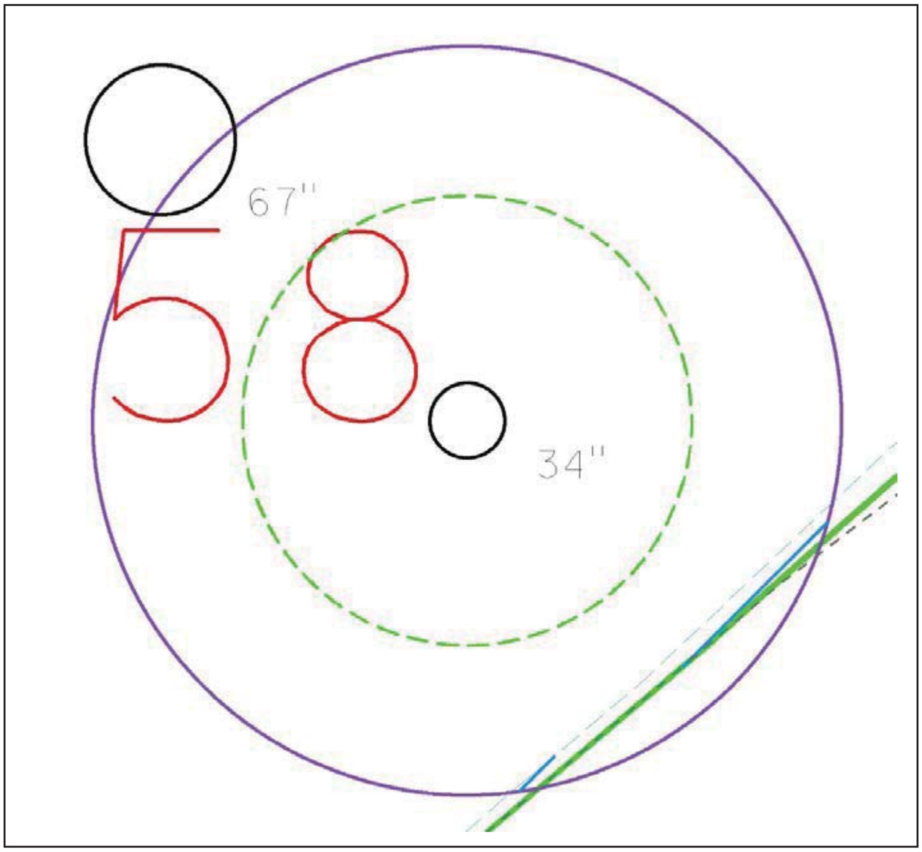


Description: Tree #57, 67 inches DBH (depicted in Attachment A, Sheet 8). Tree is away from road.

Work in structural root zone? No

Details of Work: New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

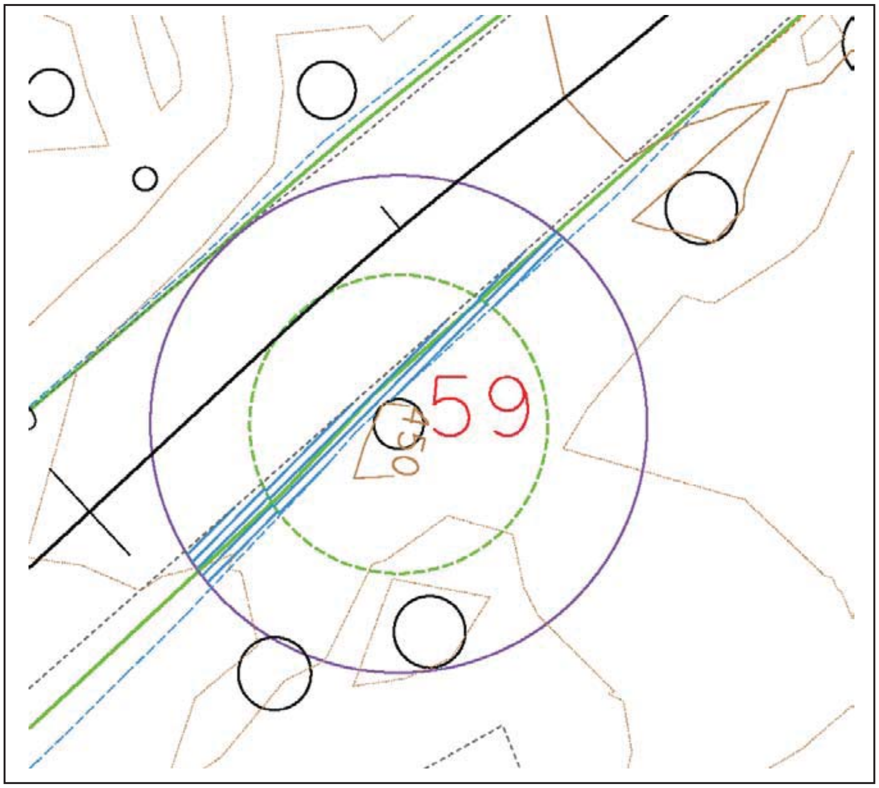


Description: Tree #58, 34 inches DBH (depicted in Attachment A, Sheet 8). This is a small tree near the road.

Work in structural root zone? No

Details of Work: The road would be widened less than a foot toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

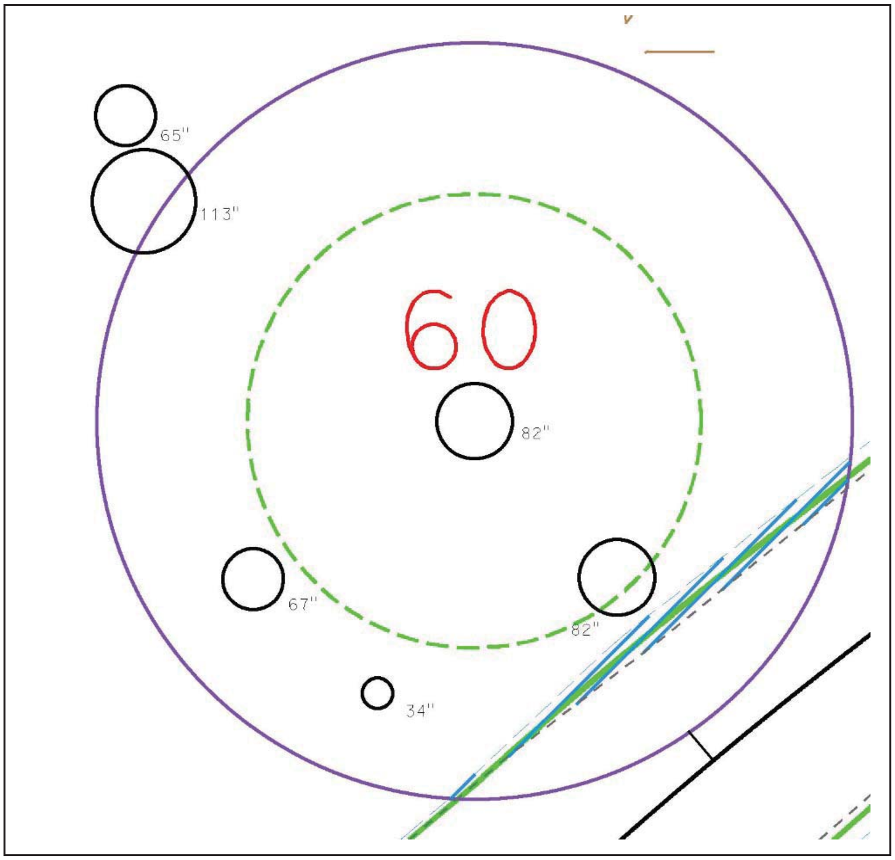


Description: Tree #59, 72 inches DBH (depicted in Attachment A, Sheet 8). There is vehicle parking behind tree.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 5 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.

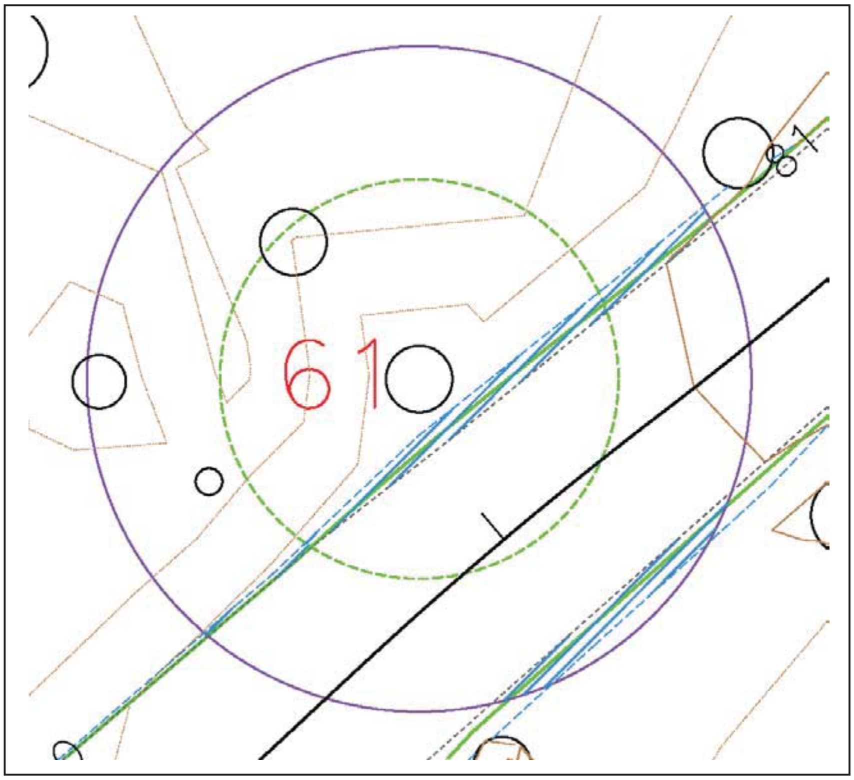


Description: Tree #60, 82 inches DBH (depicted in Attachment A, Sheet 9).

Work in structural root zone? No

Details of Work: The road would be widened approximately 1 foot toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

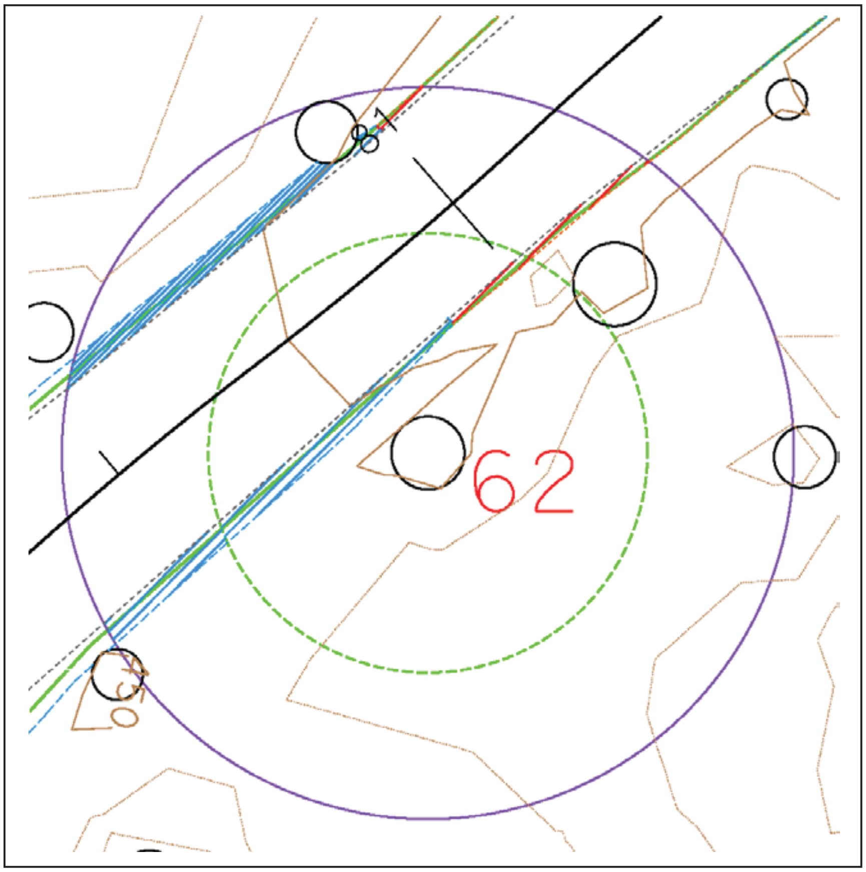


Description: Tree #61, 82 inches DBH (depicted in Attachment A, Sheet 8).

Work in structural root zone? Yes

Details of Work: The road would be widened up to 1 foot toward the tree. Across the road it would be widened up to 1 foot. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.

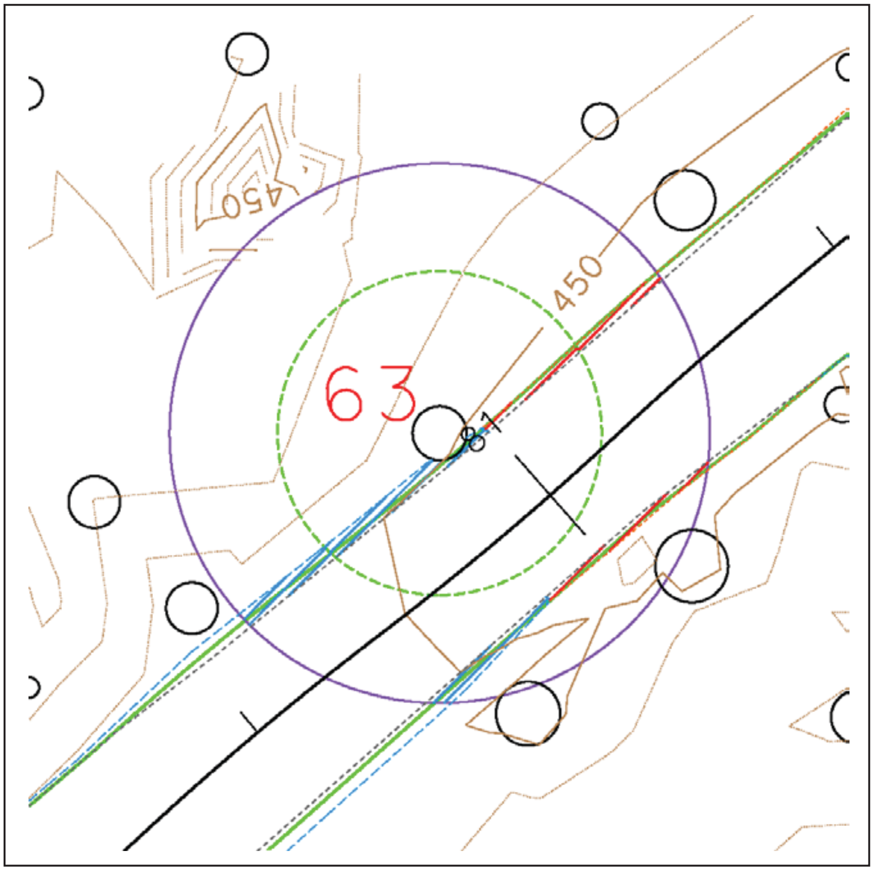


Description: Tree #62, 94 inches DBH (depicted in Attachment A, Sheet 9). Tree was apparently struck by a vehicle and has formed a substantial callus roll at the wound edges.

Work in structural root zone? Yes

Details of Work: The road would be widened approximately 1 foot toward the tree. Across the road it would be widened approximately 1 foot. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

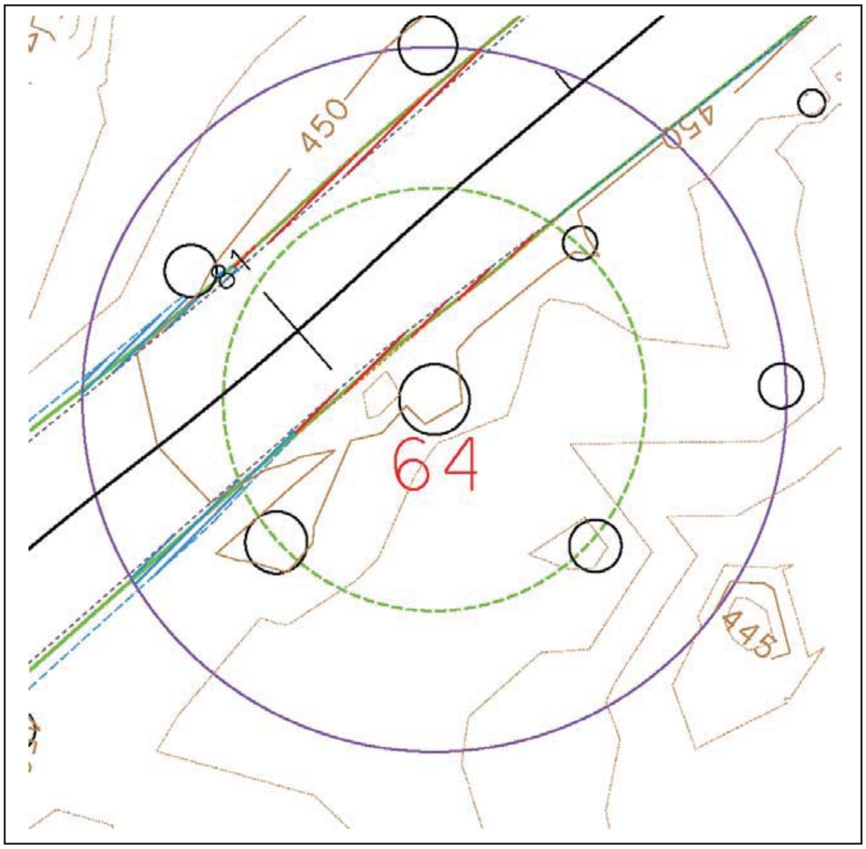


Description: Tree #63, 86 inches DBH (depicted in Attachment A, Sheet 9). Basal flare of tree may have been cut when road was constructed; tree appears to have been struck by vehicles.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 1 foot on either side of the tree; across the road, it would be widened up to 1 foot. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.



Description: Tree #64, 116 inches DBH (depicted in Attachment A, Sheet 9). Root flare of tree has been cut back at edge of road.

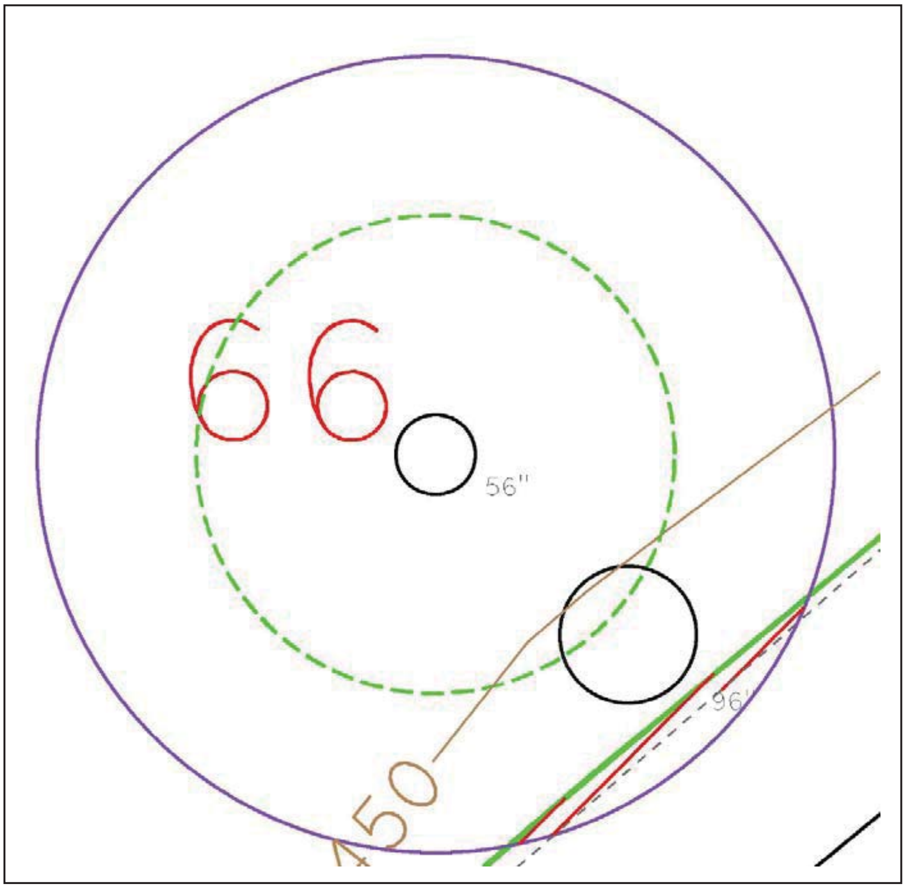
Work in structural root zone? Yes

Details of Work: The road would be widened up to 1 foot toward the tree. Across the road, it would be widened up to 1 foot. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

#65 Eliminated. Previously mapped; project work not within root health zone.

Description: Tree #65, 86 inches DBH (depicted in Attachment A, Sheet 9).

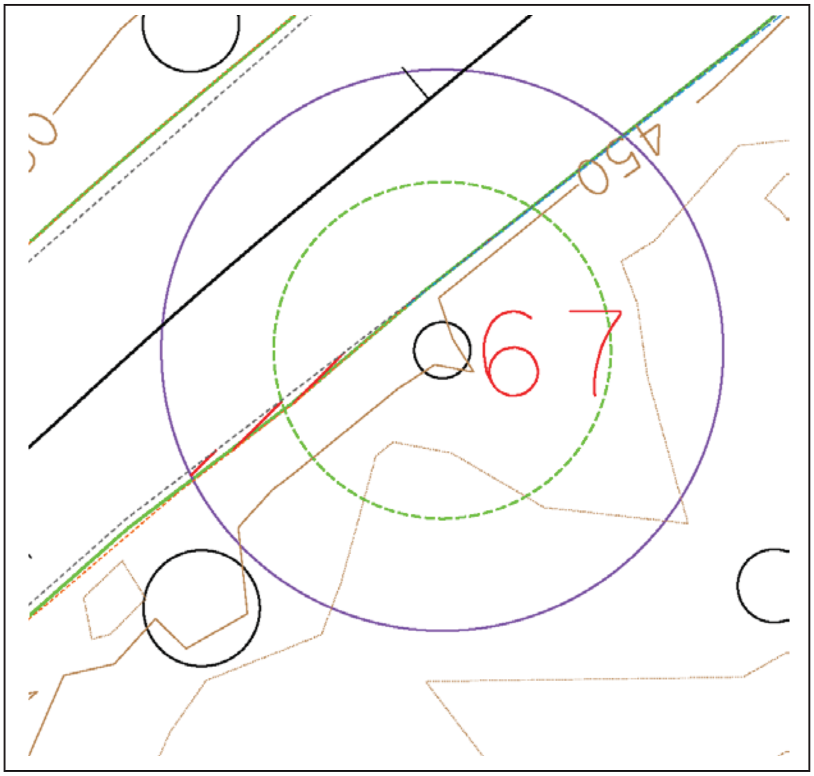


Description: Tree #66, 56 inches DBH (depicted in Attachment A, Sheet 9). Tree is farther away from road, behind tree 68.

Work in structural root zone? No

Details of Work: The road would be widened up to 1 foot toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

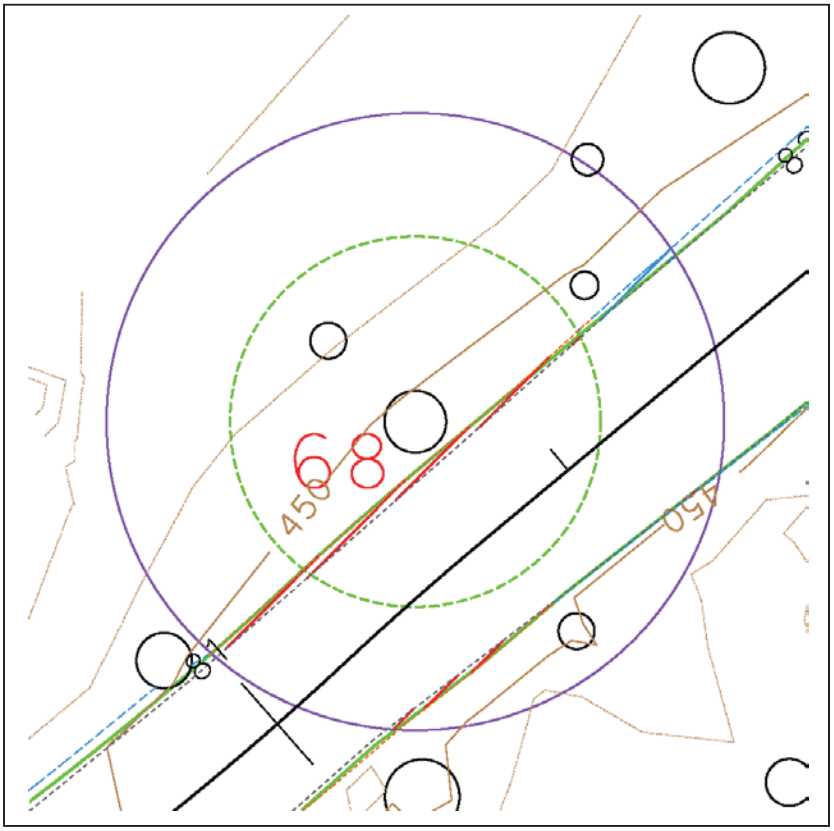


Description: Tree #67, 57 inches DBH (depicted in Attachment A, Sheet 9). Tree appears to have been struck by a vehicle, or perhaps cut to accommodate road, and injury has callused over.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 1 foot toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.

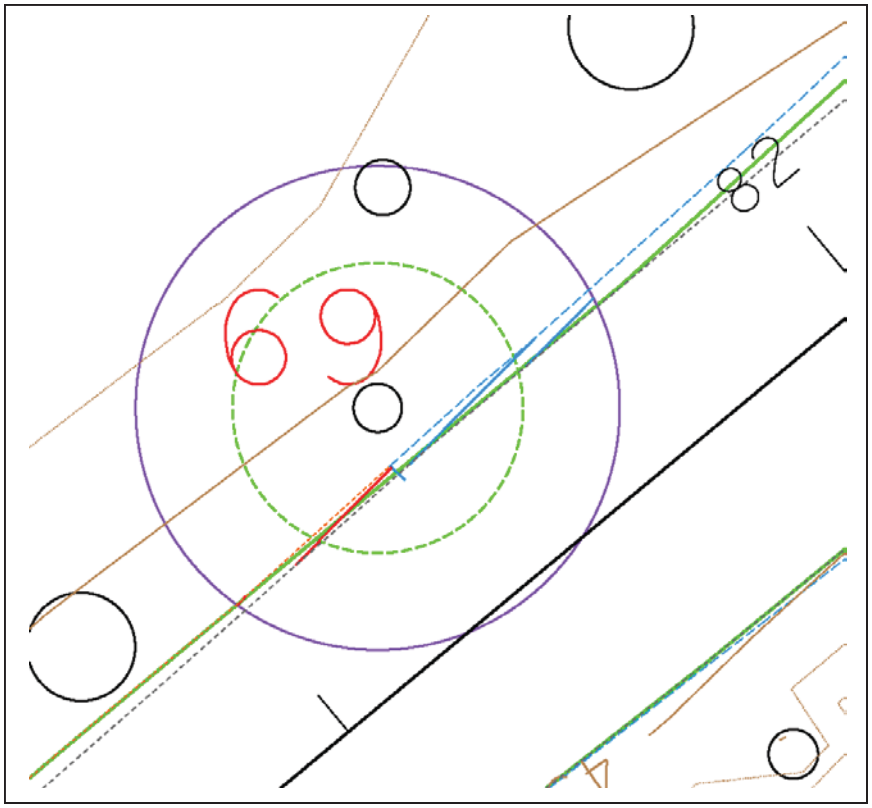


Description: Tree #68, 96 inches DBH (depicted in Attachment A, Sheet 9). Trunk of tree appears to have been struck repeatedly by vehicles.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 1 foot toward the tree; across the road, it would be widened up to 1 foot. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.



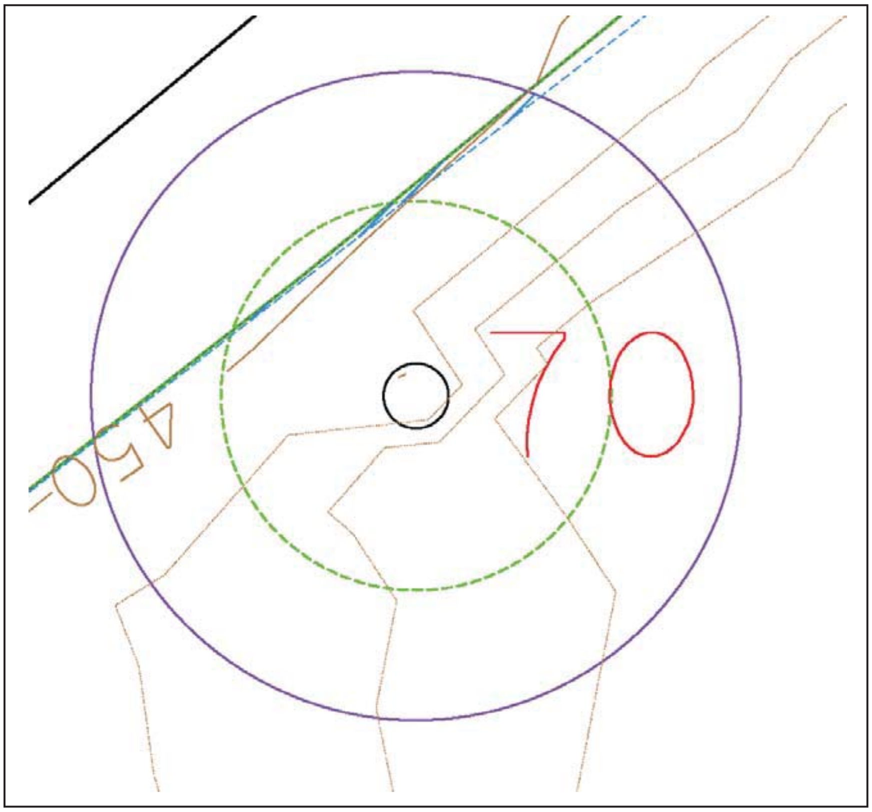
Description: Tree #69, 43 inches DBH (depicted in Attachment A, Sheet 9).

Work in structural root zone? Yes

Details of Work: The road would be widened up to 1 foot toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.

Individual Tree Details

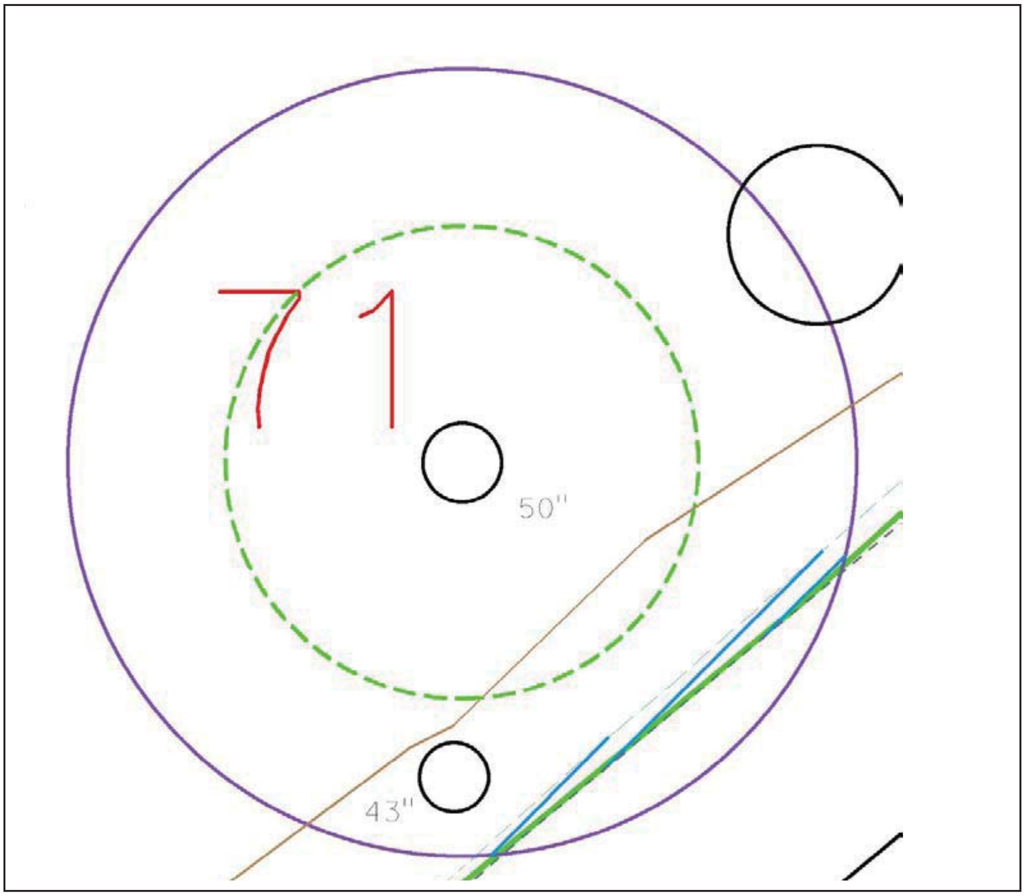


Description: Tree #70, 44 inches DBH (depicted in Attachment A, Sheet 9).

Work in structural root zone? Yes

Details of Work: New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

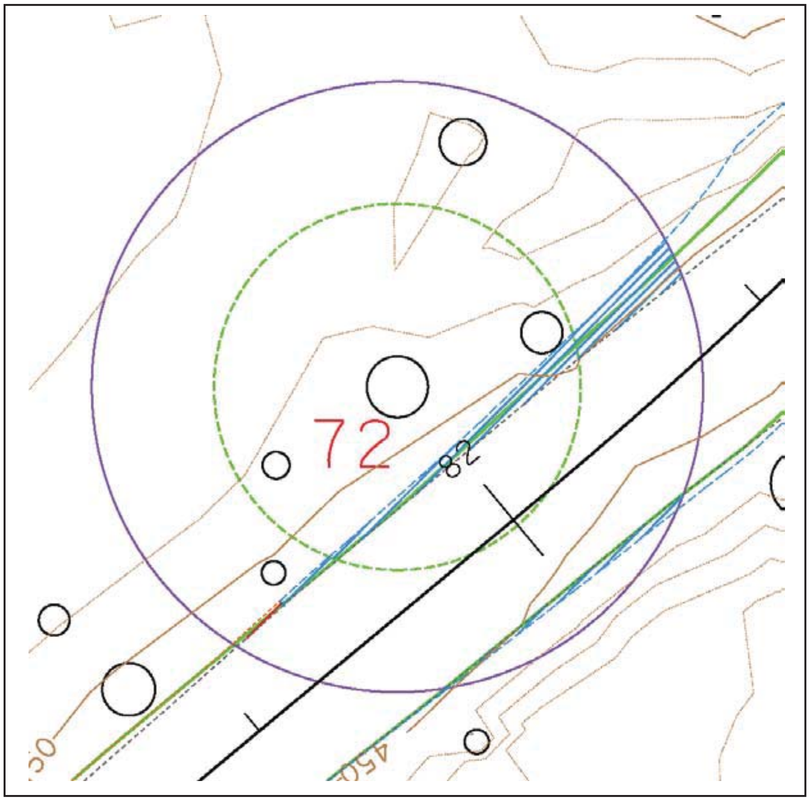


Description: Tree #71, 50 inches DBH (depicted in Attachment A, Sheet 9).

Work in structural root zone? No

Details of Work: New soils would be placed to construct embankment outside of structural root zone (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

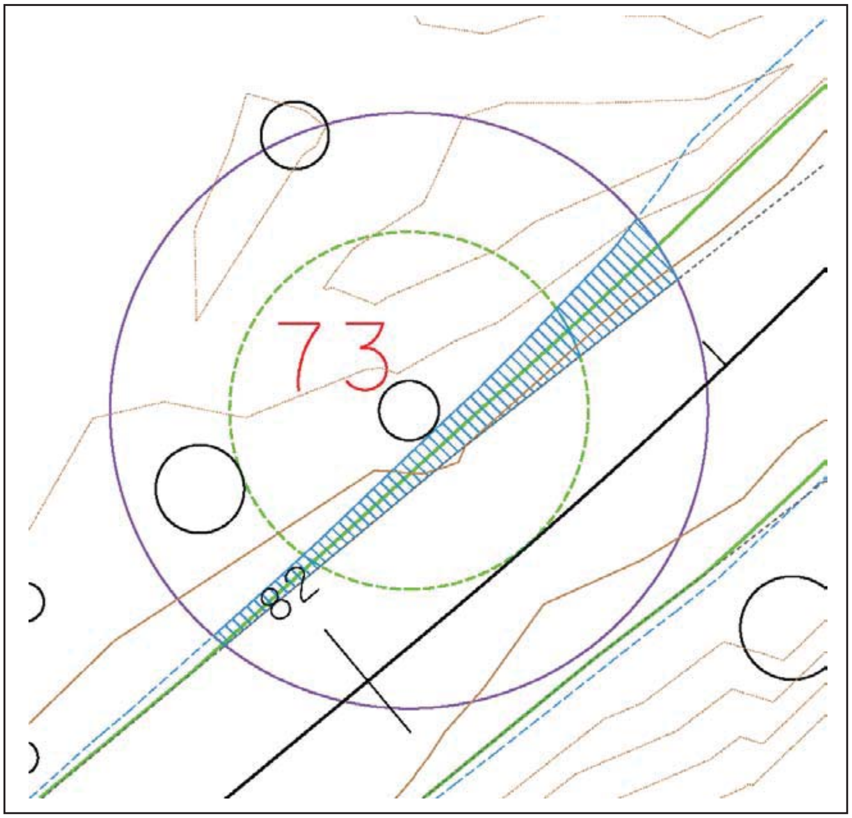


Description: Tree #72, 112 inches DBH (depicted in Attachment A, Sheet 9).

Work in structural root zone? Yes

Details of Work: The road would be widened up to 2 feet toward the tree; Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

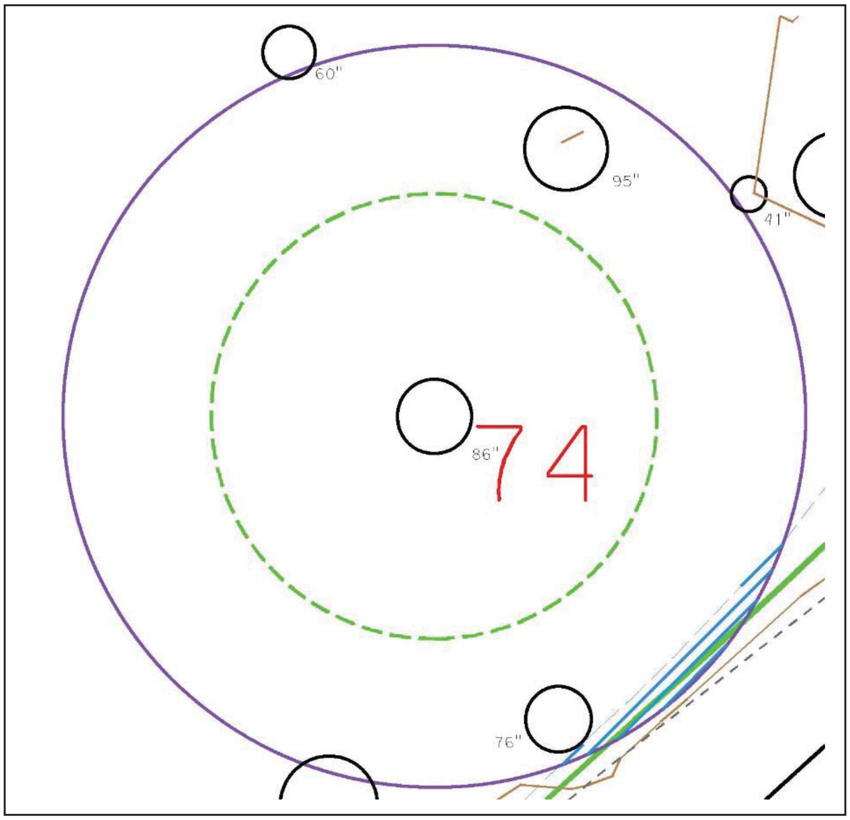


Description: Tree #73, 76 inches DBH (depicted in Attachment A, Sheet 9). Tree base appears to have been struck by a vehicle.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 4 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance may be a reduction in root health sufficient to cause lasting visible dieback of wood in the uppermost crown; tree survival is not threatened.

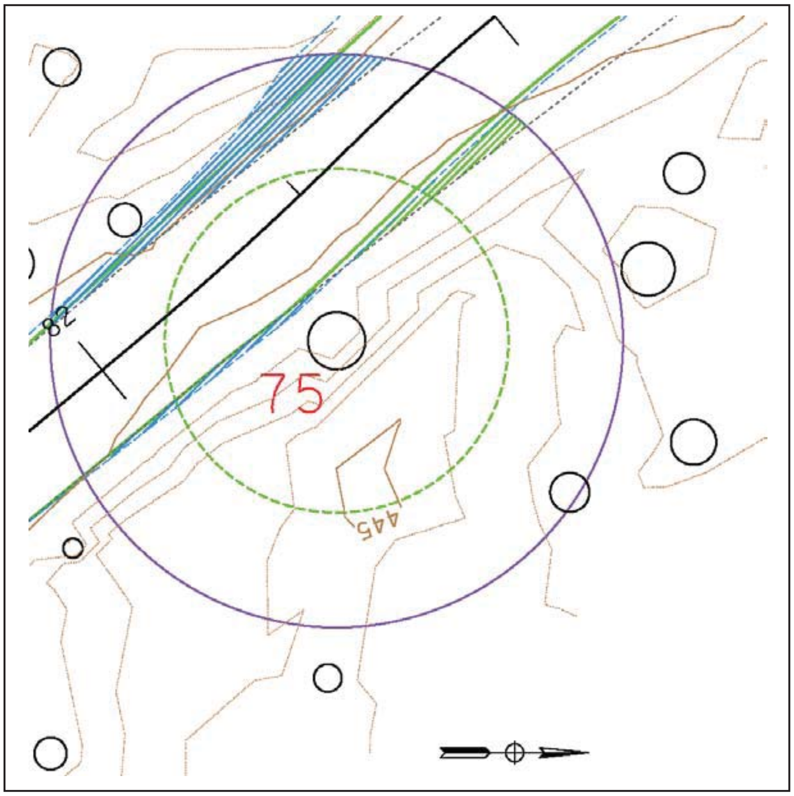


Description: Tree #74, 86 inches DBH (depicted in Attachment A, Sheet 9).

Work in structural root zone? No

Details of Work: The road would be widened up to 3 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

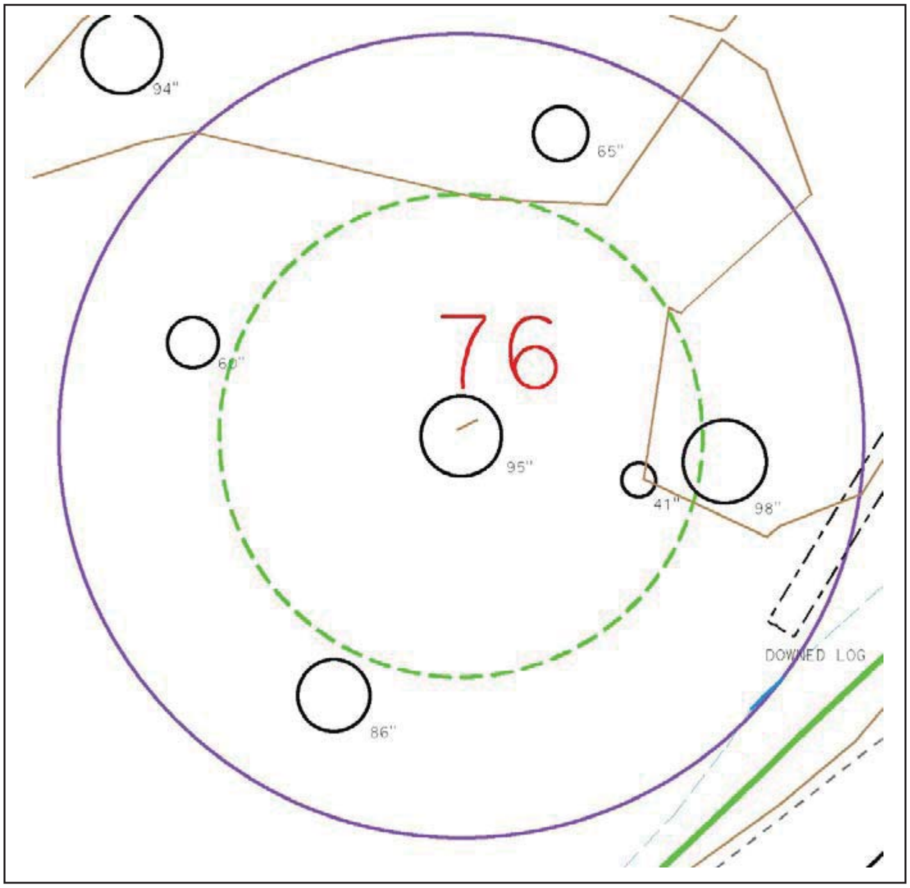


Description: Tree #75, 132 inches DBH (depicted in Attachment A, Sheet 9).

Work in structural root zone? Yes

Details of Work: The road would be moved up to 5 feet away from the tree; across the road, it would be widened up to 4 feet. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. Where pavement would be removed, road materials would be replaced with gravel at the road edge, and native soils and duff beyond. New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

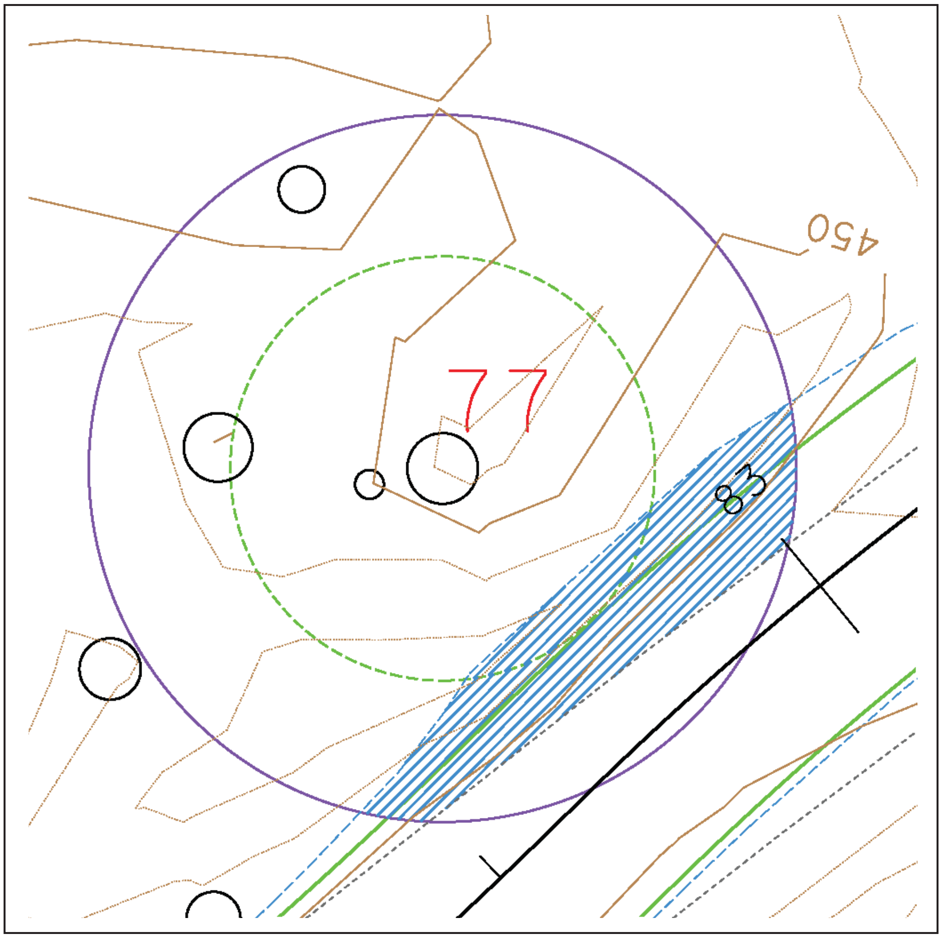


Description: Tree #76, 95 inches DBH (depicted in Attachment A, Sheet 9).

Work in structural root zone? No

Details of Work: New soils would be placed to construct embankment (average depth 6 to 18 inches).

Evaluation: Root zone disturbance would have no effect on tree health.

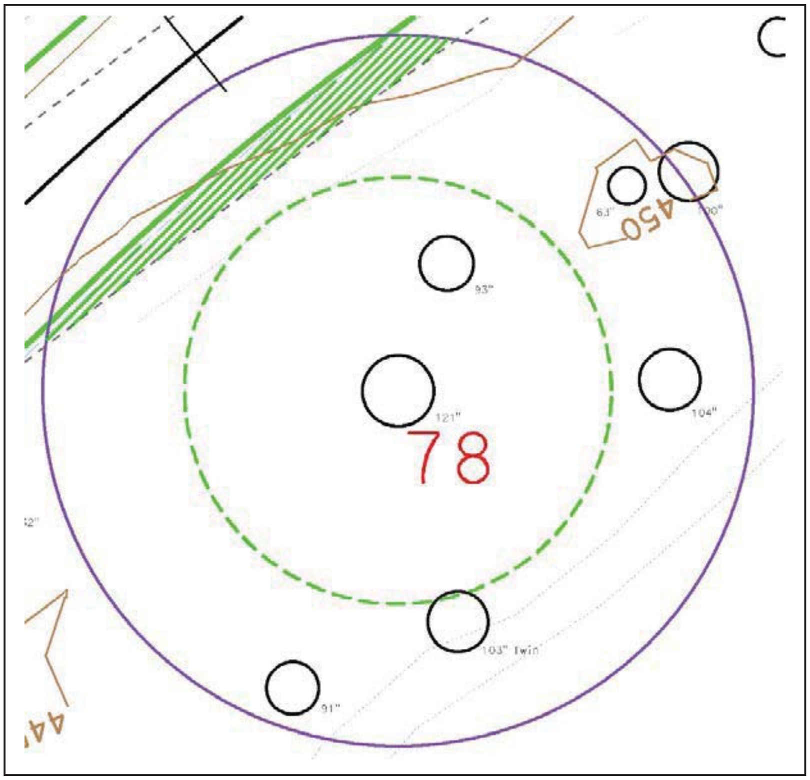


Description: Tree #77, 98 inches DBH (depicted in Attachment A, Sheet 9).

Work in structural root zone? Yes

Details of Work: The road would be widened up to 8 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 18 to 30 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

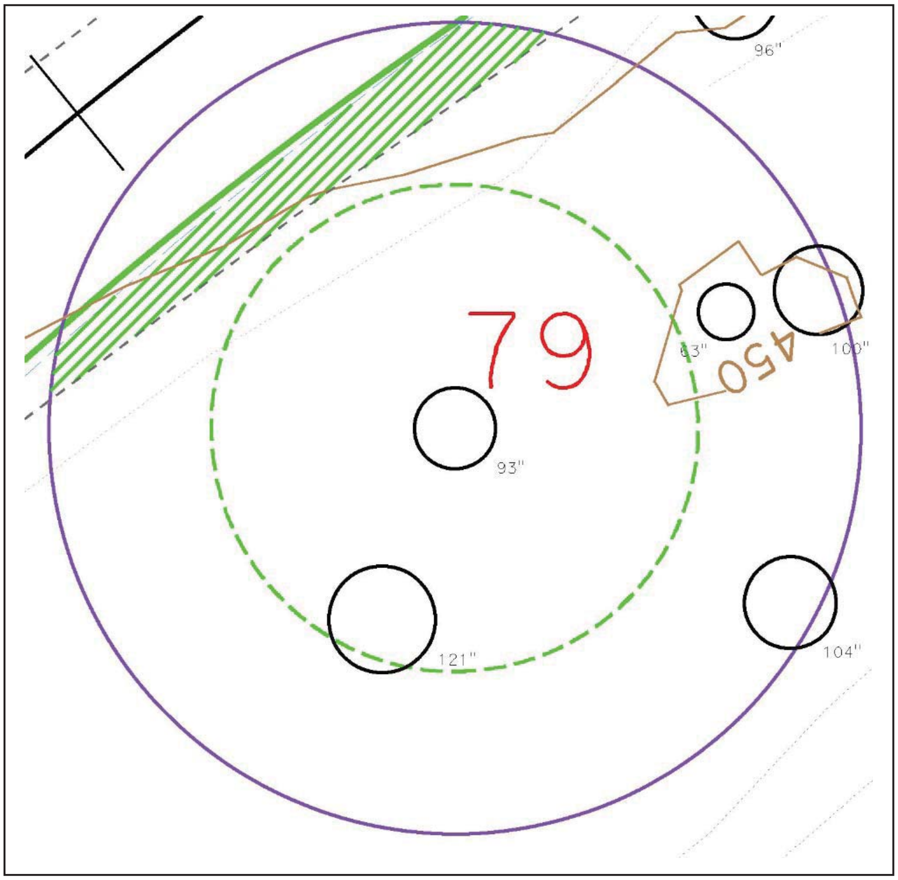


Description: Tree #78, 121 inches DBH (depicted in Attachment A, Sheet 9).

Work in structural root zone? No

Details of Work: The road would be moved up to 6 feet away from the tree. Where pavement would be removed, road materials would be replaced with gravel at the road edge, and native soils and duff beyond. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

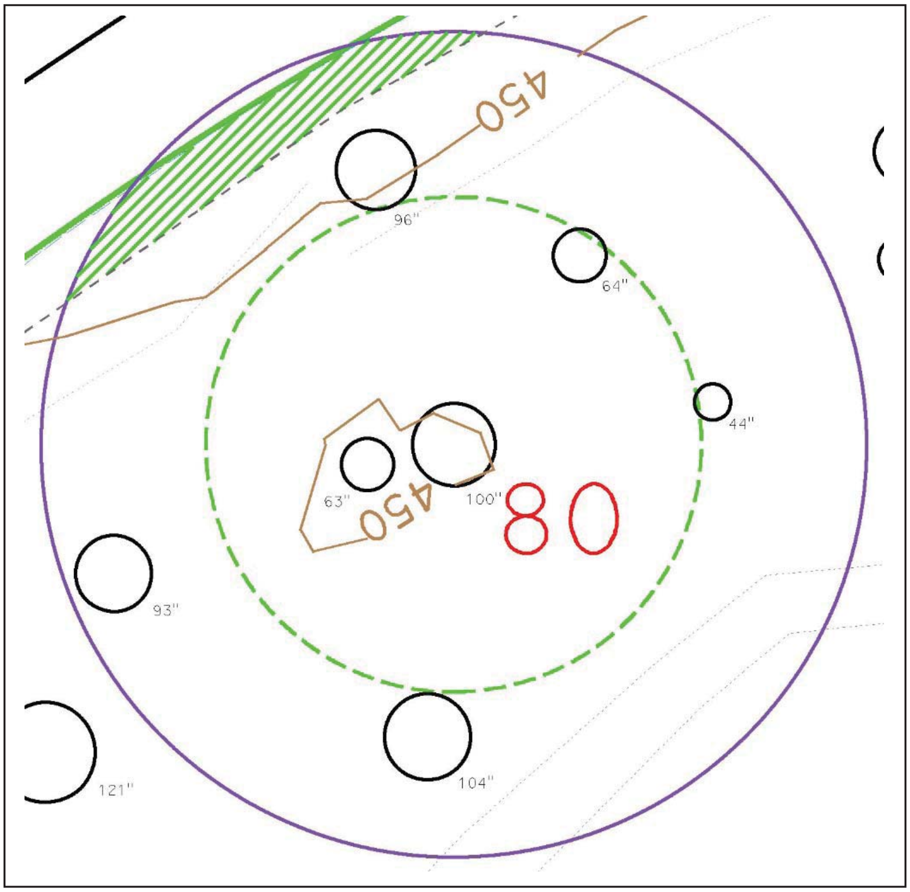


Description: Tree #79, 93 inches DBH (depicted in Attachment A, Sheet 9).

Work in structural root zone? No

Details of Work: The road would be moved approximately 6 feet away from the tree. Where pavement would be removed, road materials would be replaced with gravel at the road edge, and native soils and duff beyond. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

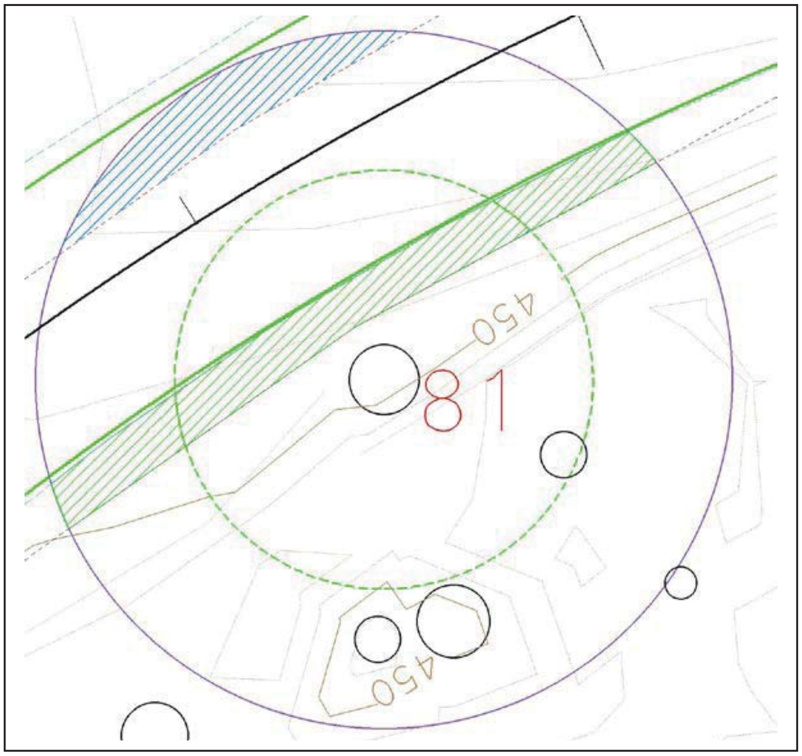


Description: Tree #80, 100 inches DBH (depicted in Attachment A, Sheet 9).

Work in structural root zone? No

Details of Work: The road would be moved approximately 6 feet away from the tree. Where pavement would be removed, road materials would be replaced with gravel at the road edge, and native soils and duff beyond. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

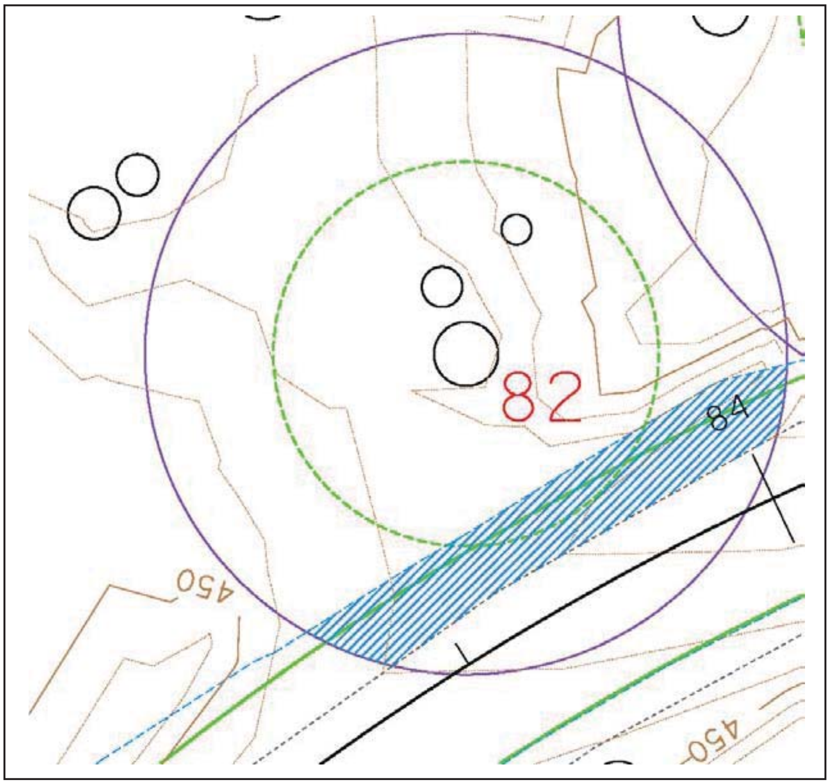


Description: Tree #81, 96 inches DBH (depicted in Attachment A, Sheet 10).

Work in structural root zone? Yes

Details of Work: The road would be moved approximately 5 feet away from the tree; across the road, it would be widened approximately 8 feet, outside of structural root zone. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials; new soils would be placed to construct embankment (average depth 6 to 18 inches). Where pavement would be removed, road materials would be replaced with gravel at the road edge, and native soils and duff beyond. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.



Description: Tree #82, 112 inches DBH (depicted in Attachment A, Sheet 10).

Work in structural root zone? Yes

Details of Work: The road would be widened approximately 8 feet toward the tree. Where road would be widened or realigned, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 18 to 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

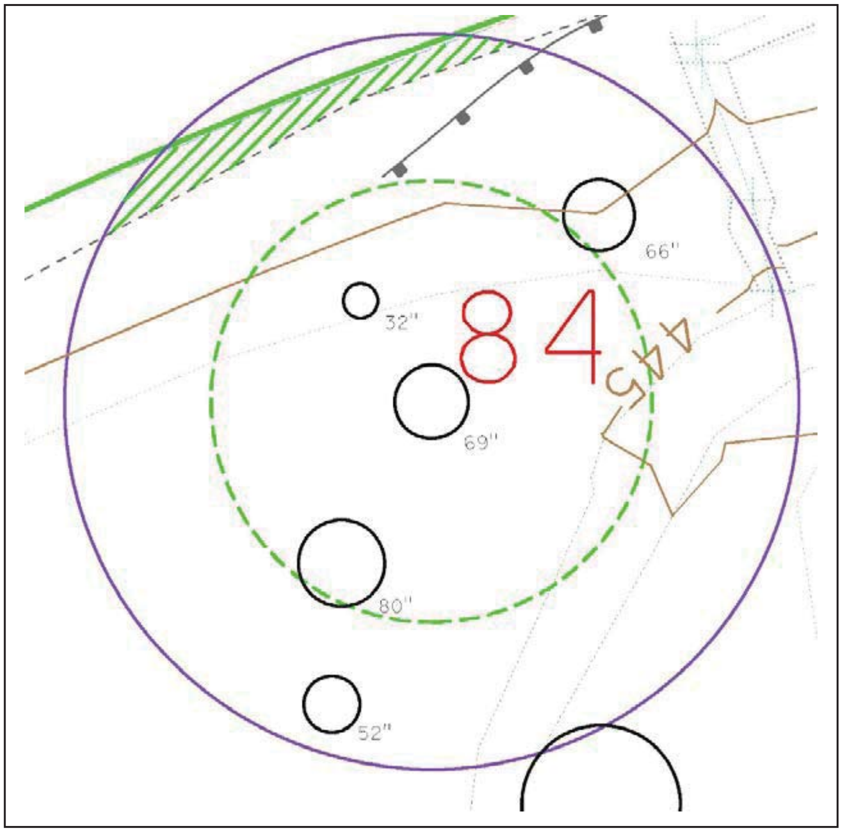
Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

Description: Tree #83, 67 inches DBH (depicted in Attachment A, Sheet 10). Tree is growing in embankment.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 5 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). Metal beam guardrail would be removed and soil would be placed into the post holes. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

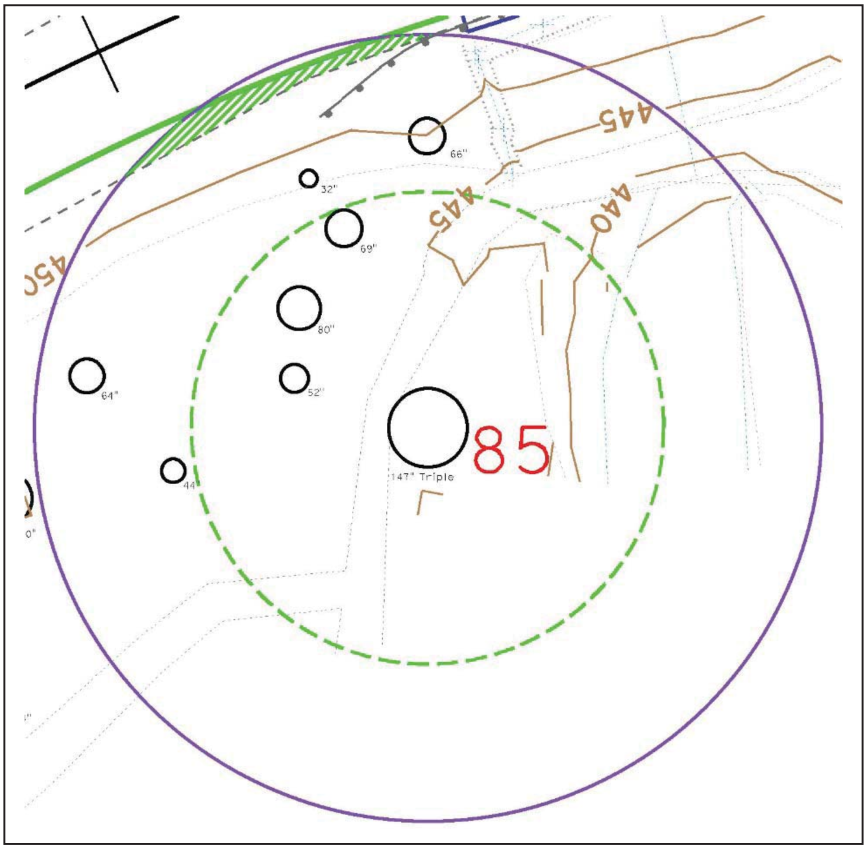


Description: Tree #84, 69 inches DBH (depicted in Attachment A, Sheet 10).

Work in structural root zone? No

Details of Work: The road would be moved up to 2 feet away from the tree. Where pavement would be removed, road materials would be replaced with gravel at the road edge, and native soils and duff beyond. Metal beam guardrail would be removed and soil would be placed into the post holes. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

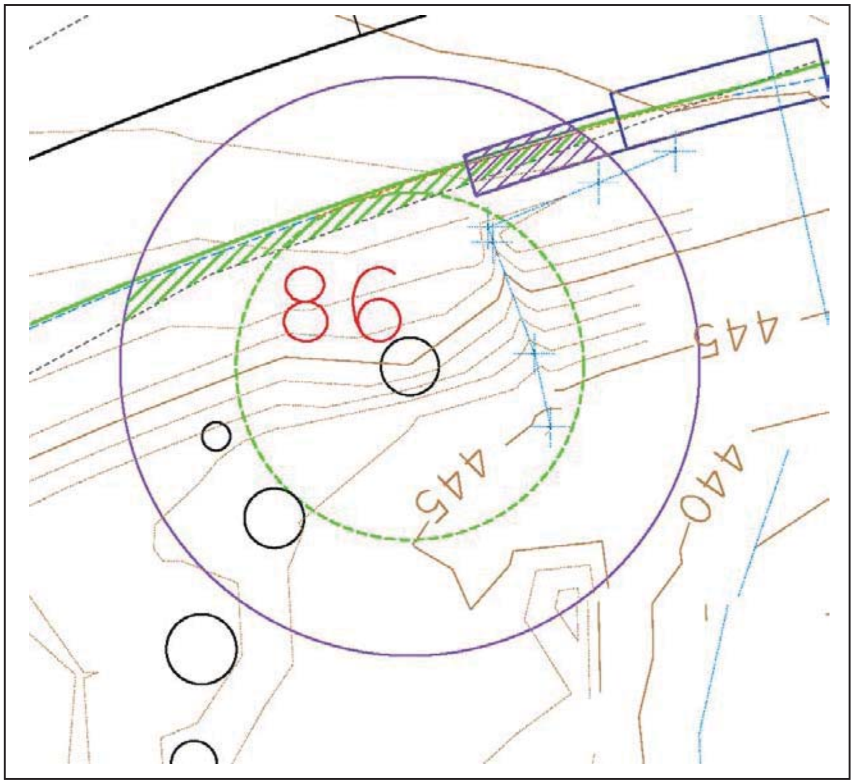


Description: Tree #85, 147 inches DBH (depicted in Attachment A, Sheet 10). Tree has three trunks.

Work in structural root zone? No

Details of Work: The road would be moved up to 3 feet away from the tree. Where pavement would be removed, road materials would be replaced with gravel at the road edge, and native soils and duff beyond. Metal beam guardrail would be removed and soil would be placed in the post holes.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

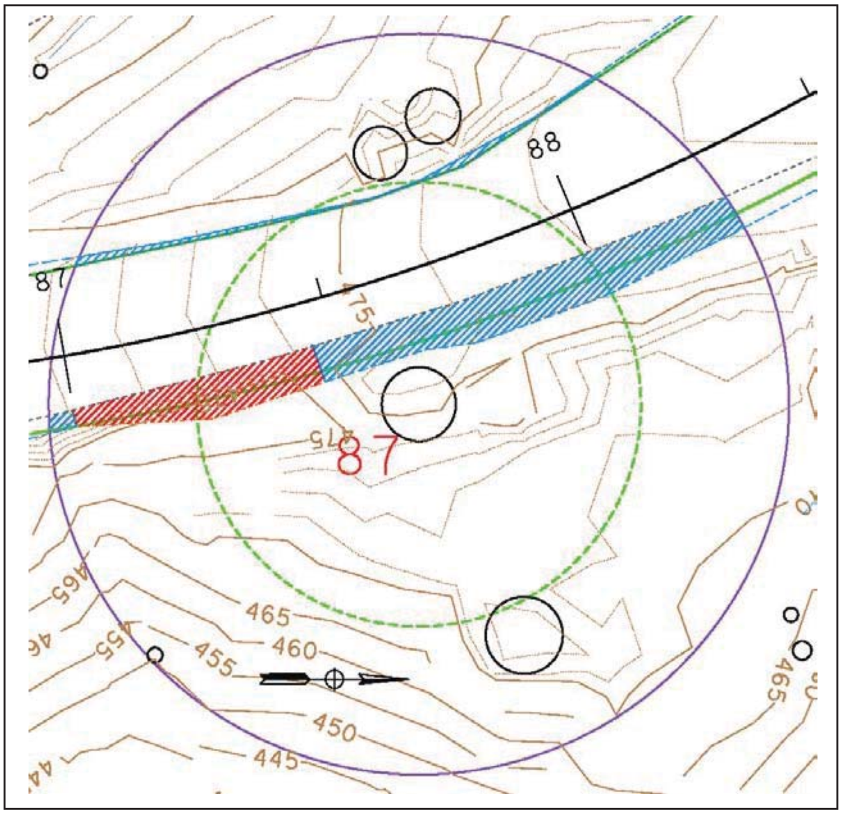


Description: Tree #86, 66 inches DBH (depicted in Attachment A, Sheet 10).

Work in structural root zone? Yes

Details of Work: The road would be moved approximately 2 feet away from the tree. Where pavement would be removed, road materials would be replaced with gravel at the road edge, and native soils and duff beyond. Metal beam guardrail would be removed and soil would be placed in the post holes; outside of structural root zone, a crash cushion would be installed in its place. For the crash cushion, soil will be removed to a depth of 1 foot, a width of 4 feet, and a length of 15 feet. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

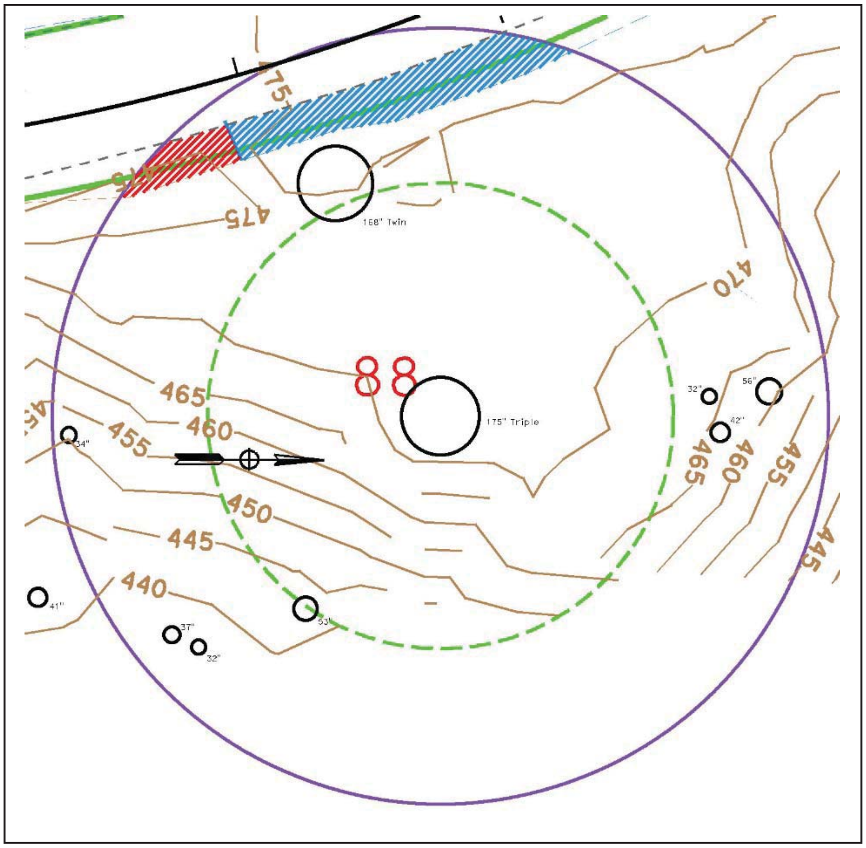


Description: Tree #87, 168 inches DBH (depicted in Attachment A, Sheet 11). Tree has two trunks.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 5 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). Soils would be removed for new roadside cut slopes (average depth 18 to 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.



Description: Tree #88, 175 inches DBH (depicted in Attachment A, Sheet 11). Tree has three trunks.

Work in structural root zone? No

Details of Work: The road would be widened up to 5 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment outside of structural root zone (average depth 6 to 18 inches). Soils would be removed for new roadside cut slopes outside of structural root zone (average depth 18 to 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

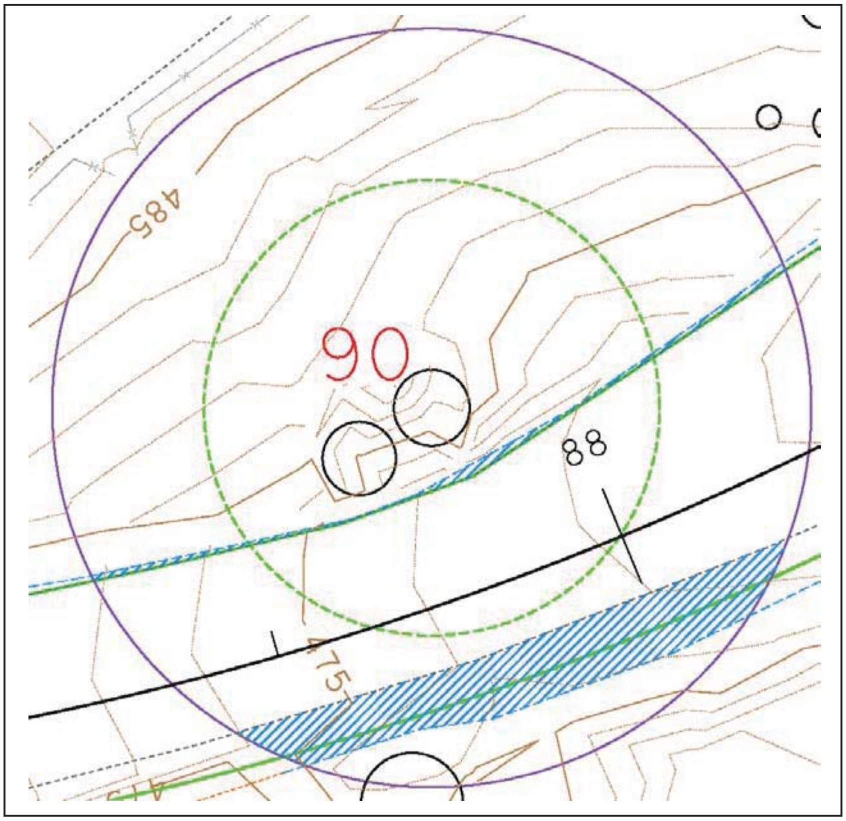
Individual Tree Details

Description: Tree #89, 121 inches DBH (depicted in Attachment A, Sheet 11). Tree and adjacent Tree #90 may have developed from a single base that is now hollowed by a fire cavity. Several large buttress roots facing the road were severed decades ago during highway construction. The uppermost top of tree is dead (“spike” top) but has vigorous crown below.

Work in structural root zone? Yes

Details of Work: The road would be widened across the road from the tree by approximately 5 feet. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). Soils would be removed for new roadside cut slopes outside of structural root zone (average depth 18 to 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

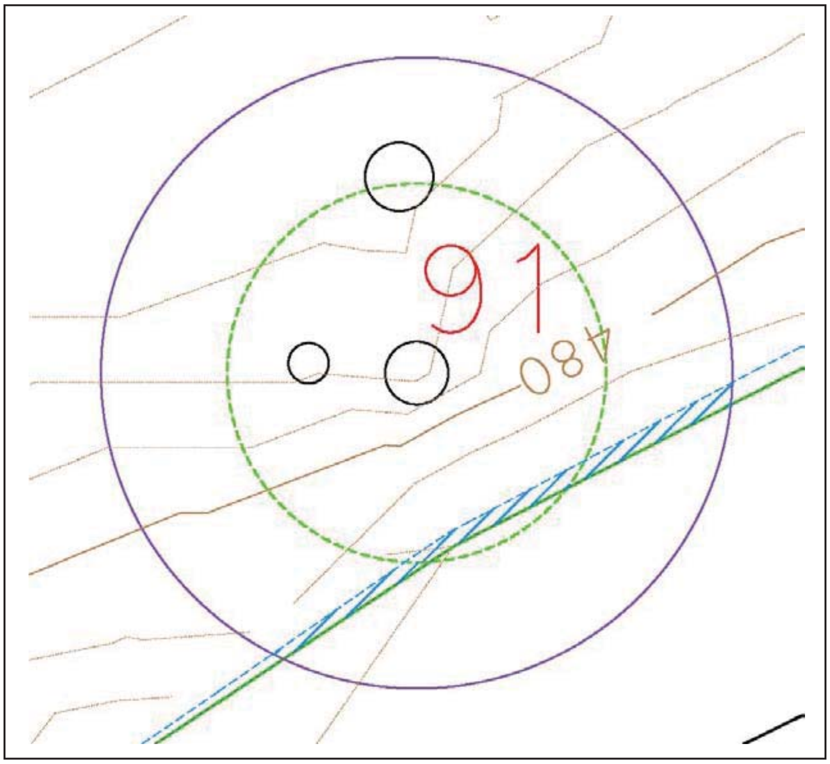


Description: Tree #90, 125 inches DBH (depicted in Attachment A, Sheet 11). Tree has two trunks. This tree and adjacent Tree #89 may have developed from a single base that is now hollowed by a fire cavity. Several large buttress roots facing the road were severed decades ago during highway construction. The tree now has a dead remnant "spike top" but maintains an apparently vigorous crown.

Work in structural root zone? Yes

Details of Work: Across the road from the tree and outside of the structural root zone, the road would be widened up to 5 feet. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches) both within and outside of the structural root zone. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

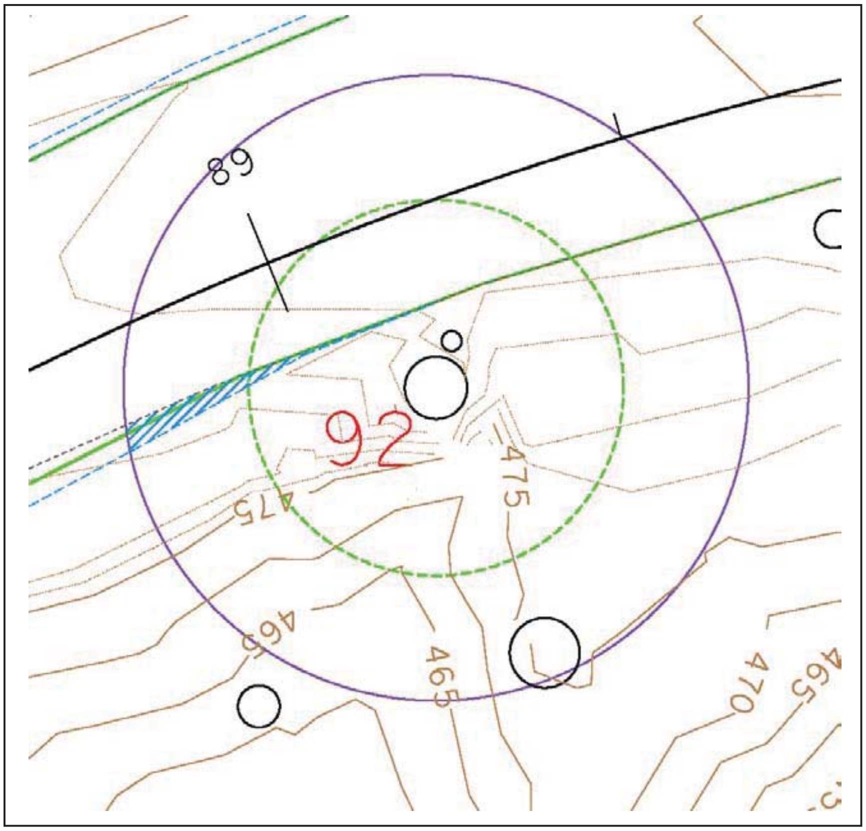


Description: Tree #91, 62 inches DBH (depicted in Attachment A, Sheet 11). Tree is away from roadway.

Work in structural root zone? Yes

Details of Work: New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

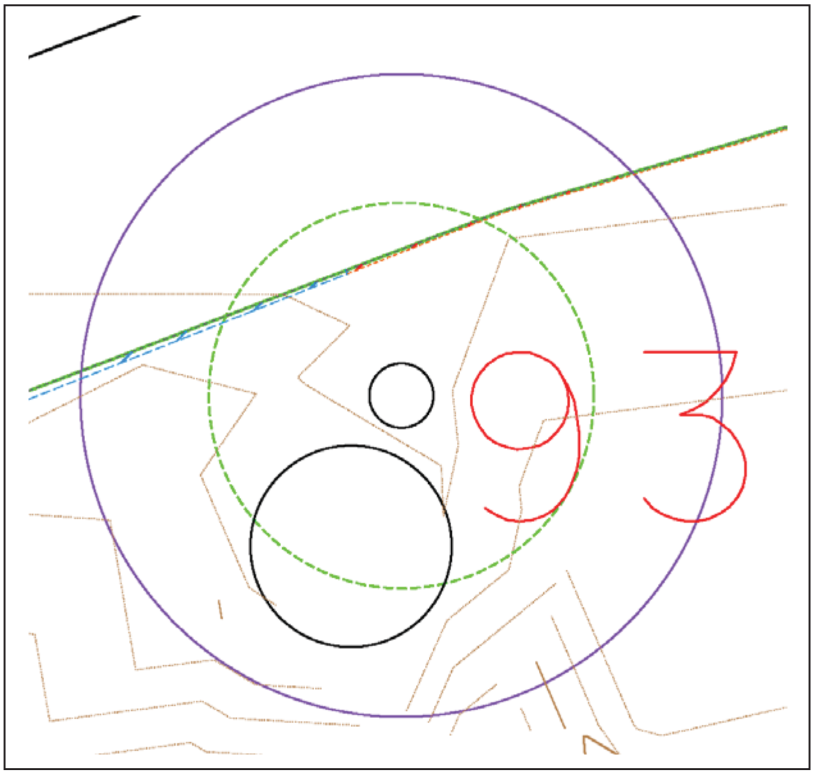


Description: Tree #92, 100 inches DBH (depicted in Attachment A, Sheet 11). Tree has two trunks. A fire scar extends from base of tree up to about 20 feet.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 1 foot toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

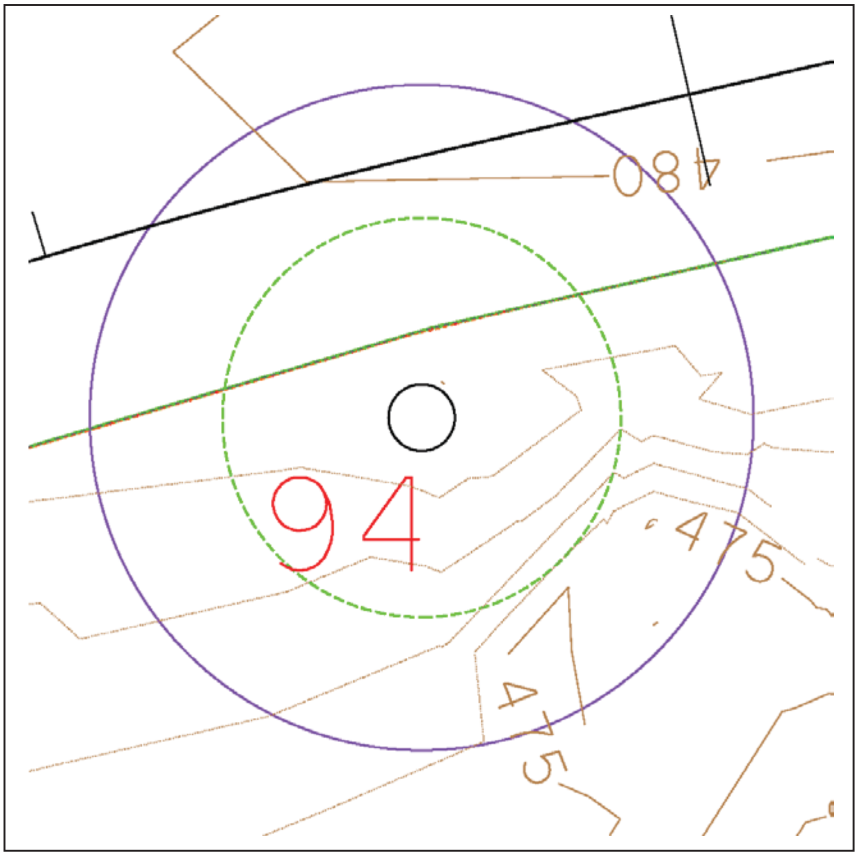


Description: Tree #93, 32 inches DBH (depicted in Attachment A, Sheet 11).

Work in structural root zone? Yes

Details of Work: The road would be widened less than 1 foot toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

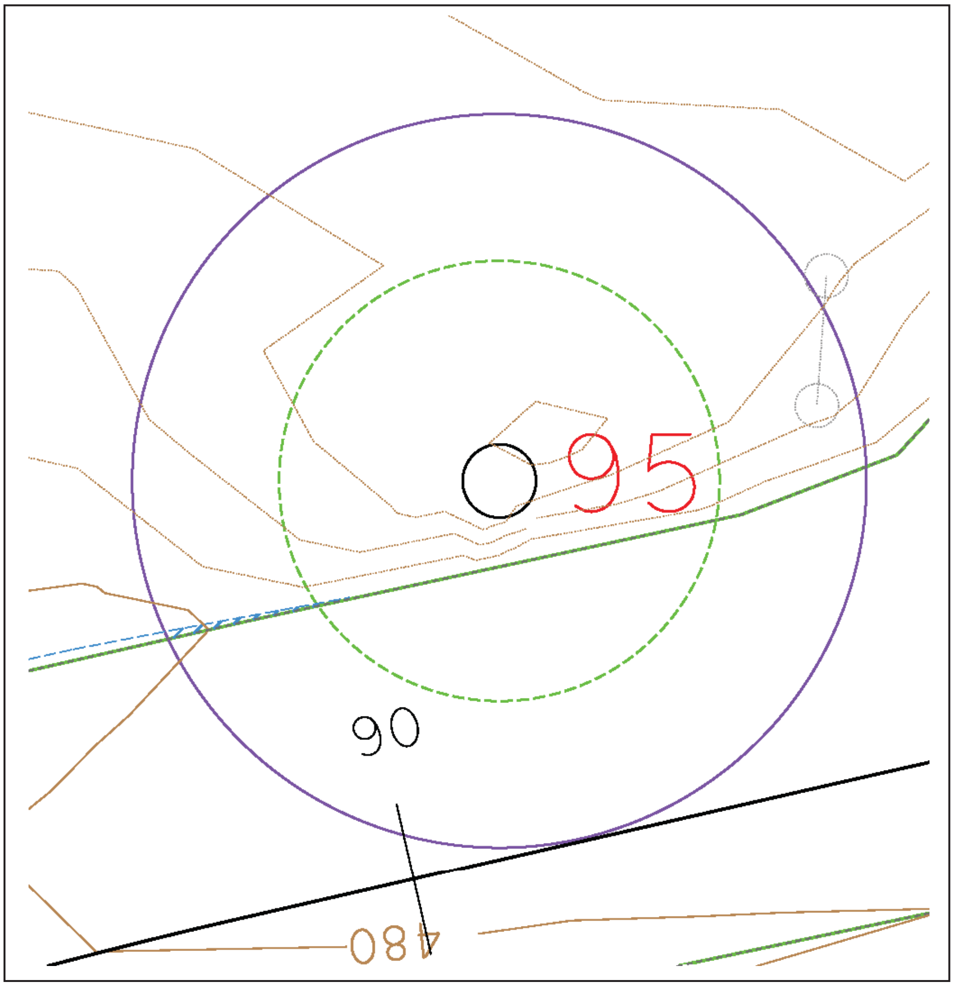


Description: Tree #94, 61 inches DBH (depicted in Attachment A, Sheet 12). Trunk has numerous dead branches on one side; tree may have been suppressed by an adjacent, now-fallen tree.

Work in structural root zone? Yes

Details of Work: The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

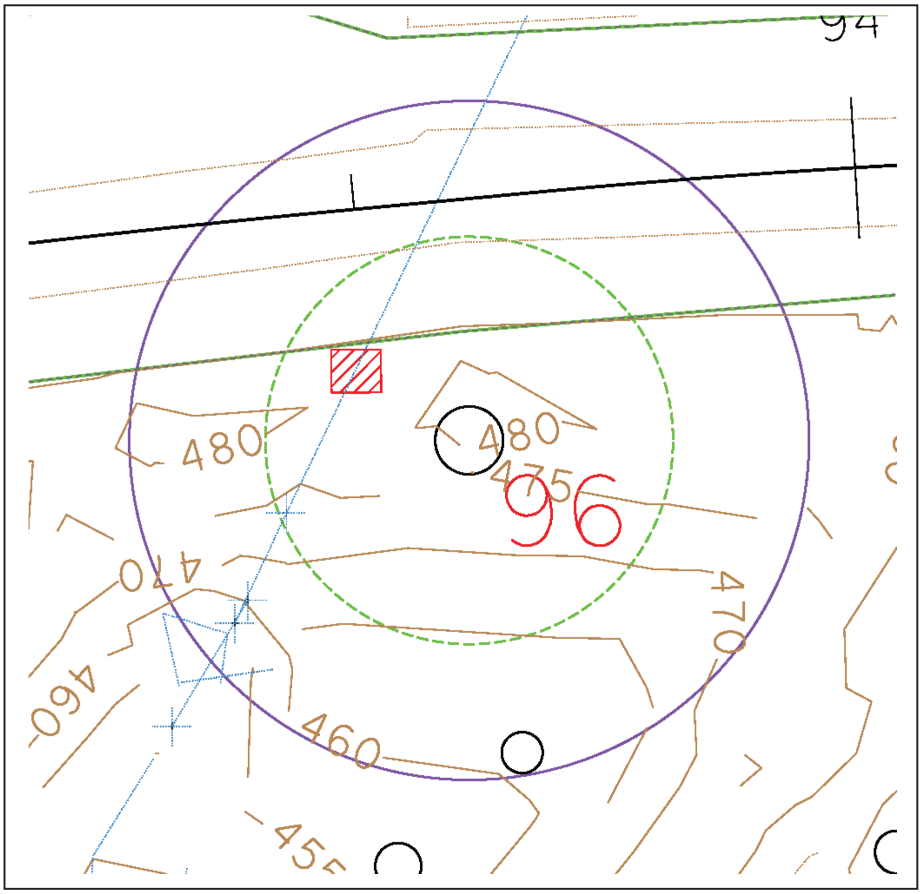


Description: Tree #95, 80 inches DBH (depicted in Attachment A, Sheet 12).

Work in structural root zone? No

Details of Work: New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

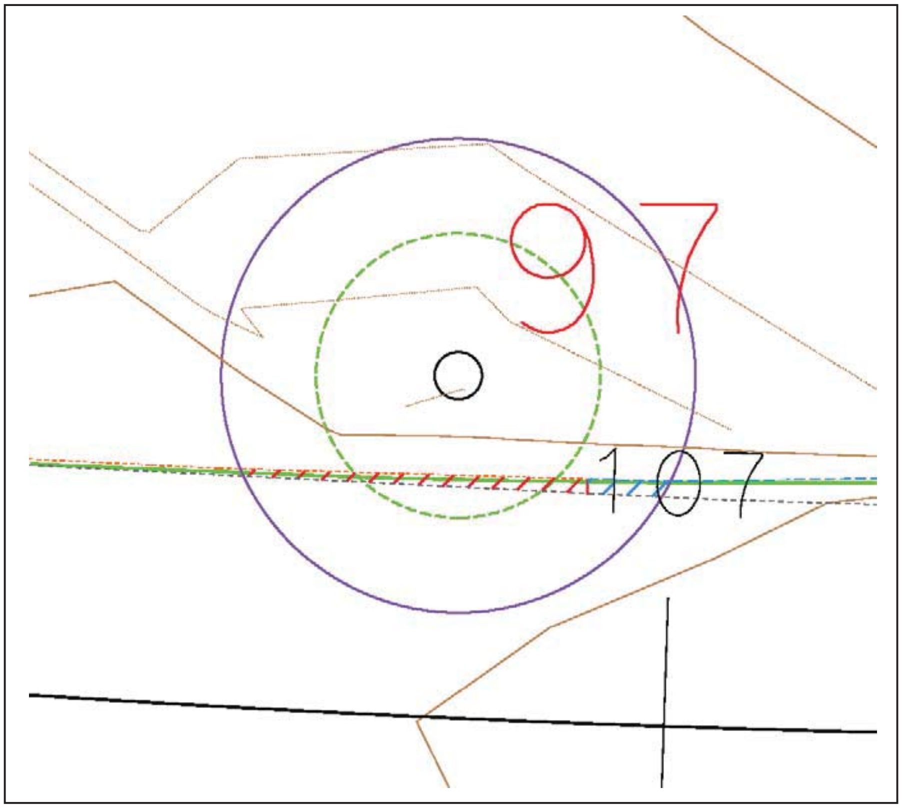


Description: Tree #96, 81 inches DBH (depicted in Attachment A, Sheet 13).

Work in structural root zone? Yes

Details of Work: A 6-foot by 6-foot hole would be dug to install a new drain inlet at the road edge, connecting to an existing culvert. An apron of pavement approximately 4 feet wide would be added between the drain inlet and the roadway to direct water to the inlet.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

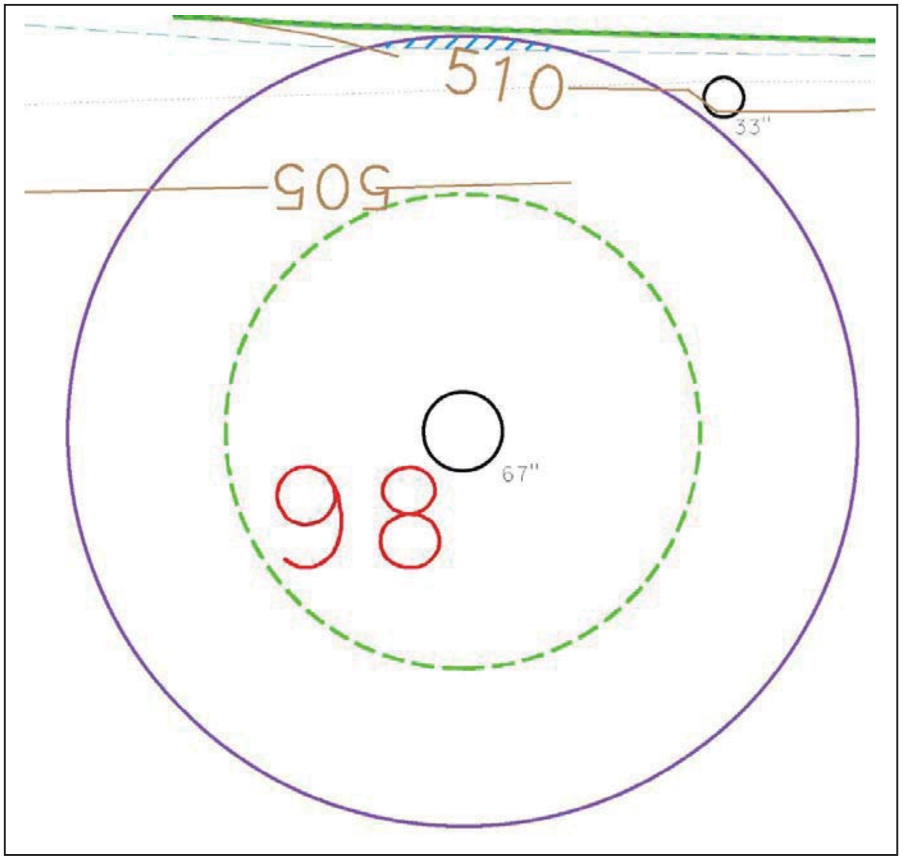


Description: Tree #97, 32 inches DBH (depicted in Attachment A, Sheet 18). Tree has a cavity at the base, on side opposite road.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 1 foot toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

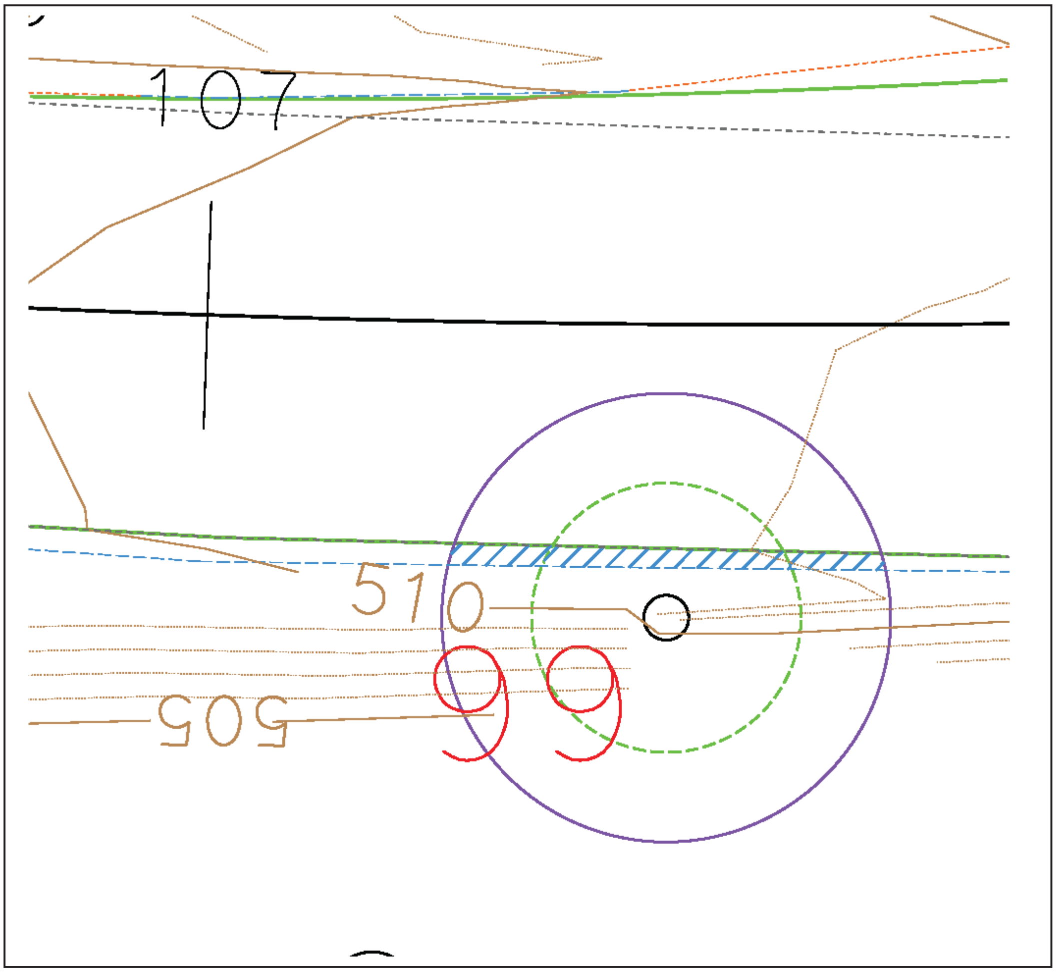


Description: Tree #98, 67 inches DBH (depicted in Attachment A, Sheet 18).

Work in structural root zone? No

Details of Work: New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.



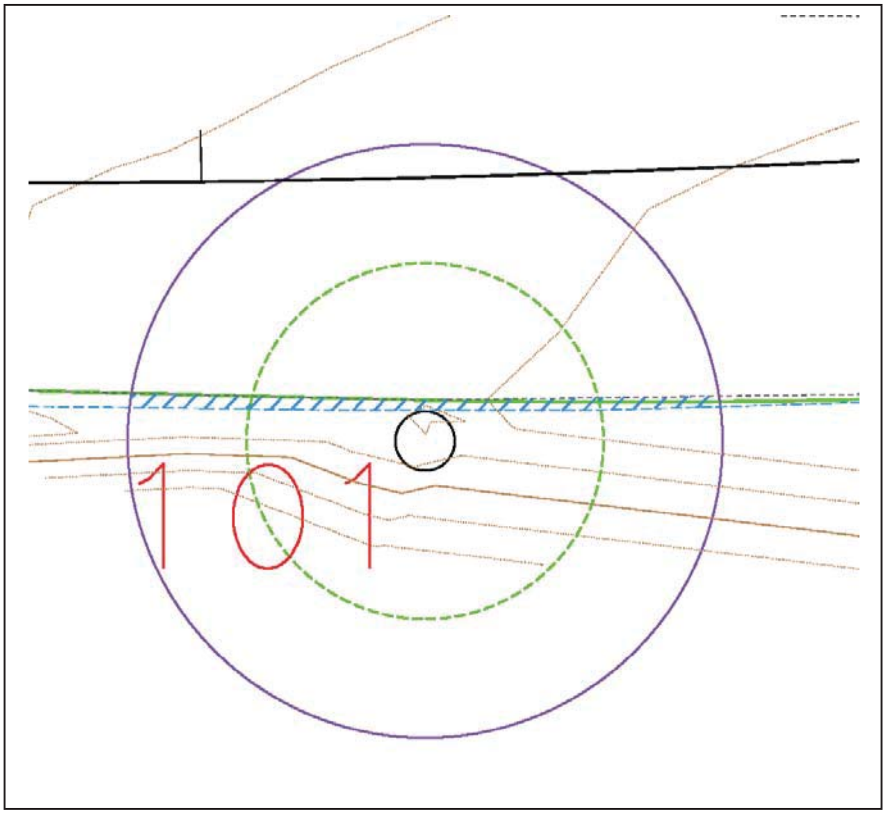
Description: Tree #99, 33 inches DBH (depicted in Attachment A, Sheet 18).

Work in structural root zone? Yes

Details of Work: New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

#100 Eliminated. Previously mapped; project work not within root health zone.

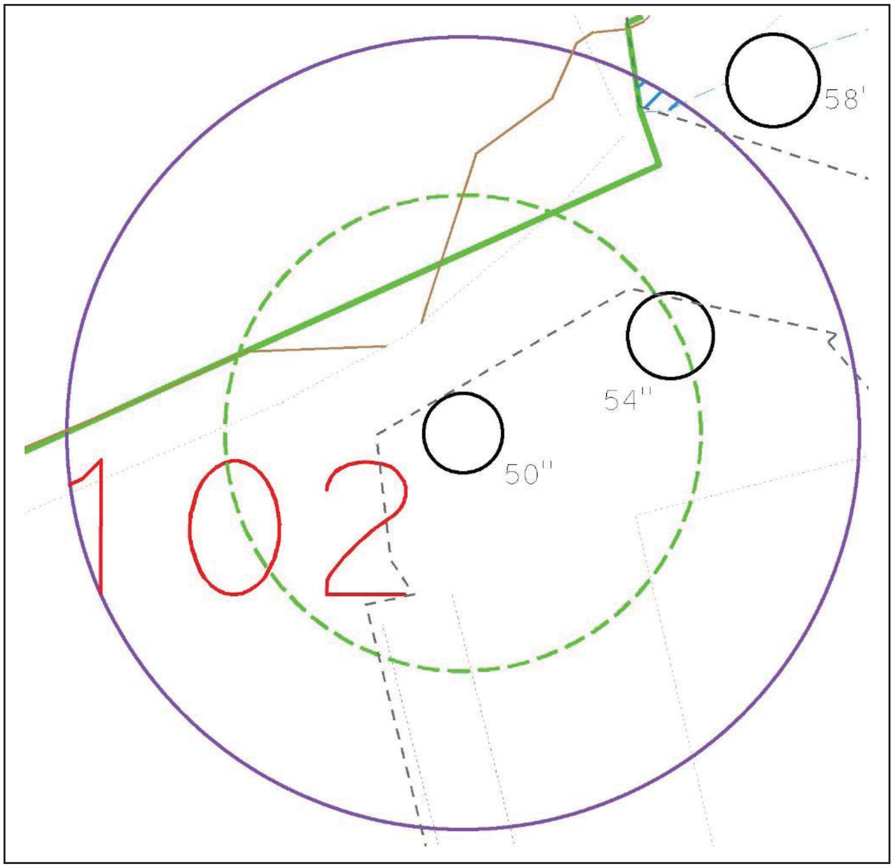


Description: Tree #101, 48 inches DBH (depicted in Attachment A, Sheet 18).

Work in structural root zone? Yes

Details of Work: New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

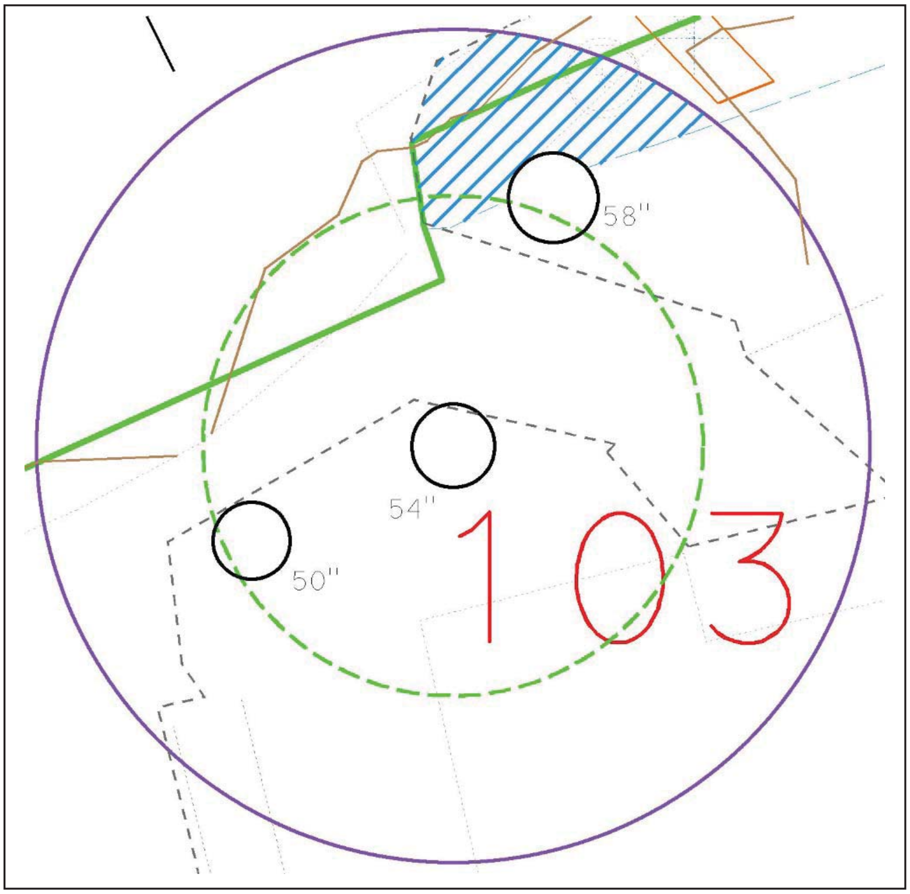


Description: Tree #102, 50 inches DBH (depicted in Attachment A, Sheet 19). This tree is adjacent to Tree #103, away from the road.

Work in structural root zone? No

Details of Work: New soils would be placed to construct embankment (average depth 0 to 6 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

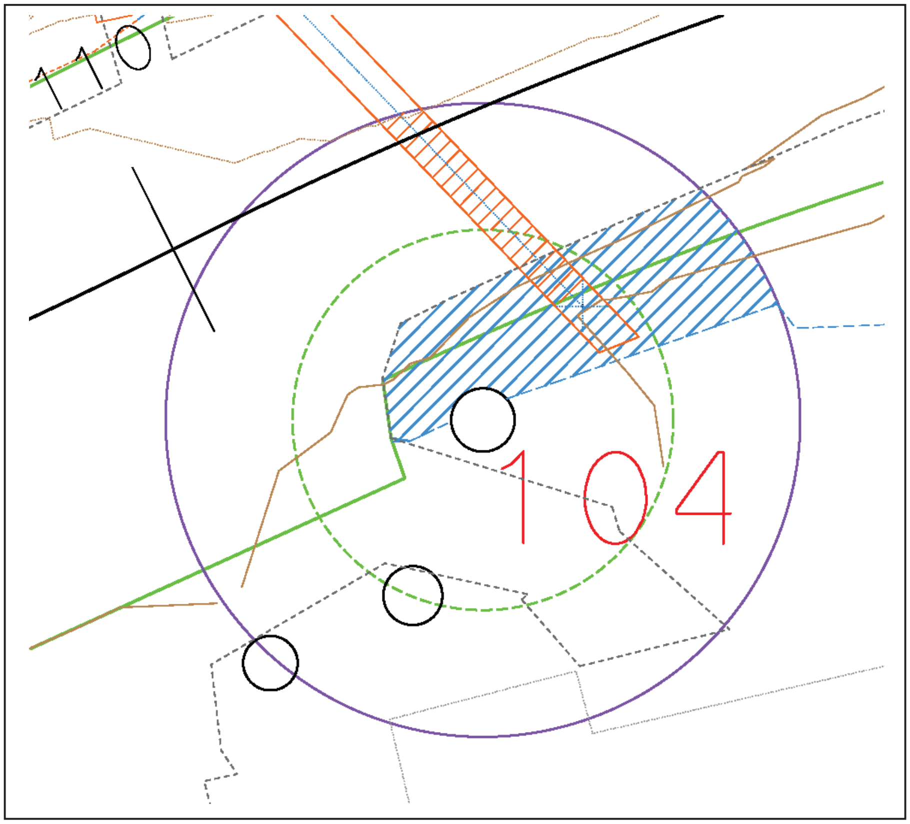


Description: Tree #103, 54 inches DBH (depicted in Attachment A, Sheet 19). Tree is growing in an island of soil in front of a building.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 4 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials outside of structural root zone. New soils would be placed to construct embankment (average depth 18 to 36 inches) both within and outside of structural root zone. Soils would be removed (average depth 18 to 36 inches) outside of structural root zone to construct a gabion wall.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

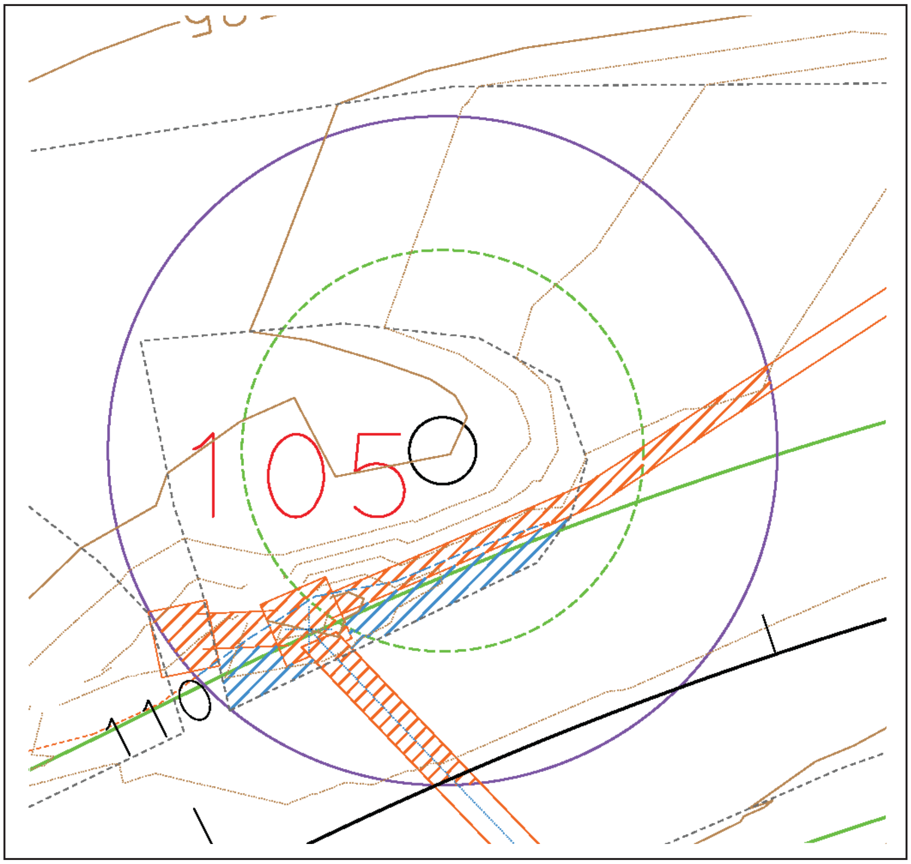


Description: Tree #104, 58 inches DBH (depicted in Attachment A, Sheet 19).

Work in structural root zone? Yes

Details of Work: The road would be widened approximately 4 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new. New soils would be placed to construct embankment (average depth 18 to 36 inches). Soils would be removed (average depth greater than 36 inches) to construct a gabion wall, which can be shaped to conform to the profile elevation of the tree. A 24-inch culvert would be replaced with a 24-inch culvert. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.

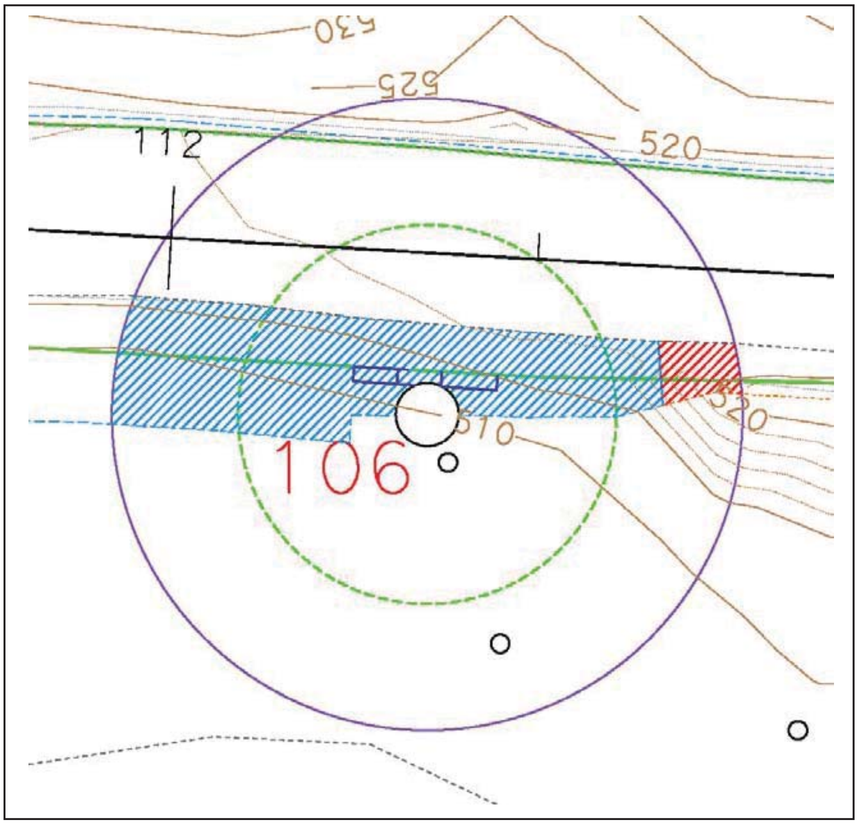


Description: Tree #105, 68 inches DBH (depicted in Attachment A, Sheet 19). Tree is growing outside of the state park on a raised mound of earth that is adjacent to private and public roadways. The buttress flare does not appear to be severed or buried and the crown appears healthy.

Work in structural root zone? Yes

Details of Work: The road would be widened up to 3 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 18 to 36 inches). Soils would be removed for new roadside cut slopes (average depth 0 to 6 inches). A 24-inch culvert would be replaced with a 24-inch culvert and extended, and two new inlets constructed. A new 12-inch slotted drain would be installed. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.



Description: Tree #106, 103 inches DBH (depicted in Attachment A, Sheet 19).Tree has two trunks. It is established at roadway height at least 10 feet above downslope buttress flare.

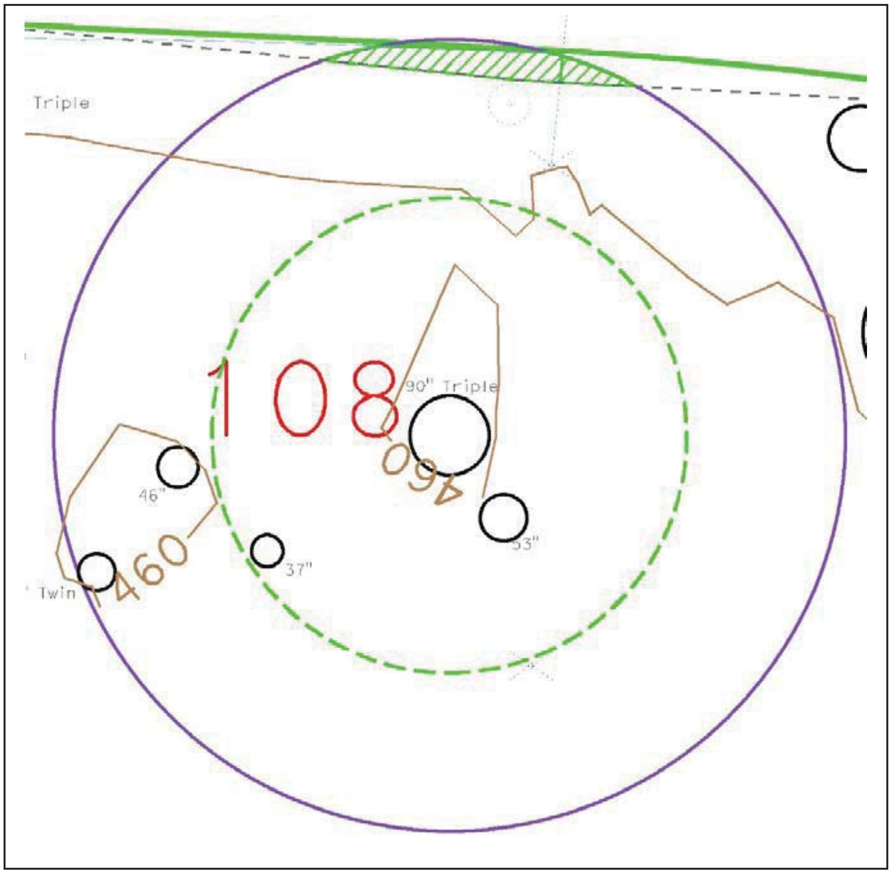
Work in structural root zone? Yes

Details of Work: The road would be widened up to 7 feet toward the tree; across the road, it would be widened approximately 2 feet. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 18 to 36 inches). Soils would be removed (average depth greater than 36 inches) to construct a gabion wall. A 30-inch diameter hole would be dug within 8 feet of the tree to construct a soldier pile wall. Soils would be removed for new roadside cut slopes (average depth greater than 36 inches). The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance may be a short-term visible reduction in foliage density that is still well within the adaptive capabilities of the tree.

#107 Eliminated. Previously mapped; project work not within root health zone.

Description: Tree #107, 73 inches DBH (depicted in Attachment A, Sheet 4). Tree has two trunks.

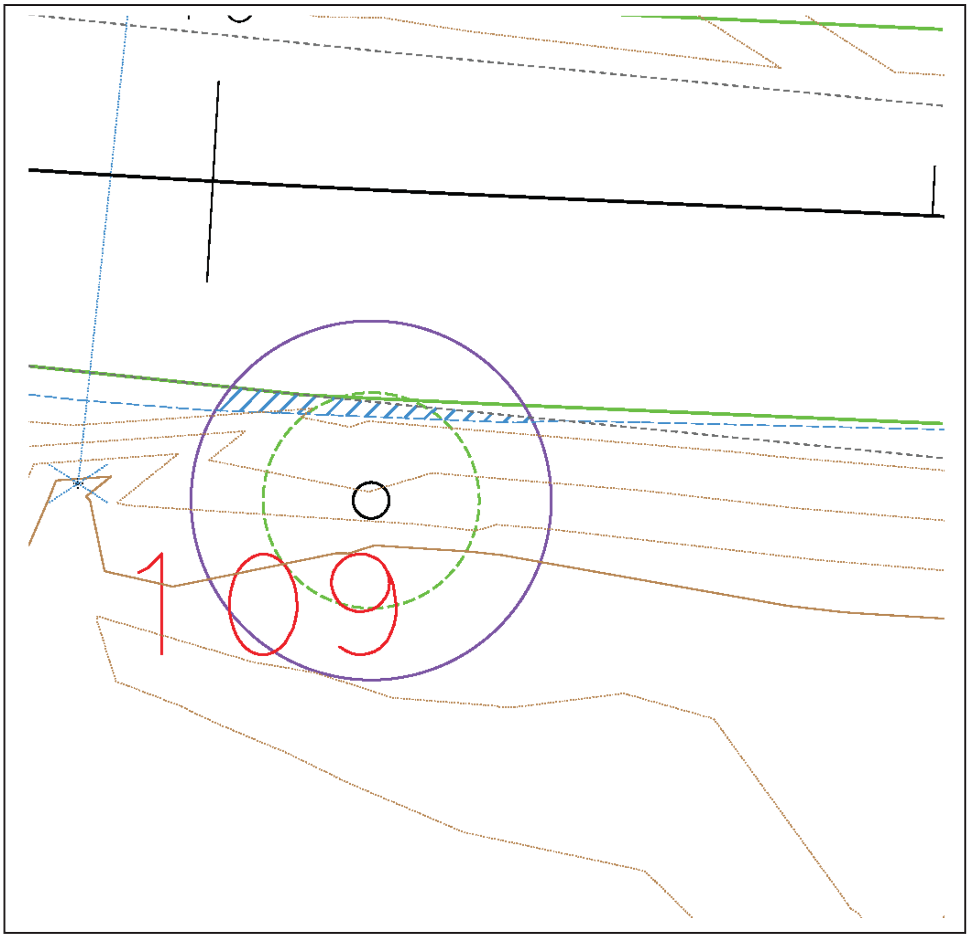


Description: Tree #108, 90 inches DBH (depicted in Attachment A, Sheet 5). Tree has three trunks.

Work in structural root zone? No

Details of Work: The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Root zone disturbance would have no effect on tree health.



Description: Tree #109, 30 inches DBH (depicted in Attachment A, Sheet 5). Tree has three trunks.

Work in structural root zone? Yes

Details of Work: New soils would be placed to construct embankment (average depth 6 to 18 inches). The top layer of roadway would be ground off and replaced with new asphalt.

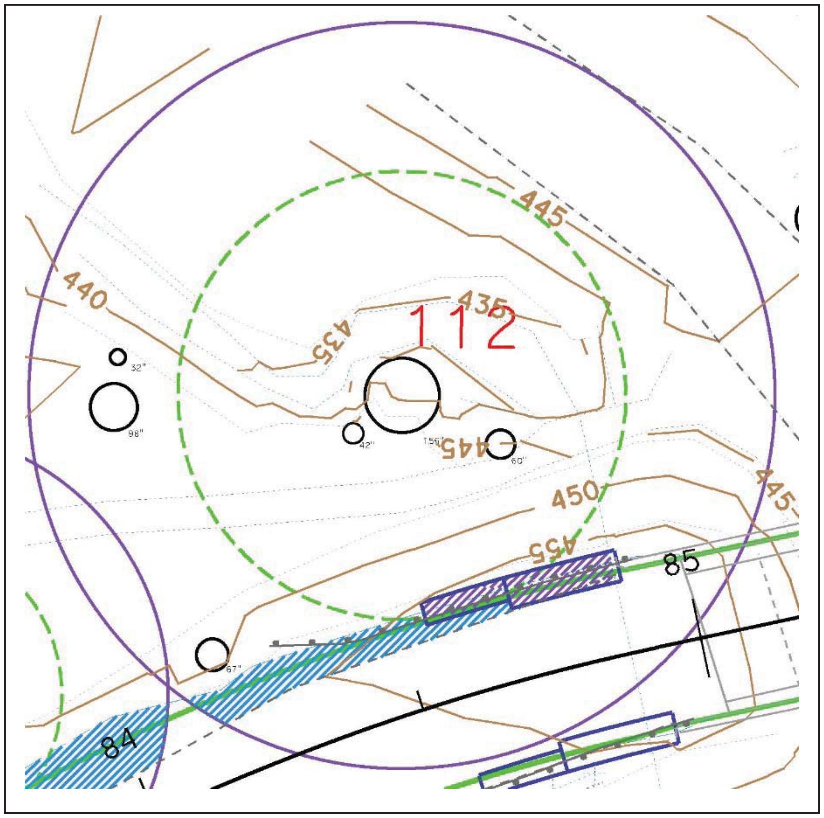
Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

#110 Eliminated. Previously mapped; project work not within root health zone.

Description: Tree #110**,** 135 inches DBH (depicted in Attachment A, Sheet 7).

#111 Eliminated. Previously mapped; project work not within root health zone.

Description: Tree #111**,** 89 inches DBH (depicted in Attachment A, Sheet 8).



Description: Tree #112, 156 inches DBH (depicted in Attachment A, Sheet 10). Tree is growing in the bank of Durphy Creek; some exposed roots are scoured by soil and rock movement on the creek side.

Work in structural root zone? Yes

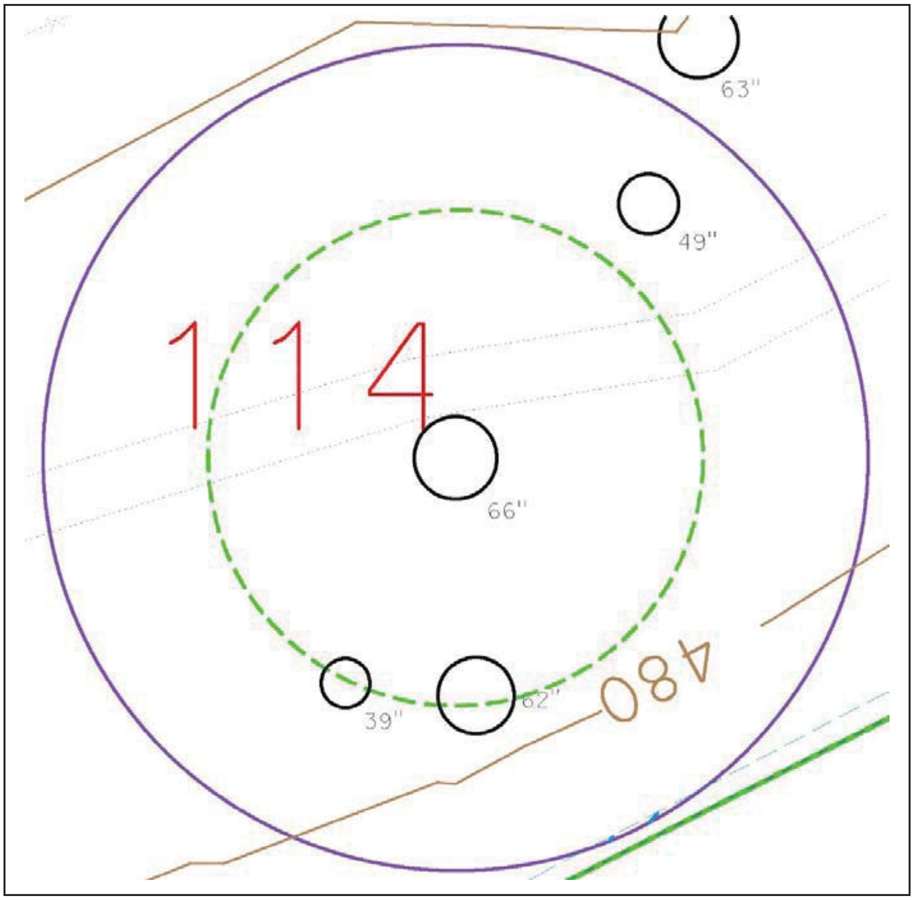
Details of Work: The road would be widened approximately 4 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth 6 to 18 inches). Metal beam guardrail would be removed and soil would be placed in the post holes; a transition barrier and crash cushion would be installed in its place. For the transition barrier, soil would be removed to a depth of 4 feet, a width of 5.5 feet, and a length of 20 feet. For the crash cushion, soil will be removed to a depth of 1 foot, a width of 4 feet, and a length of 15 feet. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is slight and there would be no decline in foliage density or tree health.

#113 Eliminated. Previously mapped; project work not within root health zone.

Description: Tree #113, 112 inches DBH (depicted in Attachment A, Sheet 11).

Individual Tree Details



Description: Tree #114, 66 inches DBH (depicted in Attachment A, Sheet 11). Tree is well off roadway.

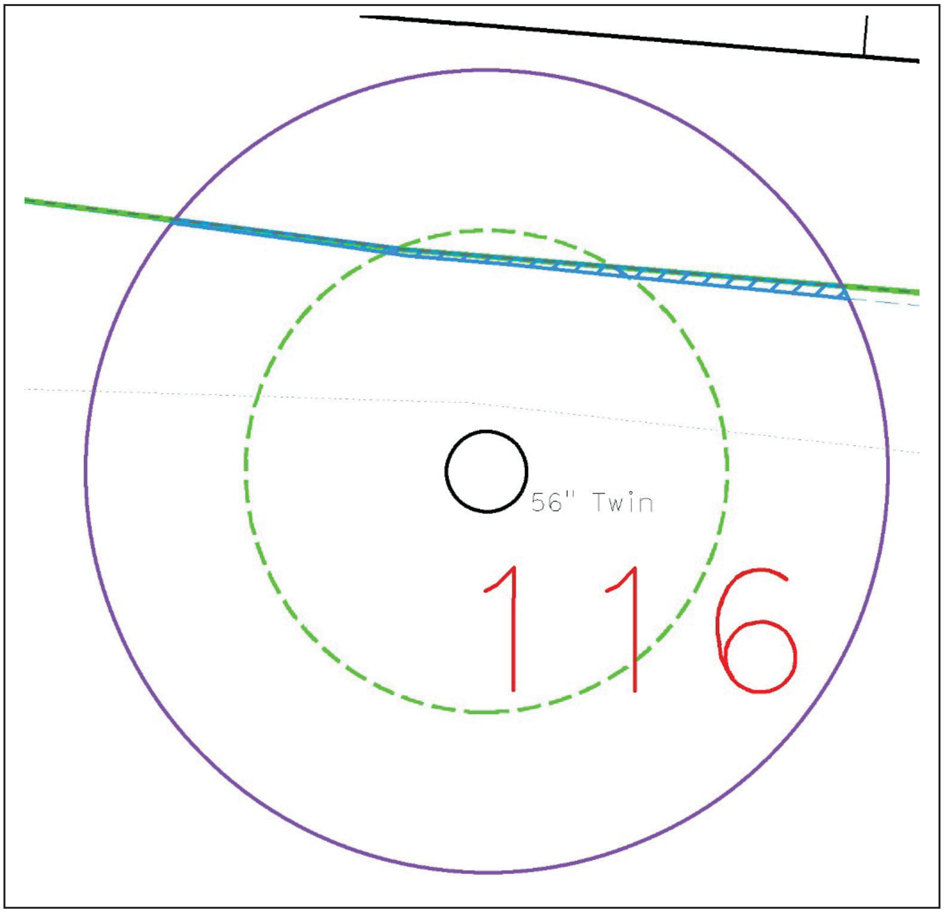
Work in structural root zone? No

Details of Work: New soils would be placed to construct embankment (average depth 0 to 6 inches).

Evaluation: Root zone disturbance would have no effect on tree health.

#115 Eliminated. Previously mapped; project work not within root health zone.

Description: Tree #115, 42 inches DBH (depicted in Attachment A, Sheet 17).Tree appears to have been struck by a vehicle.

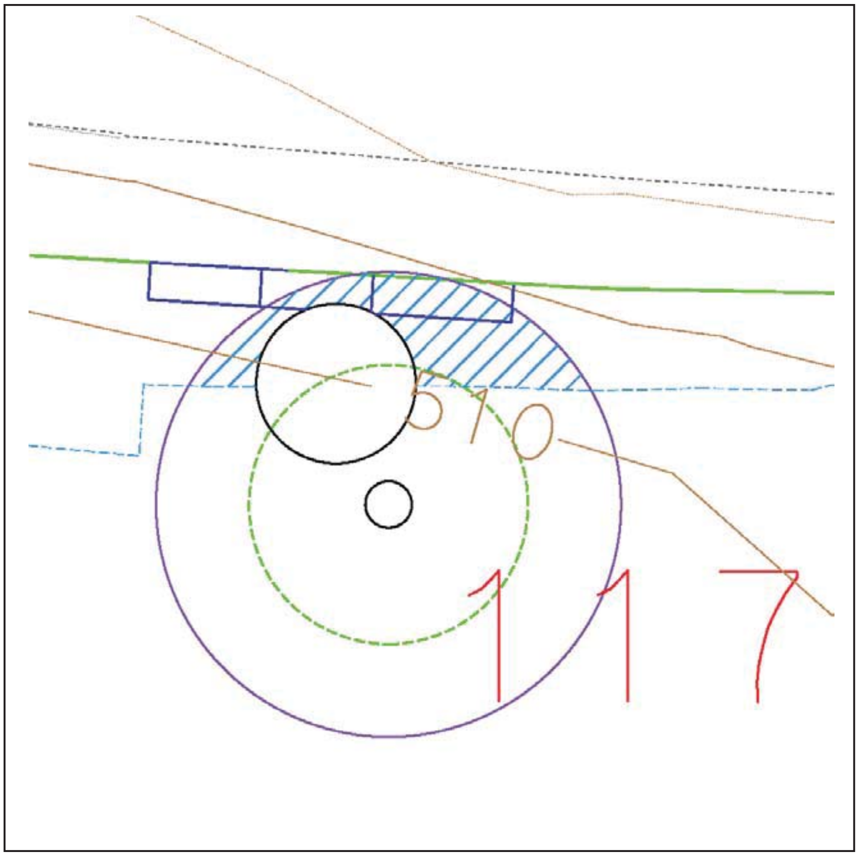


Description: Tree #116, 56 inches DBH (depicted in Attachment A, Sheet 17). Tree has two trunks.

Work in structural root zone? Yes

Details of Work: New soils would be placed to construct embankment (average depth less than 6 inches). Pavement layers of entire roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

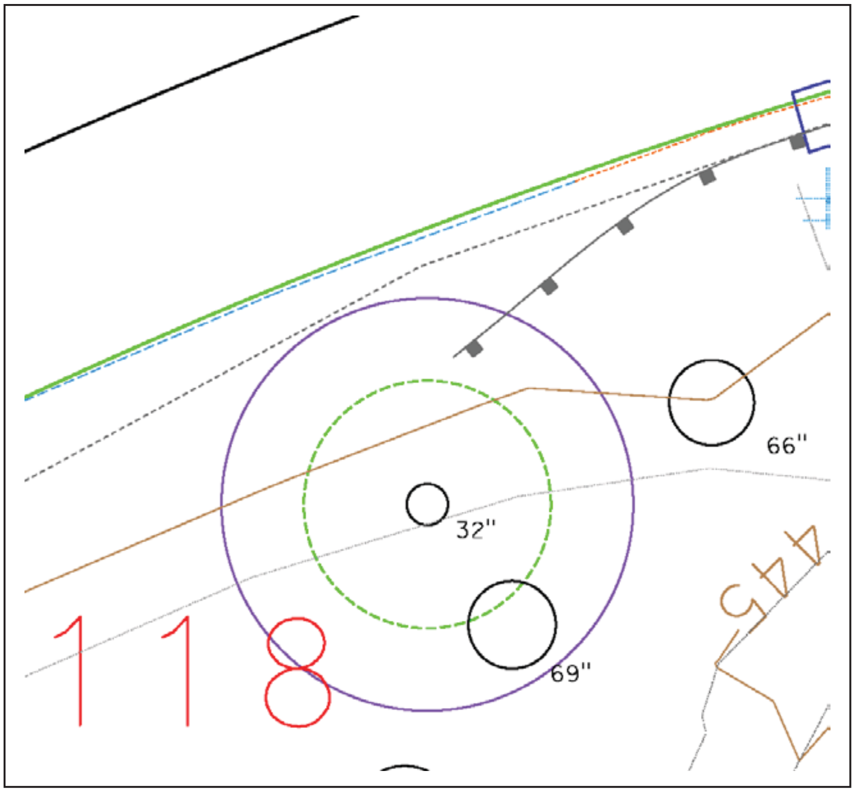


Description: Tree #117, 30 inches DBH (depicted in Attachment A, Sheet 19). Trunk of tree is partially buried against bank.

Work in structural root zone? Yes

Details of Work: The road would be widened approximately 7 feet toward the tree. Where road would be widened, soil and old road materials would be dug out and replaced with new road materials. New soils would be placed to construct embankment (average depth greater than 36 inches). Soils would be removed (average depth greater than 36 inches) to construct a gabion wall. The top layer of roadway would be ground off and replaced with new asphalt.

Evaluation: Effect of root zone disturbance is very slight and there would be no decline in foliage density or tree health.

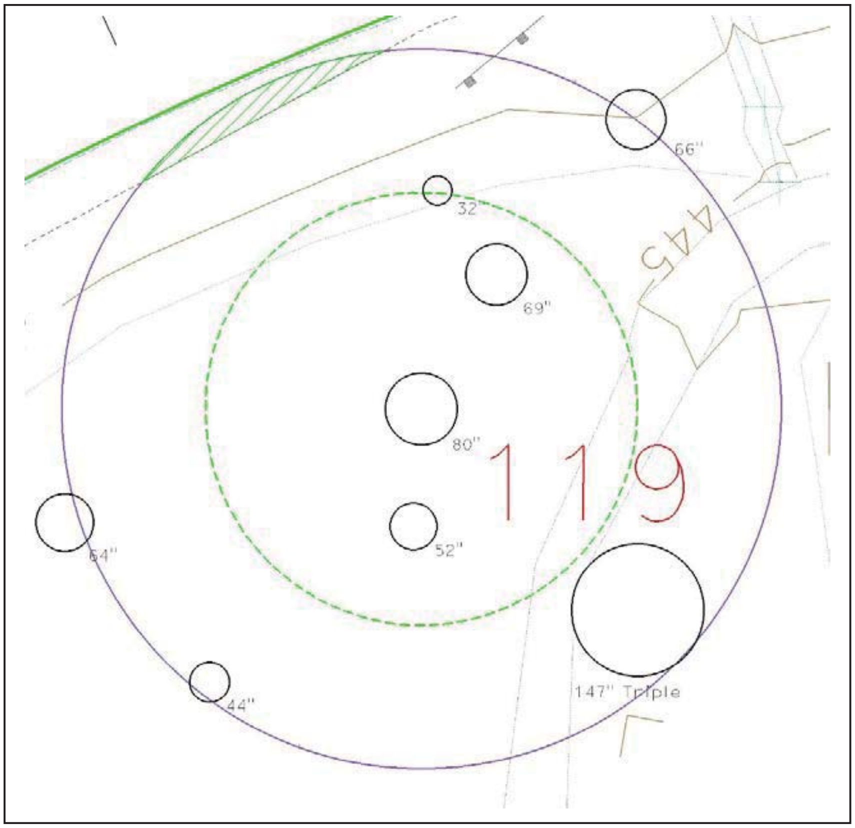


Description: Tree #118, 32 inches DBH (depicted in Attachment A, Sheet 10).

Work in structural root zone? No

Details of Work: Metal beam guardrail would be removed and soil would be placed in the post holes.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.

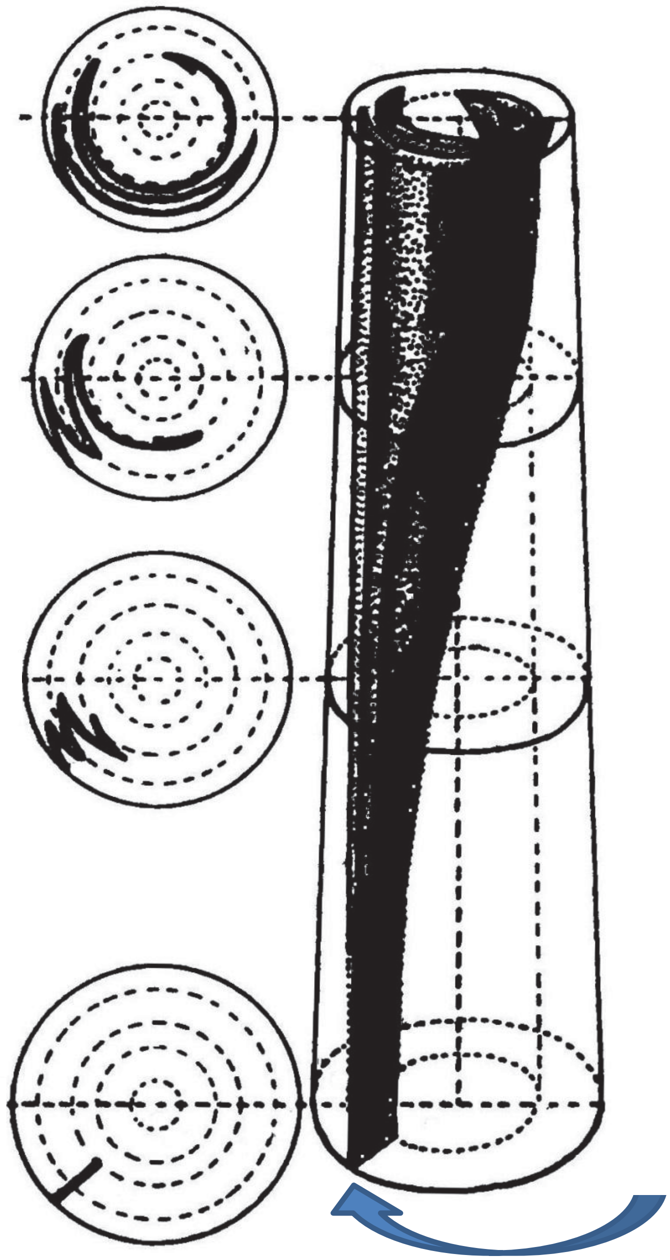


Description: Tree #119, 80 inches DBH (depicted in Attachment A, Sheet 10).

Work in structural root zone? No

Details of Work: Where pavement would be removed, road materials would be replaced with gravel at the road edge, and native soils and duff beyond. Metal beam guardrail would be removed and soil would be placed into the post holes.

Evaluation: Effect of root zone disturbance is extremely minor and there would be no decline in foliage density or tree health.



INTERLOCKED SAP ASCENT IN COAST REDWOODS

Coast redwoods *(Sequoia sempervirens)* are extraordinarily efficient in their ability to lift water from individual roots to locations throughout the tree's canopy. The pattern of upward water movement shown here, called "interlocked ascent," indicates that a root in one location will lift water in a zigzag pattern that extends around the trunk as it rises. Therefore, if a root is cut in one location at the tree's base, there will *not* be corresponding dieback in the tree directly above the severed root—other roots will still supply water to the entire canopy.

The illustration shows how tracheidal (sap) channels transported the dye that was administered by trunk injection in an experiment to investigate patterns of sap ascent. The numbers indicate the height in centimeters of the transverse (cross) sections (approximately 3, 5, and 7 feet) above the injection site. Illustration adapted from Rudinsky, J. A., and J. P. Vité. 1959. Certain Ecological and Phylogenetic Aspects of the Pattern of Water Conduction in Conifers. *Forest Science* 5(3):259–266.