Certified Arborist and Registered Professional Forester

FORESTER/ARBORIST REPORT

"Ruby 1" and "Ruby 2", "Patrick Creek Narrows 2", and "Washington Curve"

Project Title:

197/199 Safe STAA Access

SR 197 and US 199 in Del Norte County
Ruby 1, 01-DN-197-PM 4.5; Ruby 2, 01-DN-197-PM 3.2-4.0;
Patrick Creek Narrows, 01-DN-199-PM 20.5-20.9, PM 23.92-24.08, & PM 25.55-25.65;
The Narrows, 01-DN-199-PM 22.7-23.0; Washington Curve, 01-DN-199-PM 26.3-26.5
EA: 01-48110, 01-45490, 01-45000, 01-47940, 01-44830

July 2012

Caltrans
CALIFORNIA DEPARTMENT OF TRANSPORTATION

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July 2012

STATE OF CALIFORNIA
Department of Transportation

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1. Introduction

Caltrans is in the planning process for road widening and bridge improvements for 7 locations, known collectively as the “197/199 Safe STAA Access Project.” Based on the Draft Environmental Impact Report/Environmental Assessment (DEIR/EA) (Caltrans 2010) and Caltrans’ tree surveys it was known that at 4 of the 7 project locations there are potential tree and forest-related effects. East-West Forestry Associates, Inc. and Urban Forestry Associates, Inc. subcontracted with ICF International, in contract with Caltrans, to evaluate the potential tree effects of the 4 project sites, which are known as “Ruby 1,” ”Ruby 2,” “Patrick Creek Narrows Location 2” and “Washington Curve.” These projects are located on State Route 197 (SR 197) and U.S. Highway 199 (US 199) east of Crescent City California per the attached map (Figure 1).

The maritime vs. inland sites are strikingly different. All are located immediately along the Smith River corridor. However, the Ruby 1 and Ruby 2 project areas are narrow strips of roadside forest edge trees in moderately to highly developed environments. These two projects are located areas that were originally Alluvial Redwood Forest (California Gap Analysis Program [GAP] land cover code 82310; Davis, Stoms et. al. 1998) on the Smith River flats, within the North Coast Ecoregion. The Washington Curve and Patrick Creek Narrows Location 2 (PCN2) projects are characterized by Mixed Evergreen Forests (GAP land cover code 81100) and Upland Douglas Fir Forests (GAP land cover code 82420) much further up the river canyon in the Klamath Ecoregion (Sleeter & Calzia 2011). The Ruby 1 and Ruby 2 projects consist of minor adjustments in road alignment and culvert replacement. The PCN2 and Washington Curve projects involve changes in alignment with large cuts of hill slopes and construction of a bridge at the PCN2 site. The developed roadside environments at Ruby 1 and Ruby 2 are far more complex in terms of potential tree effects versus the sparsely forested slopes in the relatively stressful climatic zone at Washington Curve and the burn site at PCN2. Consequently, the analyses of effects at the sites differ for the roadside versus the hillside trees.

The forester and the arborist team evaluated potential effects to redwood trees, remnants of an old-growth forest, at the Ruby 1 and Ruby 2 project locations and potential effects to old Douglas-fir trees at PCN2. The team specifically evaluated proposed development in terms of concomitant effects on assessed trees and stands. The forester/arborist team determined that an analysis of younger trees greater than 5” in diameter at breast height (DBH, measured at 4.5 feet above ground level) at all these locations is desirable, considering the importance of the younger trees to the health and survival of the old trees. The team did a less intensive analysis of the early seral stage forests at Washington Curve hillside cut and the PCN2 hillside cut, which was recently burned in a wildfire.

In order to efficiently complete these tasks, the forester/arborist team, Tom Gaman, Registered Professional Forester #1776, and Ray Moritz, Consulting Arborist and Society of American Foresters Certified Forester #241, visited the four project sites the week of 5 December 2011. During that week, the forester/arborist team was accompanied by the Caltrans' Staff. The team reviewed all planned project effects, conducted a comprehensive on-site inventory of all potentially affected trees, and evaluated potential project effects on tree-by-tree and stand level bases. This report provides a description of the tree inventory and an evaluation of potential tree-related effects.

The two members of the forester/arborist team collectively have 3 degrees in forestry and over 70 years of experience inventorying and evaluating trees in California. Much of the assessment is based upon their professional experience and judgment.

2. Project Background

The project sites are all located along the Smith River in a wild and scenic river corridor as shown in Figure 1. The Ruby 1 and Ruby 2 projects are located on SR197 in coast redwood forests with associated minor components of red alder, emergent wetland and previously disturbed vegetation, near the Ruby van Deventer County Park. The Patrick Creek Narrows locations and Washington Curve project locations are located within the Six Rivers National Forest with sparse Douglas-fir and mixed hardwood vegetation with minor components of white alder forest and ruderal vegetation on disturbed sites. The total extent of the roadside forested areas of concern is approximately 20 acres at most, or less that 0.02% of the Smith River watershed area.

The sites are well documented in the DEIR/EA and further described in the "Effects by Project Location" section below.

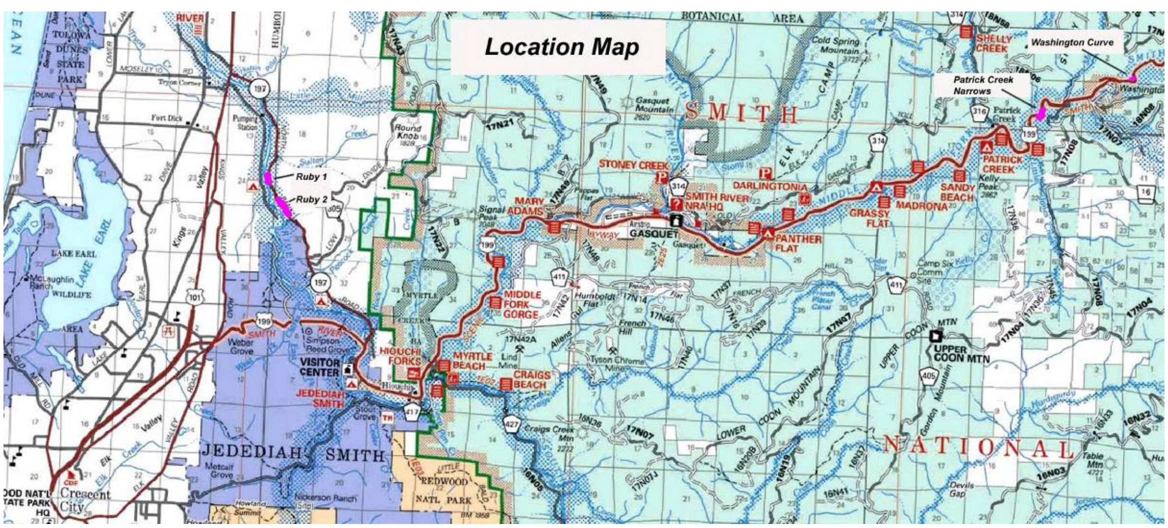

Figure 1. Project Vicinity and Location Map (Caltrans)

3. Biology and Literature Review

The team reviewed project documents including layouts, typical cross-sections, existing tree mapping, the DEIR/EA (available on-line), and other materials provided by Caltrans. The team also conducted a literature review of the biology and management of Douglas-fir and coast redwood, species tolerances of construction effects, and root system characteristics.

A number of issues have arisen as the result of planning for this road project. This literature review and biological discussion is focused on the matters of major concern.

a. Old-Growth Redwood Forest

The forester/arborist team reviewed literature addressing the term “old growth.” Old-growth is defined by botanists, ecologists and foresters as natural forest stands that exhibit unique ecological features and a complex of distinguishing characteristics, including:

- Mixed age stands with distinct regeneration patterns (McBride and Jacobs 1977).
- Trees of great age relative to the longevity of the species (Singer 2009).
- Large diameter trees with diameters of 2 to 4 meters and heights of 60 to 100 meters (Dagley 2007).
- Trees greater than 36 inches in diameter (California State Parks informal communications).
- Enormous wood mass (Dagley 2011; M. Barbour and J. Major 1977).
- Complex trunks with “goose pen” butt hollows, cavities, dead branches, often with multiple leaders (some of which may be dead), massive branches and large vertical sprouts (Dagley 2007).
- Multiple layer canopies with redwoods forming the dominant crown class, sometimes sharing the upper canopy with Douglas-fir, and hardwoods restricted to the intermediate or suppressed canopy classes (Dagley 2007).
- Regeneration is random, clumped gap-phase reproduction (Dagley 2007).
- Coarse woody debris (Singer 2009).
- Snags (standing dead trees) (Dagley 2007).
- Fertile, intact, and generally acidic soils (USDA Forest Service 1993).
- Healthy fungal ecosystems (Giusti 2007; Singer 2009).
- Minimal human disturbance (Franklin et. al. 1981; USDA Forest Service 1993).

In forest ecology literature, the term “old-growth” is not generally applied to individual large coast redwoods trees outside the context of the old-growth forest or stand. The literature review found no research addressing remnant trees of old-growth forests. Individual very large old remnant trees from former old-growth forests that have been harvested were found in the project area. These large, old trees were given special consideration, and are identified as “old trees” for the purpose of this report. The root “potential effects zone” (PEZ) was greatly expanded in evaluating such trees because that zone is based on a multiple of the diameter of the tree (see Section 5). In arboricultural literature and municipal ordinances, large old native trees and trees of historical significance in urbanized/developed environments, some of which may be remnant trees of old growth forest, are often awarded “heritage tree” status (Bernhardt E. and Swiecki T. 1991). Special consideration for the preservation and protection of such old trees is typically required. The trees at the project sites have not been designated as heritage trees.

b. Old-Growth Douglas-Fir Forest

Old-growth Douglas-fir is defined by botanists, ecologists and foresters as natural forests stands that exhibit unique ecological features and a complex of distinguishing characteristics, including:

- Most often occurring with the dominant crown class that is even-age (Franklin, et al. 1981).
- Trees of great age (200 to 750 years) relative to the longevity of the species
- Large trees with dominant tree diameters of 1 to 3 meters and heights of 50 to 90 meters (Franklin et al. 1981).
- Massive living and dead branches, dead leaders are common resulting from drought, beetle epidemics, and other factors (USDA Forest Service 1993).
- Multiple layer canopies with old Douglas-fir forming the dominant crown class (USDA Forest Service 1993), sometimes sharing the upper canopy with Douglas-fir, and hardwoods that are mostly restricted to intermediate or suppressed canopy classes.
- An accumulation of standing dead trees (USDA Forest Service 1993).
- The forest floor is typically littered with coarse woody debris (trunks and large branches, Singer 2009).
- Intact soils with a well-developed herbaceous layer (Franklin, J. F. and Spies, T. A. 1991).
- An abundance of nitrogen-fixing epiphytes and bacteria
- Healthy fungal ecosystems, including fungi in the organic soil, and standing and fallen and decayed logs (USDA Forest Service 1993).
- Minimal human disturbance (Franklin et al 1981).

“Old-growth” therefore cannot be applied to individual Douglas-fir trees outside the context of the old-growth forest or stand because the characteristics of old growth that distinguish it from young growth and “second” growth involve the full range of forest stand ecology, soils, hydrology, wildlife, and forest species composition and structure. In this report such individuals, most of which are now remnants in the absence of their former old growth forests, are referred to as simply “old” trees.

c. Structural Roots, Absorbing Roots, and Root Development

Structural roots of the large old trees are the major lateral roots close to the tree base, within the “zone of rapid taper,” approximately within a radial area from the root attachment to six feet from the root crown. Beyond this zone, roots rapidly divide into smaller lateral roots, then thin fibrous roots and, ultimately, into absorbing roots commonly called “feeder” roots.

The function of structural roots is to mechanically support the aerial portion of the tree, conduct soil nutrients, minerals and water from the smaller roots to the trunk, and store energy reserves. The structural root zone includes the large lateral “buttress” and “sinker” roots close to the tree trunk base (typically within six to nine feet of the base). These are the roots that support the tree’s vertical load and wind lever force loading. The “feeder root” zone is composed of the absorbing roots and fine roots. Ninety percent of these roots are in the upper foot of soil and distal to the structural root zone, even well beyond the canopy drip line. Note that the drip line or canopy perimeter, rule of thumb has no biological significance with respect to root growth extension and health. These are short-lived roots that often dieback during droughts and freezes. They rapidly regenerate during conditions favorable for growth (Urban 2008).

Most of the absorbing roots are within one foot of the soil surface and grow upward from the woody roots. The term “feeder root” is a misnomer, but it is commonly used to describe non-woody absorbing roots (Shigo 1993; Harris, Clark and Matheny 1999). They are considered to be ephemeral in that they are to the most extent very short-lived (days or weeks). Absorbing roots exude carbohydrates into the surrounding soil that supports a rich environment of symbiotic bacteria and fungi (mycorrhizae) that help the tree absorb soil nutrients, minerals and water.

The species populating the four sites can be separated into two distinctive groups from a root structure perspective. The oaks, bay laurels, tanoaks, big leaf maple and knobcone pine all have roots that divide rapidly and have zones of rapid taper that are relatively limited. Large lateral roots and sinker roots of these species are quite close to the trunk, six feet or less. In contrast, the coast redwood and Douglas-fir form large buttress roots and long laterals in maturity to support the massive weight of the aerial portions of these trees. Large laterals up to 15 centimeters (6 inches) in diameter may extend great distances (more than 20 feet from the tree base). Coast redwood develops the most extensive lateral root system of its associate species by far. Coast redwood also has the shallowest root system of its associate species, and yet it is the most wind firm of its associate large conifers, quite likely a function of its massive root system. Coast redwood is also the most tolerant of root disturbance. It can grow successionally higher root systems from adventitious buds on its trunk as alluvial silt builds up on redwood-populated stream benches over many years. Redwoods have been found to be buried in 30 feet of fill and still thriving (USDA Forest Service, 1990). Redwoods are also highly tolerant of root exposing stream bank erosion. Redwoods greater than 210 feet tall with 30% of their root systems fully exposed by river cutting or slides have formed new adventitious root systems lower on their trunks to compensate for dead, exposed roots. Removal of up to 40% of the absorbing roots of trees in general, including redwood, is unlikely to have a substantial effect on the overall health and stability of the trees because absorbing roots are ephemeral under undisturbed conditions and reproduce rapidly (Harris, Clark and Matheny 1999). Removal or shaving of up to 20% of the structural support roots is unlikely to affect tree stability because trees generally have a safety factor in the range of 4.5 times the strength required to resist the expected stress load (Dunster 2009). None of the large redwoods at the project sites would be affected to this extent.

d. Tree Failure

Tree failure is the structural failure of branches, trunks or roots due to excessive forces exercised on the whole tree or tree part from trunk or branch weight or by external forces acting on the tree as a whole, including wind, snow, ice, effect from other falling trees, or earthquake ground acceleration.

e. Disturbance Distance from the Tree (Potential Effects Zone)

The type of disturbance is more important than the distance from the tree. Generally, the structural supporting root zone radius is less than 3 times the DBH (State of California Parks and Recreation 2011). A root radius of three times DBH encompasses the major structural roots that support the tree weight and wind loads. Smiley, Fraedrich and Henderickson found that 3 times DBH is the “minimum” radial distance from the tree for serious root disturbance, “preferably” 5 times the DBH. Most of the laterally extending roots beyond the 3 times DBH zone are rope-like and 0.5 to 1.0 inches in diameter on young trees and 1.0 to 2.0 inches in diameter in mature trees. (Hagen 2001). For redwood and other resilient species the team assessed a root zone of 5 times DBH to protect the long term health and stability of the trees (Smiley, Fraedrich and Hendrickson 2002). For Douglas-fir the team assessed a root zone of 10 times tree diameter because this species is susceptible to aggressive root disease and decay fungi which can affect both tree health and stability over time. An optimum tree protection zone (in feet) for trees with good tolerance to disturbance 360° around the tree is 0.75 ft. times DBH (i.e., 27 foot radius for a 36 inch DBH tree). For moderately tolerant species 1.0 ft. times DBH in inches is optimum and for trees that are poorly tolerant to disturbance 1.25 ft. times the DBH in inches (Matheny and Clark 1998). However, roads typically affect only one side of the root zone, less than 50% of the total root zone. Most healthy trees would tolerate the removal of 50% of their absorbing roots (Sinclair, Lyon and Johnson 1987). As long as large lateral roots and sinker roots, which provide tree structural stability and occur only in the first nine feet of root extension, are not removed most trees should tolerate excavation affecting 20% of the root zone.

No known sinker roots will be affected by the project. This analysis assessed trees within the PEZ. This was defined on a tree by tree basis, as whether there would be any ground disturbing activities within the 5 times the DBH from the face of the tree (or 10 times for Douglas-fir). This is further discussed in Section 5 of this report.

f. Ground Penetrating Radar (GPR) and Air-Spade®

Ground penetrating radar is a state of the art method used for general determination of tree roots, water lines, and other underground utilities, and it has been found to be valuable in many situations where there is concern about severe damage to unseen structural roots. The forester/arborist team researched the issue and determined that there are a very small number of trees with root systems severely affected by the project. Also, with GPR there is a likelihood of false readings indicating roots where there are only voids, old decayed wood, boards and soil tubes filled with dissimilar soil material. Given the time and expenditure of public resources required, that ground penetrating radar is not appropriate in this instance.

In this situation, the use of an Air-Spade® is suitable for excavation within the root zones of trees with moderate or greater root effects and which shall have more than 20% of their root zones affected. Concern for greater disturbance and long term tree health might dictate the use of root-friendly excavation methods to determine the location of roots and/or limit root disturbance. The Air-Spade® Excavator uses blasts of compressed air to remove soil around roots, without physically damaging the roots. It is used by arborists for excavations near trees where there are concerns about impacts to roots. It is not efficient at excavating dry soil and creates an unacceptable amount of dust when used on dry soils adjacent to roads. The soil should be deep irrigated 48 hours prior to excavation, allowed to drain, and then excavated.

4. Potential Tree Effects

Based on the literature review and professional experience, the forester/arborist team considered the major potential effects of the proposed project on old and younger redwood and Douglas-fir trees, and other native trees in the area. These contributed to the development of the tree inventory and assessment methods discussed in Section 5.

a. Breaking/Severing the Structural Roots

Breaking, severing, fracturing, shaving or debarking of structural roots could occur where structural roots are close to the surface and heavy equipment grading, excavation, or compaction and paving would take place. Unless roots of high value are isolated from heavy equipment, damage could occur. Where there is not enough depth from finish grade to the root system, asphalt is sometimes laid directly over roots and the roots may be wounded or killed by heat damage. Road construction and improvements typically affect only one side of the root zone, less than 50% of the total root zone. Most healthy trees would tolerate the removal of 50% of their absorbing roots as long as the soil conditions allowed regeneration (Sinclair, Lyon and Johnson 1987). As long as sinker roots are not removed, most trees should tolerate excavation affecting 20% of the root zone. Redwoods, in particular, are very tolerant of root disturbance and pruning. Root sprouts from cut laterals and secondary roots grow rapidly, easily extending 10 feet in a single year. The redwood forest is located in the rough coastal canyon and riparian environments where natural disturbance events are common. Their roots are constantly being buried or exposed by the natural events of flood stage river cutting and sedimentation, terrestrial erosion, landslides and deposition. They are among the longest living species and are well adapted to disturbance. No known sinker roots would be cut by this project, except on some trees designated for removal. Protective measures can be implemented to preserve structural and sinker roots of trees to be retained.

b. Grading and Compaction of Soil within the Structural and Absorbing Root Zone

Soil under roadways and supporting shoulders is typically graded to remove the organic top soil and compacted to approximately the 90^{th}–95^{th} percentile with heavy rollers or "sheepsfoot compactors." This means that all the soil macropore space and much of the micropore space has collapsed. Tree root health requires approximately 50% pore space (an equal amount of macropores and micropores), and absorbing roots require organic topsoil for good tree health. The macro pores are those than drain rapidly to soil "field capacity moisture content" and provide soil aeration. Micropores allow moisture to move up from the water table via capillary action and hold water for tree root absorption (Urban, 2008). More than 90% of the absorbing roots occur in the top one foot of natural soils (Harris et al. 1999).

c. Fill in the Critical Root Zone

The critical root zone or critical root radius has been defined variously by arborists and urban foresters to be DBH X 18 (a 10 inch tree would have a 180 inch (15ft.) critical root radius. Fill soil is one of the most damaging construction operations affecting root systems. Fill soil is often dense, massive subsoil with low pore space deposited on top of the native grade and typically compacted in lifts to assure resistance to erosion, subsidence or collapse. Fill inhibits water infiltration, percolation through the soil profile, soil aeration, and release of toxic gases (CO, CO_2 and methane), creating an unfavorable root environment. Compacted fill soil also inhibits the infiltration of precipitation and ground water recharge. There are now available a number of engineered structural soils, the best known of which is Cornell Mix or CU-Structural Soil. These soils can be compacted to the greater load capacity typically required for major highways and still provide a healthy root environment. The key is to provide a rock skeleton, the pore space of which is filled with a clay loam bound by a water-holding polymer, the combination of which provides a healthy well-aerated root environment with adequate soil moisture holding capacity (Grabosky et al. 1998).

d. Alteration of Soil pH

A slightly acid soil (pH 6.5 is typically ideal) is needed for soil nutrient uptake by trees. Excessively acid soils and alkaline soils may substantially affect nutrient uptake and tree health. Compacted and paved soils can result in carbon dioxide (CO_2) and carbon monoxide (CO) build-up that is converted into carbonic acid that can acidify the soil and prohibit soil nutrient availability to plants.

However, additional large CO_2-trapping layers of pavement are not anticipated for areas where substantial tree root zones would be covered. Acidification potential is soil type dependent. Most soils have abundant buffering agents and it is very difficult to significantly change soil pH. When CO_2 is trapped in the soil by compaction or pavement it is converted to carbonic acid that can make nutrients unavailable to trees. When the soil is decompacted or otherwise aerated the soil moves quickly back to its original pH (Urban 2008). The forester/arborist team expects that, due to the relatively small area to be compacted and filled or paved in the project area, there will be no measurable effect on soil CO_2 levels.

e. Root Impact and Root Mortality

Lateral roots compartmentalize wounds rapidly by creating boundaries to decay (Shigo, 1993, pg. 199). Absorbing roots are ephemeral (naturally live for short periods of a few days to a few weeks, in some cases a month), and are regularly replaced. The vast majority of effect zone trees will have no root zone effects connected with the project. Of those that have effects, almost all will have less than 20% of the root zone disturbed, and the majority of those will have less than 10%. Of those trees where roots will be disturbed, most of the disturbance will be absorbing roots that occur in the upper foot of soil and which are ephemeral, living only a few days to a few weeks under undisturbed conditions (Dunster 2009; Urban 2008). A small percent of secondary roots and larger lateral roots could be affected by the project, particularly those trees along the Washington Curve and PCN2 road cuts. Different species have varying sensitivity to root effects with coast redwood being the least sensitive, oaks, bay laurel, tanoak being moderately tolerant and Douglas-fir, red alder, cedars and big leaf maple being the most sensitive. Coast redwood is uniquely tolerant of root exposure, fill and root cutting. It has been known to produce entirely new adventitious root systems where river silt deposition from flooding has built up soils around the trees, even up to 30 feet deep, or where river scouring has removed the surrounding soil redwoods grow a new lower root system (USDA Forest Service 1990).

Roots grow much more rapidly than the aerial portions of trees, often up to 10 feet in a year (Urban 2008). Cut root wounds are typically compartmentalized rapidly, small roots sprout from around the cut, and a few sprouts quickly dominate and grow rapidly. Coast redwood root sprouts have been known to grow to two to three inches in diameter within two years after cutting (personal observation). Fractured and crushed roots will also sprout new growth but cannot compartmentalize decay as rapidly and effectively. Therefore it is far better to cut roots greater than one inch in diameter that are likely to be damaged during construction.

Trees of the same species that are within root extension of each other may graft their roots together forming a common root matrix. This is particularly common with redwoods, oaks and Douglas-fir. The formation of a common root matrix buffers the trees against the systemic effects of both natural and development effects. Natural root grafts provide important physiological benefits to trees within the matrix, including the transfer of soil water and minerals, organic compounds and even beneficial fungi. Root grafts can also serve to transfer pathogens form one tree to the next. However, the competitive benefits of natural grafting apparently outweigh the risks or this phenomenon would not be so prevalent across a wide spectrum of species (S. Lev-Yadun 2011).

f. Death of Treetops

Treetops, also called leaders, naturally dieback in coast redwood due to drought, prolonged soil saturation, rodent girdling, and natural slides and fill. Human effects causing dieback include soil compaction and impermeable paving of large areas of the critical root zone, misapplication of herbicides, and disruption of the natural hydrology. As discussed above, root grafting buffers individual trees and the stand as a whole against stress-related dieback.

g. Reduction in Radial and Height Growth

Most trees naturally respond to root effects by extending their roots in other areas of the critical root zone. Thus, typically the reduction in tree height and diameter growth is only temporary.

h. Platform Roots

The ability of trees to grow new roots is species dependent, and a function of the soil environment throughout the critical root zone. Redwoods are uniquely proficient in growing new adventitious roots from latent buds on their trunks, and new “platform root” systems when deep natural fill occurs due to stream sedimentation or terrestrial erosion (Burns and Honkala 1990). Oaks and Douglas-fir are not capable of establishing entirely new root systems after sedimentation or erosion. The proposed work at the project sites studied effects of only a small percentage, typically 10% or less, of the critical root zones of most roadside trees. The trees at the edge of the major cuts at Washington Curve and Patrick Creek Narrows may be affected up to 30% of the critical root zone. Most healthy, vigorous trees can tolerate this amount of disturbance (Harris, Clark and Matheny 1999, pg. 310; Sinclair, Lyon, and Johnson 1987). Knobcone pine will not tolerate a 30% reduction in root system but the knobcone pine are poor competitors, short-lived and consequently in decline at this site. At Washington Curve they are currently being displaced by other more competitive species such as canyon live oak, which is growing under the pine and is more tolerant to root disturbance (Harris et. al, 1999).

i. Wind Throw

Most of the affected roadside trees are currently exposed to stand edge conditions and have adapted to development and increased exposure over many years. Based upon the inventory, the level of disturbance of roadside trees required for this project is not expected to have a substantial effect on the integrity of the structural root systems. Coast redwood is the most wind firm of all its associate species (USDA Forest Service 1990).

Douglas-fir is a relatively wind firm species where soils allow deep root penetration. The structural roots tend to grow obliquely into the lower soil horizons. Most of the surface roots are ropelike (USDA Forest Service 1990). Where there are high water tables, dense clay soils, or shallow soils, the root systems may be quite shallow. We have not observed unusually clayey soils or high water tables at any of the study sites. Shallow soil conditions were observed at Washington Curve, the proposed road cut areas at Patrick Creek Narrows 1 and 2 and at Patrick Creek Narrows 3.

j. Tree Failure

Tree failure is the structural failure of branches, trunks or roots due to excessive forces exercised by the tree mass or by external forces acting on the whole of the tree or tree parts. External forces include wind, snow, ice, impact from other falling trees or earthquake ground acceleration. Road improvement operations can destabilize retained trees through root effects, stand alteration, or indirect effects such as changes in soil aeration, soil saturation or soil dehydration. Some potential tree failures can be avoided through protective measures such as root protection during construction, use of the Air-Spade® and other measures.

k. Hydrological Effects and Road Runoff

Substantial changes in the hydrology of a site can have widespread effects on tree health and stability. Massive cuts can disrupt the lateral movement of water and root zone soil recharge. Extensive new pavement over the critical root zone may substantially reduce precipitation infiltration and soil water recharge causing tree dieback or even mortality. Long periods of soil saturation reduce soil cohesion and tree anchorage and can even cause massive root mortality and whole tree failure. The effect of road construction on retained trees depends on the extent of increased runoff versus infiltration, the extent and duration of saturation and the condition of the undisturbed portion of the critical root zone (Smiley 2009). While the existing roads and driveways decrease water infiltration and ground water recharge and increase runoff, the adjacent trees are well-adapted to these conditions. The proposed project involves so little surface area it would have no measurable effect on infiltration and runoff.

l. Changes in Crown or Tree Canopy Temperatures

The project sites are along the Smith River and Middle Fork Smith River and have been subject to the evaporative stress of edge locations and canyon winds prior to the level of development we see today. While the natural distribution of redwood forest indicates that this species has a strong preference for the relatively cool, moist, high precipitation, foggy maritime environment it does perform well in environments where prolonged high temperatures may occur during the dry season and fog is less frequent if there is high moisture availability (Borchert, M., D. Seggatta. and M. Purser 1988). Redwoods growing on more open sites, such as forest edge or on steep slopes appear to withstand the greater exposure (Daubenmire 1975). The redwood sites at Ruby 1 and Ruby 2 are on river flats with less competition and good soil moisture availability. Most of the old trees have been exposed to edge conditions for many decades since there was intact forest.

m. Anticipated Effect to Surrounding Trees from Tree Removal

When a new stand edge is created by removing trees at the edge of an intact stand the internal sheltered trees suddenly exposed will have a relatively higher probability of failure. Internal trees generally rely on the presence of surrounding trees for stability, have smaller diameters, lower live crown ratios (LCR – the percent live canopy relative to the total height of the tree), and have not developed the required reaction wood to counter the wind forces at the edge of the stand. This affects conifer trees (redwood, Douglas-fir, true firs, cedars, pines, etc.) more than hardwood trees (oak, bay laurel, maple, madrone, etc.) (Dunster, J. 2009; Daubenmire 1975; Borchert et. al. 1988). The proposed plan only creates new stand edge conditions where there will be large cuts at PCN2 and Washington Curve. The species adjacent to the PCN2 and Washington Curve sites are well adapted to their high exposure to canyon winds.

n. Species Relative Tolerances of Construction Root Effects (cut, fill, grading, trenching, heat, soil compaction, pruning, shaving, poor aeration, seasonal saturation, pavement installation, etc.)

Urban Forestry and Arboricultural observations have rated various genera and species for tolerance of construction effects. The follow is a summary of those ratings.

Table 1. Tolerance of Roots to Construction Effects by Species

Common Name	Latin Name	Tolerance	Source
Vine maple	*Acer Cincinatum*	Good	Peepre, undated Costello & Jones, 2003
Big leaf maple	*Acer macrophyllum*	Good	Matheny & Clark, 1998
California Buckeye	*Aesculus californica*	Good	Matheny & Clark, 1998
Alder, Red	*Alnus rubra*	Poor	Peepre, undated, Costello & Jones, 2003
Madrone	*Arbutus menziesii*	Poor	Matheny & Clark, 1998, Moritz, 2012
Incense Cedar	*Calocedrus decurrens*	Moderate	Matheny & Clark, 1998
False cypress	*Chamaecyparis* spp.	Good	Gilbert, 1996
Pacific dogwood	*Cornus nuttallii*	Good	Peepre, undated
Ash	*Fraxinus* spp	Moderate	Fraedrich, 1995
Sitka Spruce	*Picea sitchensis*	Moderate	Matheny & Clark, 1998
Knobcone Pine	*Pinus attenuata*	Moderate	Moritz 2012 – poor for fill
Ponderosa Pine	*Pinus ponderosa*	Good	Matheny & Clark, 1998
Poplars, California	*Populus* spp.	Poor	Matheny & Clark, 1998
Douglas-fir	*Pseudotsuga menziesii*	Poor	Dunster, 2011 – Fill & saturation
		Good	Matheny & Clark 1998-Pruning
Canyon Live Oak	*Quercus chrysolepis*	Good	Moritz, 2012
Oregon White Oak	*Quercus garryana*	Good	Matheny & Clark, 1998
Coast Redwood	*Sequoia sempervirens*	Good	Moritz, 2012 Matheny & Clark, 1998

Note that the tolerance of coast redwood to root disturbance is very high while Douglas-fir is generally poor. Douglas-fir is tolerant of fill if limited to 25% of critical root zone but may experience decline slowly at fill greater than 25%. Douglas-fir tolerates limited root pruning if less than 20% of critical root zone affected.

Under the following conditions, root pruning should be avoided:

- Trees that are stressed by drought, insect infestation, disease, excessive trimming or prior root disturbance (Mann 2002. Impacts "Root Pruning: The Good the Bad and the Ugly." In Roots vs. Infrastructure. CUFC Conference)
- Trees leaning more than 40° (Dunster 2009. Tree Risk Assessment In Urban Areas and the Urban/Rural Interface)
- Trees with extensive root decay (more than 33% of structural roots have less than 33% shell wall thickness) (Dunster 2009)
- Trees with excessive trunk heart rot, where the trunk shell wall is less than the trunk radius X 0.33 (Mattheck 2004. The Face of Failure)
- Trees with root crown cavity openings more than 30% of the root crown circumference (Mattheck and Breloer 1994. The Body Language of Trees: A Handbook For Failure Analysis)

- Trees that would have been root pruned on another side
- Species considered intolerant of root pruning (Costello and Jones 2003)

5. Methods

a. Tree Inventory Development

Caltrans staff provided the forester/arborist team with the DEIR/EA, design documents, some tree records, some bibliographic materials, and public comments on the DEIR/EA. The forester/arborist team reviewed the most current project information prepared by Caltrans Project Development Team (PDT) for the 4 project locations. The team had a telephone conference meeting with Caltrans PDT on November 15, 2011. There was a follow-up meeting in Eureka at Caltrans offices on December 5, 2011. Subsequently the forester/arborist team spent 3 days in the field (December 6, 7, and 8) with Caltrans' engineering and project staff inspecting the sites and assessing potential road improvement project effects.

Large numbers of native trees occur at all four sites. Based on forester/arborist team member experience, the initial field reconnaissance, and the literature review, the team determined that trees that will remain, within a pre-specified PEZ, after the project is complete, have the greatest likelihood of being affected by the project. Therefore the team determined that it would objectively evaluate all retained trees within the PEZ at each of the 4 project sites of interest.

Each tree has a "structural root zone," composed of a larger set of roots that physically support the above-ground mass of the living tree, and an extended much-larger feeder/absorbing root zone which is composed of finer roots and nonfibrous absorbing roots which take up water, minerals and nutrients. Some fine rope-like lateral roots have been determined to extend under and across roads and even to the far side of formidable barriers in the developed environment. However, a general rule applies that the closer to the tree, the more important the roots for both tree health and stability.

Although there is no absolute rule, the State of California Parks and Recreation Handbook (State of California Parks and Recreation 2011) suggests that the "root health zone" is a circular area with the tree trunk at the center and a radius of 5 times the diameter of the tree trunk measured at breast height" (DBH). This includes the "structural root zone of 3 times the diameter of the tree" and a portion of the smaller roots and absorbing root zone. The forester/arborist team decided that this was a reasonable standard of impact for resilient tree species. Therefore the "potential effects zone" or PEZ on the road work side of the trees for this project was determined to be 5 times the diameter for all trees except Douglas-fir. The forester/arborist team concluded that Douglas-fir's greater sensitivity to root disturbance and high susceptibility to root disease and windthrow required the application of a 10 X DBH PEZ. As such, a 14" redwood tree would have a PEZ zone of 70" (from the face of the tree at its root crown) while a 14" Douglas-fir would have a PEZ with a 140" radius (from the root crown face of the tree). If work is planned, no matter how minor, within the PEZ of any tree, then that tree was evaluated. Additionally, trees that had special importance (such as the large old redwoods at Ruby 2) and trees outside of the effect zone that could be affected by the construction (for instance, alongside a driveway) were also evaluated. In the interest of time, similar and adjacent hardwood trees (mostly 6–10" in DBH) were evaluated as groups. The PEZ trees evaluated in this report are not necessarily the same trees that were identified in the DEIR/EA. The reason for this is that the DEIR/EA identified many trees that are outside of the PEZ, and, as such, are not directly relevant to the project as planned.

The forester/arborist team concluded during the first day of field work that Caltrans had done an adequate job of identifying trees to be removed as a result of the project. Therefore they simply reviewed these trees at all project sites, and did not comprehensively evaluate trees that would be cut, except to note that no large old redwood trees would be removed as a result of the project.

The team recognizes that roadside trees within the historic highway rights-of-way have by now adapted to or declined from the existing and historic root disturbances and other road effects. Therefore roadside trees were evaluated for their current condition, and potential project effects. Distance from the project activity to the face of each tree and percentage of root zone affected were taken into account.

The site conditions and the proposed road improvements for the roadside trees vs. the hillside trees and the project locations are quite dissimilar so the team adopted separate inventory methodologies: a methodology for roadside trees and another for hillside trees. In all up to 28 observations were recorded for each potentially affected "roadside tree" as shown in Table 2 ("Tree Effects Data Collection Form" used at Ruby 1, Ruby 2 and roadside at PCN2), while less-detailed inventory methodology was adopted for potentially affected "hillside trees," all of which would either be removed or retained (Table 5, used at Washington Curve and for hillside trees at PCN2). Trees that would be removed as a result of the project were noted as to number, species, and diameter, but not further evaluated. For the trees that will remain, the resulting data set provides a basis for evaluating tree-level and stand level effects.

All tree locations and associated tree level data were imported into the geographic information system (GIS). Therefore, all data items and tree records can be evaluated individually or in clumps relative to the planned highway improvement efforts.

Many trees were located in the field using Garmin GPS waypoints. Such locations are subject to measurable error. While every effort was taken to locate trees correctly, some trees were difficult to access in the field and are therefore subject to other location error. In particular, trees at PCN2 are located on steep and sometimes gravely hazardous terrain above the travel lane and are subject to this type of location error. The tree mapping as presented in this report is for reference purposes. The trees referenced are tagged and readily identifiable in the field.

Trees stems 5” and larger in diameter at breast height (DBH) were recorded. Smaller trees, 4.9” and less, were not tallied. Many trees at all of the project sites are multiple stemmed trees and they were recorded as “clumps,” or individual multiple stemmed trees. In the case of redwoods such trees are multi-stemmed trees which sprouted from a single root base, primarily because they were previously harvested or cut down by humans. Oaks are naturally multi-stemmed and many were recorded as clumps. In the case of alders and small maples at PCN2, clusters or minor groups of smaller trees (similar trees usually in the 6–10” diameter classes and located within close proximity to one another) were simply too numerous to individually tally using the “Roadside Method.” Such clusters were also recorded as clumps. On the hillsides, where the “Hillside Method” was utilized, some clusters of smaller madrones and tanoaks were recorded as clumps. In all cases of clumps multiple stem diameters were measured and recorded. Therefore this project contains a count of the number of individual trees (which includes individual single-stemmed *and* multi-stemmed trees) by species, size class and other variables. In cases where maples and alders were aggregated as clumps the number of existing tree *stems* is also reported.

In this manner the forester/arborist team assessed the following number of trees at the four sites:

- 57 individual live trees and/or multiple trunk trees or clumped trees at the Ruby 1 site, with a total of 105 stems; trees to be removed were not recorded at Ruby 1.
- 87 individual live trees, multiple trunk trees or otherwise clumped trees at the Ruby 2 site, with a total of 153 stems to be retained; 7 stems to be removed and a stump were also recorded.
- 16 live single-stemmed trees at the PCN2 site were measured using the “Roadside Method” described below. Also at this site 31 additional individual trees and clumps of trees on the burned hillside above the road cut, and a small number of riverine alders and maples, were evaluated using the “Hillside Method,” also described below.
- 143 trees or groups of trees, 179 stems in all, at the Washington Curve project location were recorded using the Hillside Method. Of these 140 stems will be removed, all within the proposed road cut.

The tree inventory for all affected trees at these locations is included in Appendix A and Appendix B (Roadside Method) and in Table 10 & Table 12 (Hillside Method).

b. Data Acquisition & Tree Evaluation Procedure

Based upon field reconnaissance and literature reviews, the forester/arborist team collected the “Roadside Method” data items identified below in Table 2 for each tree in the effect zone at Ruby 1 and Ruby 2, and for sensitive roadside trees at PCN2. The “Hillside Method,” where only species, size, and “save” or “remove” collected, was used at all other locations (Table 5).

At the Roadside Method locations the team evaluated the current condition of each tree in the PEZ that would be retained (rather than removed) and that could be adversely affected by the project. The team also recorded data for potential effects including root zone effects, wind effects, effects from increases in ambient light, wind throw effects, potential effects that would result from adjacent tree removals, and construction mechanical equipment such as graders and backhoes used during road construction.

Table 2. "Roadside Method" Tree Effects Data Collection Forms

Caltrans Field PEZ Surveys on SR 197 and US 199		
Ruby 1 & Ruby 2, Patrick Creek Narrows Location 2 (East side of road)		
December 6, 7 & 8, 2011		
Item #	**Data Item**	**Variable response**
1	Tree #	
2	Species	
3	DBH (inches)	
4	GPS waypoint (when applicable)	
5	photo#	
6	Removal Code	Protect or Remove
7	Live Crown Ratio	% of total height compacted crown ratio
8	Tree Position	D=dominant, C=Co-dominant, I=Intermediate, S=Suppressed
9	Existing baseline condition and tree defects (as identified in Dec. 2011)	
a.	Top damage	y/n
b.	Bole damage	y/n
c.	Root damage	y/n
d.	Root cut depth	Inches
e.	Root fill depth	Inches
f.	Compaction	y/n
g.	Culvert in PEZ	y/n
h.	Paving in PEZ	y/n
10	Distance (horizontal feet) to project footprint from face of tree	
11	Potential project effects (for retained PEZ trees only)	
a.	% of root zone affected	% root zone
b.	root zone effects	0 (negligible) or 1 (low) to 5 (high)
c.	wind movement effects	0 (negligible) or 1 (low) to 5 (high)
d.	increased light effects	0 (negligible) or 1 (low) to 5 (high)
e.	increased windthrow effects	0 (negligible) or 1 (low) to 5 (high)
f.	adjacent tree removal effects	0 (negligible) or 1 (low) to 5 (high)
g.	mechanical damage during construction	0 (negligible) or 1 (low) to 5 (high)
12	Miscellaneous comments	Text

Numbered photographs are referenced for most roadside trees. Although too numerous to reproduce here, the forester/arborist team has provided Caltrans with photographs referenced in this report.

"Roadside Method" Tree Effect Severity Categories

Percent of Root Zone (face of tree at base to 5 times the tree DBH, 10 times DBH for Douglas-fir) Effects were rated 0 to 5 as follows.

Table 3. Percent of Root Zone Effect Severity Categories

Effect Severity Category	Description of Effect
0 - None	No measurable effect
1 - Minimal	Less than 10% of root zone (absorbing roots only)
2 - Slight	10% to 20% of root zone
3 - Moderate	20% to 30% of root zone (Absorbing and < 3″ laterals)
4 - Considerable	30% to 40% root zone (< 30% of Structural + Associated small laterals & absorbing roots)
5 - Severe	> 40% of root zone (< 3″ laterals & < 30% structural)

"Roadside Method" Health and Structural Stability Potential Project Effects were evaluated 0 to 5 as follows.

Table 4. Health and Structural Stability Effect Severity Categories

Effect Severity Category	Extent and Duration of Effect
0 - None	No project related effect on health and stability
1 - Minimal	Minor short term effect, recovery within weeks
2 - Slight	Minor health effect; recovery within months
3 - Moderate	Moderate health and/or stability; recovery 1 year
4 - Considerable	Serious impact intervention necessary
5 - Severe	Intervention unlikely to improve condition

The hillside trees were generally smaller, younger, more numerous, and, in the view of the forester/arborist team, less ecologically important than the larger, older individuals inventoried utilizing the "roadside method." Data items are shown in the table below.

Table 5. "Hillside Method" Tree Data Collection Forms

Caltrans Field Tree Effect Surveys on US 199		
Item #	**Data Item**	**Variable response**
1	Tree #	
2	Species	
3	DBH (inches)	
6	Removal Code	Retain/Remove
13	Miscellaneous comments	Text

Both the Roadside Method and Hillside Method provide quantitative means for assessing tree effects and assure that tree protection is applied at the tree level, as may be necessary. The entire data set has been included in the Appendices A & B.

6. Results: Summary of Tree Inventory & Effects by Project Location

Based on the inventory of all trees at each project location, the forester/arborist team evaluated potential effects for every tree within the PEZ at Ruby 1 and Ruby 2, PCN2, and Washington Curve where work is planned within the tree effect zone, as described above.

The forester/arborist team prepared the summaries that are contained in this section and an assessment of overall effects in the conclusion to this report.

a. Ruby 1

The Ruby 1 site is located in a dense coastal alluvial redwood forest dominated by redwood trees. Ruby 1 includes a small number of large redwood trees that, although large and undoubtedly quite old, appear much younger than their counterparts at Ruby 2. The project site is located at Mile Post 4.5 on North Bank Road (SR 197) approximately 2.5 miles south of its junction with SR 101. The location is adjacent to the Ruby van Deventer County Park, a public camping area and Smith River access. From there the Ruby 1 project area extends southeasterly for approximately 700 feet. Affected trees are located on both sides of the road. The setting is further described in the DEIR/EA Section 2.3.1.1 (Caltrans 2010).

State Route 197 and Del Norte County's Ruby van Deventer County Park have been in existence for decades. All of the trees along SR 197 have had to adjust to the cumulative effects of runoff, grading, cut, fill, compaction, impervious road and parking areas construction, traffic, and road maintenance, yet the trees remain in remarkably healthy condition.

The current proposed highway improvement project entails lengthening a curve, widening the shoulder by varying widths, and improving the super elevation and friction by adding asphalt concrete (away from the river) at the inside of a curve. One culvert would be replaced, one culvert inlet would be extended and one new inlet would be installed. The project is described in the DEIR/EA. Trees to be removed include 2 alders, a rotted 42" bay stump with many sprouts, and a clump of 2 redwood trees 17" & 18" in diameter.

Figure 2. Ruby 1 at Ruby van Deventer Camping Area is Characterized by a Harvested Forest that Re-Sprouted

Inventory of Trees in Potential Effects Zone at Ruby 1

The forester/arborist team evaluated the Ruby 1 site on December 6, 2011. For Ruby 1 which is comprised entirely of roadside trees using the intensive “Roadside Method” inventory methodology, the team examined the data and created histograms showing the relative number of trees affected by each evaluation category. Trees that must be removed were not further evaluated except to note their existence within the project footprint. The team determined that, in addition to 6 trees to be removed as noted above, there are 57 individual retained trees or clumps of trees (105 individual tree stems) over 5” in diameter within the effect zone, including 8 bay trees, 48 redwood trees and an alder.

Table 6. Ruby 1 Summary of Potential Tree Effects

Species		DBH Class (inches)				
		5–11.9	12–23.9	24–35.9	36+	Total
Redwood	Removal		2			2
	Retain	6	13	10	19	48
Alder	Removal	2				2
	Retain		1			1
Bay	Removal					
	Retain		8			8
Total						**61**

Notes:
1. multiple stemmed trees are represented by the stem of largest diameter.
2. a 42″ hollow bay stump will be removed and a very large redwood stump is to be retained
3. blank indicates zero trees

Table 7. Ruby 1 Summary of Potential Effects on Large Old Trees (greater than 36 inches DBH)

Tree #	Species	DBH (inches)	Distance to Project Footprint (feet)	Root Effects	Sum of Effects
294	Redwood	42	1	0	1
297	Redwood	70	0	0	1
303	Redwood	50,50	23	0	0
304	Redwood	40,34,44,15,23	11	1	1
306	Redwood	43	4	2	3
307	Redwood	45	7	2	2
395	Redwood	39	21	0	0
397	Redwood	39	5	0	0
400	Redwood	53	11	0	0
593	Redwood	57	12	0	0
594	Redwood	50,50,16,16,16	1	1	1
598	Redwood	50,42	0	1	1
599	Redwood	60,40	1	1	1
600	Redwood	59	0	1	1
703	Redwood	55	13	1	1
724	Redwood	60,50	13	1	1
600A	Redwood	65,75	25	0	0
703A	Redwood	45,18	2	0	0
724A	Redwood	82	30	0	0

Ruby 1 Location: Summary of Existing Numbers/Types of Trees – 61 total trees assessed

- Trees proposed to be removed – 2 alders, a rotted 42″ bay stump with many live sprouts, and a clump of 2 redwood trees 17″ & 18″ in diameter.
- PEZ retained trees further evaluated – 8 bay trees, 48 redwood trees, and 1 alder tree.

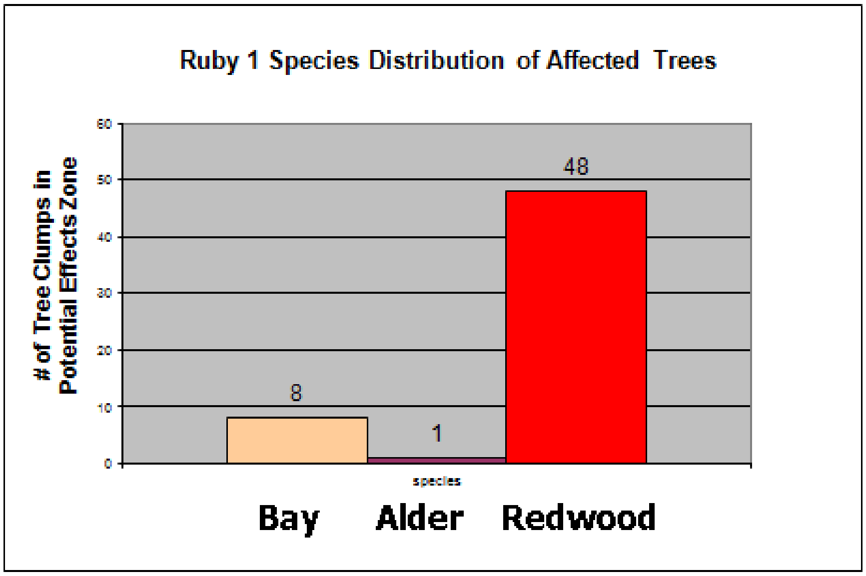

Figure 3. Ruby 1 Species Distribution of Affected Trees

This diameter distribution shows that 19 of the affected retained trees are greater than 36" in DBH. Potentially affected trees, essentially all redwood, include 3 trees in the 70-90" DBH ranges and 10 trees in the 50–60" range. None of these larger trees will be removed.

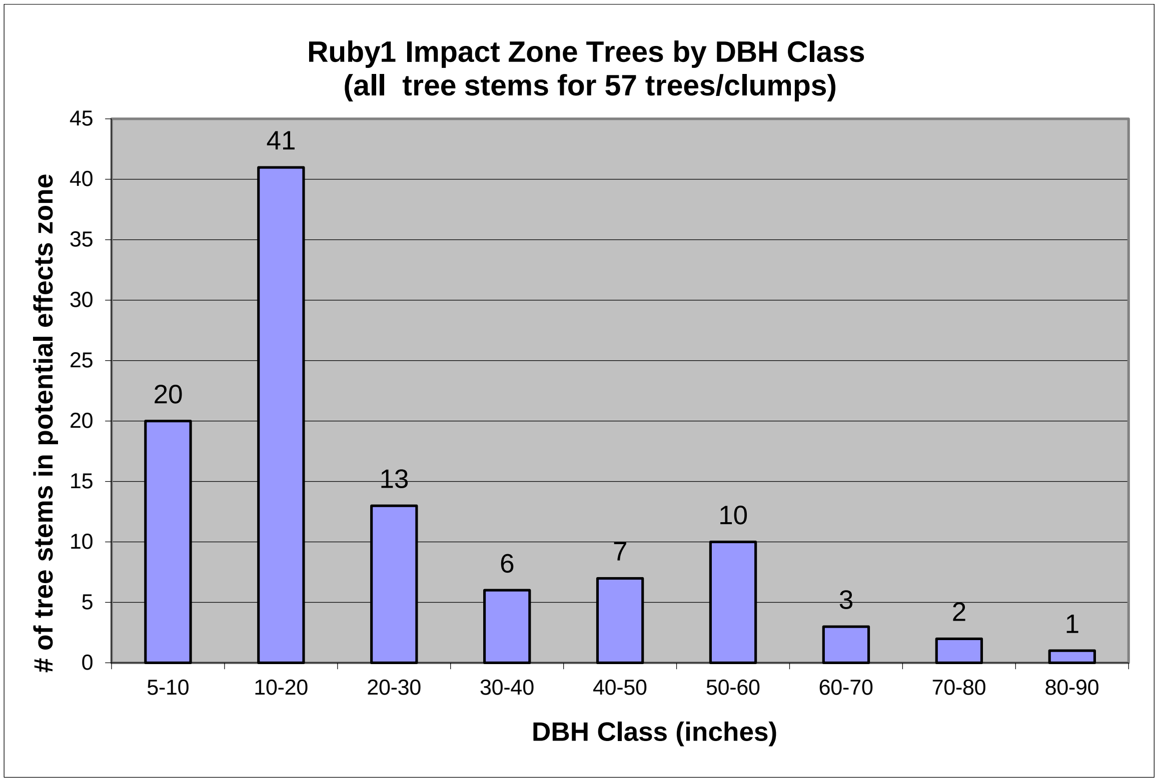

Figure 4. Ruby 1 Impact Zone

Visual Representation of the Data

This section summarizes the results of individual tree-by-tree assessments of potential tree effects at Ruby 1, including removals.

Potential effects anticipated for the 57 trees that would remain after construction at Ruby 1 are summarized in the following figures. Each figure corresponds to a potential project effect as shown in Item 11 of Table 2 (see Methods). Discussion of each figure is included in the following section.

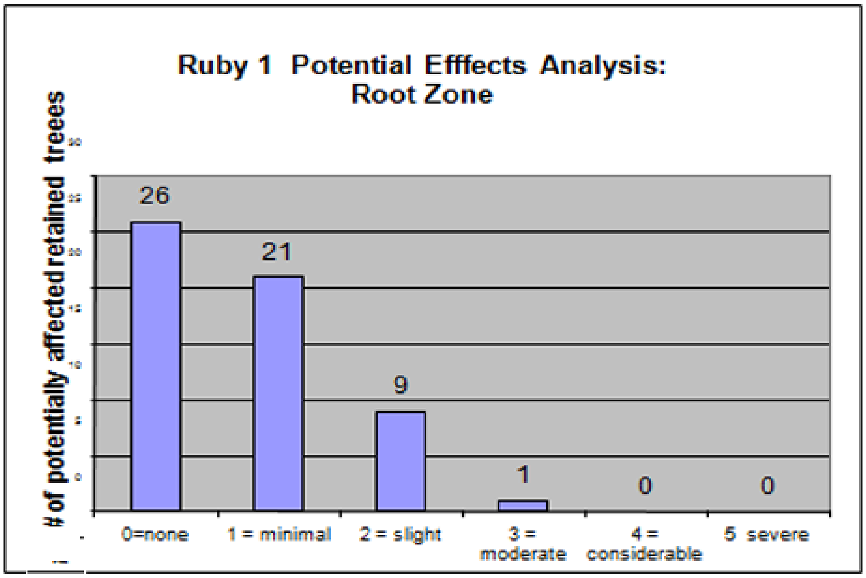

Figure 5. Ruby 1 Root Zone Effects Analysis

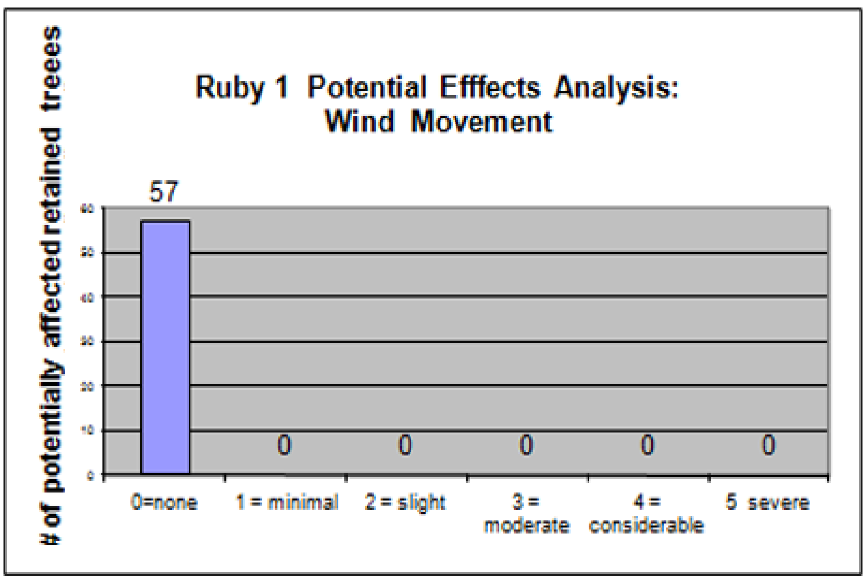

Figure 6. Ruby 1 Wind Movement Effects Analysis

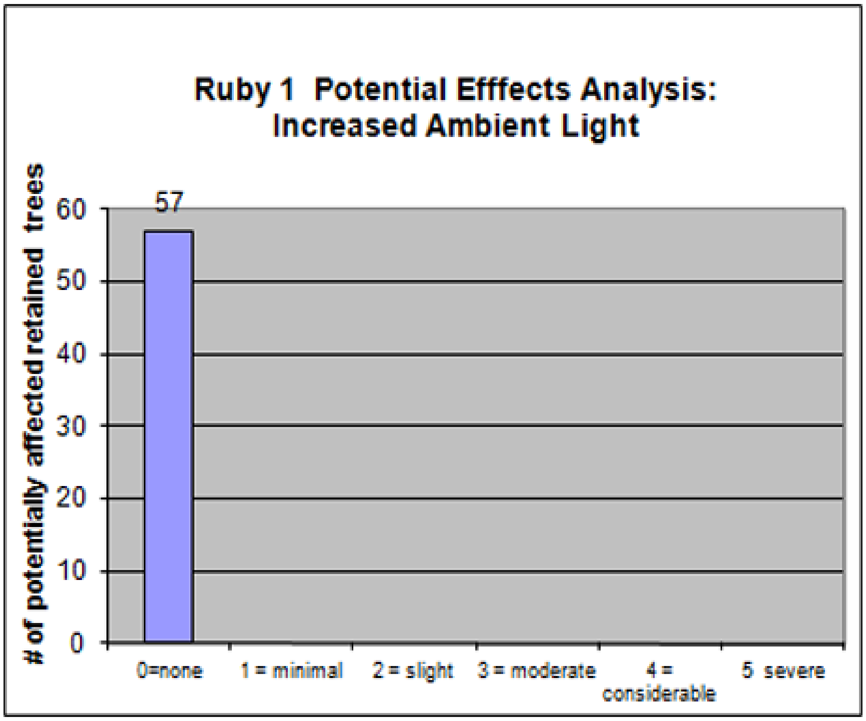

Figure 7. Ruby 1 Increased Ambient Light Effects Analysis

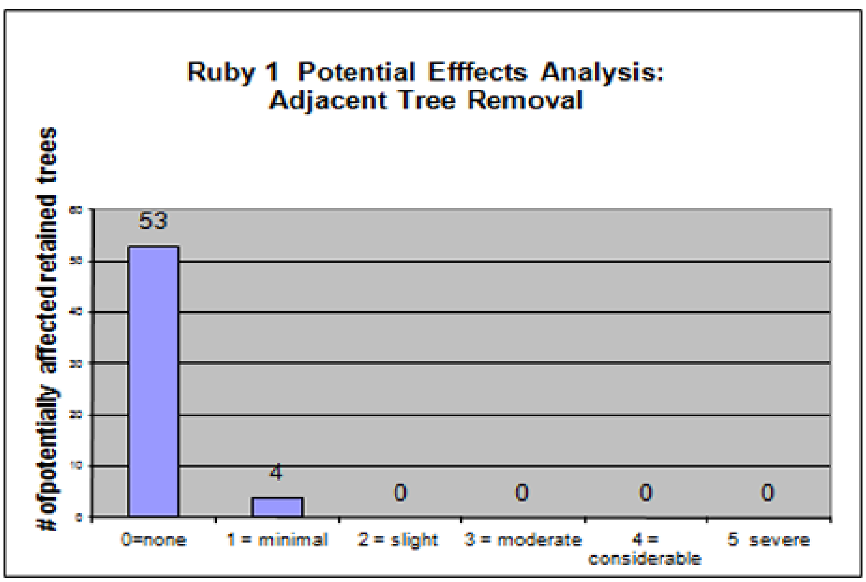

Figure 8. Ruby 1 Adjacent Tree Removal Effects Analysis

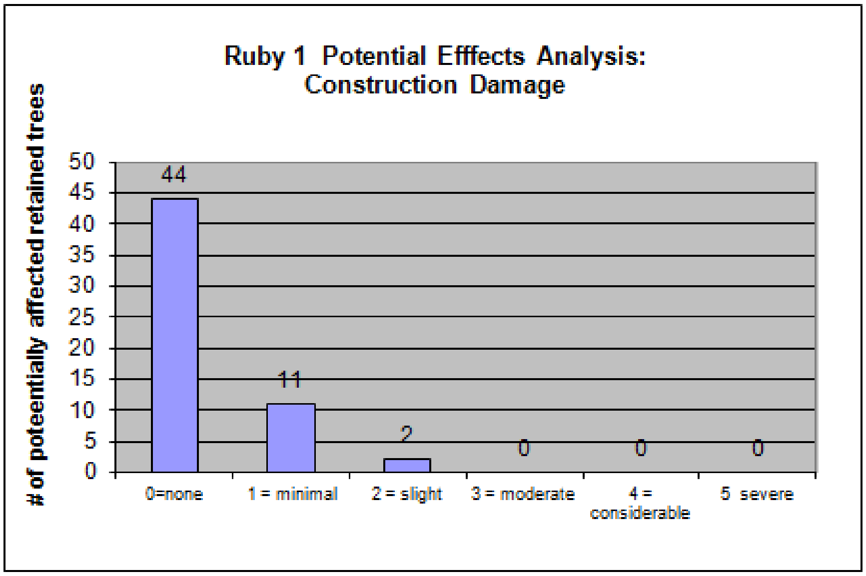

Figure 9. Ruby 1 Construction Damage Effects Analysis

Discussion of Ruby 1 Effects

All the trees evaluated at Ruby 1 have already been affected by the existence of a highway in the immediate vicinity. As most of the trees are native and pre-date the highway, it is clear that the trees have previously endured and responded to construction effects. The forester/arborist team evaluated the existing baseline condition of each tree according to the Roadside Method and assessed the potential effects that would likely be the result of the construction activities proposed by Caltrans.

For all potential effects evaluated, most trees would have none or minimal negative effects if construction occurs, (see Table 7 for large trees and appendices for all data). As all the trees to be removed are co-dominant or understory trees, there would be zero or negligible effect from increased ambient light. Likewise, wind movement effects would be zero or negligible. The forester/arborist team determined, using a wind gauge, that incremental wind and air movement due to vehicle traffic is almost unmeasurable. No dominant canopy trees, those which usually receive the most wind, would be removed. Therefore, assuming that the improvements would not lead to a significant increase in traffic, the team could find no evidence of any potential tree effects from such increased wind velocity. Since Ruby 1 is in a low-lying area alongside a river, redwood trees would likely respond to increased desiccation from “traffic wind” via the uptake of small amounts of additional moisture, readily available in the water table. Adjacent tree removal effect would be higher than “none” for only 2 trees, and in those cases the team determined those effects to be “minimal.” The rest of the trees would have an adjacent tree removal effect of “none.” The data demonstrate that the potential tree effects of the proposed road construction would be less than “considerable” for every data item evaluated. No potentially severe effects were noted for any tree evaluated.

Although root effects 26 of the trees were “none,” and 21 other trees had “minimal” effects, there are 10 trees at Ruby 1 where root damage may be “slight” or “moderate.” The root effects were considered to be the most important of the other effects analyzed. Table 7 demonstrates that for the large old redwoods at the site the root effects are all none, minimal or slight. Therefore the project is not likely to adversely affect the health of these large old trees.

These trees have exhibited such resilience in response to the earlier highway, residential development and driveway construction activities, that indications are they can tolerate the “minimal” root disturbance connected with the proposed project without detriment. For the two 16” redwood trees (603a and 604a across from the campground entrance) that exhibit “moderate” potential root effects, nearby root excavations may be undertaken via the use of an Air-Spade®.

In addition to the removal of 2 alders, a heavily decayed 42” bay stump with many sprouts, and 2 redwood trees (17” & 18” DBH), retained trees construction potential effects were “none” for 44 trees, “minimal” for 11 trees, and “slight” for 2 trees. Since the individual tree effects are minimal, the potential effects at the stand or forest level are negligible. The forester/arborist team felt that the Caltrans design team had done a thoughtful job and had taken considerable effort to protect trees at Ruby 1.

b. Ruby 2

The Ruby 2 site is located on SR 197 between PM 3.2 and 4.0. The Ruby 2 project site, 2307 linear feet in length, is located in a residential area along the Smith River, approximately a mile southeast of Ruby 1 and includes remnants of an “old growth” stand that once dominated over thousands of acres in the vicinity, and which can still be found in the nearby Jedediah Smith State Park, immediately south of the project site. The area provides frontage for a number of private residences in a neighborhood of houses that are located along the Smith River and set back 200’ from the highway. The dominant vegetation at the Ruby 2 site is characterized as alluvial redwood forest with a hardwood understory. Inspection of the aerial imagery shows that on some of the parcels trees have been harvested and vegetation cleared for homesteads, while remnant old redwood trees remain in the vicinity. The original redwood stand is fragmented yet healthy very large old trees (such as the one on the report cover) remain in the PEZ. The road improvement plan includes protection of the several large old redwood trees, some of which are 8–12 feet in diameter and located close to the existing pavement of the traveled roadway.

Figure 10. Large Old Remnant Redwood Trees are alongside SR 197 at Ruby 2

According to the DEIR/EA, 18 trees and 4 large old previously-harvested redwood stumps would be removed as a result of the project. Within the project footprint, nine tree stems including one 30” redwood, one 24” redwood, and an 18” associated redwood sprout, 4 alder stems 10 to 13” in diameter, an 18” bay and 2 maple stems 13” and 8” will be removed. None of the live trees to be removed are large, old trees. These are noted at 3 locations in Figure 11.

The “Ruby 2 Two-Foot Widening in Spot Locations” involves replacing culverts, excavation of 170 cubic yards of cut-and-fill material and shoulder modifications. Essentially it involves placement of new pavement and shoulder in effort to straighten 2 problematic curves. This strategy has reduced potential effects to the low level reflected in the data.

The PEZ trees are mapped in the GIS as shown on an overlay on the aerial imagery in Figure 11 below.

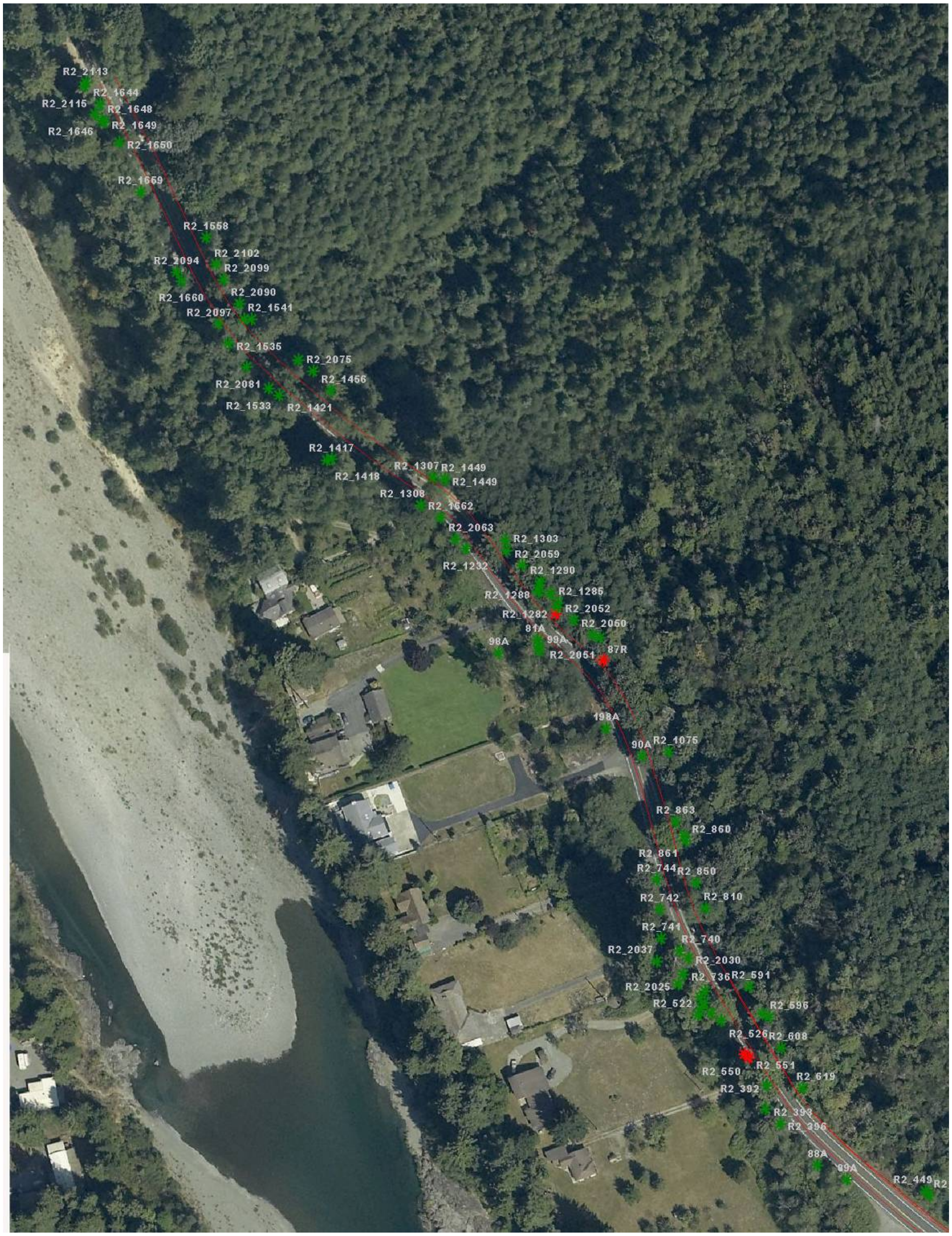

Figure 11. Trees in the Ruby 2 Project Area Effect Zone (Green Trees to be Protected, Red to be Removed)

The Smith River shows in the left side of the image.

Inventory of Trees in Potential Effects Zone at Ruby 2

The forester/arborist team evaluated the Ruby 2 site on December 7, 2011. For Ruby 2 which is comprised entirely of roadside trees using the intensive “Roadside Method” inventory methodology, the team examined the data and created histograms showing the relative number of trees affected by each evaluation category. Trees that must be removed were not further evaluated except to note their existence in the project footprint. The team determined that there are 91 individual trees or clumps of trees (as described above), containing 161 stems greater than or equal to 5.0” in diameter, within the PEZ. Of the 91, 87 tree clumps (or 153 stems) will be retained. Species are more than 70% redwood. Included within the PEZ, there are 9 very large and apparently healthy old redwood trees, ranging in diameter from 76” to 138”, which will remain relatively unaffected by the project.

Table 8. Ruby 2 Summary of Potential Tree Effects

Species		DBH Class (inches)				
		5–11.9	**12–23.9**	**24–35.9**	**36+**	**Total**
Redwood	Removal		1	2		3
	Retain	2	13	9	37	61
Douglas-fir	Removal					
	Retain		5	1		6
Alder	Removal		1			1
	Retain	3	3			6
Bay	Removal		1			1
	Retain		3		2	5
Maple	Removal		1			1
	Retain	1	4	1		6
Red Cedar	Removal					
	Retain		1			1
Total						**91**

Notes:
1. multiple stemmed trees are represented by the stem of largest diameter.
2. blank indicates zero trees.
3. A single clump of 4 alder steps will be removed.

This diameter distribution shows that 39 of the 91 potentially affected trees are greater than or equal to 36” in DBH. There are 30 tree stems in the project area greater than 40” in diameter.

Table 9. Ruby 2 Summary of Potential Effects on Large Old Trees (greater than 36 inches DBH)

Tree #	Species	DBH (inches)	Distance to Project Footprint (feet)	Root Effects	Sum of Effects
392	Redwood	138	0	0	1
396	Redwood	55,36	13	0	0
522	Redwood	76	26	0	0
524	Redwood	70	11	1	1
526	Redwood	93	3	2	2
736	Redwood	118	10	0	0
740	Redwood	59	5	1	1
741	Redwood	80,36	0	1	1
861	Bay Laurel	40,36	14	0	0
1223	Redwood	39,7	0	0	0
1284	Redwood	41	7	2	12
1289	Redwood	56	10	2	4
1290	Redwood	39,11	9	2	2
1303	Redwood	63	0	2	4
1307	Redwood	38,16	0	2	4
1307	Redwood	38,16	0	2	5
1308	Redwood	68	5	1	1
1417	Redwood	36,32	22	0	0
1418	Redwood	70,30,66	28	0	0
1421	Redwood	59	4	0	0
1449	Redwood	41,14	4	2	4
1449	Redwood	44,13	4	2	4
1456	Redwood	40	12	1	1
1533	Bay Laurel	53	10	0	0
1541	Redwood	41	10	0	0
1644	Redwood	39	6	1	1
1646	Redwood	40	19	0	0
1648	Redwood	38	15	0	0
1649	Redwood	36	13	0	0
1650	Redwood	65,36,16	3	1	1
1660	Redwood	36,9	14	0	0
1662	Redwood	108	0	1	1
2025	Redwood	119	24	0	0
2037	Redwood	122	36	0	0
2097	Redwood	48,30	0	1	1
2113	Redwood	44,16	9	0	0
2115	Redwood	38	9	0	0

Total Potential Effects

This section summarizes the results of individual tree-by-tree assessments of potential effects at Ruby 1, including removals.

Root zone effects are mostly none, minimal or slight, but some moderate effects will occur. Root zone effects for large old trees (Table 7) are none, minimal or slight. Tree #1284 has a Sum of Effects of 12, and this is due in large part to an adjacent stump being removed. This tree may suffer some temporary stress, but is likely to survive without long term negative effects.

Visual Representation of the Data

Potential effects anticipated for the 87 trees and groups of trees that would remain after construction at Ruby 2 are summarized in the following figures. Each figure corresponds to a potential project effect as shown in Item 11 of Table 2 (see Methods). Discussion of each figure is included in the following section.

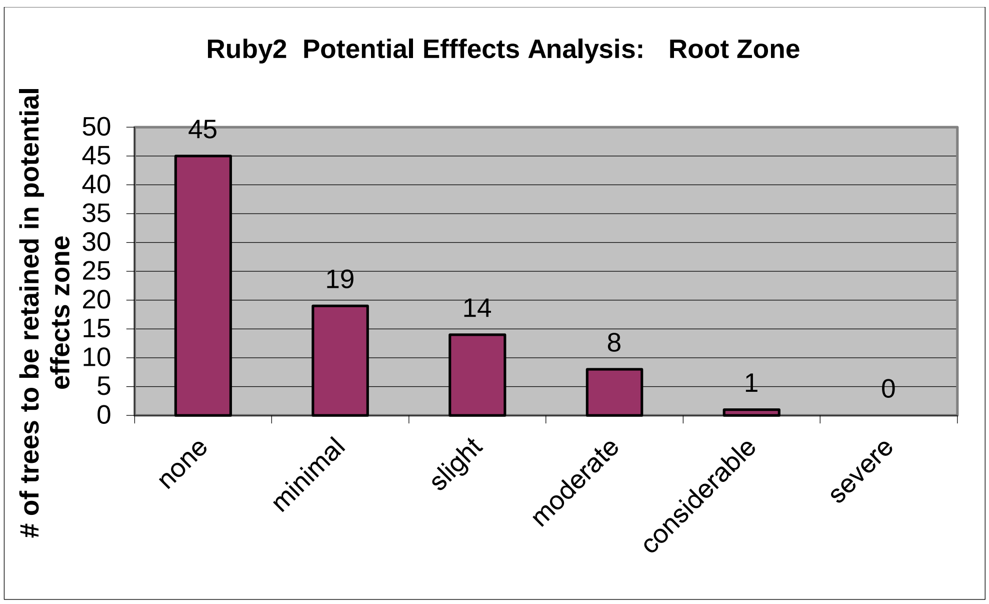

Figure 12. Ruby 2 Root Zone Effects Analysis

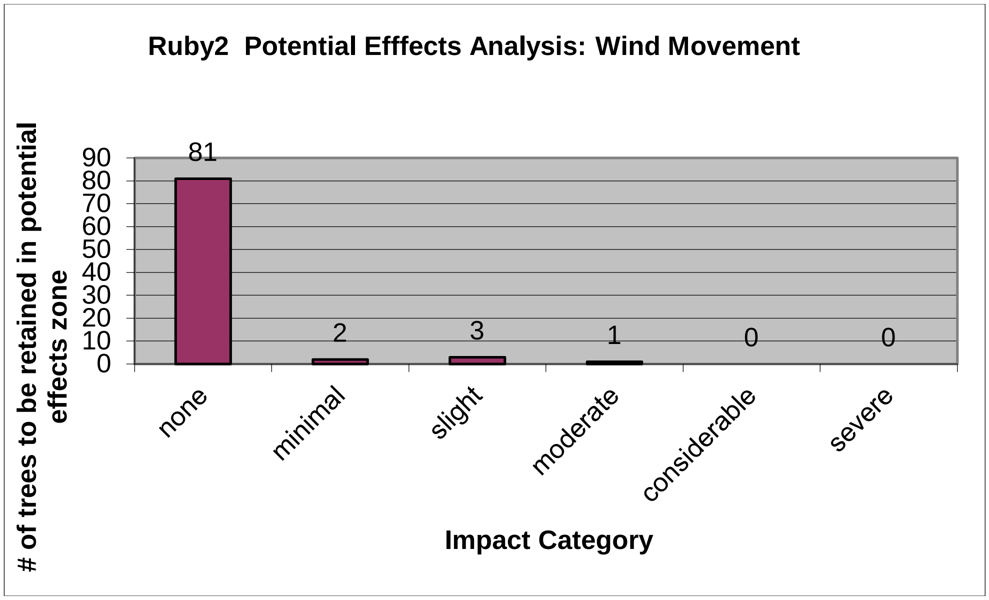

Figure 13. Ruby 2Wind Movement Effects Analysis

Increased windthrow effects are negligible except in those locations where nearby roots will be excavated.

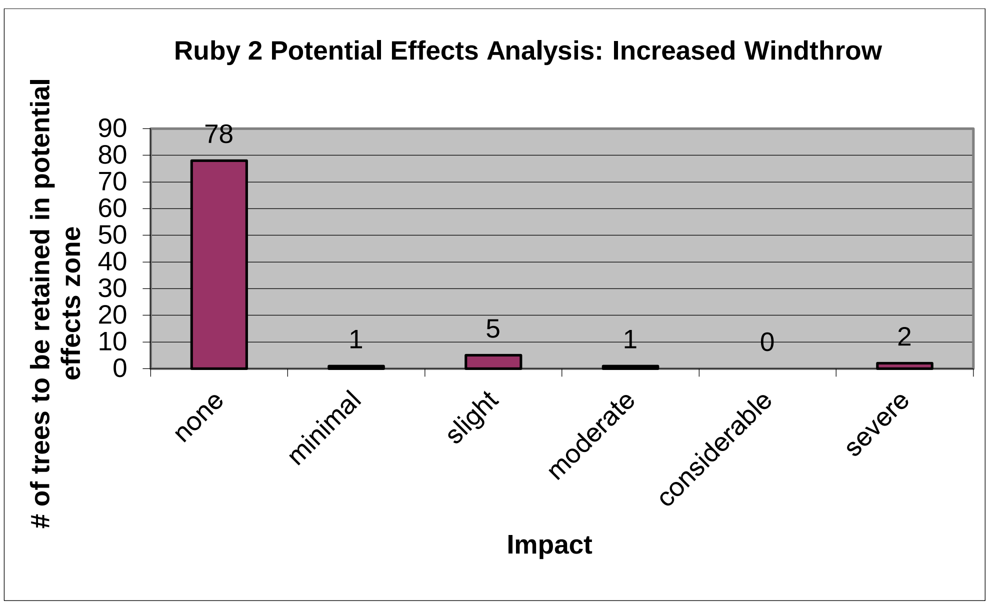

Figure 14. Ruby 2 Increased Windthrow Effects Analysis

Ambient light effects are almost all “none” because large overstory trees will remain.

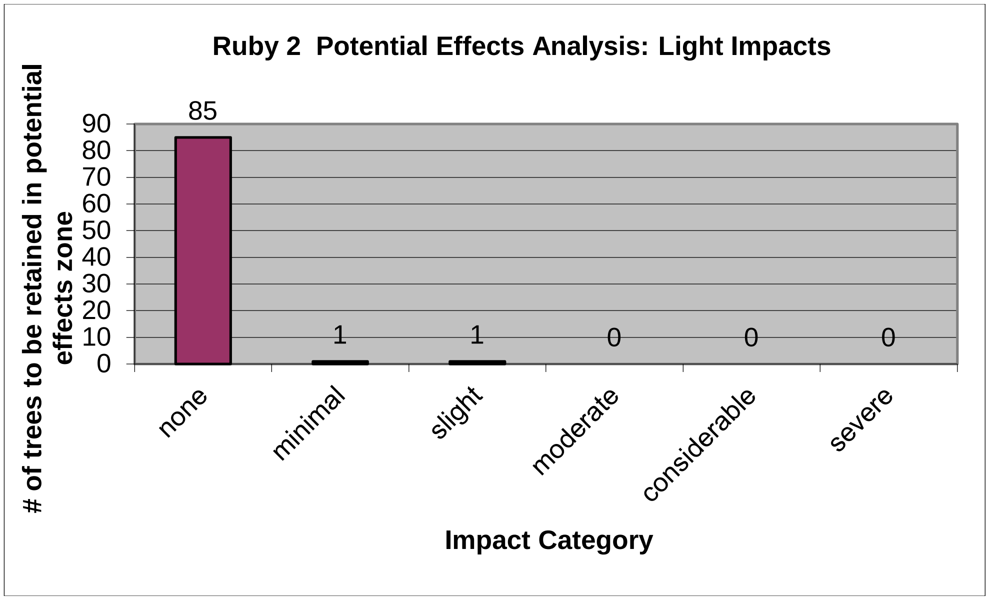

Figure 15. Ruby 2 Light Impacts Effects Analysis

Effects from nearby tree management and removal will be mostly “none.”

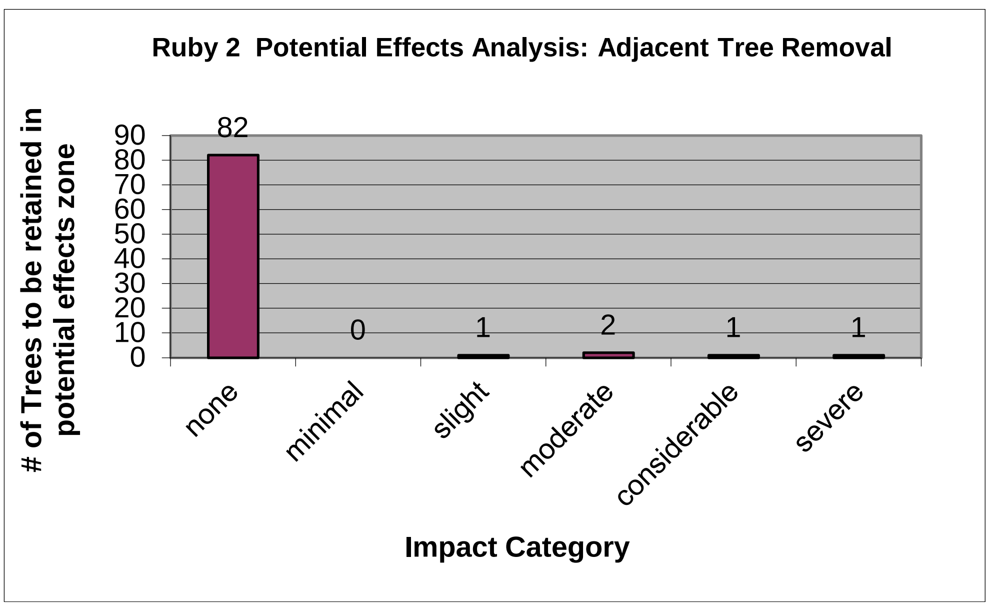

Figure 16. Ruby 2 Adjacent Tree Removal Effects Analysis

Construction damage potential is mostly "none" although it is slight for a small number of trees. One big leaf maple hanging over the road may have moderate or considerable effects, because it appears structurally unsound at this time.

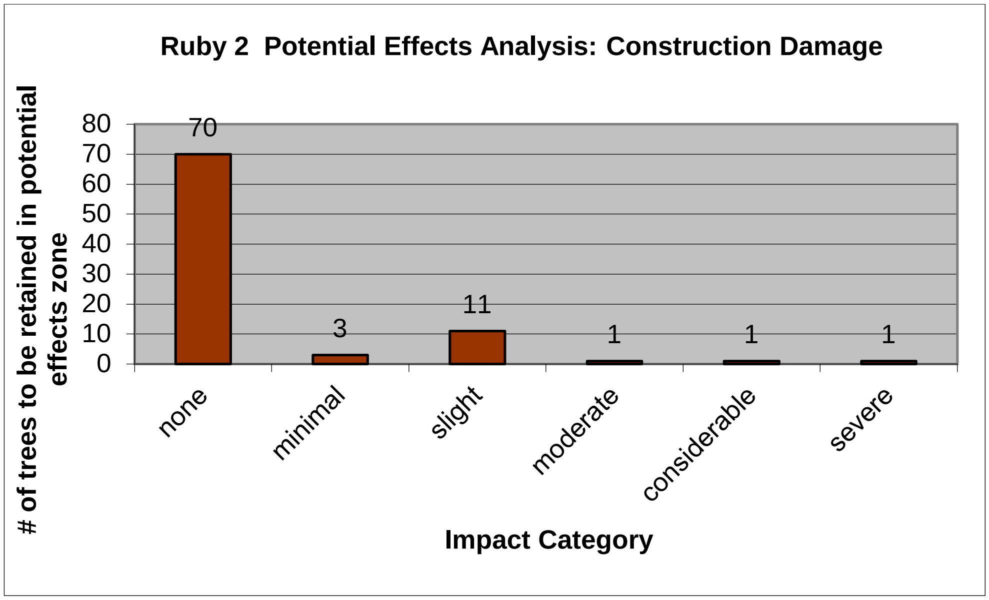

Figure 17. Construction Damage Effects Analysis

The forester/arborist team also evaluated potential root area effects on a tree-by-tree basis. Of the 87 live trees evaluated (many with multiple stems) that will remain, four had root effects of over 30% of the root effect area.

Discussion of Ruby 2 Effects

All the trees evaluated have been affected to some extent by the existence of a highway in the immediate vicinity. As many of the trees pre-dated the construction of SR 197, it is clear that the trees have previously endured and responded to construction effects. The forester/arborist team evaluated both the existing condition of each tree (bole damage, root damage, compaction damage, the existing presence of a culvert, paving, root pruning and fill) and assessed the marginal potential effects that would likely be the result of the construction as it has been proposed by Caltrans. The effects that are discussed here relate to those marginal effects that would result in the future due to the current highway construction proposal.

The data demonstrate that tree effects of the proposed road construction are mostly "none" for every data item evaluated. Two-thirds of the trees have "none" or "minimal" root zone effects. Wind movement effects are "none" for all trees except a single tree with "minimal" and another single tree with "slight" effects. Two trees have "slight" increased potential for windthrow. As can be seen from the data there was a small number of trees with minimal and slight effects in each of the other categories.

As with Ruby 1, construction damage potential effects and root zone potential effects turned out to be the most significant variables. The area of most concern is potential root effects. Although root potential effects for half of the trees were “none,” and 19 other trees had “minimal” potential effects, there are 14 trees at Ruby 2 where root damage may be “slight” and another 8 trees with potentially “moderate” root effects, in addition to the “considerable” effects to the big leaf maple noted below. We feel that the grove trees, having exhibited such resilience at the earlier highway and driveway construction activities, can tolerate moderate root effects without detriment, but it is in everybody’s interest to minimize every effect possible. Table 10 below identifies those trees that would be most affected by project activity. Special care shall be taken to protect and reduce effects from construction and compaction in the vicinities of R2_1284 and R2_1289. These are 41″ and 56″ redwood trees that will have 20–25% of their root zones affected. The forester/arborist team assessed that these trees are sufficiently resilient to withstand the proposed effects.

There are 7 very large old redwood trees that deserve special attention:

- R2_1662: photographs 134,135. This large old 108″ DBH redwood tree, already located at the very edge of the road, would have 5% of its root zone affected, and potential additional effects are slight.
- R2_741: photo 146-147. This is a double 80″ DBH and 36″ DBH redwood with substantial existing cut and fill and severe branch top mortality. It is set back from the road and marginal project effects would be minimal.
- R2_740: This 59” DBH redwood is set back from the road, is 5′ from the effect area and has 5% of its roots zone affected. It is sufficiently resilient to withstand construction effects. Root effects are anticipated to be minimal.
- R2_2037: This 122” DBH redwood is set far back from the road and is 36′ from the effect area. No effect would occur.
- R2_736 and R2_2025 are 118″ DBH and 119″ DBH pair of redwoods (photo 154) 10′ and 24′ from the effect area. We anticipate no additional potential effects because improvements in the area are limited to minor grading of a 2′ shoulder in 0–2% of the root zone.
- R2_392. (cover photo and photo 162). This 138″ DBH redwood is alongside the present roadway. Disturbance on that side of the road will be limited to the present roadway. There is “minimal” potential for construction and root effects and other effects are “none.” The Caltrans engineering team has recognized this tree as being of highest value.

The trees most affected are noted in the table below. All trees are listed in Appendix A and Appendix B.

Table 10. Ruby 2 Trees Most Affected by Potential Root Effects (all project effects are listed in Appendix A)

Ruby 2 Tree Clump Major Effects Summary				Distance from Face of Tree to Project Footprint (feet)
Tree	Sum of Effects	Species	DBH (inches)	
1287	16	Redwood	11	4
1285	15	Maple	16,16	15
810	12	Alder	15	11
1284	12	Redwood	41	7
1288	12	Redwood	17	1
1307	8	Redwood	38,16	0
1540	8	Redwood	27	0
619	6	Redwood	27	7
1303	6	Redwood	63	0
1307	6	Redwood	38,16	0
1449	6	Redwood	44,13	4
2030	5	Douglas-Fir	18	3
1075	5	Maple	22	18
1304	5	Redwood	18,27	1
1449	5	Redwood	41,14	4
744	4	Maple	33	0
90a	4	Maple	6,5,7,8,5	10
1289	4	Redwood	56	10

The evaluation team noted “Severe” effect potential from wind throw for a single 22” big leaf maple (R2_1075) which already hangs severely over the road way. We would recommend removal of that tree. Another big leaf maple (R2_1285), with a double 16” stem, had severe potential effects due to removal of an adjacent tree and the potential for construction effects. A stump (that will be removed) supports that tree and we recommend removal of the tree also. Nearby we noted considerable effects to an 11” redwood (R2_1287) that would have 40% of its root zone affected. That tree is presently in poor condition and may require removal.

In all cases the forester/arborist team assumed that roots will be present in the project’s limits of disturbance. However, potential construction effects on trees that would remain after construction were “none” for 70 trees, “minimal” for 3 trees, and “slight” for 11 trees.

Since the individual tree effects are minimal, the potential effects at the stand or forest level are negligible. The forester/arborist team felt that the Caltrans design team had done a thoughtful job and had taken considerable effort to protect trees the Ruby 2 project site.

c. Wind Effects (Ruby 1 and 2 sites)

The forester/arborist team considered potential changes in wind speed connected with the project. The open river canyon environments of Washington Curve and PCN2 are highly exposed to canyon-channeled winds and the projects will have no effect on the wind environment at either site. The team measured wind speed as vehicles traveled the Ruby 2 Corridor. A wind meter was placed in the travel lanes and along the road and observed during and after the movement of car to twin trailer size vehicles through the existing road corridor.

Our measurements of the winds generated by passing vehicles, including cars, small trucks and large semi-trailers on a straight redwood forested section of road indicate that the wind generation is less than or equal to 6.1 miles per hour and duration is 1 to 23 seconds. The forester/arborist team could find no evidence for tree effects from such increased wind velocity. The team noted that the forest type and road site trees are along a riparian corridor flood plain and not water-limited at either of the Ruby sites. We do not expect any adverse effects as a result of minor increase in vehicle wind generation. The team concluded that the projects at these sites would have no measurable effect on the tree canopies at the Ruby 1 and Ruby 2 sites.

Table 11. State Route 197 – Ruby 2 Wind Data
(wind peak speed and elevated wind duration – taken at 4.5 feet above grade)

Vehicle Type	Peak Wind Speed	Wind Duration	Notes
Semitrailer Truck	4.5 mph	5 seconds	In Travel lane
Semitrailer Truck	0.0 mph	–	Opposite side of road
Dump Truck	0.9 mph	7.0 seconds	Opposite side of road
Pickup Truck	0.1 mph	1.0 seconds	In Travel Lane
Car	0.1 mph	1.0 seconds	In Travel Lane
Tandem Dump Truck + 3 cars	4.5 mph	23.0 seconds	Line of vehicles
Tandem Lumber	6.1 mph	21.0 seconds	In Travel Lane
Tandem Dump	3.9 mph	19 seconds	In Travel Lane
3 Car Row	2.9 mph	11 seconds	In Travel Lane

d. Patrick Creek Narrows Location 2

The PCN2 site is within, and surrounded by, the Six Rivers National Forest (green on the map in Figure 1), which encompasses most of the upper portion of the 108,000-acre Smith River watershed. The PCN2 improvements involve replacement of a bridge crossing the Smith River that was constructed almost a century ago. In addition a road cut will reduce the curve south of the bridge. The site itself is generally described in the DEIR/EA Section 2.3.2 (Caltrans 2010). According to the DEIR/EA the area includes 2.88 acres of Douglas-fir forest, 0.38 acre of white alder forest and woodland, 0.707 acres of Smith River riverine, 0.005 acres of seeps and drainages, 0.5 acres of disturbed site, and 1.26 acres of sparsely vegetated woodland. The latter is the area of the proposed road cut.

Immediately to the east of the bridge northern approach is the stand shown in Figure 19. The dominant trees there are scattered large old Douglas-fir with regenerating younger trees, standing dead and lying dead woody material in the openings. This stand might well be considered "old growth" as it is relatively undisturbed. The stand of trees was not evaluated although 2 large old Douglas-fir trees alongside the highway are unavoidable and will be removed as a consequence of the project. Their removal will not change the characteristics of the "old growth" stand, which is located entirely upslope.

The hillside above the road cut is an area of sparsely vegetated mixed hardwood/conifer forest on very steep (averaging approx. 80%) slopes that characterize the area, and which recently burned. The net immediate tree-loss effect of the project would be the removal of 2 Douglas-fir trees > 30" DBH (9_PAT 52" DBH and 36_PAT 34" DBH), removal of one each 8", 15", 17", 21", 24" and 26" DBH Douglas-fir, and removal of 48 hardwood trees (individuals and clumps; Table 12).

As can be seen from the photo images, the PCN2 road cut is within the ecological context of much-larger native forests in the Smith River Canyon. The area is already affected by the existing road, and fire. Although the road cut is in itself a major landscape change, the forest at that site is relatively unexceptional, and overall forest-level effects would be minor when viewed within the context of the landscape at PCN2 (see Figure 18).

Figure 18. Google Maps Imagery Showing the Curve at Patrick Creek Narrows 2

North side of bridge/east side of road: The new bridge is set just to the east of the existing bridge. Construction of the northern approach to the bridge will result in removal of 9_PAT, a 52″ DBH, "old" Douglas-fir. The trees 1-PAT, 16_PAT, 23_PAT, 30_PAT, and 18_PAT, 51″, 40″, 29″ and 35″ Douglas-fir trees just above the river bank (photo 237) will remain, but are within the PEZ. Also on the north side of the new bridge a number of smaller hardwoods (tanoak, canyon live oak, a bay and big leaf maple) would be removed and others will remain. With the exception of a 20″ big leaf maple and an 18″ canyon live oak, all of the hardwoods to be removed are in the 6–15″ diameter range.

Figure 19. "Old Growth" Douglas-Fir Stand Looking East at the North Side of the Proposed New Bridge

Trees 16, 23 & 30 will be protected. These are Douglas-fir trees 51″, 40″ and 29″ trees.

South side of new bridge/ east side of road: The roadwork immediately south of the bridge would be at the east side of the existing road way. This is a steep embankment descending into the Smith River and an elevated roadway would be constructed at the site. Tree 36_PAT a native 34" Douglas-fir would be removed. Also 40_PAT and 43_PAT, 17" and 26" Douglas-firs, will be removed as a result of relocation of the bridge approach. A minor ridge in the area, immediately east of the roadway will remain undisturbed and should also serve to protect the residual tree population.

Figure 20. Location of the Proposed Bridge, East Side of US 199 at Patrick Creek Narrows Location 2

Patrick Creek Narrows Location 2 Road Cut: Caltrans also plans to reduce the angle of the curve at the southern approach to the bridge. This would require a major road cut in the location shown inside the green line in Figure 22 below. The area of the road cut is characterized as a recently burned, dry, low site, southern exposure mixed hardwood forest type with scattered Douglas-fir. Most of the larger (15–24”) Douglas-fir succumbed to the fire, as evidenced by logs on the hillside. The road cut would result in the removal of 76 hardwood tree stems including 2 canyon live oak trees with 15 stems each. Also 4 Douglas-fir trees would be removed in the area with estimated diameters of 8, 24, 15 and 21 inches. The arborist/forester team also estimated that a Douglas-fir, two 10” madrones, and 3 tanoaks (10”, 13” & 16”) within the effect zone, but outside of the road cut, will survive following construction. Essentially all other nearby hillside trees are presently standing dead as a result of recent wildfire, and so trees to be retained are not otherwise reported.

The following figures show the area, tree locations, and the tree inventory.

Figure 21. The Existing Road Cut at Patrick Creek Narrows Location 2 Will be Enlarged

Figure 22. Patrick Creek Narrows Location 2
Approximate Locations of Significant Trees

In Figure 22, Red = "Remove," Green = "Save." In addition all trees will be removed from the "Road Cut Area" shown. Note that the GPS waypoints are shown above. Some GPS locations, such as 40_PAT are on the roadway, but the trees are actually on the embankment; the actual locations were inaccessible while in the field.

Table 12. Tree Removals at Patrick Creek Narrows Location 2
(note that records marked with an asterisk represent multiple tree stems)

Tree #	Species	DBH (inches)	Photo#	RMVLCODE
4	TO	13		Remove
6	QUCH	13,9*		Remove
7	TO	8		Remove
9	DFOG	52	236	Remove
8	TO	6		Remove
10	TO	8		Remove
11	TO	18		Remove
12	TO	8		Remove
13	TO	6		Remove
14	TO	15,6,15*		Remove
15	BAY	10		Remove
17	BM	15,20*		Remove
20	BM	14		Remove
21	DF	6		Remove
22	BAY	5		Remove
24	DF	10		Remove
26	BM	8		Remove
27	TO	10,6*		Remove
29	QUCH	6		Remove
31	BM			Remove
32	BM	6		Remove
33	BM	7		Remove
34	BM	6		Remove
36	DFOG	34	269 & 245	Remove
40	DF	17	272	Remove
42	TO	13	273	Remove
43	DF	26	273	Remove
89	TO	10		Remove
(Not numbered)	BM	10,8*	251	Remove
	TO	10,10,8,8*	251	Remove
	DF	8	252	Remove
	QUCH	8	252	Remove
	DF	24	252	Remove
	QUCH	6	253	Remove
	QUCH	18	253	Remove
	QUCH	8	254	Remove
	QUCH	8	254	Remove
	MD	6	254	Remove
	QUCH	10	254	Remove
	TO	10	254	Remove
	TO	6,6	254	Remove
	QUCH	14	254	Remove

Tree #	Species	DBH (inches)	Photo#	RMVLCODE
	QUCH	12	254	Remove
	QUCH	18	255	Remove
	QUCH	8,8,8,10*	255	Remove
	QUCH	12	255	Remove
	MD	12,12*	255	Remove
	QUCH	6″x15, 8″x15*	257	Remove
	DF	15	257	Remove
	MD	10,8,6,6*	257	Remove
	QUCH	8,8,6,6*	259	Remove
	QUCH	8,6*	259	Remove
	QUCH	8,6*	259	Remove
	QUCH	8	259	Remove
	DF	21	259	Remove
	QUCH	8,8,8,7*	259	Remove

* = multiple tree stems.
QUCH = canyon live oak.
DF = Douglas-fir.
TO = tanoak.
MD = madrone.
DFOG = DF old.

Discussion of Patrick Creek Narrows Location 2

Summary of Tree Removals East of Route 199:

- 5 Douglas-fir with an average DBH of 28.3″, ranging from 6″ to 52″.
- 11 tanoak with an average DBH of 10.5″, ranging from 6″to 18″ (Two multiple-trunk tanoaks were 15″,6″,15″ and 10″,6″ respectively).
- 2 canyon live oaks with an average DBH of 9.5″.
- 2 bay laurel with an average DBH of 7.5″.
- 14 big leaf maple stems in 7 tree clumps with an average DBH Of 10″ (One tree had 7 stems ranging from 5″ to 10″).

Summary of Tree Removals on Hillside above Rt. 199 (80 tree stems in all)

- 4 Douglas-fir with an average DBH of 17″, ranging from 8″ to 24″.
- 3 tanoak with an average DBH of 9″, ranging from 6.6 to 10″ (1 multiple-trunk tanoak was 10″, 8″,10″ and 8″ respectively).
- 17 canyon live oaks with an average DBH of 9.9″, ranging 8 to 18″ (Note: Six were multiple stemmed. The largest trunk diameter was used for averaging).
- 2 Pacific madrones with an average DBH of 11″.
- 1 big leaf maples with an average DBH of 10″ & 8″.

Table 13. Patrick Creek Narrow Location 2: Effects to Large Old Trees (greater than 36 inches DBH)

Tree #	Species	DBH (inches)	Distance to Project Footprint (feet)	Root Effects	Sum of Effects
1_PAT	Douglas-fir	53	18	2	2
9_PAT	Douglas-fir	52	NA	NA	Removal
16_PAT	Douglas-fir	51	24	0	0
23_PAT	Douglas-fir	40	10	3	6
50_PAT	Douglas-fir	37	2	0	0

There are a few large, old trees at this site along the north side of the bridge and east side of the roadway, associated with the stand of old growth Douglas-fir. One large Douglas-fir will be removed (9_PAT) as it is in the project footprint, and another (23_PAT) will have moderate root effects.

Also of note include: PAT_45 (33 in DBH) would have a substantial root area affected and may not survive as 40 percent of its root zone would be disrupted (Root Effects 5 or Severe). This tree is close to the project footprint on the outside curve above the Smith River.

e. Washington Curve

The Washington Curve road cut is intended to straighten a compound curve and add lane width and shoulder width. The forest that characterizes the area is mixed tanoak/madrone hardwood, Douglas-fir and knobcone pine. In forestry terms the area to be affected is dry, south-facing, has steep slopes, thin soils and low site productivity. The Washington Curve improvements, as proposed, would remove approximately 3 acres of native forest. The road cut extends 850 feet through a low site and south-facing knobcone pine, tanoak, canyon live oak stand on a steep slope with thin soils. The trees are in the 5” to 20” diameter range. At the west end of the road cut there is a small number of larger young Douglas-fir, one as large as 26”, growing where the soils are deeper and soil moisture is more readily available. The proposed project would remove one hundred forty tree (143) stems and have potential effects on an additional 36 trees that would remain.

As can be seen from the photo images, the Washington Curve road cut is within the ecological context of much-larger native forests in the Smith River Canyon. The area is already affected by the existing road and multiple human effects. The forest ecological effects of the cut and other road improvements are relatively minor when viewed within the context of the landscape at PCN2 (see Figure 23).

Figure 23. Google Maps Imagery of Washington Curve

The forester/arborist team reviewed the Washington Curve hillside site accompanied by the Caltrans' Staff. The steep slope and forest structure created very difficult access. At Washington Curve the boundaries of the uphill road cut are clearly staked. The forester/arborist team inventoried all of the trees to be removed and the trees to remain within the effect zone. The team did not record exact locations of any of the trees along or below the staked limits of excavation and grading, which is on a steep brushy hillside. Sufficient data was taken to reveal the extent of effects.

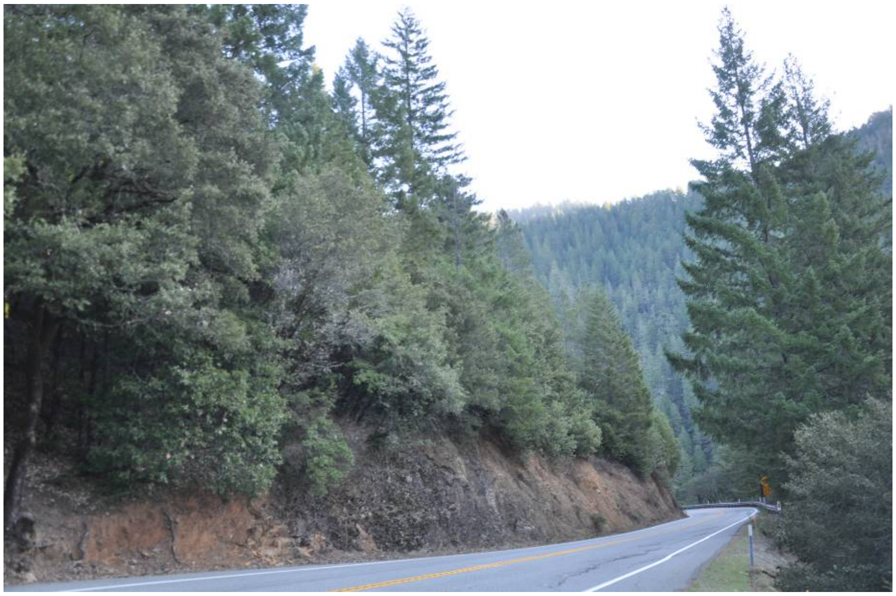

Figure 24. The Proposed Washington Curve Road Cut (shown on the left side of the road)

The forester/arborist crew traveled along the staked road cut and inventoried trees to be removed, and also those that would remain undisturbed above the road cut inside the species dependent 5–10 times DBH “effect zone.” The evaluation is simply based upon whether or not the tree is within the road cut, affected by the road cut, or within the PEZ (10x DBH for Douglas-fir and 5X DBH for all other species). If any tree falls within the road cut then the plan is to remove the tree.

Figure 25. Declining Knobcone Pine and Hardwood at Washington Curve Road Cut

Trees to Be Removed

The inventory, shown in Table 14, demonstrates that 140 tree stems will be removed and up to 39 tree stems will remain at the upper edge of the road cut:

- 27 Douglas-fir average DBH 13" ranging from 5 to 26 inches in diameter.
- 32 knobcone pines average DBH 9.8" ranging from 6 to 16 inches DBH
- The 49 remaining trees/clumps to be removed are tanoak, canyon live oak with an average diameter of 6.6 inches, ranging from 5 to 14 inches.
- All 39 "Save" trees within the PEZ will be retained except any with clear root damage, as determined by the arborist on-site during and after construction.

In all, the volume of the trees to be removed from the road cut area (Figure 26) represents approximately 8 cords of hardwood, 5 cords of knobcone pine and 8 cords of Douglas-fir. This is the approximate equivalent volume to 1.5 legally loaded log trucks. The inventory is presented in Table 14. All trees are marked on-site with identifying numbers.

Figure 26. Washington Curve with Road Cut Area Shown

Potential Effects Zone Trees Discussion

The inventory demonstrates that 36 trees (39 stems) are in the PEZ and 107 trees (140 stems) are located within in the removal area (footprint of the cut). The knobcone pine are in decline and may be affected by root disturbance. Other than 17 knobcone pine, 19 other trees in the effect zone outside of the road cut will most likely survive. The upper 2 feet portion of the road cut, as it meets with the natural terrain, will be “rounded” to achieve a stable angle of soil repose. Thus, retained trees close to the cut may succumb to root damage, root desiccation, or wind throw.

Knobcone pine at Washington Curve is in significant decline, as it is a short-lived tree living on droughty soils and dependent on fire for regeneration. Therefore any low-vigor knobcone within 10 feet of the rounding zone should be removed to prevent declining trees from falling into the travel lanes. Based on review of a number of nearby road cuts, the forester/arborist team estimates that residual forest trees outside of the effect zone will be unaffected. Overall, the forester/arborist team concluded that wind, root and light potential effects will be minimal, and that other effects will be negligible.

Effect Summary:

- 143 total trees/clumps assessed would be affected by the project.
- 107 Trees would be removed. Of the 107 removed trees there are, 27 Douglas-fir, 32 knobcone pine, 32 tanoak, 14 canyon live oak and 2 madrone.
- 36 trees (39 stems) would remain. Of the remaining trees there would be 9 Douglas-fir, 18 knobcone pine, 1 madrone, 4 tanoaks, and 5 canyon live oaks.

Table 14. Trees within Project Limits and Potential Root Effects Zone at Washington Curve (note that records marked with an asterisk represent multiple tree stems)

Tree #	Species	DBH (inches)	Plan
1	DF	17	Save
6	DF	11	Save
8	DF	22	Save
13	KP	8	Save
17	KP	7	Save
19	KP	10	Save
24	KP	8	Save
26	TO	11,7,8*	Save
29	KP	13	Save
32	KP	9	Save
34	KP	8	Save
42	KP	9	Save
46	KP	11	Save
48	TO	5,8*	Save
50	KP	7	Save
52	KP	6	Save
71	KP	8	Save
77	KP	11	Save
80	KP	8	Save
82	KP	9	Save
87	KP	11	Save
89	KP	11	Save
93	QUCH	8	Save
94	QUCH	9	Save
96	QUCH	9	Save
97	QUCH	6	Save
112	QUCH	5	Save
115	TO	8	Save
116	TO	5	Save
118	DF	8	Save
119	DF	5	Save
120	DF	20	Save
121	DF	10	Save
135	DF	10	Save
140	DF	22	Save
142	MD	6	Save

* = multiple tree stem.
DF = Douglas-fir.
KP = Knobcone pine.
QUCH = Canyon live oak.
TO = Tanoak.
MD = Madrone.

Tree #	Species	DBH (inches)	Plan
2	DF	28	Remove
3	DF	8	Remove
4	DF	10	Remove
5	KP	9	Remove
7	TO	9,8,5*	Remove
9	DF	15	Remove
10	KP	15	Remove
11	DF	8	Remove
12	KP	10	Remove
14	TO	10,8*	Remove
15	KP	9	Remove
16	DF	12	Remove
18	KP	7	Remove
20	DF	7	Remove
21	DF	8	Remove
22	DF	11	Remove
23	KP	10	Remove
25	KP	7	Remove
27	TO	6,6,5,5*	Remove
28	TO	10,10*	Remove
30	TO	8	Remove
31	TO	5,5,7*	Remove
33	KP	10	Remove
35	KP	12	Remove
36	DF	10	Remove
37	TO	6	Remove
38	KP	7	Remove
39	KP	11	Remove
40	KP	10	Remove
41	KP	7	Remove
43	KP	11	Remove
44	KP	7	Remove
47	KP	9	Remove
49	KP	6	Remove
51	KP	9	Remove
53	KP	16	Remove
54	KP	6	Remove
55	KP	9	Remove
56	KP	10	Remove
57	TO	5	Remove
58	TO	7	Remove
59	KP	13	Remove
60	TO	9,6*	Remove
61	TO	6	Remove
62	TO	5	Remove
63	TO	6	Remove

Tree #	Species	DBH (inches)	Plan
64	TO	7	Remove
65	TO	8	Remove
66	QUCH	6	Remove
67	DF	19	Remove
68	QUCH	6	Remove
69	TO	10,6*	Remove
70	TO	7	Remove
72	TO	6,5,5,5,5*	Remove
73	TO	11	Remove
74	DF	20	Remove
75	DF	22	Remove
76	KP	7	Remove
78	DF	7	Remove
79	DF	7	Remove
81	DF	20	Remove
83	DF	16	Remove
84	DF	9	Remove
85	QUCH	5	Remove
86	KP	12	Remove
88	KP	10	Remove
90	TO	6	Remove
91	QUCH	6	Remove
92	KP	9	Remove
95	TO	5,6,6*	Remove
98	TO	8	Remove
99	KP	14	Remove
101	QUCH	6,5,5*	Remove
102	KP	9	Remove
103	TO	5	Remove
104	KP	12	Remove
105	TO	6,6*	Remove
106	KP	12	Remove
107	KP	11	Remove
108	DF	5	Remove
109	DF	12	Remove
110	TO	7	Remove
111	QUCH	5	Remove
113	QUCH	5	Remove
114	QUCH	6	Remove
117	QUCH	5	Remove
122	DF	10	Remove
123	DF	9	Remove
126	TO	7	Remove
127	MD	7	Remove
128	TO	9,6*	Remove
129	TO	6,5*	Remove
130	TO	8,5*	Remove
131	TO	9	Remove
132	QUCH	7,5*	Remove

Tree #	Species	DBH (inches)	Plan
133	DF	18	Remove
134	MD	7	Remove
136	DF	13	Remove
137	DF	9	Remove
139	QUCH	5,5,5,5*	Remove
141	DF	26	Remove
144	QUCH	10,5*	Remove
145	TO	8,5,5*	Remove
146	TO	6,5,5*	Remove
147	QUCH	12	Remove
148	QUCH	15,14*	Remove
318	DF	12	Remove

* = multiple tree stem.
DF = Douglas-fir.
KP = Knobcone pine.
QUCH = Canyon live oak.
TO = Tanoak.
MD = Madrone.

7. Conclusions

Old-Growth. Members of the forester/arborist team each have over 30 years of experience in forestry inventory, and tree management throughout California. They have cored, and determined the age and dendrochronology of thousands of redwood trees. Based upon our considerable experience we did not utilize any universal definition for “old-growth.” We gleaned those common characteristics of old-growth coast redwood and Douglas-fir from the literature and employed them to conclude that the forest north and east of the PCN2 bridge site is old-growth Douglas-fir forest. There is at least one group of old trees that is remnant of a cut-over former stand of old-growth redwood (at Ruby 2). In addition, a number of large redwoods exist at Ruby 1, each of which is undoubtedly quite old.

Tree removal effects. Implementation of these highway improvement projects will result in the unavoidable removals of trees as noted in this report. There will be little to no effect on the large, old redwoods remaining at the Ruby 1 and Ruby 2 project sites. Except for 2 Douglas-fir, as noted in this report, to be removed at PCN2, the project will have little effect on the remaining large old trees.

Tree-level effects. Although effects are not considerable at the aggregated level, the forester/arborist team determined that there are moderate effects upon individual trees. Most are related to root zone effects, and construction-related effects. Noted baseline conditions and potential effects for all roadside trees at the individual tree level are included in Appendix A & B.

Ecological context. It is important to view these road improvement related effects within the context of the Smith River watershed which is 108,000 aces in size, and mostly heavily forested with native redwood, mixed conifer and hardwood forests. The removal of a small number of trees along the highway corridor will not significantly affect the forest ecosystems within the watershed.

8. References and Literature Cited

Bernhardt, E. and Swiecki, T. 1991. Guidelines for Developing and Ealuating Tree Ordinances. For California Urban Forestry Program, California Dept. of Forestry and Fire Protection.

Borchert, M., D. Seggatta. and M. Purser, 1988. Coast Redwood Ecological Types of Southern Monterey County, California. USDA FS Gen. Tech. Rpt. PSW-107, 27 pp.

Burns, Russell M., and Barbara H. Honkala, tech. coords. 1990. Silvics of North America: 1. Conifers; 2. Hardwoods. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC. vol.2, 877 p.

Caltrans. 2010. Draft Environmental Impact Report/ Environmental Assessment. June 2010. State Clearinghouse Number: 2008082128, SR 197 and US 199 in Del Norte County, Ruby 1, 01-DN-197-PM 4.5; Ruby 2, 01-DN-197-PM 3.2-4.0;Patrick Creek Narrows, 01-DN-199-PM 20.5-20.9, PM 23.92-24.08, & PM 25.55-25.65;The Narrows, 01-DN-199-PM 22.7-23.0; Washington Curve, 01-DN-199-PM 26.3-26.5, EA: 01-48110, 01-45490, 01-45000, 01-47940, 01-44830. State of California Department of Transportation.

Costello, L. R. and Jones, K. S. 2003. Reducing Infrastructure Damage By Tree Roots: A Compendium of Strategies. 119 pp.

Dagley, C. M. 2007. Old redwood forest restoration: Quantifying forest characteristics and development of initial restoration treatments. Dissertation, U.C. Berkeley. 96 pp.

Daubenmire, R. 1975. The community status of coastal redwood, *Sequoia sempervirens*. A report prepared for the U.S. Nat. Park Service. 17p.

Davis, F. W., D. M. Stoms, A. D. Hollander, K. A. Thomas, P. A. Stine, D. Odion, M. I. Borchert, J. H. Thorne, M. V. Gray, R. E. Walker, K. Warner, and J. Graae. 1998. The California Gap Analysis Project--Final Report. University of California, Santa Barbara, CA. [http://www.biogeog.ucsb.edu/projects/gap/gap_rep.html].

Dunster. 2009. Tree Risk Assessment in Urban Areas and the Urban/Rural Interface. 68 pp.

Franklin, J. F. and T. A. Spies. 1991. Ecological Definitions of Old-Growth Douglas Fir Forests. Pp, 61-69 in: Wildlife and Vegetation of Unmanaged Douglas -Fir Forests. Gen. Tech. Rep. PNW-GTR-285.

Franklin, J. F., C. Kermit, W. Denison, A. McKee, C. Maser, J. Sedell, F. Swanson and G. Juday. 1981. Ecological Characteristics of Old-Growth Douglas-Fir Forests. USDA FS Gen. Tech. Rep. PNW-118. 48 pp.

Giusti, G. A. 2007. Structural Characteristics of an Old-Growth Coast Redwood Stand in Mendocino County, California. USDA FS Gen. Tech. Rep. PSW-GTR-194. pp.161-168.

Grabosky, J., Bassuk, N. L., Urban, J. and Trowbridge, P. 1998. Structural Soil: An Innovative Medium Under Pavement that Improves Street Tree Vigor. ASLA Proceedings Annual Conference, pp183-185.

Harris, R., Clark, J, and Matheny, N. 1999. Arboriculture, 3rd Edition. 887 pp.

Mann. 2002. Impacts "Root Pruning: The Good the Bad and the Ugly." In Roots vs. Infrastructure. CUFC Conference

Matheny and Clark. 1998. Trees and Development: A Technical Guide to Preservation of Trees During Land Development. 179 pp.

Mattheck and Breloer 1994. The Body Language of Trees: A Handbook For Failure Analysis. London, England: Her Majesty's Stationary Office. 240 p.

Mattheck, C. 2004. The Face of Failure in Nature and Engineering. Verlag Forschungszentrum Karlsruhe.

McBride, J. and D. Jacobs. 1977. Ecology of Redwood and the Impacts of Man's Use of the Redwood Forest as a Site for Recreational Activities-A Literature Review. USNPS Tech. Rep. No. 1.

Simcha Le-Yadun. 2011. Why should trees have natural root grafts? Tree Physiology. Volume 31, Issue 6, pp. 575-578.

Sinclair, W.A., Lyon, H.H., and Johnson, W.T. 1987. Diseases of Trees and Shrubs. Comstock Publishing Associates, Ithaca, NY, 574p.

Singer, S. 2009. Old-Growth Forests of the Santa Cruz Mtns. Santa Cruz Mountains. Santa Cruz Bioregional Council. Available: www.scmbc.net/ogforests.htm.

Sleeter, B & Calzia, J. 2011. US Geological Survey Land Cover Trends Report. Klamath Mountains Ecoregion. Available: http://landcovertrends.usgs.gov/west/eco78Report.html

Smiley, E.T, B. Fraedrick, and N. Hendrickson. 2002. Tree risk management. Bartlett Tree Research Laboratory.

Smiley, T. E. 2009. Sidewalk Repair Near Trees, Bartlett Tree Research Laboratories Technical Report. Bartlett Tree Experts, Inc. pp. 3.

State of California Parks and Recreation. 2011. Department Operating Manual (DOM), Section DOM 0310.6.1.

Urban, J. 2008. Up From the Roots - Healthy Soils and Trees in the Built Environment. ISA, 479 pp.

USDA Forest Service. 1990. Agricultural Handbook 654, Silvics of North America, Vol. 1, Conifers. 675 pp.

USDA Forest Service. 1993. Region 6 Interim Old Growth Definition. See http://www.blm.gov/or/plans/surveyandmanage/files/16-region6_old_growth_def.pdf

Appendix A. Tree Inventory Summary & Comments

RECNO	Tree	Tree #	Species	DBH in/Stem	Plan Status	Photo #	Clump No.	LCR %	Position	Comments
RUBY 1										
1	R1_294	294	rw	42	Protect	62&63&64	0	60	D	on roadway edge now 135 ft tall
2	R1_295	295	rw	34	Protect	62&64	0	50	C	
3	R1_296	296	rw	29	Protect	65	0	50	D	
4	R1_297	297	rw	70	Protect	66	0	60	D	
5	R1_298	298	bay	20,15,16	Protect	70	0	30	I	
6	R1_303	303	rw	50,50	Protect	59	0	50	D	2 50 inch stems
7	R1_304	304	rw	40,34,44,15,23	Protect	54&55&56	3	70	D	5-stemmed sprout
8	R1_306	306	rw	43	Protect	46	0	55	D	wrap ppz fencing
9	R1_307	307	rw	45	Protect	46	0	55	D	
10	R1_308	308	rw	16.4	Protect	41	1	25	I	
11	R1_311	311	rw	15.6	Protect	41	1	30	I	wrap trunk in construction
12	R1_392	392	rw	25.5	Protect	39		40	C	
13	R1_393	393	rw	26.7	Protect			30	C	
14	R1_394	394	rw	26.3	Protect	40		30	C	
15	R1_395	395	rw	39	Protect		0	40	D	
16	R1_396	396	stump	84	Protect					
17	397A	397A	rw	11	Protect	41	1	10	S	sprout OFF 397
18	R1_397	397	rw	39	Protect	41	1	40	D	
19	R1_398	398	rw	27	Protect		2	30	C	111 ft tall
20	R1_399	399	rw	30	Protect		2	40	C	
21	R1_400	400	rw	53	Protect	44&45	2	40	C	
22	R1_401	401	rw	19	Protect	44&45	2	50	I	
23	R1_425	425	rw	21	Protect	67	0	75	D	
24	R1_590	590	bay	8,12,15	Protect		0	60	I	
25	R1_591	591	bay	12	Protect		0	25	I	
26	R1_592	592	bay	17	Protect	74	0	30	I	
27	R1_593	593	rw	57	Protect	75	0	45	D	
28	R1_594	594	rw	50,50,16,16,16	Protect	76	5	60	D	cluster of 5
29	R1_597	597	bay	14,16,15	Protect		6	50	C	outside impact zone
30	R1_596	596	bay	19	Protect	77	6	50	C	
31	R1_598	598	rw	50,42	Protect	78	0	50	D	Double rw
32	R1_599	599	rw	60,40	Protect	79&80	0	50	D	0Double rw
33	599A	599A	ra	16	Protect	102	0	35	D	gps 599a
34	R1_600	600	rw	59	Protect	86	0	55	D	772 on map
35	R1_604	604	bay	18,21,10	Protect	83	7	30	I	incl 605
36	703B	703B	rw	29.3	Protect		0	50	I	gps703b
37	703C	703C	rw	15	Protect		0	50	I	gps gps 703b
38	703A	703A	rw	45,18	Protect	47&48&49&50	0	75	D	clumps of bay alder nearby no impactsgps703a
39	R1_706	706	rw	20	Protect		0	30	C	
40	R1_703	703	rw	55	Protect		3	70	D	
41	R1_709	709	rw	29	Protect	58	0	20	I	
42	294A	294A	bay	17,15	Protect	61&60	0	40	I	2stem rotted 50 inch cavity skeleton
43	R1_727	727	rw	32	Protect		4	50	I	
44	R1_721	721	rw	15	Protect	71	4	50	I	has crossing stem
45	603A	603A	rw	16	Protect	97	0	40	D	603awrap esa
46	604A	604A	rw	9,11,10	Protect	98	10	30	C	also 603a gps
47	605A	605A	rw	18	Protect	99	0	45	D	605a gps

Appendix A. Continued

RECNO	Tree	Tree #	Species	DBH in/Stem	Plan Status	Photo #	Clump No.	LCR %	Position	Comments
48	606A	606A	rw	6,6,7,5	Protect		11	30	C	very young sprouts606a gps
49	607A	607A	rw	8,11	Protect	108	13	40	C	all 10 yr sprouts607a gps
50	608A	608A	rw	10,10,8,6,6,10,6,6	Protect	107	12	60	C	all 10 yr sprouts608a gps
51	609A	609A	rw	12,7,6,5	Protect	109	13	50	C	all 10 yr sprouts
52	610A	610A	rw	18,20,12	Protect	111	14	50	D	610a gps
53	611A	611A	rw	14	Protect	111	0	50	C	611a gps
54	R1_724	724	rw	60,50	Protect	71	4	60	D	
55	724A	724A	rw	82	Protect	72&73	0	50	D	old growth characteristics gps 724a
56	600A	600A	rw	65,75	Protect	84&85	0	60	D	old growth characteristics gps 724a 600a gps
57	601A	601A	rw	17,16,7.10,8	Protect	87&88	8	50	D	20 year old sprouts601a gps
58	602A	602A	rw	9,5,6	Protect	89&90	9	60	D	10 year old sprouts602a gps
RUBY 2										
59	R2_2113	2113	rw	44,16	Protect	119	20	70	D	0
60	R2_2115	2115	rw	38	Protect	119	20	70	D	0
61	R2_1644	1644	rw	39	Protect	120	0	70	D	
62	R2_1646	1646	rw	40	Protect	120	0	50	C	
63	R2_1648	1648	rw	38	Protect	121	0	50	C	
64	R2_1649	1649	rw	36	Protect	121	0	40	C	
65	R2_1650	1650	rw	65,36,16	Protect	123	21	50	D	tree nos 1650 1651 and 2104older sprout est 150yrs very minor impacts shoullder backing 2 tft only
66	R2_1659	1659	rw	18	Protect	124	0	30	I	essentially outside impact zone
67	R2_2094	2094	rw	9	Protect	125	22	80	I	
68	R2_1660	1660	rw	36,9	Protect	125	22	70	C	incl 2093
69	R2_2097	2097	rw	48,30	Protect	126	23	65	D	
70	R2_1535	1535	rw	23,52	Protect	127	24	60	D	150 yr large
71	R2_2081	2081	ra	13	Protect	128	0	35	C	
72	R2_1533	1533	bay	53	Protect	129	0	15	C	rotted w cavity
73	R2_1421	1421	rw	59	Protect	130	0	60	D	shoulder backing only in this area
74	R2_1417	1417	rw	36,32	Protect	131&132	25	65	D	essentially out of impact zone
75	R2_1418	1418	rw	70,30,66	Protect	131&132	26	75	D	essentially out of impact zone
76	R2_1308	1308	rw	68	Protect	133	0	75	D	
77	R2_1662	1662	rw	108	Protect	134&135	0	50	D	large og tree at edge of road
78	R2_2063	2063	df	17	Protect	136	0	25	C	10x zone
79	R2_1232	1232	df	21	Protect	137	0	65	D	10x zone
80	98A	98A	ra	7	Protect	138&139	0	50	C	low vigor alder
81	R2_1223	1223	rw	39,7	Protect	138&140	27	30	D	180 deg root zone away from project
82	99A	99A	rw	9	Protect	138	0	50	I	180 deg root zone away from project
83	81A	81A	ra	9	Protect	138	0	50	C	adequate canopy low value tree
84	87R	87R	ra	10,13,11,12	Remove	141	28			to be removal
85	R2_744	744	bm	33	Protect	144	0	60	D	
86	R2_742	742	bay	19,14,9,20	Protect	145	29	80	C	
87	R2_741	741	rwog	80,36	Protect	146	30	40	D	dying branches unknown cause
88	R2_740	740	rwog	59	Protect	148	0	40	C	
89	R2_2037	2037	rwog	122	Protect	150	0	70	D	mostly away from impact area
90	R2_2030	2030	df	18	Protect	153	0	45	I	
91	R2_736	736	rwog	118	Protect	154	0	45	D	
92	R2_2025	2025	rwog	119	Protect	155&154	0	40	D	
93	R2_735	735	df	22	Protect	156	0	40	I	
94	R2_2021	2021	redcedar	18	Protect	156	0	50	I	outside of impact area

Appendix A. Continued

RECNO	Tree	Tree #	Species	DBH in/Stem	Plan Status	Photo #	Clump No.	LCR %	Position	Comments
95	R2_524	524	rwog	70	Protect	157	0	30	D	
96	R2_523	523	rw	29	Protect	158	0	35	I	
97	R2_522	522	rwog	76	Protect	158	0	40	D	
98	R2_525	525	rw	34	Protect	159	0	40	I	associate with og grove
99	R2_526	526	rwog	93	Protect	160	0	45	D	disturbances impact shoulder backing added 200 sq ft area no change in paved area
100	R2_550	550	bay	18	Remove					to be removed
101	R2_551	551	maple	13,8	Remove					to be removed
102	R2_392	392	rwog	138	Protect	162	0	45	D	disturbances limited to present impact area in roadway prism impact negligable
103	R2_393	393	rw	28,32	Protect	163	31	60	C	includes 394
104	R2_396	396	rw	55,36	Protect	164	32	50	D	
105	88A	88A	ra	8,8,8,10,7	Protect	165	33	45	C	clump of alders
106	89A	89A	ra	13,6,8,10,12	Protect	166	34	30	C	clump of alders
107	R2_451	451	rw	28,16	Protect		35	90	D	
108	R2_449	449	rw	15	Protect		0	30	I	
109	R2_619	619	rw	27	Protect	174	0	60	D	up bank w cut dead stump below
110	R2_608	608	rw	17	Protect	175	0	40	C	
111	R2_596	596	df	14	Protect	177	0	30	C	
112	R2_594	594	rw	23,14,20,23,8	Protect	177	36	60	D	592 594 593 595
113	R2_591	591	df	26	Protect	178	0	50	D	
114	R2_810	810	ra	15	Protect	179	0	50	C	
115	R2_850	850	rw	16	Protect	180	0	50	C	no impacts at all
116	R2_160	860	rw	15	Protect	181	0	30	C	no impacts at all
117	R2_861	861	bay	40,36	Protect	181	37	60	D	
118	R2_863	863	rw	23	Protect	182	0	35	C	
119	90A	90A	bm	6,5,7,8,5	Protect	184	38	50	C	falling apart naturally now
120	R2_1075	1075	bm	22	Protect	185	0	70	D	0heavy lean over road will fail eventually
121	198A	198A	bm	16,12,12,11,10,14,16	Protect		39	50	D	no impacts
122	R2_2050	2050	rw	22,41,29	Protect	191	40	50	D	1108 also
123	R2_2051	2051	rw	14	Protect	191	0	20	I	
124	R2_2052	2052	rw	28,20	Protect		41	50	C	no impacts
125	R2_1282	1282	rw		Remove					
126	R2_1284	1284	rw	41	Protect		0	30	D	stump adjacent to be removed
127	R2_1285	1285	bm	16,16	Protect	192	42	25	C	will falll during construction as supported by stump
128	R2_1287	1287	rw	11	Protect	192	0	15	S	may collapse due to root zone infirm now
129	R2_2056	2056	rw	12	Protect	193	0	20	S	
130	91A	91A	bm	17,15	Protect		42	30	C	
131	R2_1288	1288	rw	17	Protect		0	30	I	
132	R2_1289	1289	rw	56	Protect	196	0	75	D	
133	R2_1290	1290	rw	39,11	Protect	197	43	70	D	2058 part of this tree
134	R2_2059	2059	bay	12,14	Protect	198	44	65	C	
135	R2_1303	1303	rw	63	Protect	199	0	70	D	
136	R2_1304	1304	rw	18,27	Protect	194	45	60	C	also 2060 grind stump adjacent
137	R2_1449	1449	rw	41,14	Protect	194	46	50	D	also 1448
138	R2_1307	1307	rw	38,16	Protect	194	47	50	C	also 1437
139	R2_1558	1558	bay	16,18	Protect	212	51	60	C	sprouting bay
140	R2_2102	2102	rw	6,5,8	Protect	210&211	50	50	C	grows on og cut stump new sprout
141	R2_2099	2099	rw	14,7,19	Protect	209	49	50	D	also 2100
142	R2_2090	2090	rw	20,12	Protect	208	48	60	C	

Appendix A. Continued

RECNO	Tree	Tree #	Species	DBH in/Stem	Plan Status	Photo #	Clump No.	LCR %	Position	Comments
143	R2_1541	1541	rw	41	Protect	207	0	30	C	clumpy with 1540
144	R2_1449	1449	rw	44,13	Protect	203	45	30	D	also 1448
145	R2_1307	1307	rw	38,16	Protect	203	46	60	D	also 1437
146	R2_1456	1456	rw	40	Protect	204	0	80	D	
147	R2_2075	2075	rw	22	Protect	205	0	70	C	
148	R2_2076	2076	rw	32,6,10,7,14,11,12,5,13	Protect	206	47	75	D	many stemmed sprout clump
149	R2_1540	1540	rw	27	Protect	207	0	60	C	esa wrap armour during construction
PATRICK CREEK NARROWS 2										
150	1_PAT	1_PAT	DF	53	Protect	234&235		70	P	0
151	9_PAT	9_PAT	DFOG	52	Remove	236		70	P	
151.5	16_PAT	16_PAT	DFOG	51	Protect	239		60	P	UPSLOPE
152	18_PAT	18_PAT	DFOG	35	Protect			60	D	
153	23_PAT	23_PAT	DFOG	40	Protect	239		50	P	
154	30_PAT	30_PAT	DFOG	29	Protect	240		45	D	
155	36_PAT	36_PAT	DFOG	34	Remove	269 & 245				
156	37_PAT	37_PAT	RA	16	Protect	269				ALONG RIVER
157	39_PAT	39_PAT	RA	12	Protect	271				ALONG RIVER
158	40_PAT	40_PAT	DF	17	Remove	272				
159	41_PAT	41_PAT	RA	14	Protect	272				ALONG RIVER
160	43_PAT	43_PAT	DF	26	Remove	273				
161	44_PAT	44_PAT	DF	33	Protect	274		50	D	
162	45_PAT	45_PAT	DF	33	Protect	275		50	D	MAY NOT SURVIVE BUT TRY TO SAVE
163	49_PAT	49_PAT	DF	31	Protect	279		65	C	
164	50_PAT	50_PAT	DF	37	Protect	280		70	D	NOT AFFECTED THOUGH CLOSE

Appendix B. Tree Current Condition & Potential Effects

Tree	Bole Damage	Root Damage	Compaction (y/n)	Culvert (y/n)	Paving	Root Cut Depth (inches)	Root Fill Depth (inches)	To Impact Zone (ft to tree)	Root Zone Affected (%)	Root Zone	Wind Movement	Light Impacts	Windthrow	Adjacent Tree Removal	Construction
										These potential effects are evaluated: 0=none to 5= high					
RUBY 1															
R1_294	y	y	y	y	y	0	12	1	5	0	0	0	0	0	1
R1_295	y	y	y	y	y	0	12	0	0	0	0	0	0	0	1
R1_296	n	y	y	y	y	0	36	2	3	0	0	0	0	0	1
R1_297	n	y	y	n	y	0	0	0	1	0	0	0	0	0	1
R1_298	y	n	n	n	n	0	0	10	0	0	0	0	0	0	0
R1_303	n	y	n	n	n	0	36	23	2	0	0	0	0	0	0
R1_304	n	y	y	y	y	0	20	11	5	1	0	0	0	0	0
R1_306	y	y	y	n	y	12	24	4	10	2	0	0	0	0	1
R1_307	n	y	y	n	y	12	24	7	10	2	0	0	0	0	0
R1_308	n	y	y	n	y	0	60	3	0	0	0	0	0	0	0
R1_311	n	y	y	n	y	0	60	3	0	0	0	0	0	0	1
R1_392	n	y	y	n	y	0	1	17	0	1	0	0	0	0	0
R1_393	n	y	y		y	0	1	18	0	1	0	0	0	0	0
R1_394	n	y	y		y	0	1	18	0	1	0	0	0	0	0
R1_395	n	y	y	n	y	0	0	21	0	0	0	0	0	0	0
R1_396															
397A	n	y	y	n	y	0	n	7	1	0	0	0	0	0	0
R1_397	n	y	n	n	y	0	24	5	1	0	0	0	0	0	0
R1_398	n	y	y	n	y	0	36	9	0	0	0	0	0	0	0
R1_399	n	y	y	n	y	0	12	19	0	0	0	0	0	0	0
R1_400	y	y	y	n	y	0	48	11	0	0	0	0	0	0	0
R1_401	y	y	y	n	y	0	0	13	0	0	0	0	0	0	0
R1_425	n	y	n	n	n	0	5	0	40	3	0	0	0	0	0
R1_590	y	y	y	n	y	0	0	2	3	0	0	0	0	0	0
R1_591	n	n	n	n	n	0	0	11	0	0	0	0	0	0	0
R1_592	n	y	y	n	n	0	24	13	1	0	0	0	0	0	0
R1_593	n	y	y	n	y	0	36	12	2	0	0	0	0	0	0
R1_594	n	y	y	n	y	0	24	1	5	1	0	0	0	0	0
R1_597	n	y	n	n	n	0	24	12	0	0	0	0	0	0	0
R1_596	n	y	n	n	n	0	12	17	0	0	0	0	0	0	0
R1_598	n	y	y	n	y	0	0	0	3	1	0	0	0	0	0
R1_599	n	y	y	n	y	0	0	1	3	1	0	0	0	0	0
599A	n	n	n	n	n	0	0	8	1	0	0	0	0	0	1
R1_600	n	y	y	n	y	0	0	0	5	1	0	0	0	0	0
R1_604	n	y	y	n	y	0	12	8	8	1	0	0	0	0	0
703B	y	y	n	y	n	0	36	23	0	1	0	0	0	0	0
703C	y	y	n	y	n	0	36	23	0	1	0	0	0	0	0
703A	n	y	y	n	y	0	12	2	0	0	0	0	0	0	0
R1_706	n	y	y	n	y	0	18	8	5	1	0	0	0	0	0
R1_703	n	y	n	y	n	0	18	13	5	1	0	0	0	0	0
R1_709	y	y	y	n	y	0	36	11	10	1	0	0		0	0
294A	y	y	y	n	y	0	30	12	1	0	0	0	0	0	0
R1_727	n	y	y	n	y	0	24	13	3	1	0	0	0	0	0
R1_721	n	y	y	n	y	0	24	13	3	1	0	0	0	0	0
603A	n	n	n	n	n	0	0	2	25	2	0	0	0	1	1
604A	n	n	0	n	n	0	0	6	20	2	0	0	0	1	1

Appendix B. Continued

Tree	Bole Damage	Root Damage	Compaction (y/n)	Culvert (y/n)	Paving	Root Cut Depth (inches)	Root Fill Depth (inches)	To Impact Zone (ft to tree)	Root Zone Affected (%)	Root Zone	Wind Movement	Light Impacts	Windthrow	Adjacent Tree Removal	Construction
										These potential effects are evaluated: 0=none to 5= high					
605A	n	n	0	0	0	0	0	8	20	1	0	0	0	1	0
606A	n	n	0	n	n	0	0	6	15	1	0	0	0	1	1
607A	0	0	0	0	n	0	0	5	20	1	0	0	0	0	0
608A	n	n	0	n	n	0	0	5	25	2	0	0	0	0	1
609A	y	n	0	n	n	0	0	8	10	2	0	0	0	0	0
610A	n	n	n	n	n	36	0	5	25	2	0	0	0	0	2
611A	n	y	n	n	n	12	0	4	15	1	0	0	0	0	2
R1_724	n	y	y	n	y	0	24	13	3	1	0	0	0	0	0
724A	n	n	n	n	n	0	0	30	1	0	0	0	0	0	0
600A	n	n	n	n	n	0	0	25	0	0	0	0	0	0	0
601A	n	n	n	n	n	0	0	2	25	2	0	0	0	0	0
602A	n	n	n	n	n	0	0	2	25	2	0	0	0	0	0
RUBY 2															
R2_2113	n	y	y	n	y	0	18	9	5	0	0	0	0	0	0
R2_2115	n	y	y	n	y	0	18	9	5	0	0	0	0	0	0
R2_1644	n	y	y	n	y	12	0	6	5	1	0	0	0	0	0
R2_1646	n	n	n	n	n	0	0	19	1	0	0	0	0	0	0
R2_1648	n	y	y	n	y	6	0	15	2	0	0	0	0	0	0
R2_1649	n	y	y	n	y	6	0	13	2	0	0	0	0	0	0
R2_1650	n	y	y	n	y	6	0	3	3	1	0	0	0	0	0
R2_1659	n	y	y	n	n	6	0	12	0	0	0	0	0	0	0
R2_2094	n	y	y	n	y	6	0	14	1	0	0	0	0	0	0
R2_1660	n	y	y	n	n	6	0	14	1	0	0	0	0	0	0
R2_2097	y	y	y	n	y	6	0	0	5	1	0	0	0	0	0
R2_1535	n	y	y	n	y	0	0	4	3	1	0	0	0	0	0
R2_2081	n	n	n	n	n	0	0	10	0	0	0	0	0	0	0
R2_1533	y	y	y	n	y	0	0	10	2	0	0	0	0	0	0
R2_1421	n	y	y	n	y	0	0	4	5	0	0	0	0	0	0
R2_1417	n	y	y	n	y	0	0	22	1	0	0	0	0	0	0
R2_1418	n	y	y	n	n	0	0	28	1	0	0	0	0	0	0
R2_1308	n	y	y	b	y	6	0	5	5	1	0	0	0	0	0
R2_1662	y	y	y	n	y	12	0	0	5	1	0	0	0	0	0
R2_2063	n	y	y	n	y	12	0	9	4	1	0	0	0	0	0
R2_1232	n	y	y	y	y	12	12	5	10	3	0	0	0	0	0
98A	y	y	y	n	n	0	48	0	30	3	0	0	0	0	0
R2_1223	y	y	n	n	n	0	72	0	1	0	0	0	0	0	0
99A	n	y	y	n	n	0	24	0	10	1	0	0	0	0	0
81A	n	y	y	n	n	0	12	0	10	3	0	0	0	0	0
87R															
R2_744	y	y	y	n	y	0	48	0	25	3	0	0	0	0	2
R2_742	y	y	y	n	n	0	40	12	5	1	0	0	0	0	0
R2_741	n	y	y	n	y	24	72	0	1	1	0	0	0	0	0
R2_740	n	y	y	n	y	12	0	5	5	1	0	0	0	0	0
R2_2037	n	n	y	n	y	0	0	36	1	0	0	0	0	0	0
R2_2030	y	y	y	n	y	0	0	3	10	2	0	0	0	0	1
R2_736	n	y	y	n	y	0	36	10	1	0	0	0	0	0	0
R2_2025	n	y	y	n	y	0	24	24	1	0	0	0	0	0	0

Appendix B. Continued

Tree	Bole Damage	Root Damage	Compaction (y/n)	Culvert (y/n)	Paving	Root Cut Depth (inches)	Root Fill Depth (inches)	To Impact Zone (ft to tree)	Root Zone Affected (%)	Root Zone	Wind Movement	Light Impacts	Windthrow	Adjacent Tree Removal	Construction
										These potential effects are evaluated: 0=none to 5= high					
R2_735	n	y	y	n	y	0	24	2	5	2	0	0	0	0	0
R2_2021	n	n	n	n	n	0	0	14	0	0	0	0	0	0	0
R2_524	n	y	y	n	y	0	36	11	2	1	0	0	0	0	0
R2_523	n	n	n	n	n	0	0	20	0	0	0	0	0	0	0
R2_522	n	y	y	n	y	0	36	26	0	0	0	0	0	0	0
R2_525	n	y	y	n	y	0	36	11	3	0	0	0	0	0	0
R2_526	n	y	y	y	y	0	24	3	2	2	0	0	0	0	0
R2_550															
R2_551															
R2_392	n	y	y	y	y	0	36	0	1	0	0	0	0	0	1
R2_393	n	n	n	n	n	0	0	18	0	0	0	0	0	0	0
R2_396	n	y	y	n	y	0	48	13	0	0	0	0	0	0	0
88A	y	n	n	n	n	0	0	6	10	1	0	0	0	0	0
89A	n	n	n	n	n	0	0	4	10	2	0	0	0	0	0
R2_451	n	n	n	n	n	0	0	16	0	0	0	0	0	0	0
R2_449	n	n	n	n	n	0	0	18	0	0	0	0	0	0	0
R2_619	n	y	n	n	n	72	0	7	0	0	2	0	2	0	2
R2_608	n	n	n	n	n	72	0	11	0	0	0	0	1	0	0
R2_596	n	n	n	n	n	60	0	16	0	0	0	0	0	0	0
R2_594	n	y	n	y	n	48	0	4	10	1	0	0	0	0	0
R2_591	n	n	n	n	n	30	0	14	5	1	0	0	0	0	0
R2_810	n	y	n	n	n	72	0	11	50	3	3	0	3	3	0
R2_850	n	n	n	n	n	0	0	13	0	0	0	0	0	0	0
R2_160	n	n	n	n	n	0	0	10	0	0	0	0	0	0	0
R2_861	y	n	y	n	y	60	0	14	1	0	0	0	0	0	0
R2_863	n	y	n	n	n	36	0	5	5	1	0	0	0	0	0
90A	y	y	n	n	n	0	0	10	10	1	1	0	2	0	0
R2_1075	n	n	n	n	n	0	0	18	0	0	0	0	5	0	0
198A	n	n	n	n	n	0	0	16	0	0	0	0	0	0	0
R2_2050	n	n	n	n	n	0	0	19	0	0	0	0	0	0	0
R2_2051	n	n	n	n	n	0	0	20	0	0	0	0	0	0	0
R2_2052	y	n	n	n	n	0	0	17	1	0	0	0	0	0	0
R2_1282															
R2_1284	n	n	n	n	n	0	0	7	25	2	2	1	2	3	2
R2_1285	n	n	n	n	n	0	0	15	0	0	0	0	5	5	5
R2_1287	n	n	n	n	n	0	0	4	40	4	2	0	2	4	4
R2_2056	n	n	n	n	n	0	0	12	5	0	0	0	0	0	0
91A	n	n	n	n	n	0	0	20	0	0	0	0	0	0	0
R2_1288	n	n	y	n	y	36	0	1	30	3	1	2	2	2	2
R2_1289	n	y	y	n	n	12	0	10	20	2	0	0	0	0	2
R2_1290	n	y	n	n	n	12	0	9	15	2	0	0	0	0	0
R2_2059	y	n	n	n	n	10	0	7	20	2	0	0	0	0	0
R2_1303	n	y	y	n	y	12	12	0	15	2	0	0	0	0	2
R2_1304	n	n	n	n	n	0	0	1	25	3	0	0	0	0	2
R2_1449	n	y	y	n	y	0	0	4	15	2	0	0	0	0	2
R2_1307	y	y	y	n	y	5	0	0	15	2	0	0	0	0	2
R2_1558	y	n	n	n	n	0	0	10	2	0	0	0	0	0	0

Appendix B. Continued

Tree	Bole Damage	Root Damage	Compaction (y/n)	Culvert (y/n)	Paving	Root Cut Depth (inches)	Root Fill Depth (inches)	To Impact Zone (ft to tree)	Root Zone Affected (%)	Root Zone	Wind Movement	Light Impacts	Windthrow	Adjacent Tree Removal	Construction
										These potential effects are evaluated: 0=none to 5= high					
R2_2102	n	n	n	n	n	0	0	7	0	0	0	0	0	0	0
R2_2099	n	y	y	n	n	12	0	7	5	2	0	0	0	0	1
R2_2090	n	y	n	n	n	0	0	6	3	0	0	0	0	0	0
R2_1541	n	y	y	n	n	0	0	10	3	0	0	0	0	0	0
R2_1449	y	y	y	n	y	0	0	4	10	2	0	0	0	0	2
R2_1307	y	y	y	n	y	0	0	0	15	2	0	0	0	0	3
R2_1456	n	y	y	n	y	0	0	12	5	1	0	0	0	0	0
R2_2075	n	n	n	n	n	0	0	17	1	0	0	0	0	0	0
R2_2076	n	n	n	n	n	0	0	14	1	1	0	0	0	0	0
R2_1540	n	y	y	n	y	12	0	0	20	3	0	0	0	0	2
PATRICK CREEK NARROWS 2															
1_PAT	N	Y	N	N	N	72	0	18	10	2	0	0	0	0	0
9_PAT	N														
16_PAT	Y	0	N	N	N	0	0	24	1	0	0	0	0	0	0
18_PAT	N	N	Y	N	N	42	0	10	10	3	0	0	1	0	2
23_PAT	N	Y	N	N	N	72	0	10	20	3	0	0	1	0	2
30_PAT	N	Y	N	N	N	72	0	15	10	1	0	0	0	0	0
36_PAT															
37_PAT								5							
39_PAT								10							
40_PAT															
41_PAT								10							
43_PAT															
44_PAT	N	Y	N	N	N	12	0	6	25	2	0	0	2	2	2
45_PAT	N	Y	Y	N	Y	24	0	0	40	5	2	0	3	1	4
49_PAT	N	N	N	N	N	0	0	10	0	0	0	0	0	0	0
50_PAT	N	Y	N	N	N	100	0	2	5	0	0	0	0	0	0