6: FINDINGS & RECOMMENDATIONS, SITE-WIDE

This chapter represents collaborative effort on the part of all Phoenix Team members, primarily My *Moritz, Laurel Collins, and Tom Gaman.*

TO OFFER GUIDELINES FOR PLANT COMMUNITY RESTORATION and fire hazard management for specific forest or brush types within the Vision Fire burn zone, this section of the Phoenix Report describes each vegetation type, outlines the forest succession that is probable in each, and describes fire hazard management actions appropriate to each. Recommended actions appropriate to each neighborhood are detailed in Chapter 8.

VEGETATION TYPES

PLANT COMMUNITIES ARE NOT STATIC: they go through a series of successive changes as they regenerate, compete for dominance, mature, decline, and die. They may replace themselves or succeed to a different mix of species or to an entirely different vegetation type. The development of future plant communities is determined by the ecology of the ecosystem and biology of the species; by natural events like storm, drought, and fire; by browsing pressure from animal species; and by human intervention through seeding, landscaping, invasive exotic plant introduction or eradication, and landscape management. The species composition and vegetation type structure of the various stages of maturation can be manipulated through management. Specific actions depend upon the objectives of the property owners.

Ecological succession is the evolution of communities, or development of the ecosystem. It involves changes in species composition, structure, and plant/animal community processes over time. Succession may be orderly and predictable; it may be periodically disturbed or interrupted by physical agents such as fire and storms or biological agents such as pest and disease epidemics. Over the long term, succession is community controlled. The community modifies the physical environment, making conditions more favorable to a succession of new populations until a stable, self-replacing population (for instance, a climax bay forest) establishes an equilibrium between the biotic and physical dements of the habitat. Such equilibrium may last until another disturbance occurs.

Biodiversity refers to the richness or variety in an ecosystem - not only the number of species but also the number of individuals of each species, the age classes, and the complexity of the mosaic of these various components. It is difficult to generalize about biodiversity relative to succession and disturbance regimes. Generally, species diversity increases through the developmental stages to the mature stages of succession. However, spatially limited disturbance, e.g., fire or storm damage, creates a diversity of age classes, community structure, and successional Stages within a region. This variation creates an aesthetic impression that is pleasing to the eye and heightens our enjoyment of the landscape. Some valued plant communities, such as the bishop pine forest, may decline and disappear without disturbance.

In the area of Inverness Ridge affected by the Vision Fire, principally four of the many vegetation types found on the Point Reyes Peninsula to-mingle. Here they are discussed in terms of their characteristics; the behavior and effects of the Vision Fire; and the vegetation response and successional trends that are consequences of the fire.

With the return over time of vegetation to burned areas, fire hazards inevitably rise again. In rating fire hazard, we employ a Marin County scale in which the numerical values 1-9 are assigned to each of five factors (aspect, slope, and fuel type in each of three defensible space zones) then summed. This system is illustrated in Appendix 8. Higher numbers mean higher fire hazard.

Presented here, for reference as you read the descriptions of plant communities, are a table and graph depicting this increase in fire hazard due to natural succession in the plant communities affected by the Vision Fire.

Fuel Type	Prior	1st year	3rd year	lOth year	LongTerm
Pine with Undergrowth	34	18	23	30	32
Hardwood with Undergrowth	29	15	19	25	29
Hardwood	22	15	17	20	22
Coastal Scrub	28	10	19	23	28

Table 1: Average Succession of Fire Hazard Ratings by Type. Assessments were made during the Phoenix study for burned areas within 100 feet of structural envelopes. This table illustrates that because the Vision Fire consumed fuel loads, the fire hazard rating in each forest type in the burn area declined dramatically. Over time, however, as the vegetation regrows, hazards will increase (without management) to levels found before the fire.

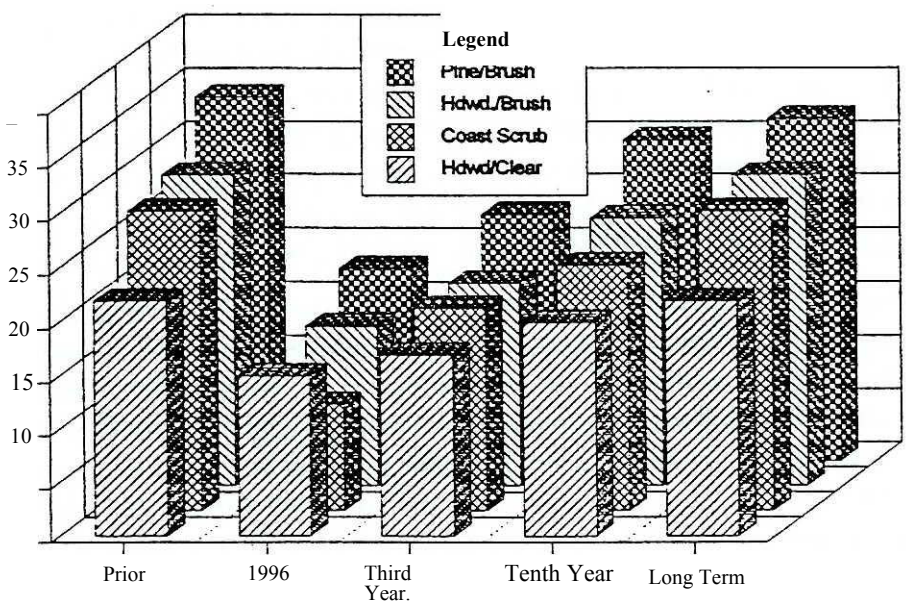


Figure 1: Fuel and Fire Hazard Succession. This 3-D graph provides another view of the relationship between fire hazard (the vertical scale labeled at left) and passing time (the horizontal scale labeled across the bottom). The four plant communities, each given its own shading, are arranged from front to back in order of natural fire hazard, with the lowest, Hardwood Forest, found in the front row. As you move from left to right, notice the drop in fire hazard in the first year following the Vision Fire, and the ultimate rise to pre-fire levels over time. Managed succession can keep fire hazards at lower levels around human habitations.

Bishop Pine Forest with Heavy Undergrowth

PRE-FIRE CHARACTERISTICS: Forest values are very high in this type. It is regarded as having the highest aesthetic value on the Ridge, with high, craggy, sea-blast sculpted canopies that are home to birds of prey, the western grey squirrel, woodpeckers, finches, and other wildlife. As we have learned, though, its beautiful architecture is also its undoing: it is very welcoming to powerful conflagrations. This forest / fuel type has the most severe Marin County Fire Service rating, ninth in a fire severity scale of nine (see Appendix 8 for an explanation of ratings). Bishop pine forest typically occurs along ridge tops and droughty slopes where soils are excessively drained and low in nutrients, and where fire historically killed the overstory and created the conditions for bishop pine regeneration every 30 to 80 years. In the absence of fire, Douglas fir forest is regenerating more successfully than bishop pine and, where the two types meet, firs are encroaching upon the pine forest.

FIRE BEHAVIOR: The Vision fire teached its greatest intensity, very high rates of spread, and produced a blizzard of fire brands in the old bishop pine forest. Crowning fire was most common in this type and reached extreme intensity. The fire was rarely controlled in pine dominated forest and no homes were saved in pine forest where defensible space work had not been done.

FIRE EFFECTS: Usually more than 90% of the forest canopy was killed. At least 90% of forest understory brush and fern canopy was consumed. According to the National Park Service, soils in this forest type experienced extreme heating, consuming most of the duff layer, seed reservoir, and surface soil organic matter. In some areas a hydrophobic (water-repelling) layer was formed a few inches below the soil surface. Since most of the bishop pines have died, the input of organic material by needle drop will be minimal for several years. Surface erosion potential may continue to be high for several yean.

VEGETATION RESPONSE: *Forest Cover*- Pine reproduction is extensive but clustered. Tan oak reproduction by seed has not been observed, and stump sprouting is minimal. Bay tree reproduction by seed has not been observed, and stump sprouting is moderate. *Understory Vegetation* - About 95% of the understory plants stump sprout (huckleberry, coffeeberry, some manzanitas, some ceanothus, live oak, tan oak, and bay). Ferns sprout from their rhizomes (roots). Where grasses were seeded, they are growing vigorously (and are depressing regeneration of bishop pine seedlings).

SUCCESSIONAL TRENDS: The pre-fire bishop pine forest was in a state of decline. The canopy had opened through mortality of pines. Underbrush and hardwoods had increased to almost complete coverage and at least ten feet in height. Pine was decreasing its presence and hardwoods were expanding their presence. The successional trend without fire was from pine to hardwood.

POST FIRE FOREST/FUEL SUCCESSION: *Prior Type* - Declining pine forest with heavy Undergrowth. *First Year*- Grass, fern, sprout, and tree seedling dominated. Exotics invasion. *Third Year*- Grass, fern, medium shrub sprout, tree sapling dominated. Exotics. *Tenth Year* -Juvenile pine, mature brush dominated. *Long-term* - Pine with shrubby undergrowth. Pine representation will increase as the seedlings mature.

Mixed Hardwood Forest with Heavy Undergrowth

PRE-FIRE CHARACTERISTICS: This forest type is dominated by coast live oak, tan oak, and bay, with scattered Douglas fir, alder, and pine in the forest canopy. The understory is dominated by coffeeberry, huckleberry, blackberry, hardwood reproduction, and sword fern, with minor components of poison oak, ceanothus, hazel, and other shrub species. Mixed hardwood forest is home to large numbers of deer, rodents, and other native wildlife. It typically occurs in valley bottoms, along side slopes, and on ridge tops at lower elevation.

FIRE BEHAVIOR: This forest/fuel type is relatively less dangerous than bishop pine forest. On Inverness Ridge it exhibits greater fire resistance than its rating (moderately severe to severe fire danger) over most of Marin County would suggest. The Vision Fire reached only moderate intensities in this forest/fuel type, with moderate rates of spread and moderate resistance to control. Crowning fire was uncommon in this type. Typically more than 90% of the vegetation in this type was crown-killed (that is, crown portions of the plants were killed). Study of the fire zone showed that almost invariably the fire was controlled and homes saved where hardwoods dominated the forest cover.

FIRE EFFECTS: Within the fire zone more than 70% of the forest canopy was killed. At least 90% of the understory brush and fern canopy was consumed: The soils experienced moderate heating, consuming much of the duff layer.

VEGETATION RESPONSE: *Forest Cover*- Tan oak reproduction by seed has not been observed, and Stump sprouting is minimal. Bay reproduction by seed has not been observed, and Stump sprouting is moderate. Coast live oaks and bays that did not experience intense charring are sprouting new canopies. Tan oaks are less likely to resprout. *Understory vegetation*- About 95% of the understory plants stump sprout (huckleberry, coffeeberry, some ceanothus, oak, tan oak, and bay) or in the case of ferns rhizome (root) sprout.

SUCCESSIONAL TRENDS: In other parts of Marin County, Douglas fir is invading this forest type and, without intervention, will evenrual1y dominate many mixed hardwood forests. On Inverness Ridge, however, these mixed hardwood forests will likely replace themselves. Douglas fir will increase its presence somewhat in burned hardwood forest where it was present before the fire. Bishop pine will become established in some areas.

POST FIRE FOREST/FUEL SUCCESSION: *Prior Type*- Mature forest with undergrowth. *First Year*- Grass, fern, sprout, and tree seedling dominated. Exotics may invade. *Third Year*- Grass, fern, medium shrub sprout, and tree sapling dominated. Exotics. *Tenth Year*- Juvenile tree, tall resprout, and mature brush dominated. *Long-term* - Hardwood with undergrowth dominated. Douglas fir and (less likely) pine may increase their presence.

Hardwood (including Bay Climax) Forest with Sparse Undergrowth

CHARACTERISTICS: This forest type is dominated by bay, tan oak, and coast live oak, or by pure bay. The understory may have scattered coffeeberry, huckelberry, blackberry, hardwood reproduction, and sword fern, with minor components of hazel and other shrub species. Climax bay forest typically is dominated by sword fern in the understory. Non-bay hardwood forest is home to deer, rodents, and other wildlife. This forest/fuel type is rated as quite fire-resistant, a

rating of (two on a nine-point severity scale. Fire entering this type typically dies down to a creeping fire with short flame lengths. These forest types typically occur on damp, north-facing side slopes, valley bottoms and at lower elevations..

FIRE BEHAVIOR: The Vision Fire reamed low moderate intensities, with low moderate rates of spread in this forest/fuel type. Fire exhibited low moderate resistance to control. Typically, only duff, scattered brush, and down and dead debris were consumed in the fire zone. Crowning fire was rare in this type. Study of the fire zone showed that almost invariably the fire was controlled and homes saved in this type.

FIRE EFFECTS: Within the fire zone more than 70% of the forest canopy was killed (although the bays are basal sprouting). At least 90% of the understory brush and fern canopy (aerial parts of plants) was consumed. The soils experienced low heating, consuming only the surface of the duff layer, scattered brush, and down and dead debris.

VEGETATION RESPONSE: *Forest Cover*- Tan oak reproduction by seed has not been observed, and stump sprouting is minimal. Bay reproduction by seed has not been observed, and stump sprouting is good. Coast live oaks, matrons, and bays that did not experience intense charring are sprouting new canopies. Tan oaks are less likely to resprout. The climax bay forest will resprout with multiple Stemmed trees where the mature trees fail to crown sprout. *Understory vegetation* The sparse understory plants stump sprout (huckleberry, coffeeberry, oak, tanoak, and immature bay) or, in the case of ferns, rhizome (root) sprout.

SUCCESSIONAL TRENDS: The successional trend in these forest types was self-replacement, and on Inverness Ridge they will likely replace themselves.

POST FIRE FOREST/FUEL SUCCESSION: *Prior Type*- Mature trees with sparse undergrowth. *First Year*- Tree resprout, fern, shrub resprout, and seedling dominated. *Third Year*- Fern, medium shrub sprout, and tree sapling dominated. *Tenth Year*- Juvenile tree, tall resprout, fern, and sparse mature brush dominated. *Long-term*- Hardwood with sparse undergrowth dominated.

Coastal Scrub

CHARACTERISTICS: This type is dominated by coyote bush, coffeeberry, poison oak, and blackberry, with minor components of toyon and other species of shrub, herb, and grass. It supports a wide variety of wildlife including deer, gray fox, white-crowned sparrows, wrentits, woodrats, rabbits, moles, shrews, and other rodents. This fuel type is rated as moderately flammable, a rating of five on a nine-point severity scale. Fire entering this type typically has a low to moderate rate of spread with moderate flame lengths. These types typically occur on ridges, side slopes, and valley bottoms exposed to sea blast.

FIRE BEHAVIOR; The Vision Fire reached low moderate to high intensities in this fuel type, with low moderate to extreme rates of spread and low to very high resistance to control. Typically, the only fire-available fuels were fine brush, twigs, standing dead plants, and down and dead debris.

FIRE EFFECTS: Within the fire zone more than 90% of the shrub canopy (i.e., fine brush) was consumed; root systems and root crowns survived. The soils experienced low heating, consuming only the duff layer and down and dead debris.

VEGETATION RESPONSE: About 95% of the coastal scrub plants stump sprout or, in the case of ferns and grasses, rhizome (root) sprout.

SUCCESSIONAL TRENDS: The canopy of this brush had almost complete coverage, and the successional trend was self-replacement.

POST FIRE FOREST/FUEL SCCCESSION: *Prior Type*- Over-mature coastal scrub. *First Year* - Shrub resprout, grass, and seedling dominated. *Third Year*- Medium shrub sprout and grass dominated. *Tenth Year* - Mature brush dominated. *Long-term* - Mature brush with excessive deadwood.

Douglas Fir Forest

In addition to the principal forest types found in the burned area of Inverness Ridge, Douglas fir occurs as a minor but significant element in all the neighborhood units of the study area. The only unit containing developed areas where fir forms substantial stands, along the spines of the main and secondary ridges, is Unit 8 (whose prevalent plant community is Mixed Hardwood with Undergrowth). The fit overstory is generally very open and breaking up (i.e., growing old and falling apart due to windthrow, limb loss, and top loss). A dense secondary canopy of hardwoods and occasional young Douglas fir has formed. Most of the fir stands have a dense undergrowth of huckleberry, coffeberry, blackberry, hardwood, and occasional Douglas fir reproduction.

In the heart of its natural range Douglas fir can live more than 1,000 years (350 years is common) and reach heights of 300 feet, but in the southern reaches of its range, like Marin County, it begins to decline and break up at 100 years old and 100 feet tall.

Our investigation found extensive root rot and abnormally fine, fibrous root growth in trees 115 years old. In addition, development and tree removal have opened the stands, making them more exposed and vulnerable to tree throw by strong winds. Windthrow, as well as top and branch failure, are common in this forest type. We found many trees hazards near homes, roads, and drives.

FIRE BEHAVIOR. The Vision Fire moved into Unit 8 under less extreme fire weather than prevailed during the early, severe stage of the fire. Fire behavior on the Drakes Summit ridge was moderate to low in intensity with relatively low rates of spread.

FIRE EFFECTS: Mature Douglas fir is more fire-tolerant than bishop pine. Its bark is more insulating, so the living tissue under the bark is usually protected from damage by moderately intense fires. Only about 15% of the fir overstory was killed in the Unit 8 sector of the Vision Fire zone. About 50% of the undergrowth crowns (nor root stocks) were killed.

SUCCESSIONAL TRENDS: Surprisingly, and opposite to the successional trends in most of Marin County, in most of the developed portions of the study area Douglas fir is declining, and mixed hardwoods are increasing their presence. Douglas fir is reproducing in some disturbed sites such as roadcuts and landslides, sometimes in "doghair thickets." Doghair reproduction will be slow to mature because of excessive competition of available light, water, and nutrients.

POST FIRE FOREST/FUEL SUCCESSION: The reproductive success of fir on disturbed sites may indicate that it will increase its numbers on fire-disturbed sites. We observed no fir reproduction, but this may appear later in the spring. Fir reproduction will have stiff competition from resprouting shrubs, seeded grasses, opportunistic exotics, and hardwood trees. We expect most of the mature fire-exposed firs will survive, but they will continue to decline and will suffer increased windthrow due to further opening of the forest from fire mortality, bulldozer clearing and damage to root systems, and other removal.

Without management we expect the following successional stages: *Prior Type*- Declining fir forest with heavy undergrowth. *First Year*- Remnant overstory with grass, fern, resprout shrubs, tree seedlings, and pioneer exotic planes dominated. *Third Year*- Grass, fern, medium shrub sprouts, tree seedling, and exotics dominated. *Tenth Year*- Mature brush, fern, tree sapling, and exotic shrub dominated, with down and dead fuel loading. *Long-term* - Hardwood dominated with mixed fir and heavy undergrowth, and heavy down and dead fuel loading.

RECOMMANDATIONS: Follow general restoration recommendations (below) and specific measures for pine forest, plus: 1) all mature and over-mature Douglas fir within reach of potential targets of value should be inspected for hazard potential; 2) young doghair fir stands should be thinned to reduce competion, increase survival, and accelerate growth; and 3) old fir stands should be replanted with local stock nom thinning or seed to preserve this valued plant community.

STRATEGIES FOR FOREST RESTORATION

THE FOLLOWING STRATEGIES FOR FOREST RESTORATION were specifically designed for the plant communities within the area of Inverness Ridge assessed in this study. If left alone, the forests will likely contain more invasive exotic plant species (see below), fewer pines and firs, and planes in stressed and stunted thickets, Managed succession, on the other hand, is an effective strategy for promoting recovery of native plant communities while producing a fire-safe environment (two goals that can be accomplished at the same time).

Management actions chosen will depend upon the goals and objectives of the property owners, and there are several considerations to weigh. The health and composition of plant communities is one; the watershed (slope stability, erosion) is another; and minimizing fire hazard is a third. The focus of this section is restoration of the plant communities in conjunction with fire hazard management.

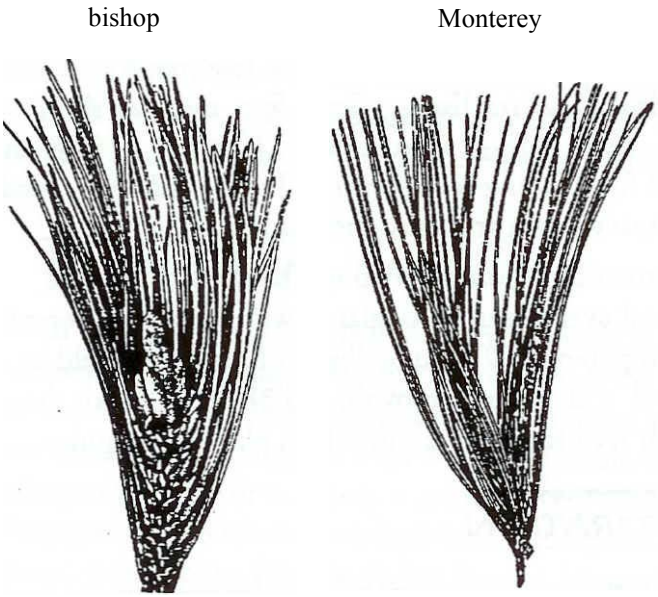
Invasive Exotic Plants

Because of our emphasis on native plant communities, this report often recommends control or removal of non-native planes, * especially species that compete with native planes and produce unwanted fuel loads. We define these "ecological weeds" as *invasive exotics* throughout this report.

The invasion of exotics in the fire zone has been rampant in post-fire Inverness. This is especially true along active and abandoned roads. *As* part of the post-fire mitigation effort, grasses have been introduced over wide areas where they will compete with native vegetation and obstruct restoration of the native plant communities.

The Phoenix Team has observed that heavily seeded areas have produced thick stands of grass that have inhibited pine and other native plant reproduction from seed. Grass will rob the soil of nutrients and water needed for successful native plant establishment and survival. At the same time we have observed no difference in erosion and soil stability between seeded sites and areas with natural grass recovery. The seeding has created a problem in that it has introduced species not native to the study area. The presence of grass also exacerbates the ignition and rapid spread of

* While certain non-native species are genuinely invasive and, if left unchecked, can damage entire ecosystems (an example is Scorch broom), ocher non-native or uncommon plants may sprout following the fire's disruption mar are desirable in a restored landscape (coast redwood or live oak seedlings would be examples),



Needles in packets of two (bishop) versus usually three (Monterey)

wildfire in the first and subsequent years of community recovery. Grass seeding should be employed more sparingly and cautiously in the future, and excluded from most future post-fire mitigation programs.

When the rebuilding process gets under way, introduction of exotic invasives will become a worse problem. Weed seeds will be carried in on trucks and heavy equipment. Scarification (scraping, grading) of building sites, drives, and toads will provide habitat for invasive pioneer weeds.

The Phoenix Team concludes that we must start our exotics and weed control program now. We recommend the following operations:

1. Mow, weed whip, or pull all introduced grasses immediately and often. Do not allow them to reseed and spread. Do not sow grasses where they will interfere with natural regeneration: they have not proved to be necessary for erosion control. Perennial grasses (such as Zorro fescue) will need to be aggressively weeded out, especially around tree seedlings. Cutting will keep them from reseeding but will not eliminate them.

2. Dig out or precisely target with herbicides all thistle immediately, and patrol your property often. Do not allow thistle plants to form seed heads.

3. Do not introduce invasive exotic ground covers like ivy, honeysuckle, matress vine, ice plant, cape weed, *Hypericum, Gazinias, Vinca, Echium, Helichrysum bractiatum* (strawflower) and *H. petioloatum,* srawberry, geranium. Ask your nursery *person* about the invasiveness of the ground covers you select.

4. Remove brooms, *Cotoneaster,* Himalayan blackberries, *Echium,* and other exotic shrubs.

5. Monterey pines are reproducing aggressively in the burn area (also in unburned areas). We recommend discrimination against this aggressive species, which is not locally native and has created many arboricultural problems. You may not be able to distinguish Monterey pine seedlings from bishop pine seedlings, and you may have to wait a couple of seasons to differentiate these closely related species. Monterey pine has deep green needles in bundles of three (there are some bundles of two on this tree). Bishop pine has yellow-green needles exclusively in bundles of two.

6. We recommend against planting non-local bishop pines in the Inverness hills. They will pollute the local genotype and will not be well adapted to local conditions.

7. We recommend active discrimination against invasive non-indigenous trees like acacia and eucalyptus.

Mulch

The disposal of chipped materials is most efficiently disposed of by broadcasting it back onto the site. * It can then be spread as a mulch. It can be applied thickly (up to six inches) to areas where the property owner wishes to discourage weeds and grass. It should not be applied thickly (mote than two inches) where the owner wishes to encourage seed germination and growth. We have observed inhibition of pine reproduction where wood chip mulch is thickly applied.

RESTORATION MANAGEMENT:

GENERAL STEPS, ALL VEGETATION TYPES

This section provides sets of recommendations divided into three time periods: the first two years, years three through ten, and long term (i.e., through the 30th year).

Under each time period, find first a set of actions broadly applicable to each of the four plant communities. Immediately following this section, find recommended actions listed that are particular to certain vegetation types.

Years 1-2

In order to fulfill the goal of creating and maintaining a fire-safe environment, a number of management actions are appropriate during the first and second years. These include thinning and moving seedlings, selecting sprouts (no more than three dominant ones) to retain from each plant, and removing sprouts selected to remove. Through the culture of resprout trees and transplanting of seedlings the owner can design the eventual forest cover to his or her own needs and, where desired, reforest areas where regeneration has failed.

Entire shrubs should be removed to establish a suitable spacing from each other and from overstory trees. In contrast, plant material from areas of dense vegetation can be transplanted to augment vegetative covet. Fertilizing, mulching (including addition of soil amendments), and irrigation can accelerate plants' regrowth. To fight disease and pests, sick plants should be removed. Lastly, volumes of debris will need to be removed: this entails removal of dead stems of shrubs and other smaller dead material, and selectively culling some dead trees. In the first or second year it is important to restore roads, rehabilitate abandoned road beds, and selectively remove dead trees that pose a hazard to roads and structures. These can be control-burned in winter or spring with appropriate permits.

* The practice of leaving as much carbon (wood) in the forest as possible is becoming widely recognized as a key factor in maintaining the health and vitality *of* forest ecologies. Leaving logs, duff, chips, and leaves in the forest recycles nutrients, promotes fungal and microbiological activity, and retains moisture in the soil, providing erosion control. Rotting wood acts as a sponge, scoring water and promoting mycelium growth. The fungal mycelium, an extensive thread-like structure, aids in water retention by absorbing and storing water in its cells. It also reduces erosion by spreading throughout the forest floor and "knitting" the top soil together. Maintaining soil moisture is fundamentally important to reducing both risk *of* fire and invasion *of* chaparral species and other potential fuel load species, e.g., poison oak, scotch broom, coyote brush, and pampas grass. In addition, mycorrhizae are essential to many trees and other plants. In this symbiotic growth involving a fungus and a plant root, the fungus (as well as protecting roots against predators and pathogens) provides nutrients to the root in exchange for sugars provided by the root to the fungus. - *Penny Livingston*

Additionally, many cautions are required during this initial period after the fire. Crown trunk sprouts should be protected from deer and rodents to promote recovery of highly valued trees near structures. Residents should not over-fertilize or spray-irrigate trees and tree sprouts.

Resprout trees can be eliminated or cultivated; because of their well established root systems (particularly bay laurel), they are difficult to kill, tend to persist, and will grow rapidly. The dead stem should be removed as soon as possible and the sprouts should be thinned to the most vigorous, not more than three per stump. Younger trees with smaller diameters sprout more vigorously and ultimately grow mature second-growth trees that are more sound and stable. Single stem regrowth tends to be better balanced and more structurally stable.

Trees that resprout from trunks, limbs, and branches - such as coast live oak and bay -- may continue to sprout and fill out over the n= couple of seasons. They may be cultured to speed recovery. Sprout photosynthesis is important for feeding the tree in the first two years. Trunk sprouts that are not selected to become new branches should be removed after the second spring. In resprouting single-trunked trees (like redwood), a new leading stem should be selected from the multiple sprouts as soon as possible. Other crown restructuring and deadwood removal should occur after the second spring.

In any case, it's important to recognize that resprouting burned trees will look scraggly, like burned trees, for years to come.

Oak and pine seedlings can be transplanted easily for three years.

Shrub seedlings may be pulled in the first spring of growth or otherwise eliminated. Shrub reproduction may be unevenly distributed, and transplanting is an option for desired distribution of shrub coverage. The land owner should favor fire-resistant shrubs over highly flammable plants (see list, Appendix 2). Remove invasive exotics (see footnote on page #) if they become a problem.

Pyrophytic (flammable) shrubs should be removed from under pyrophytic trees or from a perimeter within ten feet of the dripline of such trees. In spacing shrubs, they should be separated from one another a distance of no less than twice the current height. Fire-resistant plants can be used as infill.

Shrub resprouts are managed in the same manner as resprouted trees (see above). The dead stem should be removed as soon as possible, and the sprouts should be thinned to the most vigorous - not more than three per stump. Spacing should be maintained as recommended for shrub seedlings.

Fertilization, mulching, and irrigation will accelerate the growth of any seed- or sprout regenerated plants. Deep fertilization is best. Surface fertilization may encourage weed invasion.

Woody plants need only nitrogen for accelerated growth, but be careful not to over-fertilize with nitrogen. It can burn your plants and pollute runoff. It is better to siphon-inject moderate amounts of nitrogen into a drip irrigation system than to apply large quantities to the surface.

Mulching can help maintain soil moisture and provide a healthier root environment for plants, as well as reduce erosion. It can restore organic matter and compounds to fire incinerated soils. It aids water and nutrient retention, and it promotes a healthy soil fauna and flora. However, excessive incorporation of poorly composted organic matter into the soil can rob your plants of nitrogen and can slow regrowth. Manure composts should be well composted to avoid root burn,

nitrogen loss, and the introduction of weeds and invasive exotics to the landscape. Heavy applications can inhibit plant recovery.

Soil amendments may be beneficial. Soils sterilized by high intensify fire can be reinjected with beneficial insects, bacteria, mycorrhizal fungi, and other soil organisms through transplanting from unburned Inverness Ridge sites or through inoculation with unburned soil. Be careful to collect only from sites where the plants are healthy and vigorous, so as not to transplant disease. Naturally, obtain permission before collecting young plants from a neighbor's property.

Irrigation may also ensure survival and rapid recovery of the plant community but is not necessary on trees and resprout stumps and can cause rot and disease during the summer months. For fern and herb ground covers, spray irrigation is fine. Drip irrigation is preferred for trees, however. During the summer, irrigation around mature oaks can cause root rot and should be avoided. Irrigation of seedlings is fine at any time of year.

Disease and pest control is best done through cultural practices and the least toxic means. Cultural practices include all the restorative actions discussed above that promote plant health and vigor, plus additional practices designed for disease and pest resistance.

The first and most effective action to fight these threats is to remove any pest- or disease infested plants as soon as possible and avoid bringing infested and non-resistant plants into the landscape. Second, avoid daytime and warm-weather irrigation, particularly surface or spray applications. Plant pathogens are favored by a warm, moist environment. Third, improve air circulation through plant separation and crown thinning. Fourth, apply the least toxic pest control chemicals (such as Bordeaux Mix ™ or Safer ™). Apply the minimal amount needed to get full coverage. Pesticides are often toxic to non-target organisms; more is not better. In most cases the plants recover from disease on their own, especially if given a favorable environment.

Transplanting from outside the fire zone to sterilized areas within it is another option. Some sites burned with such intensity that little or no natural revegetation will occur for a long time. Transplants, even native plant species, will require more irrigation and general maintenance than plants seeded by nature. A rule of thumb is to water twice a week the first year and less the second year.

Fire-killed tree removal is not necessary for forest restoration. Logging, in fact, may damage otherwise stable soils. Wildlife trees (burned trees) may be valuable assets to the fire zone. The wildlife value of a tree may be enhanced through proper trimming and the mechanical creation of habitat; tree failure potential can often be reduced through thinning and balancing. Raptor (osprey) nesting can be encouraged through the creation of palmate tops for supporting nests. Bark should be stripped from the finger branches and crotch area to reduce the rate of decay. All cuts should be angled to shed water. Leave one or two finger branches longer for perches. Bat habitat can be created by making steep upward cuts through the bark and white wood of the trunks. Cavity nesting for rodents and birds can be enhanced through the mechanical creation of cavities with a chainsaw route tip or chainsaw drill.

Abandoned roads could be restored by putting the fill and side-cast soils up against the cut banks to trap eroding soil and begin the re-contouring of the road cuts. Chipping onto abandoned roads will help break up runoff and restore organic matter. The road tread could be disced to break up compacted surfaces, in order to increase infiltration. Alternately, slash could be packed against

the cut banks. As part of restoring abandoned roads, planting *is* encouraged. We strongly recommend not reopening abandoned roads if they will not be used and maintained.

Years 3-10

During the third through tenth years less action is required, bur management is still important to maintain a fire-safe environment that is ecologically sound.

Resprout trees - Raise crowns one-third of height, that *is,* prune the lower third of branches smaller than 3" in diameter. Remove dead and unwanted sprouts.

Shrub seedlings and resprouts - Continue thinning to attain crown-to-crown separation of twice the coral height.

Fertilization, mulching, and irrigation may continue to speed growth.

Monitor for disease and pests, and treat as discussed above.

Years 11-30

The 11-30th-year period has a few significant major actions. Residents should thin pines and shrubs to spacing desired when vegetation *is* mature. Prune lower branches of trees and shrubs to ten feet, or above the grade at slope dripline. Raise crowns one-third of height (at least ten feet above grade at upslope dripline/tree canopy edge).

Resprout trees - Raise crowns one-third of height (at least ten feet. above grade at up-slope dripline).

Shrub reproduction - Continue thinning for proper spacing (two rimes height).

Fertilization, mulching, and irrigation may continue to speed growth.

RESTORATION MANAGEMENT:
STEPS SPECIFIC TO PARTICULAR VEGETATION TYPES

Years 1-2

PINE FOREST: Pine seedlings may be thinned and adjacent grass removed to reduce competition, increase survival, and accelerate growth. Irrigation will encourage exotics and an eradication program should be initiated.

COASTAL SCRUB: Through the culture of resprout shrubs and seedlings and the transplanting of seedlings, the coastal scrub cover can be designed, in part to revegetate areas where regeneration has failed. Shrub seedlings may be pulled during their first spring. Shrub reproduction may be unevenly distributed, and transplanting is an option for desired distribution of shrub coverage. Fire-resistant shrubs should be favored over highly flammable plants (see list, Appendix 2). Remove exotics. Shrubs should be separated from one another or maintained in groups not exceeding 18 feet in diameter and separated from one another for a distance of no less than two times the current height.

Years 3-10

PINE FOREST: Continue thinning pine seedlings to reduce competition. Seeding or transplanting to sites that fail to reproduce is an option. Raise crowns one-third of height.

COASTAL SCRUB: Seeding or transplanting to sites that fail to reproduce is still an option but more difficult. Continue thinning or clumping shrub seedlings and resprouts, with a maximum diameter of 15 feet and separation of two times the total height.

Years 11-30

PINE FOREST: Thin pines to final mature spacing. Raise crowns one-third of height (at least ten feet above grade at upslope dripline).

COASTAL SCRUB: Shrub reproduction - Continue thinning for proper spacing (two times height).

FIRE HAZARD MANAGEMENT: SUMMARY

WITHIN THE LARGER ACREAGE BURNED BY THE VISION FIRE, a small part of the developed east-facing slope of the Inverness Ridge burned. Homes in the rest of the Inverness Ridge communities, as well as wildlands and watersheds, continue to be at serious risk.

The principles of modern fire ecology dictate that we must be respectful of both the natural environment and the power and peril of uncontrolled conflagrations. It is also now recognized that our passive, overly protective management of the land has had a tremendous impact on natural plant communities and has subverted natural processes, including periodic fire, leading to a decline in biodiversity and to destructive fires of unnatural size and intensity.

Antiquated strategies for fuel management (clearing, firebreaks, and bare mineral soil exposure) typically have conflicted with other aesthetic and environmental values: erosion control and slope stability, wildlife habitat preservation, the maintenance of biodiversity, forest restoration, and maintenance of the natural beauty of the many plant communities in which we live and work.

The Phoenix Team believes that homeowners can have a beautiful narural landscape and manage for fire hazard at the same time. Many of the same operations recommended for forest restoration are also recommended for fire hazard reduction.

Fire hazard management in the "urban/wildland interface" requires management of wildland and landscape vegetation to reduce the intensity and rate of spread of a potential wildfire to a level that can be suppressed with basic firefighting resources - a fire engine and three firefighters.

State law and local ordinances require that roads and drives provide adequate safe access and egress for emergency evacuation and response. They require that landscape vegetation be managed so as not to provide the rapid transmission of fire from the landscape to the structure or visa versa.

State Public Resource Code 4291 and Marin County Code Title 24 do not specify how defensible space around structures should be achieved. They require "clearing away...all flammable vegetation or other combustible growth," but "this subdivision does not apply to single specimens of trees, ornamental shrubbery, or similar plants which are used for ground

cover, if they do not form a means of rapidly transmitting fire from the native growth to any building or structure." (PRC 4291 (a)).

Creating defensible space around each structure, in fact, is essential for fire hazard management for residents and home-owners. It consists of managing vegetation in an area in order to calm fire behavior, reduce ignition of the structure, and provide space for firefighters to take defensive action. The size of the area needed to calm the fire depends on current vegetation type, topography, development density, and access. As the new (post-Vision Fire) plant community develops through various successional stages from a grass-dominated landscape to mature pine forest, the fuel type or "model" will pass through successional changes and require various types and levels of treatment to provide defensible space.

Study of the Vision Fire zone demonstrated that almost invariably the fire was controlled and homes saved where hardwoods dominated the forest cover. The fire was rarely controlled in pine dominated forest, and no homes were saved in pine forest where defensible space work had not been done.

The fire safety approach adopted here focuses on making fuels unavailable to a potential fire. There are four ways to make fuels unavailable to fire:

1) Favor fire-resistant plants, and discriminate against pyrophytic plants in your defensible space zone (see plant list, Appendix 2).

2) Remove dead or cured plants, and clean up down and dead debris.

3) Disrupt the horizontal and vertical continuity of fuels (plants). Separate shrubs and trees to provide space between plants to discourage the rapid horizontal transmission of fire across the landscape. Raise nee crowns, and clear or trim undergrowth to prevent the vertical transmission of fire into tree crowns. Use only highly fire-resistant plants adjacent to structures (the 0- to 10-foot critical zone: see below).

4) Maintain high fuel moisture through irrigation and deadwood removal.

Wildland areas outside the defensible space zones and roadside treatments may be managed to accelerate forest restoration and renewal in a manner similar to those recommended above but with a view toward reducing available fuels and achieving greater fire resistance.

DEFENSIBLE SPACE: RECOMMENDATIONS

DEFENSIBLE SPACE IS THE AREA AROUND THE BUILDING(S) and other flammable structures on a developed property where you can prevent the rapid spread of high-intensity fire by reducing fuel loads. The area of defensible space needed depends on: general conditions, such as the areas topography, major fuel types, access, and development density; and site conditions, such as slope, aspect (direction of slope), and specific fuel type. Defensible space might vary from a minimum of 30 x 30 x 30 feet upslope, across slope, and downslope from the structural envelope in a low fire hazard zone to a minimum of 50 x 50 x 100 feet in a high fire hazard Zone.

Defensible space consists of four fuel modification zones (defined by local Marin County Fire Department ordinance): 1-10 feet, 11-30 feet, 30-50 feet, and 51-100 feet from a structure. For

fire hazard mitigation, there are six kinds of vegetation to address within the defensible space surrounding a structure, with some actions common to all four zones.

Actions Necessary in All Fuel Zones:

Annual maintenance is very important in all zones. When "firescaping" is done properly, however, annual maintenance does not become a big chore.

Remove deadwood, favor non-pyrophytic plants, and protect from construction the plants to be retained.

Thin sprouts of trees and shrubs to three per stump, and space clumps of plants to two times their height.

Thin seedlings to create a spacing of no less than two limes the height of the crown.

Prune lower branches up to ten feet in height, or in shorter plants one-third of the lower branches, until the plants reach 30 feet in height.

Create spaces between trees so that crowns of each tree are separated by ten feet.

GRASS & HERBS - Mow to no more than six inches high. Mulch or remove cuttings.

BRUSH RESPROUTS & SEEDLINGS - Thin sprouts to no more than three per stump. Remove all deadwood. Thin to spacing of no mote than twice the mature height.

TREE RESPROUTS - Thin sprouts to no more than three per stump. Remove deadwood. Thin to no less than ten feet crown-to-crown spacing.

TREE SEEDLINGS - Remove deadwood. Thin to no less than ten feet crown-to-crown spacing.

STANDING TREES - Remove deadwood. Keep only safe wildlife trees. Thin to no less than ten feet crown-to-crown spacing.

DOWN & DEAD TREES & BRUSH - Remove, chip, or multi-cut, arid scatter all debris less than six inches diameter in defensible space zones. Maximize soil contact of all lop and scattered leaf material.

Actions Particular to a Fuel Zone

ZONE 1. The zone closest to the home is most crucial for structure survival and access for firefighters. Safe fire suppression access around the structure(s) must be provided, and the landscape must be highly maintained to prevent structural ignition from direct flame impingement. The landscape must also accommodate the design and materials of the structure, especially its fire vulnerable features: post-supported structures and areas under decks should be free of all plants and debris; flammable plants should be avoided under overhangs and near windows. No flammable plants or trees should be placed against the structure. Branches should be pruned ten feet back from roof, chimney, and deck. Protect plants from construction.

Plants in this zone need to be the most fire-retardant and should not include any pyrophytes (flammable plants) that are high in oils and resins, such as pines and junipers, or any dead plants. While this zone can have specimen trees, its landscaping is best comprised of fire-retardant foundation planting. When irrigation is limited, use more of your available water in this zone than other zones. Plants with high moisture content are less likely to burn.

Avoid fire brand "beds of opportunity," such as debris or wood piles. Landscape construction should be of non-combustible materials. Non-flammable patios, walkways, rock, gravel, and mulch can be used as fuel breaks for this zone. Removal of all dead wood (on structural elements as well as in the garden) is crucial. Dead trees and brush can be cm and chipped, or multicut, and spread on the site as mulch. Alternately this material can be removed or burned in piles.

GRASS, HERBS - Mow to a height no greater than three inches.

BRUSH RESPROUTS & SEEDLINGS - Remove all pyrophytes. Keep highly fire-resistant plants only. No pyrophytic brush against structure.

TREE RESPROUTS - Keep sprouts of fire-resistant trees (thinned to no mote man three per stump). Remove all deadwood and pyrophytic trees. Favor highly fire-resistant plants.

TREE SEEDLINGS - Remove all dead plants. Discriminate against pyrophytes. Favor highly fire-resistant planes. Favor hardwoods.

STANDING TREES- Remove all dead trees and pyrophytic trees. Limb up (raise crowns) to no less man ten feet above grade, and reduce crowns to ten feet from chimneys, roofs, decks, etc.

DOWN & DEAD TREES & BRUSH - Do not stack firewood in this zone.

ZONE 2. The zone 11-30 feet from the structure (or **11** feet to the property line) is the crucial working zone for structural defense: it operates as working area for firefighting and for egress for residents and firefighters. Minimal resources should be able to suppress fire in this zone. Provide for safe access and escape.

This is a well maintained, irrigated area of well spaced and trimmed fire-resistant planes. Favor low planes up to 18 inches high, such as fire-resistant ground covers, and separated clusters of well trimmed and deadwooded native or ornamental shrubs. Also, well maintained taller shrubs and trees, limbed up to a minimum of ten feet above grade, are permitted. Dead trees and brush can be cur, chipped, and spread on sire as mulch. Alternately, this material can be removed or burned in piles.

GRASS, HERBS - Mow to three inches high.

ALL RESPROUTS & SEEDLINGS - Discriminate against pyrophytes. Create a green belt.

TREE SEEDLINGS - Thin to no less man twice the height of crown-to-crown spacing. STANDING

TREES - Remove all dead trees. Discriminate against pyrophytes.

DOWN & DEAD TREES & BRUSH - Remove, chip, multicut (to less man two inches in diameter and four inches in length), and scatter evenly over the sire as mulching material; or pileburn all debris.

ZONE 3. The area 31-50 feet away From the structure (or 31 feet to the property line) is a belt managed as a fuelbreak downslope, on sidehills, or between the structural envelope and heavy fuels. A single firefighting unit should be able to suppress fire in this zone. Break up horizontal (crown-to-crown) and vertical (ground-to-crown) fuel continuity. Manage vegetation as in Zone 2, with the addition of clusters of native vegetation, which are acceptable when separated by a distance of two rimes the height of the planes and when each cluster is smaller man 18 feet in circumference. All dead material should be pruned out of these clusters, removed, chipped or multi-cur (to less man two inches in diameter and four inches in length), and scattered evenly over the site as mulching material. Mulching also helps prevent grass and weed encroachment on the treated areas,

helps maintain the soil moisture for the desired plants, and minimizes soil erosion. Dead material that is larger than six inches in diameter can remain.

ALL GRASS & CURED WEEDS - Mow or weed whip to a maximum stubble height of six inches. Mulch/remove cuttings.

ALL OTHERS - Exactly as in Actions Necessary in All Fuel Zones.

ZONE 4. The area 51-100 feet from the structure, or to the property line, reinforces defensible space closer to the structure wherever steep slopes, warm southwest aspects, heavy fuels, or poor access justify enhanced fuel management. The intent of vegetation management in this zone is to reduce the total fuel load and resulting heat output from a wildfire. Selectively remove and limb up trees and shrubs to break up the crown-to-crown and ground-tO-crown continuity of fuels. Favor fire-resistant plants. Thin and deadwood the remaining trees and shrubs to reduce the total fuel load. Most other actions are the same as for Zone 3, e.g., mulri-cutting for mulch and clusters of native brush.

ALL GRASS & CURED WEEDS - Mow or weed whip to a maximum srubble height of six inches. Mulch/remove cuttings.

ALL OTHERS - Exactly as in Exactly as in Actions Necessary in All Fuel Zones.

Actions Particular to Vegetation Type

In a very few instances, some specific actions particular to the plant community are required for defensible space beyond those summarized above.

Pine Forest with Heavy Undergrowth - Burned

IN FUEL MODIFICATION ZONE 4: Current State law and local codes can require only a maximum of 100 feet of defensible space. Depending on fire hazard factors, up to 150 feet of defensible space might be advisable.

Pine Forest with Heavy Undergrowth - Unburned

OVERALL: Grass, herbs - (This fuel type is absent in the mature pine forest.) Annually mow to 3 inches where present, and remove cuttings.. .

BRUSH IN ZONE 1: Highly fire-resistant, low-growing (1S") shrubs are preferred in Zone 1

OTHER ZONES: *Standing trees*- Limb up (raise crowns) as high as possible, no less than ten feet above grade, and thin crowns to reduce total fuel load, as well as reducing crowns to ten feet from chimneys, roofs, decks. *Young trees* - Remove all deadwood; discriminate against pyrophytes; thin to no less than two times the height (at a given time) of crown-to-crown spacing.

Hardwood Forest with Heavy Undergrowth - Unburned

IN EACH FUEL MODIFICATION ZONE: In dense stands of sword ferns, cut down every third sword fern each year to provide a mosaic of fresh growth.

Hardwood Forest with Sparse Undergrowth - Unburned

This forest/fuel type tends to be fire-resistant, even the Bay Forest Climax type. If the trees are limbed up and deadwooded, then the dominant fuel that carries a potential for fire tends to consist of down and dead debris and old and dead sword fern fronds. An intact canopy wiII reduce light penetration and undergrowth.

IN EACH FUEL MODIFICATION ZONE: In dense stands of sword ferns, cut down every *third* sword fern each year to provide a mosaic of fresh growth.

ROADS AND DRIVES

IN A FIRE, MOST OF THE DEATHS AND INJURIES TO CITIZENS OCCUR ON DRIVES AND ROADS. The ability to evacuate areas safely and fight interface fires is dependent on having roads with adequate width, turning radio, turnouts and turnarounds, and proper vertical and horizontal clearance.

The Inverness Ridge generally has poor to very poor road access, with long slow climbs up even the main roads; narrow, unpaved, dead-end secondary roads serving multiple dwellings; long shared drives; and long, often unsigned single drives. Most of the roads and drives are narrow (below state standards for safe evacuation and response) with hairpin turns that slow or even halt fire response. The roadside fuel loading is typically very heavy and very flammable.

Fire could easily prevent evacuation and/or emergency response.

Better turn-arounds, back-arounds, or hammerheads should be provided at the ends of the main and secondary roads and ends of drives over 150 feet in length.

Turnouts (weather-surfaced parking spaces a minimum of 30 feet long and 8 feet wide with adequate roadside fuel management) should be located along Drakes View Drive at least every 400 feet. Long drives (150+ feet) should have a turnout near the midpoint. Parking in these spaces should be discouraged.

Local ordinances require fuel management along roads and drives for a minimum of ten feet from road, turnouts, and turn-arounds. They also require a minimum of 15 feet clearance above travel lanes. The Vision Fire clearly demonstrated that these minimum "clearances" are inadequate for safe evacuation and firefighting. Where possible, defensible space and vertical clearance from vehicle use corridors should be increased.

Driveways should have the same minimal vertical and horizontal fuel management. Good firescaping is particularly important where the drive approaches the parking area, garage, or home because this is where families will gather to load their vehicles and evacuate in the event of a wild fire.

Dead or damaged unstable trees along road and drive cutbanks (above) and spoil banks (below) should be removed to avoid uprooting and disturbance or obstruction of the road or drive.

Many property addresses are not clearly posted. This can be a serious problem in both fire and medical emergencies when minutes count. Addresses should be posted at the entrance to all drives and shared drives, and at the intersections of shared and individual drives, with clear directions to the individual homes. Addresses should also be posted at the homes themselves. The address signs should have bright four-inch numbers with at least a 3/8-inch stroke on a contrasting background.