STUMP AND LARGE ROOT REMOVAL TO CONTROL ROOT DISEASE

Two major root diseases of conifer species in British Columbia are caused by *Armillaria* (Cleary *et al*. 2008) and *Phellinus* (Sturrock *et al*. 2006) . These two fungal pathogens infect roots and over time they can occupy all large roots and infect the lower bole of a tree. This infected tree is now a source of inoculum and will continue to be as the tree lives. This source of inoculum can infect other trees where their roots come into contact, and as well the fungus can grow through the soil to infect other trees. When the tree is harvested the stump is now also a source of inoculum, which is ideal for infecting other, newly planted trees.

> *The effect of chronic root infections on the quantity, quality, and value of timber products has an overall greater impact on timber resources, than mortality alone* (Cruickshank, 2010).

According to Morrison *et al*. (1991), inoculum longevity and infection potential of *Armillaria* and *Phellinus weirii* are greatest in the lower part of the stump and large diameter roots near the stump. Bloomberg and Reynolds (1982) demonstrated that the larger diameter roots transfer *Phellinus weirii* infection more efficiently.

Root rot is a disease of the site and is likely to persist on the site even with stumping. However, stumping does lessen the impact and it prevents an intensification of the disease

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Root disease infected stumps and roots can infect other trees and newly planted trees. If infected stumps and large roots are not removed, root disease can persist.

STUMP AND LARGE ROOT REMOVAL

Root disease management as stump and large root removal, is a classical disease control method used in forests and many horticultural crops. A comparative analysis of different root disease control methods of infested forest sites (chemical, biological, integrated Silvicultural systems) shows that stump removal, although expensive, is the most effective method of control and eradication of root disease (Shaw *et al*. 1978 & 1980, Thies 1984, Morrison *et al*. 1991, Thies *et al*. 1995, Sturrock 2000, Vasaitis *et al*. 2008).

Both *Armillaria ostoyae* and *Phellinus sulphurascens* can cause reductions in tree diameter and height, and they cause mortality, (Cruickshank *et al*. 2009). Root systems colonized by these fungi provide disease inoculum for infection of other nearby trees. Root and butt rots are diseases of the site; that is, they do not die out when diseased trees are harvested. Once the tree is harvested, and depending on the fungal species and size and species of stumps, the inoculum may be viable for up to 50 years (Hansen 1979). This poses a long- term threat to site productivity in subsequent stand rotations

- Benefits of stump removal

- Reduces disease inoculum in soil;
- Reduces potential infected root contact with regenerating tree roots;
- Improves reforestation of susceptible host species;
- Improves overall seedling establishment; and
- Increases tree growth and stand productivity. (Caution, this is not true for all sites.)

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ROOT DISEASE

- Biology

- *Armillaria* and *Phellinus*
  - Only *Armillaria* produces rhizomorphs (a root-like aggregation of mycelium) that grow through the soil and that can come into contact with uninfected roots
  - Both pathogens spread belowground by mycelia growth along roots and across root contacts between infected and healthy tree roots.

It is important to recognise that there usually is a significant difference between the numbers of trees observed with disease symptoms and the actual number of trees infected. (Norris et al., 1998).

All coniferous species less than 15 years of age are highly susceptible to mortality by *Armillaria* root disease; thereafter some conifers develop tolerance to the fungus (Cleary *et al*. 2008).

Douglas-Fir is the most economically important host for *Phellinus* sp., but most coniferous species in BC have some degree of susceptibility to *Phellinus*. Most *Phellinus* root rot centers are associated with Douglas-fir forest types.

- Practices that will increase root disease

Selective harvesting and thinning in a site can increase the incidence of root disease infection and root disease mortality (Cruickshank *et al*. 1997 and Morrison *et al*. 2001). This practice leaves infected stumps in place that have pre-existing root contacts to the surrounding trees. For *Armillaria* only, thinning an infected site can greatly enhance the spread of root disease by increasing the fungal food base and allowing unhindered spread through dead root systems.

For *Phellinus*, root disease intensification occurs when prompt regeneration with a susceptible species is placed in close proximity to infected stumps. This is usually the result of root disease not being properly identified pre harvest, especially where harvesting occurs right up to the edge of root rot left behind in wildlife tree patches or along block boundaries. Harvesting operations that avoid root rot areas because there is insufficient volume present can result in reduced harvest opportunities. It is assumed that these root rot areas will produce harvest opportunities in the future, but in many cases this may not happen, especially where they naturally regenerate back to Douglas-fir.

In areas of high hazard and risk to root disease many forest management activities exacerbate incidence and spread by creating stumps for a fungal food base. (Contact regional forest pathologist for most up to date landscape level hazard information).

ROOT DISEASE MANAGEMENT

It is impossible to completely sanitize the site of root disease, but stump and root removal prevents the build-up of inoculum in the next rotation stand and it reduces losses to acceptable levels from a forest management perspective. Ideally, it's best not to make the problem worse.

– What is effective treatment?

Complete stump and large root removal is seldom achieved in practice, and removing already decayed stumps and roots usually results in some of their biomass being left in the soil (Sturrock *et al*., 1994, Omdal *et al*. 2001). Despite this, machines designed to remove *Phellinus* and *Armillaria* infected conifer stumps are highly efficient, and have been shown to remove 83–94% of the estimated belowground biomass (Bloomberg *et al*. 1988, Omdal *et al*. 2001). Furthermore, over 80% of root remnants left in the soil were less than 5 cm in diameter (Sturrock *et al*., 1994, Omdal *et al*. 2001).

– Partial and incomplete stump and large root removal

Subsequent infection in a site from root disease is tied to the size and number of stumps that the fungal pathogen occupies. Partial stump removal; not removing the largest stumps (i.e., >70cm diameter), leaving the smallest stumps, not removing the largest roots - biologically these scenarios leave disease inoculum in the site which can infect trees. It is a well-known and accepted fact that root disease infected stumps are disease inoculum, and leaving any inoculum in the site will cause disease in the surviving trees. Small, broken roots can serve as viable inoculum of the pathogen. However, it is viable inoculum for only a few years.

<u>A partial stump and large root removal study,</u>
(Roth *et al*., 2000 - *Armillaria* site) with 4 treatments; 1) all stumps and roots were removed by machine and hand, 2) all stumps and roots removed by machine, 3) large stumps left on site but large roots removed, 4) no root removal. Results indicate that the more stump and root removal that occurs, the less resulting root disease in subsequent years.

– Is there a maximum stump size/diameter that cannot be stumped?

Excavators with a hydraulically operated gripping thumb are recommended for stump removal, due to their maneuverability, low impact to site and the ability to extract even the most severely infected stumps, and stumps of large diameter (**> 76 cm**) (Bloomberg and Reynolds 1988, Thies 1987 & 1995, Smith and Wass 1989 & 1991 & 1994, Morrison *et al*. 1991, Sturrock *et al*. 1994, Wass and Smith 1997, Omdal *et al*. 2001).

It is anticipated that successful stumping operations require an excavator that is large enough to easily undermine root systems (Appendix 1 – Standards for mechanical stumping for root disease control), the excavator has the ability to pull and lift a stump or stump section, and that the excavator applies low ground pressure (Thies and Sturrock 1995). In BC, Sturrock (2000) recommends the use of excavators with a hydraulically operated gripping thumb to pull stumps or push-fall trees.

Site conditions (stony and rock-strewn) may influence the ability to remove stumps. However, any number of stumps or roots, large or small, left in a site will render a stumping treatment ineffective.

– Area of risk around stumps

There is no effective distance from an infected stump at which trees can be planted to reduce stump inoculum contact (Morrison *et al*. 2000). Roots of stumps have spread meters from the base and overlap other roots so that all of the planted area is at risk.

Inoculum longevity is proportional to stump size; thus, inoculum associated with larger stumps remains viable longer. Large infected stumps have the advantage of space and time to spread disease; pathogenic fungi in larger root systems (space) can infect healthy trees over a longer period (time).

Large infected stumps have the advantage of space and time to spread disease; pathogenic fungi in larger root systems (space) can infect healthy trees over a longer period (time).

Area of risk around stumps - research results - The rate of spread of *Armillaria* from Douglas-Fir stumps has been calculated to be 0.22m/year in BC (van der Kamp 1993). This is considerably slower than the rate of spread of 1.0m/year in a ponderosa pine stand (Shaw *et al*. 1976). For *Armillaria*, the average time from first appearance of aboveground symptoms (basal resinosis) to tree death was 6 years.

- Burning stumps

Burning stumps has no significant effect on seedlings mortality caused by *Armillaria* root disease. Whitney and Irwin (2005) found that the number of saplings killed by *Amillaria* 10 years after a prescribed burn was not significantly different for seedling mortality at an unburned site, with endemic *Armillaria*. They also found that there was no significant difference for mortality between severely burned, moderately charred and lightly scorched stumps. Fire and burning stumps is not efficient in reducing mortality in subsequent plantations.

– Variable retention

Variable retention – Biodiversity and structural diversity - In cases where root disease has been assessed and determined to be present in retention areas, it is imperative that no areas be intentionally left as a retention area. The benefits of leaving retention must be carefully weighed against the need to reduce root rot inoculum levels.

> Paper Birch in retention areas; Birch less than 15 years of age are resistant to *Armillaria*, but as they age they become tolerant to the disease, but not immune (Morrison, *et al*. 1991). Leaving tolerant, infected older Birch in a retention area will allow *Armillaria* the potential to infect surrounding hosts. More problematic is cutting older Birch and leaving the stumps and this inoculum will infect surrounding conifer hosts (Baleshta *et al.,* 2005).

Variable retention - Reforestation - Where retention areas are known to contain root disease, and stumping cannot occur, reforestation must include ecologically suitable alternate species plantings around the retention area. Consideration for resistant trees (e.g. western redcedar, larch, white pine, aspen and birch) should be given and allowed wherever possible. A resistant barrier between stumped and unstumped areas must be wide enough to prevent the spread of the root disease into susceptible trees Morrison *et al*., 1988; Morrison and Mallett, 1996). Planting resistant or tolerant species would also apply to areas that cannot be stumped because of slope stability issues.

– Site disturbance

Site disturbance due to stumping cannot be equated with site degradation. In many cases, site disturbance was shown to be beneficial for establishment and growth of a subsequent stand (Sturrock, 2000). Stumping treatment differences and its effect on soil bulk density disappeared within 10 years of stump removal; the increased levels of soil bulk density caused by stump removal on moderately coarse soils were not sufficient to reduce tree growth (Hope, 2007). Norris, *et al.* (2014) found that heavily compacted, stumped areas, had increased soil bulk density, which negatively affected the stand development (decreased tree volumes). However, they found tree survival was higher in all treatments, except unstumped areas.

Site disturbance – invasive plants **-** Regulations on the subject of preventing the introduction of invasive plants into forested site exists in FRPA (section17) '*a person who prepares a forest stewardship plan must specify measures in the plan to prevent the introduction or spread of species of plants'*. Best practices for preventing the spread of invasive plants, (ISC, 2013), provides detailed guidance. When controlling for root disease the preventative guidance should not boost invasive species. However, the main reason for stumping - to remove inoculum - must not be lost.

Plants that first colonize disturbed areas or lands are called ruderal plants. Ruderal plants, often invasive endemic or alien species, will dominate these disturbed areas until native species being to out-compete the invasive plants. However, there can be conditions where the disturbance is so great that the ruderal species can become permanently established and thereafter dominate the landscape. To avoid this condition seek advice from ecology specialists.

– Control with biological agents

Currently, the province of British Columbia does not support the use of biological agents for the control of root disease. The testing of the biological agents *Hypholoma fasciculare* to treat root disease is a relatively recent development in British Columbia (Chapman *et al.,* 2004). One published experiment (Chapman , 2001) assessed the biocontrol activity of *Hypholoma* on calcareous soils; soils in which stumping is not recommended.

Biological control relies on competition or parasitism or other natural mechanisms, but typically involves an active human management role. The limitations of biological control are difficult to forecast; they will however, become properly known only after greatly expanded research over a long period. A relatively simple limitation with biological control is that the host population (in this case *Armillaria* sp.) will continue to exist at a level predetermined by the properties of the host and its natural enemies and of the habitat, and most likely not completely removed by other organisms. Nevertheless, biological control in natural environments can be very complex.

CONCLUSIONS

Stump and large root removal from forest areas in almost all cases results in;

a) reduction of root rot in the next forest generation,

b) improved seedling establishment, and

c) increased tree growth and stand productivity.

AVAILABLE DATA STRONGLY SUGGESTS THAT ALL STUMPS AND LARGE ROOTS WITH ROT MUST BE REMOVED DURING STUMPING.

RECOMMENDATIONS

Excavator – Use large excavators with a toe and gripping thumb. An assessment of the site, either pre- or post-harvest will determine the on-site maximum stump size and the appropriate excavator to be used. Stumps should be shaken free of soil and placed upside down back in their holes.

Hazard and Risk assessment - In order to develop a prescription that adequately addresses root disease, a landscape level hazard and risk assessment is required and it should be included in Forest Stewardship Plans. All high hazard and high risk biogeoclimatic subzones (see table below) should be considered as infected at a level exceeding the maximum treatment threshold, unless stated otherwise in the prescription (For treatment thresholds refer to British Columbia Ministry of Forests. 1995). If the disease is absent from the strata then the prescription must explicitly state so. A root disease assessment should always be carried out as stumping is a high cost treatment that needs to be used judiciously even in high risk ecosystems.

Landscape level hazard and risk values for Armillaria root disease by BEC – Refer to the Root Disease Management Guidebook (British Columbia Ministry of Forests. 1995)

BEC zone	subzone	Armillaria hazard
ESSF	wc1	HIGH
ICH	dw; mk1; mk2; mw1; mw2; mw3; vk1; wk1; xw	HIGH
IDF	dk1; dk2; dm1; dm2; mw1; mw2; xh1; xh2	HIGH
MS	dk; dm1; dm2	HIGH
PP	dh1; dh2	HIGH

Slope – Although, guidance (Cleary *et al*. 2008) and other literature (Vasaitis *et al*. 2008) suggest stump removal on slopes up to 35% grade, stump removal on greater pitched slopes can be done, provided safety and environmental issues are observed.

Soil types – Stump removal should, preferably be conducted when soil moisture is low. For additional guidance refer to soil guidebooks (British Columbia Ministry of Forests 1999 and 2001). Some soil type cautions;

calcareous soils	Stump removal may bring the carbonates of calcareous soils closer to the surface thereby increasing pH and reducing nutrient availability, since certain mineral nutrients are sensitive to pH, which may affect their mobility and ultimately tree growth.
clays soils	Soils tend to be heavy and impervious and can become easily compacted, which makes the soil unfavorable for seedling growth.
silty clay loam soils	Soil-profiles which are easily disturbed and then further eroded in rainstorms and water run-off, which can result in mass wasting and soil displacement.

PUBLICATIONS

Root disease biology, surveys and management guidance for British Columbia

British Columbia Ministry of Forests. 1995. British Columbia root disease management guidebook. Victoria, BC: Government of British Columbia. https://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/root/roottoc.htm

Cleary, M., van der Kamp. B. and Morrison, D. 2008. British Columbia's southern interior forests: *Armillaria* root disease stand establishment decision aid. British Columbia Journal of Ecosystems and Management, 9: 60-65.

Norris, D., McLaughlin, J. and Curran, M. 1998. *Armillaria* root disease management guidelines for the Nelson forest region. Technical Report TR-014. Victoria, BC: Government of British Columbia.

Sturrock, R., Zeglen, S. and Turner, J. 2006. British Columbia's coastal forests: Laminated root rot forest health, stand establishment decision aid. British Columbia Journal of Ecosystems and Management, 7: 41-43.

General reviews of root disease management

Cleary, M.R., Arhipova, N., Morrison, D.J., Thomsen, I.M., Sturrock, R.N., Vasaitis, R., Gaitieks, T. and Stenlid, J. 2013. Stump removal to control root disease in Canada and Scandinavia: A synthesis of results from long-term trials. Forest Ecology and Management, 290: 5-14.

Shaw, C.G. III, Omdal, D.W., Ramsey-Kroll, A. and Roth, L.F. 2012. Inoculum reduction measures to manage *Armillaria* root disease in a severely infected stand of Ponderosa Pine in South-central Washington: 35 year results. Western Journal of Applied Forestry, 27: 25-29.

Vasaitis, R., Stenlid, J. Thomsen, I.M. Barklund. P.G and Dahlberg, A. 2008. Stump removal to control root rot in forested stands A literature study. Silva Fennica, 42: 457-483.

Other publications

Baleshta, K.E., Simard, S.W., Guy, R.D. and Chanway, C.P. 2005. Reducing paper birch density increases Douglas-fir growth rate and *Armillaria* root disease incidence in southern interior British Columbia. Forest Ecology and Management, 208: 1-13.

Bloomberg, W.J. and Reynolds, G. 1982. Factors affecting transfer and spread of *Phellinus weirii* mycelium in roots of second-growth Douglas-fir. Canadian Journal of Forest Research 12: 424-427

Bloomberg, W.J. and Reynolds, G. 1988. Equipment trials for uprooting root rot-infected stumps. Western Journal of Applied Forestry, 3: 80-82.

British Columbia Ministry of Forests. 1999. Hazard assessment keys for evaluating site sensitivity to soil degrading processes guidebook. 2nd editon, Version 2.1. Forest Practices Branch, B.C. Ministry of Forests, Victoria, B.C. Forest Practices Code of British Columbia

Guidebook. https://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/HAZARD/HazardAssessKeys-web.pdf

British Columbia Ministry of Forests. 2001. Soil Conservation Guidebook. 2nd editon. Forest Practices Branch, Ministry of Forests, Victoria, B.C. Forest Practices Code of British Columbia Guidebook. http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/soil/soiltoc.htm

Chapman, B., Begin, E. and Curran, M. 2001. Using *Hypholoma fasciculare* inoculation as a means to control *Armillaria* root disease on calcareous soils: Trial establishment and Monitoring. Cariboo Forest Region Research Station. Extension Note 33.

Chapman, B., Xiao, G. and Myers, S. 2004. Early result from field trials *using Hypholoma fasciculare* to reduce *Armillaria ostoyae* root disease. Canadian Journal of Botany, 82: 962-969.

Cruickshank, M.G., Morrison, D.J. and Punja, Z.K. 1997. Incidence of *Armillaria* species in precommerical thinning stumps and spread of *Armillaria ostoyae* to adjacent Douglas-Fir trees. Canadian Journal of Forest Research, 27: 481-490.

Cruickshank, M.G., Morrison, D.J. and Lalumiere, A. 2009. The interaction between competition in interior Douglas-Fir plantations and disease caused by *Armillaria ostoyae* In British Columbia. Forest Ecology Management, 257: 443-452.

Cruickshank, M.G. 2010. Effect of *Armillaria* root disease on quality and value of green Douglas-Fir lumber. The Forestry Chronicle, 86: 263-266.

Hansen, E.M. 1979. Survival of *Phellinus weirii* in Douglas-Fir stumps after logging. Canadian Journal of Forest Research, 9: 484-488.

Hope, G.D. 2007. Changes in soil properties, tree growth, and nutrition over a period of 10 years after stump removal and scarification on moderately coarse soils in interior British Columbia. Forest Ecology and Management, 242: 625-635.

ISC (Invasive Species Council of British Columbia). 2013. Best Practices, for preventing the spread of invasive plants during forest management activities – A pocket guide for British Columbia's forest workers. Province of British Columbia, 72pp.

Morrison, D.J. and Mallett, K. 1996. Silviculture management of *Armillaria* root disease in western Canadian forests. Canadian Journal of Plant Pathology, 18: 194-199.

Morrison, D.J. Merler, H. and Norris, D. 1991. Detection, recognition and management of *Armillaria* and *Phellinus* root disease in the southern interior of British Columbia. Forestry Canada and BC Ministry of Forests, Victoria, BC, FRDA Rep. 179.

Morrison, D.J., Pellow, K.W., Nemec, A.F.L. and Norris, D. 2000. Visible versus actual incidence of A*rmillaria* root disease in juvenile coniferous stands in the Southern Interior of British Columbia. Canadian Journal of Forest Research, 30: 405-414.

Morrison, D.J., Pellow, K.W., Nemec, A.F.L. and Norris, D. 2001. Effects of selective cutting on the epidemiology of *Armillaria* root disease in the southern interior of British Columbia. Canadian Journal of Forest Research, 31: 59-70.

Morrison, D.J., Wallis, G.W. and Weir, L.C. 1988. Control of *Armillaria* and *Phellinus* root disease: 20-year results from the Skimikin stump removal experiment. Canadian Forest Service, Pacific Forestry Centre, Information Report BC-X-302.

Norris, C.E, Hogg, K.E., Maynard, D.G. and Curran, M.P. 2014. Stumping trials in British Columbia – organic matter removal and compaction effects ion tree growth from seedlings to midrotation stands. Canadian Journal of Forest Research, 44: 1402-1418.

Omdal, D.W., Shaw, C.G. III, and Jacobi, W.R. 2001. Evaluation of three machines to remove *Armillaria*- and *Annosum*-infected stumps. Western Journal of Applied Forestry, 16: 22-25.

Roth, Shaw, C.G. III, and Rolph, L. 2000. Inoculum reduction measures to control *Armillaria* root disease in severity infested stand of ponderosa pine in south-central Washington: 20 year results. Western Journal of Applied Forestry, 15: 92-100.

Shaw, C.G. III and Roth, L.F. 1978. Control of *Armillaria* root rot in managed coniferous forests. A literature review. European Journal of Forest Pathology, 8: 163-174.

Shaw, C.G. III and Roth, L.F. 1980. Control of *Armillaria* root rot in managed coniferous forests. In: Dimitri, L. (ed.). Proceedings of the 5th IUFRO conference on problems of root and butt rot in conifers, Germany, 1978. Hessische Forstliche Versuchsanstalt, Hann. Munden. p. 245-258.

Smith, R.B. and Wass, E.F. 1989. Soil displacement in stump-uprooting equipment trials on a root rot-infested cutover. Journal of Soil and Water Conservation, 44: 351-352.

Smith, R.B. and Wass, E.F. 1991. Impacts of two stumping operations on site productivity in interior British Columbia. Forestry Canada, Pacific Forestry Centre, Information Report BC-X-327. Victoria, British Columbia. 43 p.

Smith, R.B. and Wass, E.F. 1994. Impacts of stump uprooting operation on properties of a calcareous loamy soil and on planted seedling performance. Forestry Canada, Pacific Forestry Centre, Information Report BC-X-344. Victoria, British Columbia. 19 p.

Sturrock, R. Phillips, E.J. and Fraser, R.G. 1994. A trial of push-falling to reduce Phellinus weirii infection of coastal Douglas-Fir. Canada-British Columbia a Partnership Agreement on Forest Resource Development: FRDA Report 217. Victoria, BC, 22 p.

Sturrock, R. 2000. Management of root diseases by stumping and push-falling. Canadian Forest Service, Victoria, British Columbia Technical transfer Note No. 16.

Thies, W.G. 1984. Laminated root rot: the quest for control. Journal of Forestry, 82: 345-356.

Thies, W.G. 1987. Stump removal to control laminated root rot. Northwest Woodlands, 3: 19-26

Thies, W. G. and Sturrock, R. 1995. Laminated root rot in western North America USDA Forest Service General Technical Report PNW-GTR-349. Portland, Oregon. 32 p.

Van der Kamp, B.J. 1993. Rate of spread of *Armillaria ostoyae* in the central interior of British Columbia. Canadian Journal of Forest Research, 23: 1239-1241.

Wass, E.F. and Smith, R.B. 1997. Impacts of stump uprooting on a gravely sandy loam soil and planted Douglas-Fir seedlings in south-coastal British Columbia. Canadian Forest Service, Pacific Forestry Centre, Information Report BC-X-368. Victoria, British Columbia. 15 p.

Whitney, R.D. and Irwin, R.N. 2005. Comparison of *Armillaria* root disease on burned and unburned harvest sites in Ontario. Forestry Chronicle, 81: 56-60.

APPENDIX 1

BRITISH COLUMBIA | Ministry of Forests, Lands and Natural Resource Operations

Standards for Mechanical Stumping for Root Disease Control

TREATMENT OBJECTIVES:

To manage for Armillaria and Phellinus root diseases. **All stumps** within the harvested boundary are to be stumped.

EQUIPMENT TYPE AND STANDARDS:

Minimum machine size is 48,500 - 58,000 lbs (125-145 hp) to minimize soil compaction.

TREATMENT SPECIFICATIONS:

Operations are restricted to sufficiently low soil moisture conditions to minimize soil compaction. **No machinery is permitted to operate within 5 metres of any stream or wetland, whether it is indicated on a map or not.** Temporary log crossings must be installed at non fish bearing stream crossings and removed upon completion of site preparation operations. **Equipment restricted to logging boundary.**

Excavator stumping: Stump on slopes of less than 30% during dry soil conditions. The contractor is to place the stump upside down into the excavation to allow for drying of the root wad. **Root wads that are partially removed or not placed upside down in the excavation will be considered unsatisfactory. Stump piling is not permitted.**

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