

City of Surrey

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Parks, Recreation and Culture Department



# **Natural Areas: Coarse Woody Debris Management Strategy**

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# Table of Contents

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<i>Introduction</i> .....	3
Coarse Woody Debris Defined .....	3
Benefits .....	3
Declining Sources of Coarse Woody Debris .....	5
Purpose and Scope .....	6
Current Situation.....	6
<i>Coarse Woody Debris Management</i> .....	7
Principles.....	7
Goals and Objectives .....	7
Land Use Types .....	8
General Guidelines.....	9
Inventory Methods .....	10
Recommended Applications .....	11
Modifications to Existing Practices .....	13
Adding Value to Surplus Urban Forest Products.....	14
Interim Storage of Coarse Woody Debris.....	15
Small Debris Management.....	15
<i>Appendix A:</i> .....	17
Various Species Closely Associated with CWD .....	17
<i>Appendix B:</i> .....	19
CWD Volumes by Biogeoclimatic Zone and Natural Disturbance Type.....	19
<i>References</i> .....	21

# Introduction

## Coarse Woody Debris Defined

Coarse woody debris (CWD) is defined as dead and downed wood such as logs, uprooted stumps, large branches and coarse roots, in all stages of decomposition. Coarse woody debris is generally greater than 7.5 cm in diameter and does not include self-supporting dead trees, dead branches that are still attached to the tree, exposed live tree roots or rooted stumps higher than 90 cm. Coarse woody debris provides an essential nutrient source for living plants to begin their life cycle; it plays an important role in the growth of forest plants and trees in nurse stumps and nurse logs.

## Benefits



salamander



Slime mold

The arrangement, diversity, distribution and relative abundance of coarse woody debris are critical in providing the following benefits to biodiversity, health and appearance of Surrey's natural areas.

- Affords a source of food, water, shelter, and cover to a wide array of wildlife and invertebrates. (See Appendix A).
- Provides refuge for micro-organisms and plant roots.
- Offers growing sites to vascular plants, bryophytes and fungi, including ectomycorrhizae.
- Absorbs and retains large amounts of moisture.
- Provides a slow release source of nutrients (e.g. for plants and trees growing in nurse stumps and logs).
- Stores carbon.
- Greatly contributes to soil structure, stability, moisture content and pH levels.
- Increases the vertical and horizontal structural diversity and total surface area of the forest floor.
- Affects slope geomorphology.

In addition to these benefits to natural ecosystems, CWD can also be productively used for other purposes—on-site or off-site, or in aquatic systems. When retained on-site, CWD may be used to:

- Enhance visual aesthetics
- Control access to areas, and isolate or protect natural area features
- Construct trail structures such as stairways or corduroy treads

- Provide seating in natural areas
- Construct technical bicycle features.

When removed from the site, CWD can be used for a variety of purposes.

- Specialty wood products, i.e. laminates and carving wood.
- Traditional lumber uses.
- Firewood.

In aquatic systems, CWD is known as large organic debris (LOD) and provides:

- Structures that alter stream-flow and create pools and other habitat features
- Places for food to accumulate; and
- Cover from temperature extremes and predators.

Coarse woody debris has been extensively documented as an extremely valuable and necessary component of sustainable natural areas. Its role in the sustainability and biodiversity of forests is prominent in management literature, as the following excerpts show:

“Decaying logs on the forest floor provide cover, microclimates, and breeding habitat for a wide variety of organisms. Woody debris should be retained in the stand...larger size pieces are preferable, as they provide the greatest longevity and potential for nutrient cycling and wildlife use in the second-growth forests. Coarse woody debris is rarely evenly distributed, but it should be as well distributed as possible throughout the block.” (Forest Practices Code, *Biodiversity Guidebook*, pp. 93-94 )

“To protect the productive potential of a forest soil, a continuous supply of organic materials must be maintained...” “...CWD can be a reliable and steady source of nutrients over more than 100 years. When coarse woody debris is added to the ecosystem at regular intervals and is well distributed, it represents a long-term source of nutrients.” (Ministry of Forests, Research program, WP30, pp. 3-4)

“It (CWD) is a major element of the structural diversity of old-growth forests. It is a major component of the habitat of many forest plants, animals (both vertebrates and invertebrates), and microorganisms. It may serve as a major refugium for organisms after disturbance, and through its persistence across disturbances... It is important in the nutrient and organic matter dynamics of forest ecosystems.” (*Woody Debris in the Forests of British Columbia: A Review of the Literature and Current Research*)

A comprehensive approach to managing natural area ecosystems would be to include the management of coarse woody debris and provide for debris levels that would contribute to the overall health of the ecosystem.

## **Declining Sources of Coarse Woody Debris**

Historically, the climax forest ecosystems that dominated the coastal areas of southern British Columbia were structurally complex and dominated by enormous trees. Much of this structural diversity was due to the large amounts of physically diverse woody debris present in the understory of the forest. However, there has been a serious decline in the abundance and diversity of coarse woody debris in the forest ecosystems of the Lower Mainland. Both wood harvesting and other management practices have contributed to this deficiency.

Early logging practices in the Lower Mainland included the removal of not only all standing trees but also any large, sound, downed wood. Following harvesting, it was common practice to burn the residual debris. In Surrey's natural areas, these activities depleted much of the original, existing CWD as well as many of the sources for future CWD.

In the late 1970's, Surrey's Parks Division (Parks) implemented a forest management program. Unfortunately, the management practices devoted little effort toward the retention of coarse woody debris, and focused instead on making the forest "clean" and "tidy." As a result, substantial wood resources were removed. CWD was also reduced by local neighbourhood volunteer initiatives, which allowed residents to haul large branches and logs out from the forest for disposal at landfills. Further reduction in CWD has also resulted from the indiscriminate removal of wood from the forest to stock personal firewood supplies.

More recent forest management practices within Parks have involved the salvage removal of large, freshly downed logs for commercial uses. Some of the funds generated from these log salvages were funneled back into reforestation efforts but the forests were still left with little or no direct input of CWD.



Where did all the CWD go?

## **Purpose and Scope**

The purpose of the management strategy is to maximize the ecological and human benefits of enhanced CWD in natural areas. The strategy identifies specific CWD management goals and objectives for natural area lands and suggests adaptive management practices and methods to help achieve those objectives. This strategy prioritizes these objectives according to general land use types, environmental sensitivity ratings, existing site conditions and pre-determined site objectives pertaining to ecosystem or individual species management. It addresses CWD in all natural areas managed or maintained, solely or cooperatively, by the Parks Division including:

- Dedicated urban forest
- Riparian areas
- Forested areas in parks
- Wetlands
- Bogs and marshes
- Grasslands and shrublands

## **Current Situation**

Many of Surrey's native urban forest ecosystems are structurally simple and, in many cases, presently lack the amounts and types of CWD necessary for long-term soil productivity, forest health and effective management of indigenous biodiversity.

Because forest floors have been actively "cleaned" of CWD in the name of visual aesthetics and perceived safety and security, large diameter CWD (>60cm in diameter) is scarce. What is present does not fulfill the decay class or distribution requirements needed for healthy, sustainable forest areas: it is either completely hard and intact, or completely decomposed. On sites where CWD is present, it is often concentrated in one area and/or is all of the same size and decay class.

Recently, Parks has implemented improved techniques for dealing with the coarse woody debris that is generated through hazard tree maintenance work. Instead of cutting the debris into small, firewood sized chunks or removing them altogether, the debris is left in longer lengths and retained on-site. Additionally, the recent mass conversion from wood burning, to gas burning fireplaces has further reduced the pressures on this forest asset. These management changes are helping to retain, and slowly replace, this lost forest component and are an important step in the right direction.

This is, however, only a beginning. It takes many decades, or even centuries, to grow and then to decay trees of larger sizes. These steps at least partially compensate for some of the habitat values that are offered by larger CWD. A number of recommendations aimed at revitalizing CWD are proposed in the following sections of this report.

# **Coarse Woody Debris Management**

## **Principles**

The following principle provides the foundation for the development of a strategic direction, goals and objectives and management program for coarse woody debris management in natural areas. The informing principle is as follows:

- Coarse woody debris is an integral part of healthy natural area ecosystems.

## **Goals and Objectives**

### **1. Fully integrate coarse woody debris management into the stewardship of Surrey's natural areas.**

Without a program to manage coarse woody debris many benefits will not be realized in natural area ecosystems. Coarse woody debris management should be a specific program in the management of natural areas as well as an adjunct activity to other management programs.

### **2. Establish coarse woody debris standards, and then integrate coarse woody debris management with other natural area management programs.**

Standards should be established for natural areas based on the general objectives for coarse woody debris management as found in this strategy, and with consideration to the specific management objectives of a particular natural area. Standards should consider whether a particular site is a 'natural' area, where prime management objectives include maximizing ecosystem health and restoring biodiversity, or a 'horticulturally developed' area where aesthetics may be an overriding concern.

Other natural area management programs, such as hazard tree management, will adhere to the objectives and standards as detailed in the *Coarse Woody Debris Management Strategy*. For instance, the removal of a hazard tree at a site should include considering whether to use the wood as coarse woody debris.

### **3. Establish a balance between ecosystem health, public safety, and visual aesthetics in CWD management.**

There are many factors to consider in the decision to retain coarse woody debris at a particular site. However, it is of particular importance to consider, in balance, the significant benefits to ecosystem health, and safety of the general public from any potential injury and the visual effects of the debris. For instance, strategies for placing coarse woody debris on site to create habitat for wildlife should not create any obstructions, trip hazards, or fire hazards.

### **4. Conduct inventories of coarse woody debris.**

Inventories of coarse woody debris should be included as a critical component in the management of natural areas, and an inventory can be conducted when other resources are being inventoried.

5. **Maximize natural area ecosystem health and to contribute to sustaining or enhancing local, indigenous biodiversity by: increasing the total volume of coarse woody debris in our natural areas to a level that is representative of comparable unmanaged natural areas achieving the following:**
  - Diversity in size, species and decay classes of CWD throughout the natural areas.
  - Adequate spatial distribution, both vertically and horizontally, of CWD throughout the natural areas.
  - Identifying and providing for CWD dependent species throughout natural areas.
6. **Maximize the benefits associated with CWD to the citizens of Surrey by:**
  - Minimizing any risks that may be associated with retaining CWD.
  - Maximizing visual aesthetics.
  - Increasing the availability of, and accessibility to, surplus CWD for value added uses.
  - Reducing the costs associated with removing and disposing of tree debris.
7. **Deter the future depletion and/or destruction of CWD by:**
  - Educating citizens, as well as City staff, as to the vital importance of CWD in natural ecosystems and changing existing misconceptions about CWD.
  - Managing the natural areas tree population so as to ensure future CWD recruits.
  - Enforcing by-laws pertaining to unauthorized activities on public land such as woodcutting and removal without a permit or destruction of habitat.
  - Providing surplus CWD to residents to deter unauthorized firewood cutting.

## **Land Use Types**

The treatment of CWD will be dependent on management objectives for a particular natural area. For instance, dedicated Urban Forests will have high-level inventories of coarse woody debris whereas recreational facility grounds will have low-level inventories of coarse woody debris. The following site-specific strategies are recommended.

### **Strategies for Natural Sites**

Natural areas should receive the greatest amount of effort directed at inventorying and restoring CWD to sustainable levels. Objectives should address distribution rates and diversity in decay/size classes and species.

In natural areas, where prime management objectives include maximizing ecosystem health and restoring biodiversity, CWD levels and characteristics should be representative of the seral stage and type of ecosystem.

Retention of wood debris should always be favoured over harvesting cut logs on these sites. Harvesting should only occur if site CWD levels are acceptable, the wood values

are high and extraction can be performed with no damage to the site. Even in these cases, compromises should be made to retain at least the best pieces from an ecological perspective (i.e. large and partially decayed or hollow).

Coarse woody debris should be imported to meet objectives if site levels are too low because it is cost effective, and resources are available to perform the work.

### **Strategies for Culturally Developed Sites**

In more developed or highly used areas (e.g. small forest pockets located within a civic building site), issues other than ecological conservation and enhancement may have priority. CWD should be utilized whenever possible but with more discretion. Where aesthetics may be an overriding concern, but where there is a lack of significant wildlife habitat potential and forest related processes, the benefits of CWD should still be considered as follows:

- The safety and visual features of retaining coarse woody debris on-site.
- The monetary value or cultural significance of the wood before deciding to retain it on-site to decompose.
- The high habitat values—where coarse woody debris must be removed, it should be stored off-site, for use on another site.

### **General Guidelines**

- Use accepted inventory techniques and established criteria for determining site-specific CWD objectives.
- Utilize only appropriately qualified staff to perform the inventories and create and carry out the site objectives.
- Minimize timber extraction for commercial purposes until CWD levels are stabilized, and salvage wood only when there will be negligible impacts to the site.
- Deter the unauthorized removal of CWD through enforcement of existing by-laws, access restrictions and public education initiatives.
- Apply a “safety first” approach to all aspects of CWD management.
- Any level of CWD is better than no CWD.

The following factors should be incorporated in the management of CWD.

- Larger pieces of CWD will generally provide greater habitat values to more species than will smaller pieces.
- Coniferous species will generally remain intact longer than deciduous species. Western red cedar will remain intact longest, normally decaying from the inside.
- Larger diameter CWD will remain intact longer than small diameter CWD
- Larger diameter and decayed CWD will retain more water, for longer periods of time, than will small diameter or hard CWD.

- Longer lengths of CWD will decay slower than short lengths and are more difficult to remove from the site. These are generally more aesthetically pleasing than short, bucked sections.
- Suspended CWD will decay slower than that laying on the forest floor.
- Fresh CWD may appear unsightly or out of place initially. These new features will gradually “blend” into the surrounding landscapes as decomposition and understory plant growth occur.

## **Inventory Methods**

For more highly developed sites, inventory and assessment may be overlooked, but for natural sites, more care must be taken to determine the best management practices. Inventories of the existing amounts and types of CWD should be undertaken, and management plans should be made to reflect site-specific conditions.

For practical inventory purposes, only the above ground component of CWD should be inventoried or actively managed. To ensure the continued presence of subterranean CWD, it is recommended that stumps and roots be left in the ground and removed only when absolutely necessary. It is recommended that the following methods be implemented where appropriate:

- **Line Transect Method**—This is the most accurate method of inventorying CWD. It is the method endorsed by the BC Ministry of Forests and Resource Inventory Committee. Line transect surveys should be performed well ahead of forest management activities as analysis of the data will be necessary.

CWD Line transect surveys should be performed to estimate CWD volumes as well as species, size and decay class distributions. These surveys should be used in high Environmentally Sensitive Areas.

- **Simplified Field Estimation Procedure**—This system also employs line transects but allows for faster, yet less accurate or descriptive estimations. This procedure does not consider species, decay class or piece position. It is intended for only rough volume, or piece per hectare estimates.

This method should be employed on all medium ESA sites and should be performed ahead of management activities to allow for analysis of the data.

- **Visual Estimation**—This is the fastest and least accurate measure of CWD and should be performed only by persons with experience. This method will supply only an estimation, and/or pictorial description, of the site’s CWD volumes and characteristics.

Visual estimation should only be used on low ESA sites, or on medium ESA sites when resources restrict the use of the other recommended methods. Its advantages are that it can be used on demand and does not need to be conducted ahead of time.

## **Recommended Applications**

### **Retaining Coarse Woody Debris**

Retain all existing on-site CWD wherever possible when performing tree work, forest management or land development activities. Guidelines are as follows:

1. Maximize lengths of all CWD.
2. When falling, leave high stump trees, and with downed trees, leave large diameter branches intact to satisfy visual appeal.
3. Leave roots and stumps intact and on site. Remove these features only when root disease control is needed. It's very difficult to reintroduce the subterranean CWD component of a forest once it's been removed.
4. Retain smaller diameter CWD if quick decomposition is desired. This should be placed against the forest floor to avoid excessive drying and away from high use or exposed areas to minimize fire risks (Refer to the *Natural Areas Fire Management Strategy*).
5. Utilize clean wood chips, preferably from native trees, where most rapid decomposition or soil coverage is desired; i.e., when there is a lack of organic materials in the duff layer; for soils that are subject to drought due to direct exposure to sunlight; to suppress undesirable plants.
6. Harvest merchantable timber only if other sources of CWD are readily available, and only if extraction methods will cause minimal negative disturbance to the site. The value of individual logs should be established prior to harvesting to justify the removal as opposed to its ecological value if retained. When log extraction is desired, efforts should be made to retain all non-merchantable portions of the log on-site.

### **Introduction of Coarse Woody Debris**

1. Import CWD from other locations to meet specific enhancement objectives. This CWD must consist of similar species to those that are naturally found on the recipient site.
2. Qualified staff should inspect all coarse woody debris prior to relocation, to identify any undesirable pathogens or potential vectors.
3. When importing CWD, minimize site disturbance. Compaction of soils or damage to vegetation must be avoided.
4. As part of the monitoring process for all CWD that is introduced to a site, through off-site imports, on-site relocations or through the felling of standing trees, record data pertaining to size, species and decay classes. In addition, keep notes on the location and positioning of significant CWD.

### **Distribution and Arrangement of Coarse Woody Debris**

1. Consider the desired positioning and distribution of CWD prior to commencing falling, bucking or pruning activities.

2. Where possible, arrange CWD to be visually pleasing as well as ecologically functional.
3. Where possible, arrange CWD so that cut ends are not visible from public areas.
4. Utilize CWD to create visual borders along trail edges, around small pocket forests and along wetland boundaries.
5. Use CWD as barriers to aid in trail deactivation or other exclusion zones.
6. Use CWD to stabilize slopes or stream banks.
7. Utilize large CWD to provide connective structures between two distinct habitat types (e.g. a semi-suspended run-log from a forest edge into meadow or field habitat).
8. Avoid creating conditions where the distribution, total volume, age, species or size class, exceeds the predetermined CWD objectives. Such conditions could potentially lead to pest organism outbreaks, fire hazards, or other unforeseen problems.
9. Where there is an excess of similar sizes and decay classes, or where forest structure is lacking in complexity, leave 20% of CWD suspended above the ground at varying heights and tilt angles. Avoid implementing suspended CWD too close to public areas. If suspension is not feasible, consider relocating CWD on the site to achieve a more even spatial distribution.
10. Arrange CWD to maximize its natural habitat attributes (e.g. orient cavities so they collect water deliberately or to create shelters from rain or wind, etc.).
11. Employ rigging and leverage techniques to gain mechanical advantage in areas that are not accessible to machinery. Utilize only experienced staff for these operations.

Ropes and hardware (carabiners etc.)	Slings and tree savers
Chains, shackles and hooks	Blocks and pulleys
Wire rope tow lines and chokers	Log lifters and peaveys
Power and hand winches	Cable pullers

Table 4. Recommended Equipment.

### **Enhancement of Coarse Woody Debris**

- Create cavities or partial openings in larger, harder CWD and where there is a lack of these features naturally occurring on the site.
- Cut into hard CWD to expedite decomposition.
- Visually and ecologically enhance CWD by creating planting sites on fresh, large diameter, horizontal CWD and stumps. Plant native shrubs, ferns and herbaceous plants.

- Plant native vegetation on older CWD to deter its destruction from trampling and mountain biking.
- Plant native vegetation around CWD to improve aesthetics and create complimentary habitat values.



Cut log notched and planted with native plants

### **Public Education**

- Create a modified version of the industry Wildlife Tree Sign to highlight feature CWD as habitat.
- Acquire copies of existing educational materials pertaining to CWD (e.g. *The Ecological Role of Dead and Downed Wood*) and distribute these materials to residents in key areas: those in which intensive CWD management activities are planned or where there is an existing or anticipated problem with opposition to CWD retention or unauthorized removal of CWD from the site.
- Compose articles for the seasonal City of Surrey Leisure Guide publications highlighting the importance of CWD and how the City manages it based on the principles contained within the *Natural Areas: Coarse Woody Debris Management Strategy*.
- Incorporate information pertaining to the benefits and purposes of CWD into existing or future interpretive signage in the City's parks and trails.
- Create presentations for staff, contractors and advisory committees to achieve 'buy-in' and compliance with CWD management objectives, and to generally educate about CWD.

### **Modifications to Existing Practices**

The following practices have been found to significantly enhance the levels, types and distribution of coarse woody debris in Surrey's natural areas. The recommended guidelines for each of these activities are intended to help achieve CWD management objectives.

In making decisions about retention, it is important to prioritize CWD management efforts by considering land type and site-specific objectives, CWD inventory survey results, and recommended CWD volumes for the site or ecosystem type.

#### **Hazard Tree Management, Storm Debris Clean-up, Stand Management**

Establish short- and long-term site level CWD objectives prior to carrying out these management activities. These objectives should reflect the priorities of retention and diversity, and after these priorities have been met any potential for salvaging merchantable timber.

- Establish a balance between downed debris, standing dead wildlife trees, dying trees and live, healthy trees. These various types of standing trees will compliment the habitat attributes of CWD and are the sources of future CWD.
- Prior to considering wood salvaging, approximate potential merchantable log values, based on a rough scale and current timber or pulp prices.
- Maximize the length of large diameter pieces when falling or pruning.
- Chip small diameter debris (<7.5cm in diameter) and retain on-site. Spread chips evenly, no deeper than 10cm and do not bury existing native vegetation.
- Do not remove any stumps or roots unless absolutely necessary.
- Consider the desired final purpose and positioning of the logs before performing falling, bucking, or pruning activities.
- Consider effects on public safety.
- If there is an excess of smaller diameter pieces or short chunks, or if there is simply a surplus of available CWD on the site, consider making this material available to the local public and special interest groups as a public service
- If surplus amounts of CWD cannot be salvaged for value added purposes, consider removing the larger pieces from the site and storing them off-site for future use (see CWD storage, section 13.0). If these options are not feasible, make this material available to the local citizens as firewood, or collect it and sell it for local charity purposes or to fund Parks programs.

### **Land Clearing and Development**

- When clearing public lands for development, retain all low value or non-merchantable logs as well as large, intact stumps and root-wads.
- Utilize these structural features in the landscaping of a new development, in adjacent forested areas for enhancement purposes, or remove them from the site for temporary storage and use for off-site enhancements.
- In order to meet specific target objectives with CWD, consider appealing to private land developers to save desirable CWD by setting it aside to be collected by the City. This would only be done in specific cases.

## **Adding Value to Surplus Urban Forest Products**

### **1. Value-Added Wood Products**

To contribute to maximizing the public benefits of our urban forests, surplus CWD should be made available to pre-chosen citizens, or local small businesses to be used for making “value added” wood products. A number of local individuals have already expressed an interest in participating in this venture.

This arrangement could lower debris management costs moderately, satisfy a local public need, and prevent the unauthorized removal or destruction of CWD. Proposals thus far include:

- High quality laminate from broadleaf maple
- Custom coat racks from various hardwood branches
- Carving wood for teaching first nation carvers
- Sculptures from large diameter maple, oak and cherry

Recommendations include:

- Creating a phone list so woodworkers can be contacted at short notice and be notified where wood is available for salvage.
- Establishing a storage facility so that desirable wood could be held until it could be collected and utilized (See “CWD Interim Storage” below).

## **2. Standard Timber Uses**

Salvaged timber should be sold, and portions of log sales revenues should be used to cover the costs associated with CWD management and reforestation. The following procedures should be adhered to when salvaging logs for commercial purposes:

- All designated logs must clearly bear Surrey’s Timbermark (NCGKY) on both ends of each log, or each log section, before they are moved from the site of origin.
- For optimum market value, softwood and hardwood log lengths should be as follows:
  1. Long logs: 18 feet long
  2. Short logs: 8’6”, 10’6”, 12’6”, 16’6”
  3. Minimum top diameter = 8”
- Cedar shake blocks may be of smaller dimensions, as per Provincial or mill specifications.

## **Interim Storage of Coarse Woody Debris**

There is an increasing demand for CWD from people such as environmental consultants and landscapers. Applications range from fish habitat creation, to decorative gardening. Arrangements to sell surplus CWD to this market should be pursued.

It has been noted that much of the CWD that is currently disposed of as “trash” during land development could be utilized for restoration and enhancement works, as well as value-added purposes, if the timing was right. This is especially true of large, intact root masses, hollow butt logs and partially decayed wood.

One way around this timing problem is to establish a central, sheltered holding area that could serve as a source of CWD while slightly reducing the disposal costs and overall waste generated through land development.

## **Small Debris Management**

As with its larger counterpart, coarse woody debris, smaller woody and non-woody debris, resulting from tree or forest management, should be designated and treated as a valuable resource.

Currently, the management of this material is neither cost effective, nor beneficial to the natural environment. It is generally loaded onto trucks and hauled away to be disposed of as trash. This represents an hourly cost to the City for loading and hauling as well as a dumping cost for unloading and storage. This type of debris management also results in net nutrient and biomass deficits in natural areas, and super concentrations in landfill sites where this debris is stockpiled.

These materials can and should be used for a variety of purposes other than landfill fodder. It can be used to amend soils, protect roots, shield soils against erosion, protect soils from compaction and improve visual aesthetics. The City of Vancouver successfully uses its leaf debris as protective garden mulch for the winter months.

- It is recommended that this small debris be utilized on-site whenever possible. Where it cannot be used, it should be hauled to a central composting facility for other productive uses.
- It is recommended that Parks investigate the feasibility of creating a central collection and processing depot to deal with this resource.

## Appendix A:

### Various Species Closely Associated with CWD

The following species lists are provided for information purposes only, as some of these species are not found in the Surrey area. It is recommended that Parks compile a similar list of species specific to Surrey that are highly dependent upon CWD. This list could be used for educational purposes and to help direct CWD management activities.

Species	Role of CWD	Status
Dusky shrew	cover, foraging, reproduction	
Water shrew	cover, foraging, reproduction	
Vagrant shrew	cover, foraging, reproduction	
Shrew mole	cover	
California myotis	foraging	
Snowshoe hare	cover	trapped
Southern red-backed vole	cover, foraging	Red-listed ( <i>occidentalis</i> subspecies)
Northern red-backed vole	cover, foraging	
Beaver	dam construction	trapped
Golden-mantled grnd. Sqr.	cover	
Deer mouse	cover	
Douglas squirrel	cover	trapped
Marten	denning, foraging	
Fisher	denning	Blue-listed, trapped
Ermine	denning, foraging, cover	Red-listed, <i>haidarum</i> subspecies Blue-listed, <i>anguinae</i> subspecies trapped
Long-tailed weasel	denning, foraging, cover	Red-listed <i>altifrontalis</i> subspecies, trapped
Grizzly bear	denning, feeding	Blue-listed, hunted
Black bear	denning, feeding	Blue-listed <i>emmonsii</i> subspecies
Mule deer	feeding in winter (lichens)	hunted

Table 5. Mammals Closely Associated with CWD (Lofroth 1995).

Species	Role of CWD	Status
Pileated woodpecker	foraging	
Ruffed grouse	drumming	hunted

Table 6. Birds Closely Associated with CWD (Lofroth 1995).

Species	Role of CWD	Status
Pacific giant salamander	reproduction	Blue-listed
Clouded salamander	cover, reproduction	
Couer d'Adlene salamander	cover, reproduction	Red-listed
Western red-backed salamander	cover	
Western skink	cover	
Rubber boa	cover	Blue-listed
Sharp-tailed snake	cover	Red-listed

Table 7. Herpetofauna Closely Associated with CWD (Lofroth 1995).

Species	role of CWD	Status
Western hemlock	germination	comm. harvested
Sitka spruce	germination	comm. harvested
Red huckleberry	germination, growth	
Gnome plant( <i>Hemitomes congestum</i> )	growth	
Candystick( <i>Allotropia virgata</i> )	growth	Blue-listed

Table 8. Vascular Plants Closely Associated with CWD (Lafroth 1995).

162 species of bracket or shelf fungi/conks
364 species of other macrofungi (some of them commercially harvested, e.g. oyster mushroom)
epiphytes (lichens in drier habitats and bryophytes in wetter habitats)

Table 9. Nonvascular Plants, Fungi, and Lichens Closely Associated with CWD (Lofroth 1995)

## Appendix B:

### CWD Volumes by Biogeoclimatic Zone and Natural Disturbance Type

Biogeoclimatic	Mean Event	Serai Stages		
		Unit	Interval	Early
CWH	200yr	<40yr	>80yr	>250yr

Table 1. Serai Stage Definitions for CWH BGC Zone in NDT2  
(Forest Practices Code of BC, Biodiversity Guidebook, Table 6, p. 23).

- The mid-serai stage, between early and mature, is not designated.
- Define serai stages by the ages presented in this table or by stand level attributes.
- The early serai column should be used for partially cut stands with less than 30% of natural stand volume.
- Younger stands less than 80 years old, or partially cut stands, can be considered mature if they provide the important habitat attributes of a mature-aged stand.
- Older mature stands can be considered old if they provide the important attributes of an even aged, climax stand.

Zone	Subzone	Variant	NDT
CWH	xm : very dry maritime	1 = eastern 2 = western	NDT2 NDT2
CWH	dm : dry maritime	no variant	NDT2
CWH	ds : dry submaritime	1 = southern 2 = central	NDT2 NDT2
CWH	mm : moist maritime	1 = submontane	NDT2
CWH	ms : moist submaritime	1 = southern 2 = central	NDT2 NDT2
CWH	wh : wet hypermaritime	1 = submontane	NDT1
CWH	wm : wet maritime	no variant	NDT1
CWH	ws : wet submaritime	1 = submontane	NDT2
CWH	vh : very wet hypermaritime	1 = southern 2 = central	NDT1, NDT3 NDT1, NDT3
CWH	vm : very wet maritime	1 = submontane 3 = central	NDT1, NDT3 NDT1

Table 2. Biogeoclimatic Units and Natural Disturbance Types in the Vancouver Forest  
(Forest Practices Code Biodiversity Guidebook, 1995, Appendix 3, pp. 81-82).

(Note: For Surrey’s purposes, it is recommended that NDT2 be accepted as the predominant Natural Disturbance Type for the area.)

NDT	Zone	Moisture	Average Total Volume (m <sup>3</sup> )	Range (m <sup>3</sup> )
1	CWH	dry	-	-
1	CWH	mesic	868.13	12.76 - 1788.05
1	CWH	wet	573.47	40.88 - 1428.25
2	CWH	dry	-	-
2	CWH	mesic	-	-
2	CWH	wet	338.96	55.52 - 440.28

Table 3. *Natural Levels of CWD in BC Forests* (BC MOF Research Program, WP 30, The Ecological Role of CWD, Appendix 2).

For combined forest types, the volume of fallen wood (>10 cm in diameter) was significantly lower in selection stands (60 m<sup>3</sup>/ha) and even-aged stands (25 m<sup>3</sup>/ha) than in old-growth stands (99 m<sup>3</sup>/ha). Volume differences were even more pronounced for large-diameter debris (>40 cm). (*Cavity trees and coarse woody debris in old growth and managed northern hardwood forests in Wisconsin and Michigan*, John M. Goodburn and Craig G. Lorimer, pp. 427-438).

The decay rate is faster for fine materials. It decreases, with increasing size, until the piece is about 20 cm in diameter and then remains approximately constant. This varies between species and ecosystem, among other factors (V. Stevens, 1997, p. 11). Changes in CWD volume throughout the life of a stand in NDT2 have been observed as follows:

a = the point after a major disturbance at which input begins to exceed decay.
b = the point after a major disturbance when input and decay are equal and stasis is reached.
c = the point at which the next stand replacing disturbance occurs (fire or wind frequency).

(V. Stevens, Working Paper, 1997, p. 13)

## References

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