Hog Fuel Boiler / Wood Ash Action Plan

Technical Report

Department of Ecology
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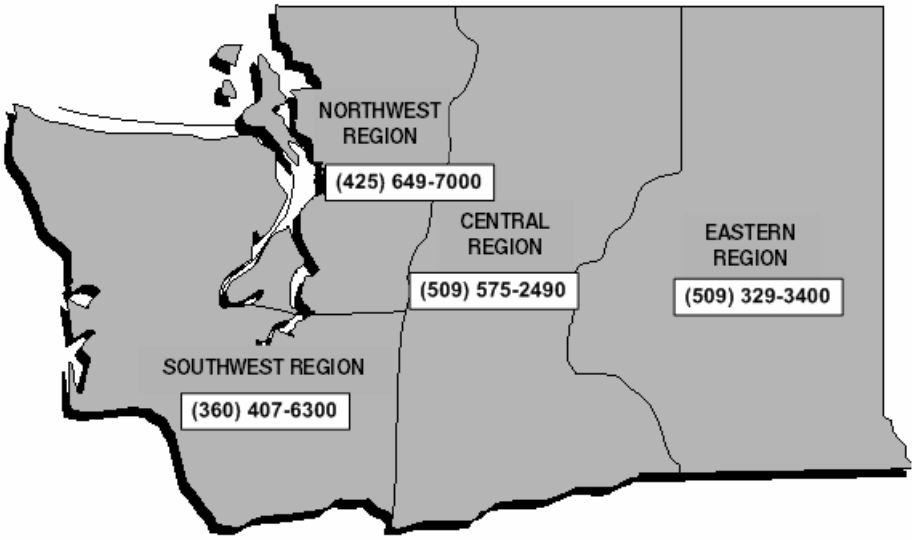

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Technical Report

The information in this technical report (as well as in the Executive Summary) is provided here so that the citizens of Washington can have a better understanding of this issue and informed decisions can be made regarding the future management of this dioxin-containing waste.

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Introduction

This paper is the full technical report summarizing the history, current management practices, and work to date on the issues surrounding wood ash from hog fuel boilers. An Executive Summary of this report is also available.

Under certain conditions wood ash may be spread on Washington state lands as a soil conditioner. Because wood ash may contain dioxins, the Washington State Department of Ecology (Ecology) is concerned about this practice. This paper explains the rationale for that concern. The paper also discusses several options for the improved management of wood ash and concludes by outlining action recommendations developed by Hazardous Waste and Toxics Reduction Program staff at Ecology. This information and the proposed recommendations for action are provided here so that informed decisions can be made regarding the management of this dioxin-containing waste.

What is Wood Ash?

Wood ash is the residue generated by wood-fired boilers used in certain industrial facilities. Although some facilities burn mixed fuels or non-wood wastes in their boilers, for the purposes of this report, "wood ash" will not include ash residues from facilities burning a low percentage of fuels other than wood or wood wastes. The focus of this report is the ash generated by pulp and paper mills, sawmills, veneer and cabinet manufacturers and other facilities with wood-fired boilers from where greater than 50% of the quarterly heat output is from the combustion of wood and wood wastes.

Wood-fired boilers (also called hog fuel boilers because the wide variety of wood and wood wastes used to feed the boilers is called "hogged fuel") generate over 200,000 tons of wood ash each year. Its high pH makes wood ash useful as a soil conditioner or liming agent, however, most wood ash is currently disposed in

landfills. Recent tests have shown that some wood ash contains variable levels of dioxins (Someshwar, 1996). Additionally, other fuels used by wood-fired boilers may include chlorine containing sludges from pulp and paper processes, tires, plastic debris and organic compounds from recycling wood wastes, cardboard, and heavy fuel oils which themselves may contain chlorinated compounds that can form dioxins when burned.

Background

Wood ash with a high pH (12.5 or above) is a solid corrosive material that is regulated under Ecology's *Dangerous Waste Regulations* (WAC 173-303-090(6)). Such wastes are caustic and can result in severe damage to unprotected eyes and skin. As a result, wood ash is regulated as a hazardous waste unless it meets certain conditions. In 1994, Ecology exempted wood ash from the *Dangerous Waste Regulations* if it does not designate as a hazardous waste for any reason other than its corrosivity. This allowed the use of wood ash as a soil conditioning or liming agent. It also allows wood ash to be disposed in solid waste landfills within the state. Prior to the exemption, if a generator chose to dispose of wood ash as a hazardous waste, it had to be shipped out-of-state since there are no hazardous waste landfills in Washington.

Testing has confirmed that wood ash often contains dioxins. In addition, Ecology now has more information on dioxin levels in soils throughout the state as well as the contributions of dioxins to soil from the land application of wood ash as a fertilizer. This information, combined with new studies on the human health impacts from dioxin exposure, has resulted in rapidly growing public support for better management of dioxin sources.

In 1998, the legislature directed Ecology to review registration applications for waste derived fertilizers including liming agents derived from wood ash. As a result, all fertilizers derived from wastes are now required to provide additional test data including an organic chemistry test to indicate if a fertilizer contains halogenated organic compounds such as dioxins. There have also been bills introduced in recent legislative sessions that have proposed banning any materials containing dioxin from being used to manufacture fertilizers. These bills have died in committee.

This paper will present information on current wood ash generation and management practices, a brief history of wood ash regulation to date, why wood ash is a concern, and recommendations for action regarding the improved management of wood ash.

Current Status of Wood Ash Land Application

In spring 2000, during discussions about the extent of land application of wood ash, the Northwest Pulp & Paper Association requested that Ecology compile information on the volume of wood ash generated by facilities using hog fuel boilers within Washington State and how wood ash is managed. Specifically, Ecology tried to determine how much ash is disposed in landfills and how much is applied to the land as a soil-conditioning agent. This was accomplished by surveying known hog fuel boiler facilities. The methods Ecology used to identify and survey Washington's hog fuel boiler facilities and the survey participation results can be found in Appendix A.

Background

A small number of the facilities surveyed were large pulp and paper mills which are regulated by Ecology's Industrial Section because of their size. The remainder of the facilities surveyed are smaller facilities that use hog fuel boilers including paper mills, sawmills, veneer and cabinet manufacturers, and other facilities burning wood waste in a boiler. (See Appendix A for more details.) The types of wood waste burned include scrap wood, wood shavings, saw dust, bark, etc. Some hog fuel is brokered among facilities; often when a facility purchases logs/timber, the seller includes its wood waste as a means of disposal, thus the purchaser buys not only logs but also the seller's wood waste.

Occasionally, logs are floated or "rafted" in seawater as a means of storage or transportation. This is not common in the United States or Washington, but it still may be occurring in Canada. The wood that is rafted can absorb the salt from seawater. When salty wood and wood waste is burned, it can produce higher levels of dioxins, due to the higher chloride content. The dioxin shows up in both the ash and the boiler's air emissions. Dioxin compounds can be

generated, unintentionally, and released to the environment from various combustion processes when chlorinated compounds are present (EPA, 1994; ATSDR. 1998). "It has been known for some time now that power boilers burning salt-laden wood waste can be a potential source of dioxins" (Luthe et al, 1996).

Other factors also contribute to the formation of dioxin in wood ash. During combustion, higher temperature or hotter burning fires generate fewer dioxins than low temperature fires. Dioxins can form at temperatures of 180-500° C or 356 – 932° F (ATSDR, 1998) and up to 600° C or 1,112° F (Luthe et al, 1996) and are usually destroyed at temperatures greater than 1,000° C or 1,832° F (Eisler, 1986). Incinerator operating conditions currently considered adequate for destruction of the most toxic form of dioxin known as 2,3,7,8-TCDD and most other chlorinated organics that can form dioxins require a temperature of at least 1,500-2,600° F (816-1427° C) with residence times of at least 30 minutes, usually 1.5 hours (ATSDR, 1998). Again, this information relates to the destruction of dioxins in waste incinerators. There is less information available on the temperatures at which dioxins are formed or prevented from forming in wood-fired boilers.

The type of fuel used in a combustion process is also a key factor in the formation of dioxins. As noted above, fuels that contain a higher chloride content can result in the formation of higher levels of dioxins. Fuels such as oily wastes and tires that contain chlorides are known to be used in hog fuel boilers (Yake et al, 1998).

Landfilling is one way to sequester or limit the dissemination of dioxin-laden ash in the environment. However, land applying dioxin-containing ash as a liming agent or fertilizer releases dioxins to the environment.

Survey Results and Discussion

Ecology identified and contacted 64 facilities of which 39 responded to the survey. It was determined that approximately 211,047 tons/year of wood ash are generated by 37 of those facilities. Two facilities responding to the survey did not give enough information to be included in wood ash volume estimates. Of this amount, about 30,920 tons/year (15%) are land applied by 17 facilities.

Twenty facilities are landfilling approximately 180,002 tons/year, or 85% of the ash produced per year. Facilities that landfill do so in their own landfills, county landfills, or possibly hazardous waste landfills such as Chemical Waste Management located in Arlington, OR.

Seventeen facilities are land applying 30,920 tons/year, or just under 15% of the ash produced per year. One facility was counted in both categories because it landfills half its ash and land applies the other half. Facilities land applying wood ash were, for the most part, using the ash for agricultural purposes as a "fertilizer" or "soil amendment" either on-site or by giving it to farmers or plant nurseries. Other uses of wood ash include using it as a soil conditioner in potting soil, filling on-site potholes, and composting.

Three facilities use other disposal methods to manage 125 tons/year ash, or less than 1% of all wood ash generated per year. These management methods included mixing the ash with hog fuel and selling that mixture as a fuel to other facilities using hog fuel boilers or combining the ash with refuse and incinerating it. (See Appendix B for further details on the information gathered through Ecology's survey of hog fuel boiler facilities.)

Current Status Summary

Most wood ash in the state is landfilled (see Table 1, below). The major pulp and paper facilities landfill their wood ash, at least in part, due to liability concerns. They are aware that wood ash may contain heavy metals and dioxins and do not want to be sued for past practices. Most smaller facilities with hog fuel boilers landfill their wood ash too. This is often an easier option than finding another outlet to manage this waste.

When Abitibi Consolidated in Steilacoom closed in December 2000, only one major pulp and paper facility (Boise Cascade) was still land applying their wood ash on their own land. Some of the smaller paper mills and other facilities with hog fuel boilers also land apply wood ash, either on their own land or by marketing the wood ash as a "product" to farmers and plant nurseries.

Land applying wood ash may significantly increase levels of dioxins in soils because of the high application rates of wood ash and the low levels of dioxins in Washington soils. This is a concern for Ecology and it is discussed in detail later in this paper.

Table 1.
Wood Ash Management by Method (tons/year)

	Land Applying (17 facilities)	**Landfilling (20 facilities)**
Total	30,920	180,002
Average per Facility	1,819	9,000

(The chart in Appendix C shows detailed information on wood ash management gathered through Ecology's survey of hog fuel boiler facilities.)

Industry provided Ecology with an indication of how dioxin values might vary in boiler wood ash; values given to Ecology ranged from 0.8 pptr TEQ[1] (from an unspecified sampling location) to 800 pptr 2,3,7,8-TCDD[2] in fly ash (top of the boiler). Note these values are ***not*** directly comparable for two reasons. First, the 0.8 pptr TEQ value is a comparison of 17 congeners (forms of dioxin) relative to 2,3,7,8-TCDD's toxicity. The other value is a measure of only one congener, 2,3,7,8-TCDD which is the most toxic form of dioxin. Second, because temperature might determine how much dioxin forms, sampling location is very important for data comparison.

The data available on dioxins in wood ash is limited. Much of the existing information has been provided by industry and, as yet, it is unverified by Ecology. This underscores the need for more information on the characteristics and constituents of wood ash. However, the fact that wood ash can contain dioxins, and it is not uncommon to apply wood ash as a fertilizer, causes concern about the long-term impacts of dioxins. As will be shown in the next section of this paper, even with very low levels of dioxins in wood ash, Washington's soils may quickly accumulate dioxins from the land application of this material. The potential impacts of that occurrence are uncertain at best.

[1] TEQ means Toxic Equivalent or the sum total of the toxicity of 17 of the 210 forms of dioxins and furans. The calculation of TEQ for an environmental sample containing 5 pptr 2,3,7,8-TCDD and 23 pptr 2,3,7,8-TCDF (considered 1/10 as toxic as 2,3,7,8-TCDD; it has a Toxicity Equivalency Factor or TEF of 0.1) is: [5+(0.1 x 23)]=7.3 pptr TEQ (Serdar et al., 1991).

[2] This value is for only one form of dioxin. There is a potential for wood ash generated in Washington to reach higher levels of dioxin contamination due to burning of mixed fuels or salty hog fuel which increase the generation of dioxins in ash.

Regulatory History of Wood Ash

Currently, three laws may apply to the disposition of wood ash. The Solid Waste Act, the Hazardous Waste Act and the Fertilizer Registration Act. Before wood ash may be given or sold to any person for use as a liming agent it first must be registered as a fertilizer under the Fertilizer Registration Act. Under this Act, Ecology provides recommendations to the Department of Agriculture on the registration of fertilizers made from wastes, such as wood ash. Ecology evaluates the waste-derived fertilizers for compliance with requirements established under the Solid Waste Act or Hazardous Waste Act. When wood ash is disposed, it is subject to either the Hazardous Waste Act or the Solid Waste Act, depending on the characteristics of the ash and the materials that were burned to produce the ash. The following discussion explains this distinction in more detail.

1977 Solid Corrosive Characteristic

Since their inception in 1977, the *Dangerous Waste Regulations* have used certain hazardous characteristics as a means to identify wastes that pose greater risks to human health or the environment than can be managed in the solid waste system. For example, the characteristic of corrosivity identifies wastes that have a very high pH. These wastes are caustic and exposure can result in severe damage to unprotected eyes and skin.

The pH of wood ash is often high enough to make the wood ash exhibit the corrosivity characteristic. The characteristics of wood ash depend on the types and quality of the fuels burned and the operating conditions of the hog fuel boiler as discussed in the previous section (Current Status of Wood Ash Land Application).

1994 Wood Ash Exclusion

In 1994, Ecology excluded ash generated in wood-fired boilers from being regulated as a dangerous waste when corrosivity is the only characteristic of a dangerous waste that the ash exhibits. This exclusion was adopted to facilitate the use of wood ash as a liming agent for soils and to allow solid waste landfill disposal of the ash in the state of Washington. Ecology is now re-evaluating that exemption in light of increasing information on the human and environmental effects of dioxin compounds.

Wood ash that meets the *Dangerous Waste Regulation* exemption is still regulated as a solid waste. Facilities applying wood ash to the land must obtain a solid waste permit from the local health department. Those facilities must comply with the state solid waste regulations (WAC 173-304) and any additional local requirements. Wood ash used as a liming agent (that is sold or given away) must be registered with the Washington State Department of Agriculture and meet all requirements for waste-derived fertilizers.

Ecology considered and evaluated the issue of polychlorinated dibenzodioxins and polychlorinated dibenzofurans associated with combusting pulp and paper mill sludges. These sludges did not designate as dangerous waste due to the presence of dioxins or furans and there were no standards specifically addressing dioxin or furan levels in ashes or air emissions. Additionally, a literature search showed that the pulp and paper mill emission concentrations of dioxin and furans were two to four orders of magnitude lower than those representative of emissions from modern municipal waste combustion systems which were deemed to be of little concern at that time.

1998 Fertilizer Registration Act

Wood ash that is applied to the land as a liming agent or soil conditioner is a commercial fertilizer and it must be registered with the Washington State Department of Agriculture as defined by law (RCW 15.54.325). In addition to verifying the agronomic capabilities of commercial fertilizers, the Department of Agriculture has, since 1998, also regulated the levels of non-nutritive metals in fertilizers with the passage of the Fertilizer Regulation Act. That act also directed Ecology to review registration applications for waste-derived fertilizers including liming agents derived from wood ash. Currently, Ecology is requiring additional test data on leachable metals and organic compounds that include dioxins for waste-derived fertilizers. In essence, wood ash that is land applied as a fertilizer is regulated primarily by the Department of Agriculture with input from Ecology. Another fertilizer regulation issue that may impact wood ash is that the environmental community is lobbying for a ban on any materials containing dioxin from use as an ingredient in fertilizers.

Year 2000 - Current Activity

The Department of Ecology has several efforts underway to reduce the environmental impact of the wood products industry. The Hazardous Waste and Toxics Reduction Program has been evaluating the idea of amending the existing wood ash exclusion and adopting rules in the *Dangerous Waste Regulations* governing the land application of dioxin-containing ash from wood-fired boilers. The Industrial Section is currently implementing Maximum Achievable Control Technology standards for the pulp and paper industry. The Air Quality Program is establishing Reasonable and Available Control Technology for wood-fired boilers.

These latter two efforts may result in a reduction or an increase in the amount of dioxins generated in wood-fired boilers. Because these requirements will cause facilities to make process changes that may affect combustion efficiency and particulate control, both the quality and quantity of the ash generated may be impacted.

Finally, the Solid Waste & Financial Assistance Program has been revising the state solid waste regulations. Those revisions will affect the regulation of solid wastes applied to the land, including wood ash. The program has also been working with the Washington State Department of Agriculture to better define responsibilities for regulating the land application of waste-derived fertilizers, including materials such as wood ash that are used as a liming agents.

Why is Ecology Concerned?

In 1997 and 1998, Ecology began testing wastes that are used for fertilizers, liming agents, and soil amendments for the presence of dioxins and heavy metals (Rogowski et al, 1998). Wood ash can be used as a liming agent, a material used to adjust the pH of soil. Ecology's sample results for wood ash indicated that sometimes dioxins and heavy metals were present. This data, combined with the reported application rates for wood ash, suggest that use of wood ash could significantly increase the dioxin and metals levels in the soil. To obtain an understanding of the existing levels of dioxins in soils across the state and to gain some perspective on this issue, Ecology sampled and tested Washington soils. Table 2, below, summarizes the results of Ecology's soil dioxin testing. For a technical discussion on soil dioxin data, see Appendix E.

Table 2.
Summary of Washington State Soil Dioxin (pptr TEQ) by Land Use

Land Use	Range	Median	Number of samples
Urban	0.13 – 19	1.7	14
Open	0.040 – 4.6	0.27	8
Forest	0.033 – 5.2	2.2	8
Total (non-agricultural)	0.033 – 19	1.2	30
Agricultural	0.0078-1.2	0.054	54
All Land Uses*	0.0078-19	1.4	84

**Estimated based on percentage of land in Washington in each land use type*

Note: Non-detect values were set to zero (ND=0). The 1.4 pptr TEQ median value for WA soils did not account for the different number of samples in each land use type.

The agricultural soil test results summarized in Table 2 indicate very low dioxin levels in Washington's agricultural soils (median of 0.054 pptr TEQ). One application of a low dioxin concentration wood ash (range 7.4 - 36.0 pptr TEQ) applied at a typical application rate for liming agents (18 - 38 tons/acre /year) could easily result in a significant increase in the dioxin concentration level (0.15 - 1.53 pptr TEQ) for many of the agricultural soils sampled (Rogowski, 1998).

Calculating Increased Soil Dioxin Levels:
The equation used to estimate the annual increase in soil dioxin TEQ is:

(Annual application rate of fertilizer in kg/ha) X (TEQ of the fertilizer) X (5 X 10^{-7}ha/kg) = Annual increase in soil TEQ (pptr) [USEPA, 1999b]

Using an annual application rate of 18 tons/acre/year (40,824 kg/ha/year) for a wood ash with a TEQ of 7.4 pptr the increase in annual soil dioxin TEQ is calculated as follows:

(40,824 kg/ha/year) X (7.4 pptr) X (5 X 10^{-7}ha/kg) = 0.15 pptr

This equation assumes an initial soil TEQ concentration equal to zero and no loss over time due to degradation, e.g., due to volatilization, erosion, plant uptake, etc.

EPA Risk Assessments

In 1999, EPA completed a risk assessment using data from the Department of Ecology's studies. EPA concluded in that risk assessment (USEPA, 1999a) that wood ash containing dioxin does represent an increased risk to highly exposed individuals (i.e., farmers). The EPA cement kiln dust (CKD) risk assessment (USEPA, 1998) used the arithmetic mean soil background concentration for dioxin of 8 pptr TEQ (USEPA, 1994) to back calculate a CKD dioxin concentration of 40 pptr TEQ. That exposure level is associated with an increased cancer risk of 10^{-5} for a farmer exposed to CKD through an indirect pathway. From this information, a regulatory limit of 40 pptr TEQ for dioxin was proposed for CKD used as an agricultural liming agent to prevent an increase in soil dioxin concentrations.

It should be noted that EPA's Science Advisory Board and others are debating a revision of the estimated increase in the risk of contracting cancer from exposure to dioxins (USEPA, 2000). If that risk estimation is increased, various regulatory limits for dioxin including the CKD limit may decrease.

EPA believes that dioxins and related compounds are "likely" cancer hazards. A weight of evidence evaluation suggests 2,3,7,8-TCDD should be characterized as a "human carcinogen" and related compounds should be considered "likely" to present a cancer hazard to humans (EPA, 2000). It is clear, considering EPA's stance, that the concern over low levels of dioxins in the environment will increase.

For the most part, ecological risks from dioxin exposure have not been examined to the same degree as human health risks. No ecological risk assessments are known to be underway or completed at this time. As a result, ecological risk from dioxin exposure is an outstanding issue with regard to setting regulatory limits.

Based on facility responses to Ecology's survey (39 of 64 known facilities), currently there is only one pulp and paper facility still land applying wood ash and at least one paper mill and some smaller facilities using hog fuel boilers that are also land applying wood ash. Many of these smaller facilities are even less aware of the potential dioxins (as well as possibly high levels of metals) in their wood ash. As discussed earlier, the potential for dioxins and metals in wood ash increases based on the type of fuels used, as well as other variables. Ecology has some data from the pulp and paper industry (larger facilities) on dioxins in their wood ash, but no data on the wood ash from smaller facilities.

Another concern is that wood ash is now being proposed as a substitute fill material around some new buildings (e.g., King County). Wood ash would be replacing a commonly used fill material, cement kiln dust, since it is less available now than it has been in the past. There is a potential for concentrating high levels of dioxin in the soil from this activity.

Are We Creating Contaminated Sites?

In Washington, sites contaminated with toxics (normally from industrial activities) are required to be cleaned up to meet certain standards. The "cleanup standards" are set by the Model Toxics Control Act (MTCA) which has governed the cleanup of contaminated sites since 1990. But prior to MTCA, staff observed firsthand the problems created when orchards became contaminated from repeated applications of a lead arsenate pesticide. Homes have been built on old orchards even though the land sometimes exceeds MTCA Method A residential use cleanup standards for lead (250 mg/kg) and arsenic (20 mg/kg), creating potential exposure pathways for residents.

The potential exists for history to repeat itself with dioxin contamination. Ecology has several on-going concerns regarding the land application of wood ash containing dioxins. Washington State soils are relatively clean, containing only low levels of dioxins. Ecology would like to keep them that way. The current MTCA Method B residential soil standard for dioxin is 6.67 pptr 2,3,7,8-TCDD and as indicated above, a single application of wood ash with a low concentration of dioxin can raise the dioxin concentration level in agricultural soils to 1.53 pptr TEQ. Multiple applications of even a low dioxin concentration wood ash on the same parcel of land could result in that land exceeding the MTCA cleanup standard for dioxin.

There are few guidelines or standards in existence for dioxins in soils (Rogowski et al, 1999). The MTCA cleanup standards are used as a reference in this report because of their applicability to the state of Washington and to help give some perspective to dioxin soil concentrations.

Policy Options

During the 1999 legislative session, Ecology committed to a rulemaking process to address dioxins in fertilizer. After researching the issue, Ecology solicited comments from industry and others on several policy options for improving regulation of the three main wastes used in waste-derived fertilizers: steel mill flue dust (also called K061), cement kiln dust, and wood ash. Ecology published three Focus Sheets (publication numbers 99-1376, 99-1377, and 99-1378) which explained the issues surrounding each waste and explored possible policy options.

Ecology met with representatives from wood ash generating industries and the environmental community to refine policy options for the reduction of dioxins in wood ash used as a fertilizer. After extensive input from industry and environmental representatives, Ecology chose to pursue an option that would have resulted in the development of a Memorandum of Agreement between Ecology and generators of wood ash used as a fertilizer. The intent of this approach was to set limits on the level of dioxins in wood ash that is land applied and to identify environmental safeguards (such as application restrictions near water and soil monitoring measures) that would be required.

To date, Ecology is still evaluating the extent of land application of dioxin containing wood ash from smaller wood-fired boilers. The applicability of a Memorandum of Agreement approach will need to be further analyzed as to its usefulness for smaller facilities with wood-fired boilers.

Proposed Strategy for Managing Wood Ash

Due to the concerns noted in this report, Ecology is proposing to gather additional data on the levels of dioxins and pH of wood ash as well as the generation and management practices of facilities that did not respond to Ecology's survey. Based on the results of this effort, within two years Ecology will evaluate if a dioxin rule is necessary for the improved management of this material.

Included in the mix of issues in the decision-making process is the fact that Washington State law has set priorities for the management of wastes that places landfilling at the bottom of the list of priorities and recycling near the top (RCW 70.95.010). The land application of clean wood ash as a recyclable material is preferable to encouraging the landfilling of this material. The conflict between a mandated priority to see that wastes are managed as recyclable materials (a higher priority method than landfilling) and an agency mission to protect the land as well as the air and the water is one of the challenges facing Ecology.

Conclusions

1. Of those facilities surveyed, it appears that most wood ash in the state is landfilled. The pulp and paper facilities landfill partly out of liability concerns. They are aware that wood ash can contain heavy metals and dioxins and do not want to be sued for past practices. While the smaller facilities may not have as much concern about liability, landfilling is often the easiest option for them.

2. To date, Ecology has identified seventeen facilities that are known to be land applying their wood ash at a rate of approximately 31,000 tons/year in total. There are a number of smaller facilities using hog fuel boilers whose wood ash management methods are still unknown.

3. Since Abitibi Consolidated in Steilacoom closed down in December 2000, only one major pulp and paper facility is still land applying their wood ash (Boise Cascade – on their own land). NOTE: Some of the paper mills and smaller facilities using hog fuel boilers are also land applying wood ash.

4. The land application of wood ash may significantly increase levels of dioxins in Washington's soils due to the high application rates of dioxin-containing wood ash combined with the low levels of dioxins currently in Washington's soils.

5. Test results for dioxins in wood ash vary. The pH for most wood ash is at the threshold that will determine if it is a solid waste or a hazardous waste. Ecology does know that some wood ash is hazardous as determined by measuring the pH and some wood ash contains significant levels of dioxins.

6. Ecology does not have test results for dioxin or pH levels from the wood ashes generated by smaller facilities using hog fuel boilers, so it is not known if the various wood ashes from these types of facilities are hazardous.

7. EPA's risk assessment concluded there is an increased risk to highly exposed individuals (i.e., farmers) due to the dioxins in a sample of ash from a facility in Washington State at the specified application rate. However, Ecology is also concerned that current risk assessments do not address the ecological impacts of dioxins.

8. From a public policy point of view, it doesn't make sense to knowingly allow dioxins to be added to Washington's soils when there is a potential to create sites contaminated with dioxins. Ecology has determined that wood ash containing dioxins above certain levels (to be determined) should not be land applied. Levels of dioxin allowed in solid waste that is land applied under a solid waste permit may be negotiated in the context of certain permit conditions, for example, monitoring the dioxin concentrations in soils.

Action Recommendations

A. At a minimum, wood ash should not cause soils to exceed MTCA cleanup levels for dioxins, and ideally, wood ash that is land applied should not cause dioxin levels to exceed background levels for soils in that area.

B. Ecology should test 6 to 12 facilities' hog fuel boiler ash for dioxin and pH and report the results by fall 2001. Samples will be taken at smaller facilities with hog fuel boilers that are known to be land applying ash. Ecology currently has no data on the ash from these types of facilities.

C. If the test results show dioxins are present in wood ash from smaller facilities using hog fuel boilers, then in the fall of 2001 Ecology should publish guidance to help those facilities minimize dioxin production.

D. Beginning in the fall of 2001, before a facility land applies a hazardous waste wood ash, a Memorandum of Agreement should be negotiated and signed by both Ecology and the facility. Ideally, this includes both on-site and off-site land applications to avoid creating future cleanup sites. The Memorandum of Agreement would require regular testing of the ashes as well as soils and it would require certain environmental safeguards (e.g., application restrictions near water, application rates that ensure background soil concentrations for dioxins will not increase, etc.). Such a Memorandum of Agreement could be developed by Ecology's Hazardous Waste and Toxic Reduction Program staff, but would be done in cooperation with Ecology's Solid Waste and Financial Assistance Program staff to ensure consistency with solid waste permitting and beneficial use determinations.

E. Within two years, Ecology should evaluate the wood ash data and the success of the Memoranda of Agreement approach and decide if a rule for the regulation of dioxins in wood ash is necessary. It is likely that both the

dangerous waste and solid waste rules would need to be amended and those amendments might include the following:

- A requirement for pH and dioxin testing of land applied wood ash;
- Notification to property owners (if off-site) by the seller of pH and dioxin test results of the wood ash;
- Prohibition of certain uses of wood ash such as fill material around new buildings;
- Modifications to the wood ash exclusion that would result in a smaller quantity of wood ash being exempt from the *Dangerous Waste Regulations*; and
- Adoption of a dioxin standard into the review criteria for waste-derived and micronutrient fertilizers.

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Appendix A

Identification and Survey Methods for Hog Fuel Boiler Facilities

"Industrial Section" facilities refer to those pulp and paper mills regulated by Ecology's Industrial Section. Non-Industrial Section regulated facilities include paper mills, sawmills, veneer and cabinet manufacturers, and other facilities that burn wood waste in a boiler.

Ten (10) "major" pulp and paper mills regulated by Ecology's Industrial Section were contacted earlier this year and asked how many tons of wood ash they generated, where their wood ash is going, where their wood ash used to go, what the dioxin levels in their wood ash are, and what factors may be impacting dioxin levels in their wood ash. After presenting this information to the Northwest Pulp & Paper Association, they asked if Ecology had the same information for other boilers throughout the state.

Ecology then began the task of identifying and surveying other facilities with hog fuel boilers in the state. A total of 55 facilities using hog fuel boilers were on a facilities list obtained from Ecology's Air Quality Program. A letter was mailed to these 55 facilities to notify them of this upcoming survey. Facilities were asked how much ash was produced in 1999, the typical range of ash produced per year, current ash management practices, past management practices, and any plans to change ash management from current practices. Facilities were also asked the source of their hog fuel, if they knew the hog fuel source, and if they burned salty hog fuel.

By combining the Industrial Section facilities and the Air Quality Program list a total of 64 facilities were contacted regarding the upcoming survey. Of the 55 facilities on the Air Quality Program list, 7 facilities were unreachable or out of business and 14 facilities did not respond. Two to three new facilities not on the original Air Quality Program list were found. Several facilities had changed names and/or management. As a result, thirty-five (35) facilities were surveyed from the Air Quality Program list, for a total of 44 facilities surveyed. The response rate for the smaller facilities was 64% and the response rate from all facilities was 69%. The results table shows data from 39 facilities; 5 facilities responded but could not give enough data to be tabulated (see Appendix B).

The units of measurement provided by the facilities varied between tons per year, cubic yards per year, and guesses of "barrels full" and "dump trucks full." A rough guess conversion was obtained. Assumptions were: 1 cubic yard ash = ½ ton dry ash; 1 cubic yard ash = 1 ton wet ash. Also assumed was an average work schedule of 6 d/wk, 50 wk/yr, 12 mo/yr. Hopefully, using these assumptions will provide very conservative estimates.

Inquiries still in progress include finding wood ash dioxin data and hog fuel origins.

Appendix B

Hog Fuel Boiler Facilities Survey Data

Facility	1999 Ash Production (Survey)	Calculated Production (tons/yr)	Current Ash Management	INDUSTRIAL Tons Land Applied	Non-Industrial Tons Land Applied	INDUSTRIAL Tons Landfilled	Non-Industrial Tons Landfilled	Non-Industrial Other Disposal
Avista Utilities - Kettle Falls	40,426 tons/year	40,426	on-site ash monofill				40,426	
Brooks Manufacturing	713 lb/year	0.36	landfill				0.36	
Buffelen Woodworking	Estimate 12 tons/year or 13.52 yd^3/year	12	landfill				12	
Cascade Hardwood	60 tons/year	60	ash combined with hog fuel & sold as fuel					60
Cowlitz Stud-Randle	about 10 yd^3/week dry & 30 yd^3/week wet	1,750	wet & dry ash spread on log yard; working with DeGoede Bulb Farm about potential use for land reclamation or soil amendment		1,750			
Daishowa America	38,000 yd^3/year	19,000	private ash monofill			19,000		
Fred Tebb & Sons	12 tons	12	landfill				12	
Georgia Pacific West	about 5,000 tons/year	5,000	Rabanco landfill			5,000		
Hampton Lumber, Cowlitz Division - Morton	about 10 yd^3/week dry & 30 yd^3/week wet	1,750	wet & dry ash to Randle facility and spread on log yard; working with DeGoede Bulb Farm about potential use for land reclamation or soil amendment		1,750			
Hardel Plywood	about 273 tons/year	273	ship ash to Little Hanford Farms in Centralia as a soil conditioner		273			
High Cascade Lumber	27,000 lbs/mo (wet)	162	on-site surface application for soil		162			

Facility	1999 Ash Production (Survey)	Calculated Production (tons/yr)	Current Ash Management	INDUSTRIAL Tons Land Applied	Non-Industrial Tons Land Applied	INDUSTRIAL Tons Landfilled	Non-Industrial Tons Landfilled	Non-Industrial Other Disposal
			building					
High Cascade Veneer	18-20 tons/year	20	blending with log yard debris and applying on-site since 1995		20			
Koenig FA & Sons	guessing 55 gal barrel full/week, maybe 200 lb/week (my calc - 10,000 lb/year based on 50 week year)	5	some in trash; land applied (dumped) on ground on-site		5			
K-Ply	never measures; guessing 12-16 yd^3/mo or 1 dump truck/mo	96	landfill				96	
Laymans Lumber	1 ton/year	1	stored on-site		1			
Longview Fibre	22,300 yd^3/year	11,150	Cowlitz County landfill - they use as landfill cover			11,150		
Longview Fibre	189 tons/year	189	Landfilled since June 2000			189		
Mayr Brothers, owned by Quality Veneer	18,250-23,725 ft^3/year	1,318	stockpiled on-site & land-mulched/tilled on-site; will sell if too much on-site, usually for potting soil		1,318			
Morton Forest Products	50-150 yd^3/year	75	1 year stockpile on site; working on using as soil amendment at DeGoede Bulb Farm. DeGoede has on-site boiler and uses ash for soil amendment (have not verified yet).		75			
Mt. Baker Plywood	about 365 yd^3/year - depends on moisture content	182.5	landfill				182.5	

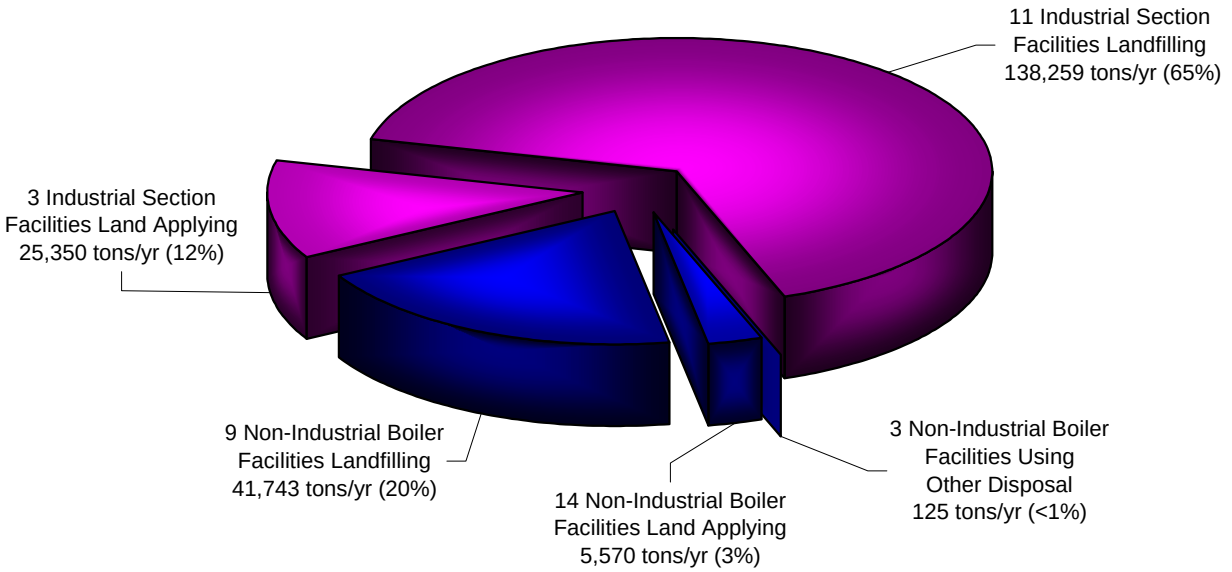
Facility	1999 Ash Production (Survey)	Calculated Production (tons/yr)	Current Ash Management	INDUSTRIAL Tons Land Applied	Non-Industrial Tons Land Applied	INDUSTRIAL Tons Landfilled	Non-Industrial Tons Landfilled	Non-Industrial Other Disposal
NW Hardwoods	57.6 tons/year	57.6	ash combined with hog fuel & sold as fuel					57.6
Oeser Company	about 6-8 tons/year	8	ash sent to "sanitary services" where they reincinerate it					8
Pacific Hardwoods	estimate 25-75 yd^3/year	37.5	local farmers using as soil amendment		37.5			
Port Townsend Paper	4,000 yd^3/year	2,000	on-site landfill in limited use fill			2,000		
Shakertown 1992	1.5-4 tons/year	4	municipal waste landfill				4	
Simpson Timber NW Operations	12,740 yd^3/year	6,370	Dayton Landfill			6,370		
Stimson Lumber Company	1,920 yd^3/year	960	Stevens Co. Landfill since 1/1/2000				960	
Vaagen Bros Lumber-Colville	62 tons/year	62	stores in pit out back; a farmer also spreads on farm with good results; some soil composting;a nursery picks up and uses for potting soil		62			
Vaagen Bros Lumber-Republic	never measured; maybe 50 tons/year	50	onsite ash landfill				50	
Wayne-Dalton Corporation	1 ton/year	1	land applied (on ground)		1			
Wilkins, Kaiser, & Olsen	2,000 lbs/week wet weight (1,400 lb/week dry weight?)	85	land application for run off control & soil building on-site		85			
Zosel Lumber	guessing 30 tons/year (runs 5 mo/year)	30	applying to log yard on haul roads on-site		30			
Abitibi	40 tons/day	12,000	used as fertilizer in Clark County	12,000				

Facility	1999 Ash Production (Survey)	Calculated Production (tons/yr)	Current Ash Management	INDUSTRIAL Tons Land Applied	Non-Industrial Tons Land Applied	INDUSTRIAL Tons Landfilled	Non-Industrial Tons Landfilled	Non-Industrial Other Disposal
Boise Cascade	12,700 tons/year	12,700	1/2 compost ash & apply to own cottonwood trees & 1/2 to own landfill	6,350		6,350		
Fort James	7,700 tons/year	7,700	own landfill			7,700		
Grays harbor	7,000 tons/year	7,000	apply as fert. to own land	7,000				
Kimberly Clark		36,500	Rabanco landfill			36,500		
Simpson Tacoma	14,000 tons/year	14,000	landfill			14,000		
Weyerhaeuser	200 yd^3/day	30,000	some land app; also mt solo landfill			30,000		
			Total (tons/year)	25,350	5,569.5	13,8259	41,742.86	125.6
			Number of Facilities	3	14	11	9	3
			Total Ash Produced (tons/year)	**211,047**				
			Total Facilities	**39**				

Appendix C

Comparison of Ash Management by Volume

From a Survey of 40 Facilities



Assumptions & Notes

* Dry Weight Assumption: 1 cubic yard = 1/2 ton
* Wet Weight Assumption: 1 cubic yard = 1 ton
* Assumed production was 6 d/wk, 50 wk/yr, 12 mo/yr
* Other disposal: 2 facilities combining ash with hog fuel and selling it as fuel; one facility is sending it off for reincineration
* Industrial Section Facilities include all pulp and paper facilities and some paper mills

The 40 facilities surveyed generate approximately 211,047 tons of wood ash per year. Of that total, approximately 30,920 tons are land applied each year.

Appendix D

Regulatory History of Wood Ash

Original Preamble when proposed in 1993:

Wood Ash Exclusion 173-303-071(3)(v)
The proposed exclusion is for wood ash that designates solely for corrosivity by WAC 173-303-090(6)(iii). Wood ash is a low toxicity, high volume waste which sometimes designates as a state-only dangerous waste due to high Ph (> 12.5). For the purpose of this exclusion wood ash means ash residue, bottom ash, and emission control dust generated from the combustion of untreated wood and wood fiber materials (i.e., wood chips, saw dust, paper waste, waste mixed paper, cardboard, tree stumps, untreated timbers, and untreated lumber). It has been demonstrated that wood ash from the combustion of untreated wood is not high in metals nor does it exhibit any other criteria or characteristics other than, at times, corrosivity as a solid material. Metals and other TC constituents are far below RCRA and DW regulatory levels. By limiting the exclusion to untreated wood, Ecology feels assured that wood ash can be managed safely in regard to public health and environment outside of the *Dangerous Waste Regulations*. This proposal does not include wood ash from the combustion of treated wood or treated wood waste such as rail road ties, telephone poles, bulkhead, treated posts, and treated lumber. Ecology did not intend for wood treated with arsenic, chrome, cadmium, creosote, pentachlorophenols, pentachlorophenates, formulations thereof, or any other types of wood preservatives or wood surface protection agents to be covered by the proposed exclusion. This exclusion also allows for the use of certain "over firing fuels" (oils, gas, coal, and other fossil fuels) in the combustion process. Fuels that are necessary to begin the combustion process of wood ash are referred to as "over firing fuels" and are considered a necessary part of that process. This allowance to the exclusion was in response to industry concern regarding the use of "over firing fuels," that wood ash generated would not fit the exclusion because these fuels would not fit the definition of untreated wood and wood fiber materials. Examples of acceptable "over firing fuels" include crude oil, RCRA used oil, gas, and coal. Materials not considered acceptable to fulfill the intent of this exclusion include, but are not limited to, oily waste, ignitable dangerous waste, solvents and solvent wastes, stoddard solvents, ink and ink oils, antifreeze, and dangerous waste fuels.

Second Preamble When Reproposed for Further Comment

Wood Ash Exclusion WAC 173-303-071(3)(v)
Ecology recently adopted an exclusion for wood ash that designates as a dangerous waste solely for corrosivity (pH above 12.5). Based on consideration of public comments received, Ecology is proposing to expand the scope of the exclusion to include ash resulting from the combustion of wood treated solely with creosote and to expand the list of acceptable wood fiber materials. Changes to the original wording were deemed significant enough to warrant an additional public comment period. The reasoning behind the original and currently proposed exclusion remains the same. Ecology believes that wood ash designating as a dangerous waste solely for corrosivity does not warrant management as a dangerous waste (Chapter 173-303 WAC), but should be managed under solid waste regulations (Chapter 173-304 WAC). Removal of the stigma often associated with the dangerous waste designation is intended to promote alternative management options. For example, wood ash historically has been successfully employed as a soil amendment utilizing both its alkaline nature in "sweetening" soils and in providing needed mineral nutrients. Expansion of ash management options also complies with the state's legislative mandate (RCW 70.105.150) to move up the waste management hierarchy, which favors waste reduction and recycling over landfill disposal. Note that the proposed exclusion is only for ash designating solely for corrosivity (WAC 173-303-090). If the ash designates under any other criteria, that is, persistence, carcinogenicity, or toxicity or if it fails as a toxicity characteristic waste, the wood ash does not meet this exclusion. The proposed exclusion does not relieve the generator of the responsibility for proper waste designation.

The proposed wording expands the exclusion to include wastewater treatment solids (sludges) as wood fiber materials qualifying for the exclusion. The sludges are typically generated in primary and secondary clarifiers associated with waste water treatment systems at wood burning facilities such as pulp and paper mills. Sludges from primary clarifiers consist of wood fibers and readily settleable solids. Sludges from secondary clarifiers consist of microorganisms and wood fiber fines. The proposed wording limits the qualifying sludges to those "associated" with the process or activity resulting in the ash. This is not meant to imply a strict locational relationship. For example, pulp and paper mills generate wood ash in their power boilers. They also typically introduce sludge form their wastewater treatment system to both reduce sludge volume and derive BTU value from the sludge. The intent is to disallow sludges that are generated from dissimilar processes whose inclusion might change the chemical composition or concentration of the resulting ash from the proposed exclusion.

Ecology evaluated the issue of the presence of chlorinated organics (dioxins and furans) associated with combusting pulp and paper mill sludges. Some concern was expressed in the previous comment period that chlorine, which may be used as a bleaching agent during the pulping process, would not be completely removed during wastewater treatment and would enter the boilers in

conjunction with the primary or secondary clarifier sludge. During combustion, chlorinated organics may be produced as unintended by-products. Although the *Dangerous Waste Regulations* do not contain a specific dioxin standard, a waste could designate based on its dioxin content as a dangerous waste under the persistence criteria as a halogenated hydrocarbon or as a carcinogenic substance at a minimum of 100 parts per million (ppm), or as a toxic dangerous waste at 10 ppm. Current data shows that the presence of chlorinated organics in ash is in the range of 100 to 300 parts per trillion, well below the level at which it would designate as a dangerous waste. It should be noted that if any associated wastewater treatment sludges were to designate as dangerous waste prior to burning, they could not be burned with the untreated wood and qualify for the exclusion. The term "deinking rejects" has been included in the proposed exclusion. This term is defined to mean the waste fiber generated in the newsprint and paper recycling operations exclusive of initial pulping rejects. Initial pulping rejects are not allowed because of the varying nature of materials introduced with the material to be recycled.

Comments received during the previous comment period indicate a need to clarify what is meant by "treated" wood. Treated wood is defined as wood treated by some substance which is intended to act as a preservative due to its inherent toxic nature; for example, pentachlorophenol and arsenic. Ecology received comments during the recently concluded regulation amendment process that the wood ash exclusion proposal and the exclusion for creosote treated wood should be linked. The current proposal expands the wood ash exclusion to include ash resulting from the combustion of wood treated solely with creosote. Again, this is a significant change from the previous proposal and therefore warrants additional public comment.

Ecology is proposing to exclude the ash from burning creosote treated wood for a number of reasons. The inclusion of creosote treated wood ash dovetails with the previous exclusion Ecology granted for creosote treated wood burned for energy recovery (see WAC 173-303-071(3)(g)(ii)) thus encouraging burning of this wood rather than landfilling. This exclusion (-071(3)(v)) is for ash that designates solely for corrosivity which makes this the appropriate subsection for the exclusion of ash from burning creosote-treated wood to ensure that it is not excluded if it designates for anything other than corrosivity. Ecology believes that the existing regulations and expected ash constituent concentrations warrant the inclusion of creosote treated wood. Creosote consists primarily of polycyclic aromatic hydrocarbons (PAHs) which are regulated as persistent dangerous wastes under WAC 173-303-103. While no process is 100% efficient, when creosote-treated wood is burned at a high temperature in an efficent industrial furnace or boiler, the usual products of wood combustion are expected (carbon monoxide, carbon dioxide, particulates, etc.). PAHs should be destroyed, although they will still be present in small amounts. An increase in the formation of chlorinated organics (dioxins and furans) is not expected because creosote contains a low (typically less than 3%) concentration of tar acids which as phenolic compounds could act as precursors to subsequent formation of chlorinated organic compounds.

WAC 173-303-071(3)(v)
Wood ash that would designate solely for corrosivity by WAC 173-303-090(6)(iii). For the purpose of this exclusion, wood ash means ash residue and emission control dust generated from the combustion of untreated wood, wood treated solely with creosote, and untreated wood fiber materials including, but not limited to ~~(i.e.,~~ wood chips, saw dust, tree stumps, paper, cardboard, ~~tree stumps, untreated timbers, and untreated lumber)~~ residuals from waste fiber recycling, deinking rejects, and associated waste water treatment solids. This exclusion allows for the use of ~~over firing fuels (~~auxiliary fuels including, but not limited to oils, gas, coal, and other fossil fuels~~)~~ in the combustion process.

Appendix E

Data on Dioxins in the Soil

The results of Ecology's soil sampling indicate that Washington soils appear to be lower in dioxin than the national averages estimated by the USEPA. For North American soils, the recently released dioxin reassessment (EPA, 2000) lists a mean rural background dioxin level of TEQ=3.6 pptr and a mean urban background dioxin level of TEQ=11.9 pptr, using the World Health Organization (Van den Berg et al, 1998) toxicity equivalent factors with (TEFs) for CDD/CDFs with non-detects (ND) set to zero. Ecology does not know what the sources are of the dioxins found in soils. The most likely primary source is aerial deposition from combustion sources. Also, from samples taken from fertilizers and soil amendments, Ecology knows that some of these products contain dioxins so they may be contributing as well. It is uncertain if fertilizers are contributing to soil dioxin levels because the concentration of dioxin in the fertilizer product must be higher than the concentration in the soil where it is being applied in order for an increase in the soil concentration to occur. Ecology does not know if any of the soil samples taken in its sampling effort to determine the level of dioxins in Washington soils came from land where wood ash was applied.