CORRIM Report:
Life Cycle Assessment for the Production of PNW Engineered I-Joist

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Addendum

The original report "CORRIM Report – Module F1 Cradle-To-Gate Life-Cycle Assessment of Composite I-Joists Produced in the Pacific Northwest Region of The United States was revised to meet the Product Category Rule (PCR) Guidance for Building-Related Products and Services Part B: Structural and Architectural Wood Products EPD Requirements. This revision was performed by WoodLife Environmental Consultants under contract with the Consortium for Research on Renewable Industrial Materials as part of the American Wood Council (AWC) EPD development of North American Wood Products.

The report might be reduced in content from the original to include only those reporting requirements for the PCR. Reference to the LCA on Pacific Northwest (PNW) I-joists should be made to the original as well as this revised report. Changes and additions from the original report may include additional required reporting impact factors and impact methods (Table A1) per the PCR and ISO (ISO 2006a-b) requirements on sensitivity analysis and interpretation of results.

Table A1 Original and updated reporting requirements

Revised Report					Original Report
Reporting Category Per Tables E1-E5 in ISO 21930:2017	**Indicator Name**	**Abbreviation**	**Units**	**Calculation Method**	**In report**
Core Mandatory Impact Indicators	Global warming potential, biogenic[1]	GWP	kg CO2e	TRACI + Manual	No
Core Mandatory Impact Indicators	Global warming potential, fossil	GWP	kg CO2e	TRACI	Yes
Core Mandatory Impact Indicators	Depletion potential of the stratospheric ozone layer	ODP	kg CFC11e	TRACI	Yes
Core Mandatory Impact Indicators	Acidification potential of soil and water sources	AP	kg SO2e	TRACI	Yes
Core Mandatory Impact Indicators	Eutrophication potential	EP	kg PO4e	TRACI	Yes
Core Mandatory Impact Indicators	Formation potential of tropospheric ozone	SFP	kg O3e	TRACI	Yes
Core Mandatory Impact Indicators	Abiotic depletion potential (ADPfossil) for fossil resources;	ADPf	MJ, NCV	CML-IA Baseline V3.05	No
Core Mandatory Impact Indicators	Fossil fuel depletion	FFD	MJ Surplus	TRACI	Yes
Use of Primary Resources	Renewable primary energy carrier used as energy	RPRE	MJ, NCV	CED, NCV	Yes
Use of Primary Resources	Renewable primary energy carrier used as material	RPRM	MJ, NCV	Manual	No
Use of Primary Resources	Non-renewable primary energy carrier used as energy	NRPRE	MJ, NCV	CED, NCV	Yes
Use of Primary Resources	Renewable primary energy carrier used as material	NRPRM	MJ, NCV	Manual	No
Secondary material, secondary fuel and recovered energy	Secondary material	SM	kg	N/A	No
Secondary material, secondary fuel and recovered energy	Renewable secondary fuel	RSF	MJ, NCV	Manual	No

[1] This indicator includes both biogenic and fossil-based carbon released. The TRACI method was modified to included CO2, biogenic removals and emissions.

Revised Report					Original Report
Secondary material, secondary fuel and recovered energy	Non-renewable secondary fuel	NRSF	MJ, NCV	N/A	No
Secondary material, secondary fuel and recovered energy	Recovered energy	RE	MJ, NCV	N/A	No
Mandatory Inventory Parameters	Consumption of freshwater resources;	FW	m3	Manual	Yes
Indicators Describing Waste	Hazardous waste disposed	HWD	kg	SP: Process Contribution	Yes
Indicators Describing Waste	Non-hazardous waste disposed	NHWD	kg	SP: Process Contribution	
Indicators Describing Waste	High-level radioactive waste, conditioned, to final repository	HLRW	kg or m3	SP: Process Contribution	
Indicators Describing Waste	Intermediate- and low-level radioactive waste, conditioned, to final repository	ILLRW	kg or m3	SP: Process Contribution	
Indicators Describing Waste	Components for re-use	CRU	kg	Manual	No
Indicators Describing Waste	Materials for recycling	MR	kg	Manual	No
Indicators Describing Waste	Materials for energy recovery	MER	kg	Manual	No
Indicators Describing Waste	Recovered energy exported from the product system	EE	MJ, NCV	Manual	No
Must include following if part of GWP					
Additional Inventory Parameters for Transparency	Biogenic Carbon Removal from Product	BCRP	kg CO2e	Manual	Yes
Additional Inventory Parameters for Transparency	Biogenic Carbon Emission from Product	BCEP	kg CO2e	Manual	Yes
Additional Inventory Parameters for Transparency	Biogenic Carbon Removal from Packaging	BCRK	kg CO2e	Manual	No
Additional Inventory Parameters for Transparency	Biogenic Carbon Emission from Packaging	BCEK	kg CO2e	Manual	No
Additional Inventory Parameters for Transparency	Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes	BCEW	kg CO2e	Manual	Yes
Additional Inventory Parameters for Transparency	Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes	CWNR	kg CO2e	Manual	No

Abbreviations

Cunit	100 cubic feet
EPDs	Environmental Product Declarations
GWP	Global Warming Potential
ISO	International Organization for Standardization
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
m^3	Cubic meter
MSF	1000 square feet
odkg	Oven Dry Weight Wood in Kilograms
PCR	Product Category Rules
tkm	Metric Tonne – Kilometers
m	meter

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1 Background

The environmental consequences of producing a material such as laminated veneer lumber (I-joists) are carried forward into the life cycle of products such as wooden structures. CORRIM, the Consortium for Research on Renewable Industrial Materials, has derived life cycle inventory (LCI) data for major wood products manufactured in several regions of the United States. The life cycle inventory data cover from forest regeneration through to final product at the mill gate. Research has covered nine major forest products, both structural and nonstructural, and four major regions: in this report we focus on I-joists produced in the US Pacific Northwest (PNW) region.

This report describes the energy and materials for producing I-joists in the PNW region of the US through a cradle-to-gate life cycle inventory on the manufacturing process. The environmental impacts, global warming, ozone depletion, acidification, smog, and eutrophication are discussed.

The focus of this report is an industry average I-joists production in the PNW region of the United States. LCI data are then used to estimate life-cycle impact assessments (LCIA). This study updates the cradle-to-gate manufacturing for I-joists in the PNW (Wilson and Dancer 2004).

The data collection was performed under "CORRIM Guidelines for Performing Life Cycle Inventories on Wood Products", undated, but current in the fall of 2012, a scientifically sound and consistent process established by CORRIM. It follows ISO 14040 standards (ISO 2006), ISO 21930 (ISO 2017), the Product Category Rules (PCR) for North American Structural and Architectural Wood Products (UL 2019) that will provide the guidance for preparation of North American wood product Environmental Product Declaration (EPD) and Part A: Life Cycle Assessment Calculations Rules and Report Requirements (UL 2018).

2 Goal and Scope

It is the goal and scope that provide the plan for conducting the LCI including data collection, compilation, and interpretation.

2.1 Goal and Objectives

2.1.1 Goals

The primary goal is to generate a gate-to-gate LCA of PNW USI-joists manufacturing and use this data to develop a cradle-to-gate profile of PNW US I-joists. The cradle-to-gate LCA will follow data and reporting requirements as outlined in the PCR (UL 2019) will provide the guidance for preparation of a business-to-business EPD.

2.1.2 Intended Audience

The primary audience for the results of this LCA report is I-joists producers in the US and CORRIM LCA practitioners.

2.1.3 Comparative Assertions

The report does not include product use and end of life phases which are required for comparative assertions relative to substitute products. If future comparative studies are intended and disclosed to the public, the LCA boundary would need to be expanded to include the use and end of life phases consistent with the ISO 14044:2006 guidelines and principles and ISO 21930 core rules for EPDs (ISO 2006, ISO 2017), and compliance with the Wood Products PCR, Part A and B (UL 2018, 2019).

2.2 Scope of Considered System

2.2.1 Functional and declared unit

In accordance with the PCR the declared unit for I-joists was one linear meter, with an oven-dried moisture content of 6 percent, dry basis. A declared unit is used in instances where the function and the reference scenario for the whole life cycle of a wood building cannot be stated (UL 2019). The inventory input data is presented as unallocated flows, all input and output flows allocated to the main product. This analysis does not take the declared unit to the use stage no service life is assigned.

The cradle-to-gate LCI was generated by combing the PNW I-joists manufacturing data collected by survey with previously published datasets for upstream manufacturing of forestry and harvesting operations, fuels, electricity, and ancillary material use.

2.2.2 System boundary

The cradle-to-gate system boundary is shown in Figure 1. The system boundary begins with regeneration in the forest and ends with I-joists at the mill gate. The system boundary included forest resource management activities such as site preparation and planting seedlings; fertilization and thinning on a subset of hectares; final harvest through transportation of roundwood to the primary breakdown facility; oriented strandboard (OSB), laminated veneer lumber (LVL), and finger joint lumber (FJL) production; transportation to the I-joist facility if needed; and I-joist production. The I-joist production complex was modeled as a single unit approach representing all the steps necessary to make I-joists. Three main unit processes exist in manufacturing I-joists: (1) routing and shaping of web and flanges, (2) assembly of I-joists, and (3) sawing and curing with energy generation as an auxiliary process. A single unit (i.e. black box) approach was used to model the I-joist process because little wood left the system except as the final product and because of the relative simplicity of the I-joist manufacturing processes. This simply means all process inputs and outputs are grouped into one I-joist process.

Fuel resources used for the cradle-to-gate production of energy and electricity were included within the cumulative system boundary. Off-site emissions include those from grid electricity production; transportation of feedstock; OSB, LVL, and FJL production; transportation to the I-joist facility; and production of fuels off site and consumed both on and off site. Ancillary material consumption data such as motor oil, waxes, paint, and hydraulic fluid were included in the analysis. Excluded from the system boundaries are fixed capital equipment and facilities, transportation of employees, land use, delivery of I-joists to construction site, construction, maintenance, use, and final disposal. Disposal of on-site waste from production manufacturing is included in the system boundary. Table 1 lists the inclusion and exclusion within the system boundaries of this study.

Table 2 System boundary inclusions and exclusions for the cradle-to-gate of PNW I-joists production

Included	Excluded
• Production of upstream processes for all resources, raw materials, fuels, and energy for I-joists production used in forestry operations, harvesting, and softwood I-joists manufacturing	• Fixed capital equipment and facilities
• Transportation of materials throughout the cradle-to-gate manufacturing life stages.	• Transportation of employees
• Packaging	• Construction, maintenance, use, and end of life treatment

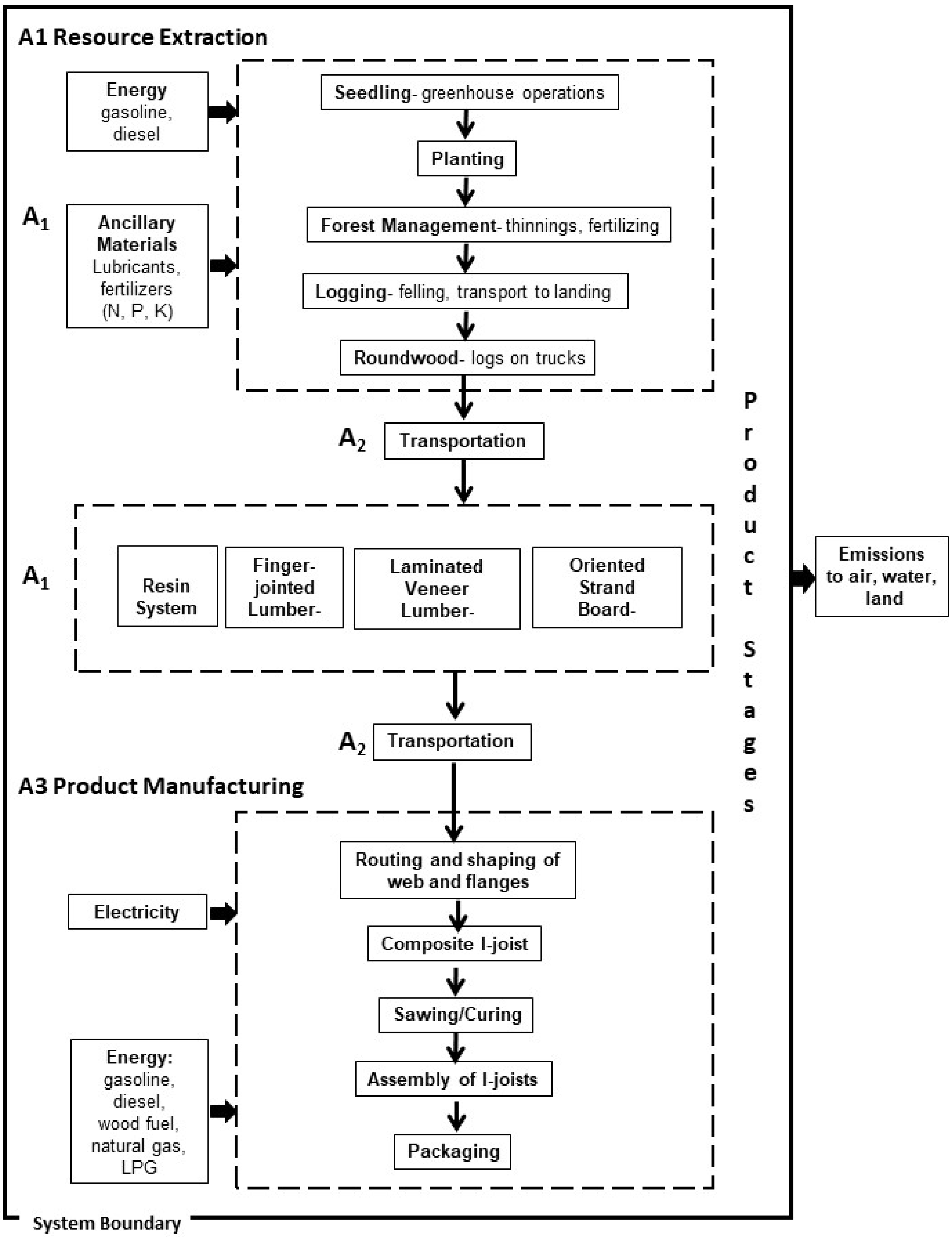


Figure 1 Cradle-to-gate system boundary for composite I-joist production in the PNW region

2.2.3 Allocation rules

Allocation is the method used to partition the environmental load of a process when several products or functions share the same process. The input material is finished oriented OSB, LVL, and FJL. A mass allocation for coproduct outputs was conservatively chosen.

2.2.4 Cut off rules

According to the PCR, if the mass/energy of a flow is less 1 percent of the cumulative mass/energy of the model flow it may be excluded, provided its environmental relevance is minor. This analysis for PNW I-joists included all energy and mass flows for primary data. No cut-offs were used in the impact assessment.

2.2.5 Data collection

Surveys were used to collect the LCI data in accordance with CORRIM guidelines and ISO standards. This study relied almost exclusively on production and emissions data provided by I-joists producers in the PNW, with some secondary data on fuels and electrical grid inputs from the US LCI database and European datasets (Datasmart2018 and Ecoinvent 3.4). Three mills provided data for 2012 I-joists and co-product production, raw material and fuel use, electricity consumption, and on-site emissions.

2.2.6 Calculation rules

For U.S. production, I-joists is commonly reported in linear feet. The survey results were converted to a unit production basis, of one linear meter (m), and a weighted average of input data was calculated based on production.

This approach resulted in an I-joists complex that represents a composite of the North American mills surveyed but may not represent any mill in particular. The U.S. LCI database was used to assess off-site impacts associated with the materials and energy used. SimaPro, version 8+ (Pré Consultants 2016) was used as the accounting program to track all of the materials. The primary data obtained from the surveys were weight-averaged using the formula shown below (Milota 2015):

$$w_1 = \frac{y_1}{(y_1 + y_2 + y_3)} = \frac{y_1}{Y_{total}} \qquad eq. 1$$

w_1 = weighing factor for mill 1
Y_{total} = total annual production of “y” mills
y_1 = annual production of Mill 1

Missing data were defined as data not reported in surveys by the I-joists facilities. When missing data occurred for survey items, they were checked with plant personnel to determine if it was an unknown value or zero. Missing data were carefully noted to make sure they were not averaged as zeros. Any outliers were resolved by contacting mill personnel.

3 Description of Industry

This study focused on large-scale production facilities that are representative of the industry. Production values and study results were reported per linear meter with an assumed average depth of 30 cm as shown in Figure 2 (depth goes from the top to the bottom of the 'I'). I-joist depth varies notably, but large quantities of I-joists made in the United States have a depth of 30 cm. These engineered structural wood products are designed to be used in the same manner as solid wood products such as sawn lumber but with different properties.

Production of I-joists is measured on a linear basis (feet, meters) with no measurement for the dimensions of height and width, which is the practice for the I-joist data given in this study. The most common dimensions of I-joists for the PNW can be found in Table 2. This LCA uses a weighted average for producing a generic I-joist (Table 2). This I-joist is slightly larger than you would expect to find in that region because of the small amount of waste and inefficiencies of producing the I-joists included in the product.

Table 3 Common dimensions for composite I-joists.

Common I–joist dimensions					
Depth	**Flange thickness**	**Width**	**Height**	**Flange thickness**	**Width**
millimeters			**inches**		
241.30	33.34	44.45	9.50	1.31	1.75
301.75	38.10	44.45	11.88	1.50	1.75
301.75	38.10	38.10	11.88	1.50	1.50
301.63	79.38	38.10	11.88	3.13	1.50
Generic I-joists dimension					
298.45	33.34	47.75	11.75	1.31	1.88

3.1 Categories of products and co-products

The main product from PNW I-joists mills is I-joists. Other products (co-products) are also produced from trimming, sawing, finishing of I-joists. These co-products could include trim, and sawdust.

3.2 Annual operating and production statistics of the industry (us total, regional)

Total U.S. I-joist production for 2012 was 109 million meters (358,900 thousand ft) (APA 2014). Three U.S. I-joist plants representing 30.7 percent of 2012 U.S. production, 33.6 million meters (110 million ft) participated in the study by providing primary data for the PNW. The surveyed plants provided detailed annual production data on their facilities, including on-site energy consumption; electrical usage; LVL, OSB, and FJL volumes; and I-joist production for 2012. Wilson and Dancer (2004) performed a 2000 U.S. I-joist LCI study that covered 33 percent (21.3 million m) of production in the PNW. Production from surveyed facilities for 2012 was an increase of 58 percent compared with 2000. In addition, unlike the earlier 2000 study, 2012 I-joist production data were not available by region. Therefore, production data by region could not be quantified for 2012.

3.3 Typical emission control measures by plant type

Common emission control devices are regenerative thermal oxidizers (RTOs) for the reduction of volatile organic compounds (VOC's) and electrostatic precipitators (ESPs) for the removal of particulate matter or particle pollution (PM). Regenerative catalytic oxidizers (RCOs) can remove more than 99.9 percent of

VOCs, but release nitrogen oxides by burning natural gas or liquefied petroleum gas. RCOs are designed to destroy VOCs and other emissions including PM and soot (USEPA 2003a). Electrostatic precipitators are used to collect particulate matter (PM) pollution but are not effective in reducing volatile organic compounds (VOC's) or hazardous air pollutants (HAP) emissions. The surveyed mills reported the installation and use of RCOs.

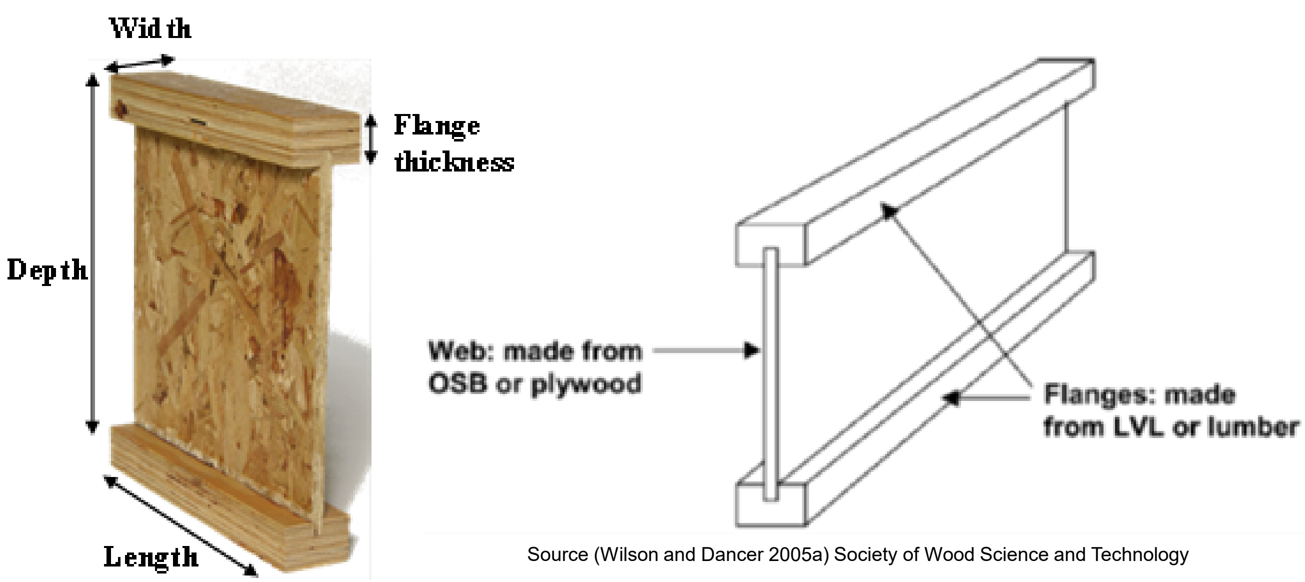
Air emission data were collected from surveyed mills. The air emission data were augmented by a secondary resource for acetone emissions from I-joist plants (USEPA 2002). Baghouses are the primary collectors of particulate matter with all three surveyed plants using this ECD. I-joist manufacturers reported on-site air emissions of acetone, carbon monoxide, formaldehyde, methanol, nitrous oxides, particulate matter, phenol, sulfur dioxide, and VOCs. All waterborne emissions occurred off site for gate-to-gate I-joist production. I-joist plants are zero- discharge facilities. Solid emissions were dominated by LVL and I-joist production stages. A total of 0.371 kg/m solid waste was generated. No dangerous substances were reported by industry that fall under ISO 21930 (ISO 2017).

4 Description of Product

I-joists fall into the North American Industry Classification System (NAICS) Code 321213—engineered wood member (except truss) manufacturing, which includes other structural wood engineered products such as FJL, parallel strand lumber, and glued–laminated timbers (USCB 2012; ASTM 2014). Additional classification codes for I-joists are the United Nations Standard Products and Services Code (UNSPSC) for wood joists 301036 07 and Construction Specifications Institute (CSI) code for engineer wood products 06 11 13 and wood I-joists 06 17 33.

I-joists have an "I" shape and are measured in linear feet in the United States (Figure 2). A composite I-joist is comprised of a web made from a structural wood panel, usually OSB but sometimes plywood (Figure 3). The web is glued between two flanges that are sometimes made from solid-sawn lumber or FJL but more commonly from LVL (USEPA 2002; Wilson and Dancer 2004; Stark et al. 2010; ASTM 2014). Typical flange size depends on the material. For LVL, the common size is 1.75 by 1.5 in. (44.5 by 38.1 mm), and for lumber flanges, the size is nominal 2 by 3 –in. (50.8 by 76.2 mm). There are many different dimensions of composite I-joists, but the most common are dimensions that directly replace 2 by 10 in. (50.8 by 254 mm) and 2 by 12 in. (50.8 by 304.8 mm) structural lumber (Table 2). I-joists are usually made in continuous lengths and then cut to 60-ft (18.29-m) lengths for shipping.

Figure 2 A Composite I-joist made from LVL and OSB



Source (Wilson and Dancer 2005a) Society of Wood Science and Technology

Figure 3 Typical composite I-joist made with laminated veneer lumber (LVL) flanges and an oriented strandboard (OSB) web.

This study focused on large-scale production facilities that are representative of the industry. Production values and study results were reported per linear meter with an assumed average depth of 30 cm as shown in Figure 3 (depth goes from the top to the bottom of the 'I'). I-joist depth varies notably, but large quantities of I-joists made in the United States have a depth of 30 cm. These engineered structural wood products are designed to be used in the same manner as solid wood products such as sawn lumber but with different properties.

4.1 Wood species

I-joists in the PNW region are primarily made with Douglas-fir (*Pseudotsuga menziesii*) flanges and Canadian aspen (*Populus tremuloides*) webs. For the LVL, the dry veneer comes from other softwood species besides Douglas-fir (*Pseudotsuga menziesii*) including white fir (*Abies concolor*), western hemlock (*Tsuga heterophylla*), lodgepole pine (*Pinus contorta*), and western larch (*Larix occidentalis*).

4.2 Moisture content

For products and coproducts produced during I-joist production a 6 percent MC on a dry basis was assumed.

5 Life cycle inventory analysis

The LCI was calculated based on 2012 production and the corresponding flows of materials during that period. No data gaps were recorded. As shown in Figure 1, the cradle-to-gate process for I-joists production is considered to comprise wood material production inputs and their transport to I-joists production and ion-site I-joists production.

5.1 A1- Resource extraction

5.1.1 Harvesting Operations

Consideration of the logs used in the production of LVL in the PNW region includes the establishment, growth, and harvest of trees. This group of activities is collectively referred to as forest resource management. Data for the forest resources management component of this analysis (Tables 3 and 4) come from Oneil and Puettmann (2017). For more details on the PNW Forest Operations see Oneil and Puettmann (2017).

Table 3 summarizes the management inputs needed to establish crop trees and grow them to harvestable size. It includes per hectare data for inputs needed for planting, site preparation, conifer release, pre-commercial thinning, and fertilization, including fuels needed to apply herbicides and fertilizers and move crews to and from the plantations. In both Oregon and Washington, forest regeneration following harvest is required by law. Minimum stocking standards (number of trees per hectare) and requirements to protect them from being overtopped by competing vegetation are set forth in the Washington Administrative Code (Washington State Legislature 2005, WAC 222-34-010) (WSL 2019) and the Oregon Forest Practices Act (Oregon Department of Forestry 2008, 629-610-0020) (USDA 2008). While regeneration from naturally occurring, seed is permitted under these regulatory frameworks, it is not commonly used because the delays in regeneration can be substantial and costly, and this method can result in a failure to adequately reforest the harvest area. Given that large private and industrial landowners are focused on the efficient production of their crops of trees, it also does not make economic sense to forego planting in favor of an uncertain outcome from naturally regenerated stands. Over the past decade, plantation management strategies have moved away from dense planting for early crown closure to a more targeted approach that relies on early weed control, low-density planting, and post planting herbicide applications as required. All harvested acres are planted, with an average planting density of 1,092 trees per ha (442 trees per acre).

Table 4 Management and Harvest Timeline and Yield (Oneil and Puettmann, 2017)

Prescription Scenarios	Commercial Thin	Ground	Cable
Entry Period/Rotation Age	25	50	50
Planting Density (Trees/ha)	0	1092	1092
Fertilization	None	35	None
Pre-commercial Thin	None	Year 15	None
Number of Trees/ha	0	741	0
Commercial Thin (m3/ha)	92	0	0
at Year	25	0	0
Final Harvest (m3/ha)	0	575	531
at Year	0	50	50
Total Harvest (m3/ha)	92	575	531
Percent Thinned	100%	14%	0%
Average Yield (m3/ha/year)	4	12	11
Percent Land in Category - Base	8%	52%	40%

No primary data using time motion studies or similar methods were collected for this project. Productivity data for forest harvesting operations were based on logging equipment and equipment configurations developed in spreadsheet models used by Johnson et al. (2005) and Han et al. (2014) and cross validated to primary survey data for the suite of available equipment options and sizes that are commonly used in the PNW Douglas-fir region (Table 4). Final fuel consumption rates are based on the allocation of total volume harvested using each harvest system to arrive at an average fuel consumption per cubic meter for the region. Fuel consumption for crew transport to conduct harvest operations was calculated from average haul distance, fuel efficiency of common vehicle types (4 x 4 trucks), and equipment productivity estimates (cubic meters per day per operation). Two-person crews per vehicle were assumed.

Table 5 Harvesting Inputs (per cubic meter) (Oneil and Puettmann, 2017)

System	Fuel Consumption	Lubricant Consumption
	L / m^3	L / m^3
Commercial Thinning (cut-to-length processor, skidder, loader)	2.372	0.043
Ground based Harvesting (feller-buncher, shovel yarder, slide boom processer, loader)	3.172	0.057
Cable Harvesting (hand felling, skyline, cut-to-length processor, loader)	3.029	0.055
Weighted average - ground harvesting systems	3.062	0.055
Overall weighted average - all harvest systems	3.051	0.055
Weighted average, crew transport all harvest operations	0.210	0.002

5.1.2 LVL production

Inputs into composite I-joist manufacturing include LVL. In the PNW, for every meter of I-joist produced, 2.135 kg (0.0039 m3) of LVL was incorporated into the final product. Dry veneers and resins are the primary raw materials consumed for the production of PNW LVL. For this study, LVL production included veneer production and transportation but not the forest resource life-cycle stage. This was consistent with OSB and FJL as well. For detailed information on the production of LVL see Bergman and Alanya-Rosenbaum (2016a).

5.1.3 Oriented strandboard production

Inputs into composite I-joist manufacturing include OSB. For every meter of I-joist produced, 1.407 kg (0.0023 m^3) of OSB was incorporated into the final product. Chips and resins are the primary raw materials consumed for the production of SE OSB (Puettmann et al. 2016)

5.1.4 Finger-jointed lumber production

Inputs into composite I-joist manufacturing include FJL. For every meter of I-joist produced, 0.780 kg (0.0017 m^3) of FJL was incorporated into the final product. Finger joints are machined on both ends of softwood lumber with special cutter heads. A structural resin such as MUF is applied, and the joints in successive boards are coupled. The resin is cured with the joint end under pressure and heat. Most manufacturers use a continuous radio-frequency curing system for this step. The surveyed mills provided primary data on FJL production and MUF resin consumption, whereas electrical consumption data for cutting or forming joints for FJL was embedded in the electricity consumed for I-joist production and therefore not noted separately. For this study, FJL production included the impacts of softwood lumber production as well as resin production.

5.1.5 Resin production

Phenol-resorcinol-formaldehyde resin is the primary resin used for both web-to-web and web-to-flange joints. PRF resins differ somewhat from other resins in that hardeners are required to help in curing glue-laminated timbers and I-joists.

5.2 A2 – Transport

Wood raw materials were delivered to the I-joist plants by truck and rail; the wood material consists primarily of OSB and FJL purchased from off site. For the surveyed mills, LVL was produced on site in conjunction with the I-joists.

Based on mill surveys, the weighted-average one-way haul distance for feedstock along with the components of the resin system are shown in Table 5. The values for LVL shipping distances were zero for the PNW because the surveyed I-joist plants produced LVL at the same site. All upstream transportation of inputs to LVL, FJL, and OSB production were included in the respective LCI input values. For example, LVL production incorporated not only dry veneer production but transportation as well. The average haul distance for feedstock along with the components of the resin system are shown in Table 5.

Table 6 Weighted-average delivery distance (one way) by mode for materials to PNW I-joists plant.

Material delivered to mill	Delivery distance
	km
OSB to I-joist plant, by truck	1,604
OSB to I-joist plant, by rail	333
LVL to I-joist plant	0
FJL to I-joist plant	40
Resin to I-joist plant	161

5.3 A3 – Product Manufacturing

This study collected primary data from representative I-joist manufacturers in the PNW that use average technology for their regions. The raw wood material to produce I-joists comes produced in manufacturing facilities in the PNW in the form LVL and FJL. For OSB, U.S. manufacturing of this material is in the southeast. In the PNW, most I-joist production occurs in conjunction with production of LVL and FJL in the same engineered wood facility or nearby. For the surveyed mills in this study, all LVL and most FJL production occurred at the same site as I-joist production.

5.3.1 Material Flows

To evaluate data quality, a mass balance was performed (Table 6). Unallocated input feedstocks of LVL, OSB, and FJL per 1 meter of I-joist were 2.318, 1.583, and 0.847 kg (oven-dry), respectively. The major coproduct produced was sawdust (0.363 OD kg), whereas I-joist produced constituted about 92 percent by mass of the total output. Phenol-resorcinol-formaldehyde resin made up most of the additives, which were overall about 0.5 percent by mass of the total input.

Table 7 Mass balance of PNW I-joists manufacturing per linear meter.

	(OD kg)	Mass (%)	CoVw [a] (%)
	Inputs		
Feedstocks			
LVL	2.3180	48.6	57.7
OSB	1.5830	33.2	3.6
FJL	0.8470	17.8	156.6
Total	4.7480	99.5	4.7
Resin system			
PRF resin	0.0157	0.3	39.9
Hardener	0.0090	0.2	
Catalyst	0.0020	0	156.6
Total	0.0250	0.5	47.1
Total inputs	4.7720	100	
Products	Outputs		
I-joist	4.3970	92.3	7.5
Coproducts			
Sawdust, sold	0.3630	7.61	99
Panel trim, sold	0.0020	0.05	
Rejects	0.0100	0.21	
Total	0.3750	7.86	98
Total outputs	4.7720	100	

[a] Production weight-averaged coefficient of variation.

5.3.2 I-joists Manufacturing

Routing and shaping of web and flanges are the first step in producing composite I-joists. This process requires machining of the OSB web pieces so they fit together at the ends as well as tapering them on the top and bottom edges so that they can be fitted into the flanges. Flanges are made primarily from LVL along with some FJL. The flanges are routed their entire length to accept the inserted tapered OSB web material. The coproduct created during this process is dry sawdust.

Resin application and pressing of the I-joist web and flanges members is the next step. Resin is applied in web-to-web and web-to-flange joints. Resins can include MDI and PRF. Assembly is done mechanically, pressing web sections end-to-end and into the top and bottom flange, which are also pressed end-to-end; the result is a continuous ribbon of I-beam that can be of infinite length. No coproducts are created during this process. The final step before packaging is sawing the I-joists to length and allowing the joints to cure. In some cases, the I-joist may be heated in a radio-frequency oven to accelerate resin cure time. For more information about composite I-joist manufacturing, see Wilson and Dancer (2004).

Table 7 gives a detailed description of the material and energy inputs and outputs crossing the system boundary of I-joist production, gate-to-gate. Under materials, wood feedstocks include OSB, LVL, and FJL. Electricity consumed on site for the PNW was calculated to be 0.378 kWh/m. Natural gas was the primary fossil fuel used on site (0.036 m^3/m). Air emissions were derived from the surveyed mills along with pertinent emissions data categorized by the EPA (USEPA 2002, 2003a, 2003b, 2003c, 2015). When available, surveyed air emission data as primary data were selected rather than secondary data.

Table 8 Unit process inputs–outputs to produce one linear meter of PNW I-joists.

	Unit/m	Value	Allocation[a] (%)
Products			
I-joist	m	1.00E+00	92.1
Sawdust, sold	kg	3.63E-01	7.6
Panel trim, sold	kg	2.21E-03	0.0
Rejects	kg	9.87E-03	0.2
Resources		0.00E+00	
Water, well, in ground	L	4.63E-03	
Materials/fuels			
Wood feedstock, LVL, oven-dried	kg	2.32E+00	
Wood feedstock, OSB, oven-dried	kg	1.58E+00	
Wood feedstock, FJL, oven-dried	kg	8.47E-01	
PRF resin	kg	1.57E-02	
Hardener	kg	8.97E-03	
Catalyst	kg	1.96E-03	
Electricity, at grid	kWh	3.78E-01	
Diesel, combusted in industrial equipment	L	2.99E-03	
Gasoline, combusted in equipment	L	5.37E-05	
Propane, combusted in industrial equipment	L	3.87E-03	
Natural gas, combusted in industrial boiler	m^3	3.64E-02	
Transport, combination truck, diesel power, OSB	tkm	2.14E+00	
Transport, rail, diesel power, OSB	tkm	6.52E-03	
Transport, combination truck, diesel power, FJL	tkm	3.76E-02	
Transport, combination truck, diesel powered, PRF resin	tkm	3.89E-03	
Transport, combination truck, diesel powered, hardener	tkm	2.22E-03	
Transport, combination truck, diesel powered, landfill waste	tkm	4.32E-03	
Hydraulic fluid	kg	1.07E-04	
Greases	kg	3.40E-06	
Motor oil	kg	4.30E-05	
Waxes (sealant)	kg	3.58E-05	
Plastic wrapping	kg	2.11E-03	
Steel strapping	kg	1.87E-04	
Potable water	kg	1.11E-04	
Plastic strapping	kg	2.69E-04	
Wrapping material - packaging	kg	4.75E-02	
Emissions to air			
Acetone[b]	kg	2.08E-07	
Carbon monoxide	kg	2.97E-05	
Formaldehyde	kg	1.30E-05	
Methanol	kg	3.09E-05	
Nitrous oxide	kg	3.51E-05	
PM10	kg	4.29E-06	
Phenol	kg	3.52E-04	
Sulfur dioxide	kg	2.70E-07	
VOCs	kg	1.82E-04	
Waste to treatment			
Waste to inert landfill	kg	3.73E-03	
Waste to recycling	kg	2.45E-03	

[a] Mass allocation approach.

[b] Secondary data (EPA 2002).

5.3.3 Equipment: Type and fuel consumption

Electrically driven motors in the mill are used for material conveying and trims saws. The emissions controls equipment is powered by electricity or natural gas. Lifts for transporting products and materials in the mill are powered by liquefied propane gas.

5.3.4 Energy use and generation

Weighted-average energy inputs consumed at the I-joist manufacturing site were developed from survey data (Table 8). Electricity and natural gas were the primary energy inputs at 0.378 kWh and 0.036 m^3 for the PNW per linear meter of I-joist.

Table 9 Weighted-average on-site energy inputs for PNW I-joists manufacturing

	Quantity	Unit	CoVw [a] (%)
Energy inputs			
Electricity	0.3780	kWh	35
Natural gas	0.0364	m^3	103
Diesel	0.0030	L	76
Propane	0.0039	L	4.7
Gasoline	0.0001	L	-

[a] Production-weighted coefficient of variation.

5.3.5 Wood-base fuels

Wood-based by-products are commonly used in the wood product industry to produce heat for the thermal energy intense processes drying and hot pressing. All wood fuel was burned in the production of upstream feedstocks (LVL, lumber, and OSB) (Bergman and Alanya-Rosenbaum 2016a, Milota 2015, Puettmann et al. 2016)

5.3.6 Packaging

Finished I-joists are packaged for transport. Inputs include final product (I-joist), and outputs include packaged I-joist. For this study, it was assumed that only wrapping material was used for each I-joist. Packing materials represent 1.14 percent of the cumulative mass of the model flow (Table 9).

Table 10 Materials used in packaging and shipping per linear meter I-joists

Material	Value	Unit	Percentage
Wrapping material	0.0475	kg	94.87%
Plastic strapping	0.0024	kg	4.75%
Steel strapping		kg	0.37
Total	0.0500	kg	100

5.4 Secondary Data Sources

Table 10 list the secondary LCI data sources used in this LCA study for raw material inputs, ancillary materials and packaging, transportation of materials and resources, fuels and energy for manufacturing, water sources, and waste streams.

Table 11 Secondary Data Sources and Data Quality Assessment

A1: Raw Material Inputs				
Inputs	**LCI Data Source**	**Geography**	**Year**	**Data Quality Assessment**
Wood resource	Database: CORRIM dataset Process: • Roundwood, softwood, average, at forest road, PNW • Laminated veneer lumber, at LVL plant, PNW • Oriented Strand Board, OSB mill, US • Finger-jointed lumber, at I-joist plant, US PNW	North America – Region Specific	2005 -2019	**Technology**: good Process models region-specific technology. **Time**: good Some data is less than 10 years old **Geography**: very good Data is representative of regional production.
Resin	Database: US EI 2.2 (Datasmart2018) Process: Phenol-resorcinol-formaldehyde resin, at plant NREL/US U	North America	2018	**Technology**: very good Process models average North American technology **Time**: good Data is less than 10 years old **Geography**: very good Data is representative of North American
A2: Raw Material Transportation				
Inputs	**LCI Data Source**	**Geography**	**Year**	**Data Quality Assessment**
Trucking	Database: US EI 2.2 (Datasmart2018) Process: Transport, combination truck, Diesel powered NREL/US U	North America	2018	**Technology**: very good Process models average North American technology **Time**: good Data is less than 10 years old **Geography**: very good Data is representative of North American trucking.
A3: Manufacturing				
Energy Inputs	**LCI Data Source**	**Geography**	**Year**	**Data Quality Assessment**

Electricity	Database: Ecoinvent 3.4 Process: Electricity, low voltage {WECC}| market for | Cut-off, U	North America – Region Specific egrid	2018	**Technology**: very good Process models average electricity technology specific to regional grids **Time**: very good Data is less than 5 years old **Geography**: very good Data is representative of regional electricity generation.
Gasoline	Database: US EI 2.2 (Datasmart2018) Process: Gasoline, combusted in equipment NREL/US U	North America	2018	**Technology**: very good Process models average North American technology **Time**: very good Data is less than 5 years old **Geography**: very good Data is representative of North American propane production and combustion.
Diesel	Database: US EI 2.2 (Datasmart2018) Process: Diesel, combusted in industrial equipment NREL/US U	North America	2018	**Technology**: very good Process models average North American technology **Time**: very good Data is less than 5 years old **Geography**: very good Data is representative of North American diesel production and combustion.
Ancillary Materials and Packaging	**LCI Data Source**	**Geography**	**Year**	**Data Quality Assessment**
Hydraulic Fluid and Lubricants	Database: US EI 2.2 (Datasmart2018) Process: Lubricating oil, at plant/US- US-EI U	North America	2018	**Technology**: very good Process models average North American technology **Time**: very good Data is less than 5 years old **Geography**: very good Data is representative of North American processes.

Plastic Strap	Database: US EI 2.2 (Datasmart2018) Process: Polyethylene, HDPE, granulate, at plant/US- US-EI U	North America	2018	**Technology**: very good Process models average North American technology **Time**: very good Data is less than 5 years old **Geography**: very good Data is representative of North American processes.
Steel Strap	Database: US EI 2.2 (Datasmart2018) Process: Chromium steel 18/8, at plant/US- US-EI U	North American	2016	**Technology**: very good Process models average North American technology **Time**: very good Data is less than 5 years old **Geography**: very good Data is representative of North American processes.
Greases and oils	Database: US EI 2.2 (Datasmart2018) Process: Proxy Oil and grease, at plant NREL/US U	North America	2018	**Technology**: very good Process models average North American technology **Time**: very good Data is less than 5 years old **Geography**: very good Data is representative of North American processes.

6 Life cycle impact assessment

The life cycle impact assessment (LCIA) phase establishes links between the life cycle inventory results and potential environmental impacts. The LCIA calculates impact indicators, such as global warming potential and smog. These impact indicators provide general, but quantifiable, indications of potential environmental impacts. The target impact indicator, the impact category, and means of characterizing the impacts are summarized below. Environmental impacts are determined using the TRACI method (Bare 2011, 2012). Each impact indicator is a measure of an aspect of a potential impact. This LCIA does not make value judgments about the impact indicators, meaning comparison indicator values are not valid. Additionally, each impact indicator value is stated in units that are not comparable to others. For the same reasons, indicators should not be combined or added. Additionally, the LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks. The primary fuels categorized into non-renewable (fossil and nuclear) and renewable (biomass, geothermal, solar, wind, hydro). Table 11 summarizes the source and scope of each impact category reported in this report as required to be in conformance with the PCR.

Table 12 Selected impact indicators, characterization models, and impact categories

Reporting Category Per Tables E1-E5 in ISO 21930:2017	Indicator Name	Abbreviation	Units
Core Mandatory Impact Indicators	Global warming potential, with biogenic[2]	GWP	kg CO2e
Core Mandatory Impact Indicators	Global warming potential, fossil	GWP	kg CO2e
Core Mandatory Impact Indicators	Depletion potential of the stratospheric ozone layer	ODP	kg CFC11e
Core Mandatory Impact Indicators	Acidification potential of soil and water sources	AP	kg SO2e
Core Mandatory Impact Indicators	Eutrophication potential	EP	kg PO4e
Core Mandatory Impact Indicators	Formation potential of tropospheric ozone	SFP	kg O3e
Core Mandatory Impact Indicators	Abiotic depletion potential (ADP fossil) for fossil resources;	ADPf	MJ, NCV
Core Mandatory Impact Indicators	Fossil fuel depletion	FFD	MJ Surplus
Use of Primary Resources	Renewable primary energy carrier used as energy	RPRE	MJ, NCV
Use of Primary Resources	Renewable primary energy carrier used as material	RPRM	MJ, NCV
Use of Primary Resources	Non-renewable primary energy carrier used as energy	NRPRE	MJ, NCV
Use of Primary Resources	Renewable primary energy carrier used as material	NRPRM	MJ, NCV
Secondary material, secondary fuel and recovered energy	Secondary material	SM	kg
Secondary material, secondary fuel and recovered energy	Renewable secondary fuel	RSF	MJ, NCV
Secondary material, secondary fuel and recovered energy	Non-renewable secondary fuel	NRSF	MJ, NCV

[2] This indicator includes both biogenic and fossil-based carbon released. The TRACI method was modified to included CO2, biogenic removals and emissions

Reporting Category Per Tables E1-E5 in ISO 21930:2017	Indicator Name	Abbreviation	Units
Secondary material, secondary fuel and recovered energy	Recovered energy	RE	MJ, NCV
Mandatory Inventory Parameters	Consumption of freshwater resources;	FW	m3
Indicators Describing Waste	Hazardous waste disposed	HWD	kg
Indicators Describing Waste	Non-hazardous waste disposed	NHWD	kg
Indicators Describing Waste	High-level radioactive waste, conditioned, to final repository	HLRW	kg or m3
Indicators Describing Waste	Intermediate- and low-level radioactive waste, conditioned, to final repository	ILLRW	kg or m3
Indicators Describing Waste	Components for re-use	CRU	kg
Indicators Describing Waste	Materials for recycling	MR	kg
Indicators Describing Waste	Materials for energy recovery	MER	kg
Indicators Describing Waste	Recovered energy exported from the product system	EE	MJ, NCV
Additional Inventory Parameters for Transparency	Biogenic Carbon Removal from Product	BCRP	kg CO2e
Additional Inventory Parameters for Transparency	Biogenic Carbon Emission from Product	BCEP	kg CO2e
Additional Inventory Parameters for Transparency	Biogenic Carbon Removal from Packaging	BCRK	kg CO2e
Additional Inventory Parameters for Transparency	Biogenic Carbon Emission from Packaging	BCEK	kg CO2e
Additional Inventory Parameters for Transparency	Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes	BCEW	kg CO2e
Additional Inventory Parameters for Transparency	Carbon Emissions from Combustion of Waste from Non-Renewable Sources used in Production Processes	CWNR	kg CO2e

Cradle-to-gate environmental performance results for all reporting indicators are listed in Table 12 for PNW I-joists. The LCIA results in these tables show the absolute values for A1-Resource Extraction, A2-Transportation, and A3-I-joists Production. For GWP, 18 percent of the CO_2 equivalent emissions come from producing I-joists (0.416 kg CO_2 eq), with 74 percent assigned to resource extraction (forestry operations, LVL, OSB, FJL, and resin) (1.741 kg CO_2 eq). Transportation was 0.191 kg CO_2 eq or 8 percent of the cradle-to-gate GWP impact.

Table 12 also provides indicators related to energy use, material resource consumption, and the waste generated. The total cradle to gate energy use was 77.04 MJ/m. Fossil energy, 39.12 MJ/m, is used for machinery, transportation, electricity, pressing, and drying. The biomass energy, 24.11 MJ/m, was used for LVL, OSB, and FJL production and pressing of I-joists. Total cradle-to-gate non-renewable fuel used represents 66 percent of the total energy and is used for machinery, transportation, electricity, presses, and drying. Total cradle-to-gate renewable energy total is 26.19 MJ and non-renewable represented 50.85 MJ.

Most of the freshwater use is in the A1 life cycle stage (84%). In the resource extraction stage, I-joist feedstock production (LVL, OSB, FJL) consumed 99 percent of the total freshwater use in A1. Total cradle-to-gate freshwater use was 13.62 L.

Most of the waste is generated in the A1 life cycle stage (80%) (Table 13). Composite I-joist (A3) generated only16, 22, and 16 percent for total waste, hazardous, and non-hazardous waste, respectively (Table 13). The A1 phase generated 78 percent of the total cradle to gate hazardous waste and 80 percent of the non-hazardous (Table 13). Within the A1 phase, feedstock production generated 99 percent of the hazardous waste, with 98 percent from OSB (Table 14). Laminated veneer lumber represented 62 percent of the non-hazard and 62 percent of the total. Forestry operations and resins represented 4 and 1 percent, of the total A1 waste, respectively.

Table 13 Environmental performance of 1 linear meter of I-joist, PNW

		Units	A1	A2	A3	Total
Core Mandatory Impact Indicator						
Global warming potential, w/biogenic	GWP	kg CO2e	11.326	0.191	(11.708)	2.347
Global warming potential, fossil	GWP	kg CO2e	1.741	0.191	0.416	2.347
Depletion potential of the stratospheric ozone layer	ODP	kg CFC11e	6.59E-08	3.57E-10	1.69E-08	8.32E-08
Acidification potential of soil and water sources	AP	kg SO2e	0.031	0.001	0.001	0.033
Eutrophication potential	EP	kg Ne	0.007	0.000	0.002	0.009
Formation potential of tropospheric ozone	SFP	kg O3e	1.010	0.030	0.018	1.058
Abiotic depletion potential (ADPfossil) for fossil resources;	ADPf	MJ, NCV	29.329	2.386	7.409	39.124
Fossil fuel depletion	FFD	MJ Surplus	3.476	0.337	0.893	4.706
Use of Primary Resources						
Renewable primary energy carrier used as energy	RPRE	MJ, NCV	23.810	0.005	2.371	26.187
Renewable primary energy carrier used as material	RPRM	MJ, NCV	112.857	-	-	112.857
Non-renewable primary energy carrier used as energy	NRPRE	MJ, NCV	40.184	2.420	8.248	50.852
Non-renewable primary energy carrier used as material	NRPRM	MJ, NCV	0.810			0.810
Secondary Material, Secondary Fuel and Recovered Energy						
Secondary material	SM	kg	-	-	-	-
Renewable secondary fuel	RSF	MJ, NCV	0.822		0.005	0.827
Non-renewable secondary fuel	NRSF	MJ, NCV	-	-	-	-
Recovered energy	RE	MJ, NCV	-	-	-	-
Mandatory Inventory Parameters						
Consumption of freshwater resources	FW	m^3	0.0114	0.0000	0.0022	0.0136
Indicators Describing Waste						
Hazardous waste disposed	HWD	kg	0.0010	0.0000	0.0003	0.0013
Non-hazardous waste disposed	NHWD	kg	0.2959	0.0144	0.0589	0.3692
High-level radioactive waste, conditioned, to final repository	HLRW	kg or m3	-	-	-	-
Intermediate- and low-level radioactive waste, conditioned, to final repository	ILLRW	kg or m3	-	-	-	-
Components for re-use	CRU	kg	-	-	-	-
Materials for recycling	MR	kg	-	-	-	-
Materials for energy recovery	MER	kg	-	-	-	-
Recovered energy exported from the product system	EE	MJ, NCV	-	-	-	-

Table 14 Distribution of waste generation by life cycle stage; A1-Resource extraction, A2-Transportation, and A3 Product manufacturing for 1 linear meter of I-joist, PNW.

	A1	A2	A3	TOTAL cradle-to-gate
Total Waste	0.2970	0.0144	0.0591	0.3705
Hazardous waste	0.0010	0.0000	0.0003	0.0013
Non-hazardous waste	0.2959	0.0144	0.0589	0.3692
% Hazardous waste	78.18%	0.01%	21.80%	100%
% Non-hazardous waste	80.15%	3.91%	15.94%	100%

Table 15 Distribution of waste generation in the A1-Resource extraction life cycle stage for 1 linear meter of I-joist, PNW.

	A1-Resource extraction		
	Forestry operations	Resin Production	Feedstock Production
% Total waste	3.87%	1.25%	99.42%
% Hazardous waste	0.57%	0.01%	94.88%
% Non-hazardous waste	3.88%	1.26%	94.89%

7 Interpretation

As defined by ISO (2006a-b), the term life cycle interpretation is the phase of the LCA that the findings of either the LCI or the LCIA, or both, are combined consistent with the defined goal and scope in order to reach conclusions and recommendations. This phase in the LCA reports the significant issues based on the results of the presented in LCI and the LCIA of this report. Additional components report an evaluation that considers completeness, sensitivity and consistency checks of the LCI and LCIA results, and conclusions, limitations, and recommendations.

7.1 Identification of the Significant Issues

The objective of this element is to structure the results from the LCI or the LCIA phases to help determine the significant issues found in the results and presented in previous sections of this report. A contribution analysis was applied for the interpretation phase of this LCA study. Contribution analysis examines the contribution of life cycles stages (A1 and A3), unit process contributions in a multi-unit manufacturing process, or specific substances which contribute an impact.

7.2 Life cycle phase contribution analysis

For global warming impact, 18 percent of the CO_2 equivalent emissions come from producing I-joists (A3), with 74 and 8 percent assigned to extraction (A1) and transportation (A2), respectively (Table 15). Resource extraction (A1) represented the highest impacts in all environmental impact categories (GWP, eutrophication, acidification, smog, and ozone depletion). Cradle-to-gate, freshwater use was also almost exclusively consumed during the A1 life cycle stages (84%) with 16 percent in A3 (Table 15).

Most of the renewable fuels were used in the A1 life-cycle stage (Table 15). Biomass energy is used in in the feedstock materials production. Ninety three percent of the biomass fuel cradle-to-gate (A1-A3) is consumed in the A1 life cycle stage. I-Joist production made up the other 7 percent, mainly from the production of LVL and FJL onsite at some mills (Table 16). Non-renewable fuel consumption cradle-to-gate was 66 percent. In summary, cradle to gate total energy for producing PNW I-joists, which includes fuel for process heat and equipment and electricity, comes from 51 percent fossil fuels,15 percent nuclear, 31 percent renewable biomass fuel, and 3 percent other renewable (Table 17).

Table 16 Cradle-to-gate PNW I-joists LCIA contribution analysis LCIA results for A1-Resource extraction, A2-Transportation, and A3-Product production

Indicator Name	Abbreviation	Units	A1	A2	A3	Total
Global warming potential, fossil	GWP	kg CO2e	74%	8%	18%	100%
Depletion potential of the stratospheric ozone layer	ODP	kg CFC11e	79%	0%	20%	100%
Acidification potential of soil and water sources	AP	kg SO2e	94%	3%	3%	100%
Eutrophication potential	EP	kg Ne	82%	1%	17%	100%
Formation potential of tropospheric ozone	SFP	kg O3e	95%	3%	2%	100%
Abiotic depletion potential (ADPfossil) for fossil resources;	ADPf	MJ, NCV	75%	6%	19%	100%
Fossil fuel depletion	FFD	MJ Surplus	74%	7%	19%	100%
Renewable primary energy carrier used as energy	RPRE	MJ, NCV	91%	0%	9%	100%
Renewable primary energy carrier used as material	RPRM	MJ, NCV	100%	0%	0%	100%
Non-renewable primary energy carrier used as energy	NRPRE	MJ, NCV	79%	5%	16%	100%
Non-renewable primary energy carrier used as material	NRPRM	MJ, NCV				
Secondary material	SM	kg				
Renewable secondary fuel	RSF	MJ, NCV				
Non-renewable secondary fuel	NRSF	MJ, NCV				
Recovered energy	RE	MJ, NCV				
Consumption of freshwater resources;	FW	m3	83.93%	0.12%	15.94%	100.00%
Hazardous waste disposed	HWD	kg	78.18%	0.01%	21.80%	100%
Non-hazardous waste disposed	NHWD	kg	80.15%	3.91%	15.94%	100%
High-level radioactive waste, conditioned, to final repository	HLRW	kg or m3				
Intermediate- and low-level radioactive waste, conditioned, to final repository	ILLRW	kg or m3				
Components for re-use	CRU	kg				
Materials for recycling	MR	kg				
Materials for energy recovery	MER	kg				
Recovered energy exported from the product system	EE	MJ, NCV				

Table 17 Cradle-to-gate PNW I-joists LCIA energy use contribution analysis results by fuel type for A1-Resource extraction, A2-Transportation, and A3-Laminated veneer production

	Unit per m	Total	A1	A2	A3
Non-renewable, fossil	MJ	100%	74.96%	6.10%	18.94%
Non-renewable, nuclear	MJ	100%	92.56%	0.29%	7.14%
Non-renewable, biomass	MJ	100%	7.53%	0.00%	92.47%
Renewable, biomass	MJ	100%	92.61%	0.00%	7.38%
Renewable, wind, solar, geothermal	MJ	100%	69.75%	0.18%	30.07%
Renewable, water	MJ	100%	71.12%	0.23%	28.66%

Table 18 Cradle-to-gate PNW I-joists LCIA energy use contribution analysis results by A1-Resource extraction, A2-Transportation, and A3- Laminated veneer production

	Unit per m	Total	A1	A2	A3
Non-renewable, fossil	MJ	50.78%	45.83%	98.36%	69.78%
Non-renewable, nuclear	MJ	15.23%	16.97%	1.43%	7.89%
Non-renewable, biomass	MJ	0.00%	0.00%	0.00%	0.00%
Renewable, biomass	MJ	31.37%	34.98%	0.04%	16.80%
Renewable, wind, solar, geothermal	MJ	0.87%	0.73%	0.05%	1.89%
Renewable, water	MJ	1.75%	1.50%	0.13%	3.64%
		100%	100%	100%	100%

7.3 Uncertainty Analysis

Some degree of uncertainty is present in the results due to the variation amongst different data providers. Tables 18-21 provides statistics for some of the key modeling parameters found to be most significant in I-joists production.

Table 19 Survey data statistics for Selected Parameters, mass balance. One linear meter of I-joist, PNW

	Weighted average (OD kg)	Mean	Min.	Max.	Mass (%)	CoVw[a] (%)
Feedstocks			Inputs			
LVL	2.3180	1.8120	0.3820	3.1250	48.6	57.7
OSB	1.5830	1.5760	1.4970	1.6380	33.2	3.6
FJL	0.8470	1.3800	-	2.6330	17.8	156.6
Total feedstock	4.7480	4.7690	4.5120	5.0750	99.5	4.7
Resin system				-		
PRF resin	0.0157	0.0130	0.0094	0.0199	0.3	39.9
Hardener	0.0090	0.0050	-	0.0151	0.2	
Catalyst	0.0020	0.0032	-	0.0061	0.0	156.6
Total resin	0.0250	0.0210	0.0130	0.0350	0.5	47.1
Total inputs	4.7720	4.7900	4.5250	5.0900	100	
Products			Outputs			
I-joist	4.3970	4.3390	3.8840	4.6400	92.3	7.5
Coproducts				-		
Sawdust, sold	0.3630	0.4800	0.1750	0.9220	7.61	99
Panel trim, sold	0.0020	0.0010	-	0.0040	0.05	
Rejects	0.0100	0.0160	-	0.0480	0.21	
Total coproducts	0.3750	0.4810	0.1790	0.9220	7.86	98
Total outputs	4.7720	4.8370	4.6730	4.9830	100.0	

[a] Production weight-averaged coefficient of variation.

Table 20 Survey data statistics for Selected Parameters, on-site energy use. One linear meter of I-joist, PNW

Energy inputs	Weighted average	Unit	Mean	Min.	Max.	CoVw [a] (%)
Electricity	0.3780	kWh	0.4330	0.2920	0.5540	0.4330
Natural gas	0.0364	m^3	0.0367	0.0173	0.0562	0.0367
Diesel	0.0030	L	0.0038	0.0016	0.0063	0.0038
Propane	0.0039	L	0.0039	0.0036	0.0041	0.0039
Gasoline	0.0001	L	0.0001	-	0.0003	0.0001

[a] Production-weighted coefficient of variation.

7.4 Completeness, consistency and sensitivity

Evaluating the LCAs completeness, sensitivity, and consistency offers confidence in and reliability of the LCA results. The completeness check process verifies whether information from the life-cycle phases of an LCA are sufficient for reaching the goals and scope and conclusions of the study and making sound interpretations of the results. Three life-cycle stages (forestry operations, wood material production, and I-joists production) were checked for data completeness including all input elements such as raw and ancillary materials input, energy input, transportation scenarios, water consumption, and outputs such as products and coproducts, emissions to air, water, and land, and final waste disposals. All input and output data were found to be complete, and no data gaps were identified.

The consistency check process verifies that the assumptions, methods, and data are consistently applied throughout the study and are in accordance with the goal and scope of the LCA. A comprehensive review process was completed for this LCA to make certain consistency was applied to the assumptions made, methods used, models, data quality including data sources, data accuracy, age, time-related coverage, technology, and geographical coverage.

Sensitivity analysis can be applied to the LCA to determine changes in results caused by variations in assumptions, methods, and data. Sensitivity analysis is a systematic approach for estimating the effects of the choices made concerning methods and data on the outcome of a study. Sensitivity analysis is a key component of data quality analysis and can be applied to quantify the impact of changes in assumptions or input data on study results. A sensitivity analysis was completed per ISO standards (ISO 2006a, 2006b) to model the effects of natural consumption and electricity consumption for I-joists production. Sensitivity analysis can be useful to understand how various process parameters contribute to environmental output factors.

During I-joists manufacturing, natural gas is used for curing resin. Changing the consumption of natural gas may have a significant effect on CPEC and GHG emissions. Lower (-20%) and higher (+20%) natural gas consumptions were selected to compare with the baseline fuel mix developed from the mill survey data. Although the usage changed by 20 percent, the outcomes changed less than 1 percent for both GHG emissions and CPEC (Table 20).

Table 21 Key parameters on changing natural gas consumption during I-joists production.

Parameter	Unit	Low (-20%)	Surveyed (0%)	High (+20%)
		Values		
GHG emissions	kg CO_2e	2.0830	2.0990	2.1160
CPEC	GJ	0.0673	0.0676	0.0679

However, changing electricity consumption by 20 percent affects the outcomes less than 2 percent for both GHG emissions and CPEC(Table 21).

Table 22 Key parameters on changing electricity consumption during I-joists production.

Parameter	Unit per m	Low (-20%)	Surveyed	High (+20%)
		Values		
GHG emissions	kg CO_2e	2.0600	2.0990	2.1380
CPEC	GJ	0.0669	0.0676	0.0683

7.5 Limitations

This LCA was created using industry average data for upstream materials. Variation can result from differences in supplier locations, manufacturing processes, manufacturing efficiency and fuel type used. This LCA does not report all of the environmental impacts due to manufacturing of the product, but rather reports the environmental impacts for those categories with established LCA-based methods to track and report. Unreported environmental impacts include (but are not limited to) factors attributable to human health, land use change, and habitat destruction. In order to assess the local impacts of product manufacturing, additional analysis is required.

This LCA report documents the results of a 'cradle-to-gate' analysis and is not a comparative assertion, defined as an environmental claim regarding the superiority or equivalence of one product versus a competing product that performs the same function. This LCA does not make any statements that the product covered by the LCA is better or worse than any other product.

8 Treatment of Biogenic Carbon

The treatment of biogenic carbon in this LCA follows the requirements set out in the reference PCR. Reporting of biogenic carbon removals and emissions is reported in as per ISO 21930 standard (ISO 2017). When biogenic carbon enters the product system it is characterized in the impact assessment with a factor of -1 kg CO_2 eq. During production, biogenic carbon emissions (CO_2) are released through the combustion of biomass fuels in boilers. As per ISO 21930, when biogenic carbon leaves the product system as CO_2 emission it has a factor of +1 kg CO_2 eq. When any wood material (product and coproducts) that contain biogenic carbon leaves the system boundary, it must be expressed with a factor of +1 kg CO_2 eq.

Forests are understood as a natural system with multiple functions, the production function of timber being one of them. Therefore, natural growth and decay processes including natural disturbances, etc., are not attributable to the production function of forests and are therefore not considered in LCA. Harvesting operations lead to temporal decreases in forest carbon pools in the respective stand. Impacts on forest carbon pools resulting from the sustainable or unsustainable management of forests, however, cannot be defined or assessed on stand level but requires the consideration of carbon pool changes on landscape level, i.e., the level based on which management decisions are made. Resulting from the fundamental principle of sustainable forest management to preserve the production function of forest, total forest carbon pools can be considered stable (or increasing) under sustainable forest management. This is due to the fact that temporal decreases of forest carbon pools resulting from harvesting on one site are compensated by increases of carbon pools on the other sites, forming together the forest area under sustainable forest management.

It is acknowledged that excessive extraction of slash, litter or roots for the purpose of bioenergy generation can lead to decreases in forest carbon pools. These activities, however, are not causally linked to the extraction of timber for the material use of wood. Effects on forest carbon pools related to the extraction of slash, litter or roots are not attributable to the material use of wood and are therefore not considered in this document.

In order to reflect the biogenic nature of wood, its renewability and its potential carbon neutrality, the system boundary between nature and the product system under study is defined as follows:

- Wood entering the product system from nature accounts for the energy content and the biogenic carbon content as material inherent properties.
- All technical processes related to forestry operations intended to produce timber, (e.g. stand establishment, tending, thinning(s), harvesting, establishment and maintenance of forest roads) are considered within the system boundary and are subject to co-product allocations as outlined in the reference PCR.
- Potential implications due to the unknown origin of wood or unsustainably produced timber are considered.
- Human induced impacts on forest carbon pools resulting in deforestation are included.

As the degradation of forest carbon pools resulting from unsustainable management of forests cannot be attributed to a specific log but is a process on landscape level, the effect of forest degradation is considered by not assuming carbon neutrality. In the case of land-use changes from forests to other land uses (e.g., deforestation), the loss of carbon in the forest carbon pools are to be considered.

Consideration of the biogenic carbon neutrality of wood is valid for North American wood products as national level inventory reporting shows overall increasing and/or neutral forest carbon stocks in recent years[3].

Using the method described above, -9.59 kg CO_2e (A1) were removed in the production of 1 m of PNW I-joists. One meter of PNW I-joists stores 2.20 kg of carbon or +8.06 kg CO_2e (C3/C4). The coproducts produced during I-joists production account for an additional +0.61 kg CO_2e (A3) for a total "emission" in wood product leaving the system boundary of +8.67 kg CO_2e. The combustion of wood fuel emitted 0.91 kg CO_2e (mostly in A1). Packaging resulting in removal of -0.038 kg CO_2e) and an emission of +0.044 kg CO_2e (A5). In summary, total removals was -9.59 kg/m CO_2e and total "emissions" was +9.59 kg/m CO_2e from cradle-to-gate (A1-A3) (Table 22). In Table 22, CO_2 flows are presented unallocated to consider co-products leaving the product system (A3). In accordance with ISO 21930, emission from packaging (BCEK) is reported in A5 and emission from main product is reported in C3/C4. The system boundary for this LCA only includes module A1-A3.

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[3] National forest carbon stocks are reported under the United Nations Framework Convention on Climate Change. See Table 7.1 for United States forest carbon stocks and Table 7.1 for Canadian forest carbon stocks. Canadian forest carbon stocks have fluctuated near net neutrality in recent years (ranging from -98 Tg to +69 Tg since 1990) while United States forest carbon stocks have shown annual stock increases of 600-900 Tg annually since 1990.

Table 23 Biogenic carbon inventory parameters. One linear meter of I-Joist, PNW

Additional Inventory Parameters		A1	A2	A3	A5	C3/C4	Total
	kg CO2e/m						
Biogenic Carbon Removal from Product	BCRP	(9.5856)					(9.5856)
Biogenic Carbon Emission from Product	BCEP			0.6120		8.0612	8.6732
Biogenic Carbon Removal from Packaging	BCRK			(0.0383)			(0.0383)
Biogenic Carbon Emission from Packaging	BCEK				0.0429		0.0429
Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production	BCEW	0.8640		0.0438			0.9078

9 Discussion

In 2013 CORRIM updated Wilson and Dancer (2004) to reflect updates in electricity grids and wood boilers (Puettmann et al. 2013). At that time, an LCIA was also conducted using the LCI data developed by Wilson and Dancer (2004). The updates were necessary to comply with the 2015 PCR for North American Structural Wood Products so an EPD on North American I-joists could be produced (https://awc.org/pdf/greenbuilding/epd/AWC-EPD-IJoists-190328.pdf). This current study conducted new mill surveys and reported results based on the 2019 PCR (UL 2019) (Bergman and Alanya-Rosenbaum, 2016b).

As noted earlier, total energy for producing 1 meter of I-joists from the PNW region was 77.04 MJ, 55 percent higher than (49.73) MJ/m from Puettmann et al. (2013). The 2013 report that only updated to include an LCIA and updates electricity grid mix and wood boiler data. This current study updated the full gate-to-gate LCI data for I-joists production based on new surveys to industry. Other changes between the two LCA's is the use of lower and higher heating values. The current study uses LHV. The 2013 study determined total energy use by calculating from the fuel raw material extraction. The current study uses a more complete capture of fuel resource use by using the Cumulative Energy Demand Method (CED).

Table 23 shows the changes between the 2013 updated LCA and the current LCA. Global warming impacts increased by 51 percent, while eutrophication increased by over 1100 percent and water use by 664 percent (Table 23). These differences can be attributed to differences in reporting requirements, LCIA methodologies, and LCI accounting methods, as well as better reporting by industry and better representation of the regional industry as a whole. Other measurements in material use also changed primarily because of requirement changes in reporting details between the previous PCR (FPInnovations 2015) and the current PCR (UL 2019) under which this report conforms too.

Table 24 LCIA comparison between updated 2013 data (based on 2007 industry surveys) and current study data (based on 2012 industry surveys) on I-joists production in the PNW

Impact category	Unit	Current Study	Past Study 2013
Global warming potential	kg CO_2 eq	2.3473	1.5578
Eutrophication Potential	kg N eq	0.0091	0.0007
Smog Potential	kg O_3 eq	1.0584	0.2532
Non-renewable fossil	MJ	39.1222	27.3080
Non-renewable nuclear	MJ	11.7297	2.6640
Renewable (solar, wind, hydroelectric, and geothermal)	MJ	2.0158	0.8610
Renewable, biomass	MJ	24.1708	18.8940
Fresh water	L	13.6234	1.7830
Solid waste (hazardous and non-hazardous)	kg	0.3705	0.2341

10 Conclusions

The cradle to gate LCA for PNW I-joists includes the LCI of forest resources and veneer production and the LCI of I-joists manufacturing that relies on primary survey data. The survey results were representative operations in the PNW region that would produce structural I-joists panels. The survey data are representative of the I-joists types and production volumes consistent with trade association production data.

Emissions from the forest resources LCI are small relative to manufacturing emissions. While other processes such as resin and veneer production that are listed in the A1 life cycle stage contribute significantly to the cradle-to-gate impacts. At the I-joists production facilities emissions to land and water are very small. Mill site airborne emissions originate mainly at presses and particulates from sawing and trimming operations.

Composite I-joist production (A3) consumed only 14 percent of the total energy with 83 percent from resin, feedstock materials, and forest operations and <1 percent to transport. Energy generated by renewable fuels, such as woody biomass, represents about 17 percent of the total energy from cradle to gate.

11 Critical review

11.1 Internal Review

The purpose of the LCA Report internal review is to check for errors and conformance with the PCR prior to submittal to for external review. The technical and editorial comments of the reviewers were carefully considered and, in most instances, incorporated into the final document. CORRIM addressed the internal review comments, as appropriate, and maintains a record of all comments and responses for future reference.

11.2 External Review

The external review process is intended to ensure consistency between the completed LCA and the principals and requirements of the International Standards on LCA (ISO 2006) and ISO 21930 - Sustainability in Buildings and Civil Engineering Works - Core Rules for Environmental Product Declarations of Construction Products and Services (ISO 2017), the Product Category Rules for North American Structural and Architectural Wood Products Part B (UL 2019) and Part A: Life Cycle Assessment Calculations Rules and Report Requirements (UL 2018).

Following CORRIM's internal review evaluation, documents were submitted to UL Environment (UL) for independent external review. The independent external review was conducted by Thomas Gloria, Ph.D., Industrial Ecology Consultants, LCACP ID: 2008-03.

12 Acknowledgements

Primary funding for this project was through a cooperative agreement between the USDA Forest Service Forest Products Laboratory and the Consortium for Research on Renewable Industrial Materials (13-CO-11111137-014). We especially thank those companies and their employees that participated in the surveys to obtain production data. In addition, this research was supported in part by an appointment to the US Forest Service Research Participation Program administered by the Oak Ridge Institute for Science and Education (ORISE) through an interagency agreement between the US Department of Energy and the US Department of Agriculture Forest Service. ORISE is managed by Oak Ridge Associated Universities (ORAU) under DOE contract number DE-AC05-06OR23100. All opinions expressed in this report are the authors' and do not necessarily reflect the policies and views of USDA, DOE, or ORAU–ORISE.The

LCIA work for this updated report to conform with the new PCR (UL 2019) was funded by the American Wood Council and the Canadian Wood Council through CORRIM.

13 Units and Conversions

Table 25 Wood conversion in developing the laminated veneer lumber

To convert from	to	multiply by
Cubic feet (ft3)	Cubic meters (m3)	0.02831685
Pounds (avdp) (lb)	Kilograms (kg)	0.4535924
Cubic inches (in^3)	Cubic centimeters (cm^3)	16.393
Btu's	Joules (J)	1054
Cubic yards (yd^3)	Cubic meters (m^3)	0.7645549
Kilometers	Meters (m)	0.001
Feet (ft)	Meters (m)	0.305
Gallons (US) (gal)	Liters (L)	3.785
Kilowatt-hours (kWh)	Megajoules (MJ)	3.6
Miles (mi)	Kilometers (km)	1.609
Ounces (avdp) (oz)	Kilograms (kg)	0.028
Square feet (ft^2)	Square meters (m^2)	0.093
Tons (short)	Kilograms (kg)	907.185
Tons (short)	Metric tons (t)	0.9071847
Pounds (lb)	Metric tons (t)	0.0004
Watts (W)	Joules/second (J/s)	1
Yards (yd)	Meters (m)	0.914
Acres (a)	Hectares (ha)	0.405

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15 Appendix 1 Conformance to North American Structural and Architectural Wood Product Category Rules

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Review of LCA Studies of Conformance to North American Structural and Architectural Wood Product Category Rules

March 27, 2020

Introduction

Underwriters Laboratory Environment (ULE) commissioned a life cycle assessment (LCA) expert to perform a verification of supporting LCAs to be used as the basis for Environmental Product Declarations (EPDs) for North American Structural and Architectural Wood products (UN CPC 31 and NAICS 321).

The review was conducted by:

Thomas P. Gloria, Ph.D., LCACP
Managing Director, Industrial Ecology Consultants
Director, Sustainability Programs, Harvard University Division of Continuing Education

This document identifies the LCA studies under review and summarizes the review objectives and the results of revisions made based on a first pass of the review.

LCA Studies Reviewed

The LCA studies reviewed include the following:

LCA Study Title	Practitioner	Date
LCA for the Production of Inland Northwest Softwood Lumber	CORRIM	March 2020
LCA for the Production of Northeast – Northcentral Softwood Lumber	CORRIM	March 2020
LCA for the Production of Oriented Strandboard Production	CORRIM	March 2020
LCA for the Production of Pacific Northwest Glued Laminated Timbers	CORRIM	March 2020
LCA for the Production of Pacific Northwest Engineered I-Joist,	CORRIM	March 2020
LCA for the Production of Pacific Northwest Softwood Lumber	CORRIM	March 2020
LCA for the Production of Pacific Northwest Laminated Veneer Lumber	CORRIM	March 2020
LCA for the Production of Pacific Northwest Softwood Plywood	CORRIM	March 2020
LCA for the Production of Southeast Glued Laminated Timbers	CORRIM	March 2020
LCA for the Production of Southeastern Engineered I-Joist	CORRIM	March 2020
LCA for the Production of Southeastern Softwood Lumber	CORRIM	March 2020
LCA for the Production of Southeast Laminated Veneer Lumber	CORRIM	March 2020
LCA for the Production of Southeast Softwood Plywood	CORRIM	March 2020
A C-to-G LCA of Canadian Glulam	Athena	March 2020
A C-to-G LCA of Canadian Wood I-Joists	Athena	March 2020
A C-to-G LCA of Canadian Surfaced Dry Softwood Lumber	Athena	March 2020
A C-to-G LCA of Canadian Laminated Veneer Lumber (LVL)	Athena	March 2020
A C-to-G LCA of Canadian Oriented Strandboard (OSB)	Athena	March 2020
A C-to-G LCA of Canadian Plywood	Athena	March 2020

Critical Review Objectives

The reviewer reviewed the LCA studies for conformance to the following applicable documents regarding the ability to support Business to Business (BtB) EPDs:

- ISO 14044:2006, Environmental management - Life cycle assessment - Requirements and guidelines;
- ISO 14040:2006, Environmental management - Life cycle assessment - Principles and framework;
- ISO 14025:2006, Environmental labeling and declarations - Type III environmental declarations - Principles and procedures;
- ISO 21930:2017, Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services.

- UL Environment: PCR for Building-Related Products and Services - Part A: Calculation Rules for the LCA and Requirements, v.3.2, December 2018.
- UL Environment: Part B: Structural and Architectural Wood Products EPD Requirements UL 10010-9 v.1.0. September 2018.

Review Results
A first pass review was performed, revisions were made by the LCA practitioners, Athena Sustainable Materials Institute (Athena) and the Consortium for Research on Renewable Industrial Materials (CORRIM). The documents listed above were reviewed against the general requirements for conformance:

- Are methods used to carry out the LCA were consistent with ISO 14040/14044 standards?
- Are methods used to carry out the LCA were scientifically and technically valid?
- Are data used were appropriate and reasonable in relation to the goal of the study?
- Do interpretations reflected the limitations identified and the goal of the study?
- Was the study report transparent and consistent?

Summary
On the basis of the objectives set forth to review the aforementioned LCA studies, **the reviewer concludes that all studies conform to the applicable standards.** The reviewer greatly appreciates the responsiveness and cooperation of all parties involved in the review process.

Respectfully,

Thomas P. Gloria, Ph.D., Newton, Massachusetts

16 Appendix 2 Original LCA Report

CRADLE-TO-GATE LIFE-CYCLE ASSESSMENT OF COMPOSITE I-JOISTS PRODUCED IN THE PACIFIC NORTHWEST REGION OF THE UNITED STATES

CORRIM FINAL REPORT

Module F1

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April 2017

Information contained in this report is based on new survey data (2012) and supersedes information in the original Phase I report (Wilson and Dancer 2004). This report is a cradle to gate LCA and includes all forestry related upstream processes and packaging of final product. CORRIM REPORT - Life Cycle Assessment of I-joist Production has not been certified but is written in compliance to the Product Category Rules North American Structural and Architectural Wood Products (June 2015) and can serve as a LCA for an Environmental Product Declaration.

1 EXECUTIVE SUMMARY

1.1 Study Goals

The goal of this study was to update life-cycle assessment (LCA) data associated with I-joist production in the Pacific Northwest (PNW) region of the United States from cradle-to-gate mill output. The authors collected primary mill data from I-joist production facilities per Consortium on Research for Renewable Industrial Materials (CORRIM) research guidelines. Comparative assertions were not a goal of this study.

1.2 Method

The authors collected primary mill data through a survey questionnaire mailed to I-joist manufacturing plants along with a site visit. This survey tracked raw material inputs (including energy), product and coproduct outputs, and pertinent emissions to water and air as well as solid waste generation. The study incorporated an industry-standard production unit to a metric production unit, one thousand linear meter (km) (i.e. declared unit). At I-joist production facilities, finger-jointed lumber (FJL) and laminated veneer lumber (LVL) production often occurred simultaneously, and if so, for the surveyed facilities, primary data were collected for these associated processes too. Secondary data, such as pre-I-joist production gate processes (e.g. forestry operations and oriented strandboard (OSB) production and electricity production), were from peer-reviewed literature per CORRIM guidelines, public databases, or other life-cycle inventory (LCI) studies completed concurrently. With primary and secondary data, material and energy balances were calculated. With these material and energy data, the LCA was constructed to conform with internationally accepted standards, whereas the LCI flows and life-cycle impact assessment (LCIA) results were generated using LCA modeling software populated by the US LCI Database. The study based all allocations on the mass of the products and coproducts. The LCIA was performed using the Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) 2 method. The following five TRACI impact categories were examined: global warming potential (GWP (kg CO_2-eq)), acidification (kg SO_2-eq), eutrophication (kg N-eq), ozone depletion (kg chlorofluorocarbons-11-eq), and photochemical smog (kg NOx-eq). Primary energy consumption, material resources consumption, and waste generation were also looked at.

1.3 Life-Cycle Inventory

Cradle-to-gate LCI flows for composite I-joist manufacturing were presented by five life stages, (1) forestry operations, (2) OSB production, (3) FJL production, (4) LVL production, and (5) I-joist production. In terms of energy use, LVL production consumed the most primary energy, followed by I-joist, OSB, and FJL production, respectively, with minor consumption from forestry operations. Emission data produced through modeling found that total estimated fossil and biomass carbon dioxide (CO_2) emissions were 1,929 and 2,166 kg/km for the PNW. I-joist production was modeled as a single unit process (i.e. black box) because the final product by mass was made up of about 92% products and the remainder were coproducts.

The amount and type of energy used during production of building materials such as I-joists are important to the products' holistic environmental impacts. Total cumulative primary energy consumption (CPEC) for cradle-to-gate production of PNW I-joists was 67.6 GJ/km. Use of renewable energy in manufacturing I-joists was substantial. Renewable biomass, by far the largest renewable energy source, represented about 39.2% of the total CPEC for all stages of production. Energy consumed during phenol-resorcinol formaldehyde (PRF) resin production along with the additives of the resin system was included in the fossil fuel use for I-joists as an upstream process. In summary, to produce 1 km of PNW I-joists from cradle-to-gate, 39.2% of the cumulative energy was from biomass (wood fuel) and 54% from nonrenewable fossil fuels, leaving a small portion of energy needs coming from nuclear (4.7%) and the remaining 1.8% from hydro, wind, solar, and geothermal sources.

1.4 Life-Cycle Impact Assessment

Environmental performance results were provided for the five impact categories (global warming (GW), acidification, eutrophication, ozone depletion, and smog), energy consumption from nonrenewable, renewable (wind, hydro, solar, and geothermal), and nuclear fuels, renewable and nonrenewable resource consumption, and solid waste generation. Environmental impacts from the five previously listed categories associated with I-joist production were small compared with the impacts associated with LVL production, which included its upstream production impacts.

1.5 Interpretation

Emissions from the forest resources LCI are small relative to manufacturing emissions (OSB, LVL, FJL, and I-joists). At the I-joist production facility, emissions mainly originate from heat production, during resin curing. Boiler emissions released were a function of the fuel burned, whereas other emissions were a function of the unit process and associated emission control device.

Cradle-to-gate LCI results showed that 1,929 kg fossil CO_2 were released in the production of 1 km of PNW I-joist. Composite I-joists are primarily made of wood and thus store carbon. Carbon content for wood products is assumed to be 50% by mass of oven-dried (OD) wood. Excluding the resin system, the carbon stored in the wood portion of 1.0 km of I-joist on a production-weighted average is equivalent to 7,255 kg CO_2 emissions if left to decay.

Data quality was high. For surveyed mills, a mass balance was performed to verify data quality. Inputs and outputs were consistent for the three surveyed mills on a cubic meter basis. In addition, total wood mass in and total wood mass out was calculated. Difference for overall wood mass was less than 2%. A difference less than 10% is considered good.

The authors compared energy inputs from the current 2012 study to the earlier CORRIM Phase I study on gate-to-gate I-joist production to show how CPEC was affected. About a 53% increase in CPEC was observed compared with the Phase I study for the PNW region. For both studies, energy generated by woody biomass and fossil fuels constituted the majority of the total energy consumed. However, with that being said, no statistical analysis was conducted on the earlier data and different companies provided the primary data for 2000. Therefore, only speculation can made on the apparent differences. In this study, the weighted coefficient of variation representing the variability in the collected process data was calculated and is presented. In addition, in this study, a sensitivity analysis was performed investigating the impact of the variation of energy inputs into I-joist production to the overall output.

1.6 Sensitivity Analysis

A sensitivity analysis was completed per the International Organization for Standardization (ISO) 14040 standards to model the effects of natural gas consumption and electricity consumption for I-joist production. The five environmental impacts from energy to produce I-joists overall were small compared with the energy impacts associated with LVL production. Therefore, for the I-joist production life-cycle stage, neither natural gas nor electrical consumption on site had a substantial impact on the overall process.

1.7 Key Findings

The results of this study were compared with the earlier CORRIM study on life-cycle evaluation of I-joist manufacturing in the United States. This study found CPEC to be substantially higher (about 53%) for the PNW compared with the earlier CORRIM study. This may be the result of increased use of emission control devices because of increased regulatory controls in the United States since the 2000s, particularly at LVL production facilities. Adoption of emission control devices outside of baghouses results in higher energy consumption, and this may explain the lower energy use in Phase I survey data. Although the contribution of forest operations contributed only 2.5% of the CPEC in this study, it should be noted that the previous CORRIM study did not include energy use resulting from forest operations.

2 ACKNOWLEDGMENT

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3 BACKGROUND

The Consortium for Research on Renewable Industrial Materials has derived LCI data for major wood products and wood production regions in the United States. The LCI data cover forest regeneration through the final product at the mill output gate. Research has covered nine major forest products, including both structural and nonstructural uses and four major regions. This report focuses on industry-average composite I-joist production in the PNW region of the United States (Wilson and Dancer 2004a). Life-cycle inventory data are then used to quantify LCIA. This study updates the cradle-to-gate manufacturing LCIA data for I-joists for the PNW. To ensure comparability and consistency, treatment of biogenic carbon was taken from the Norwegian Solid Wood Product Product Category Rules (PCR) (Aasestad 2008) and the PCR for North American Structural and Architectural Wood Products (FPInnovations 2015). This report does not include any comparative assertions. Using the LCIA outcomes, APA – The Engineered Wood Association and its members can explore potential process and parameter improvements internally and new conversion technologies along with the identification of environmental 'hotspots'. Life-cycle assessment practitioners can use the data for their studies, and product customers can use the data (perhaps in the eventual form of an environmental product declaration (EPD)) to assist in product selection along with building specifiers looking for green building products with documentation. This LCA is in conformance with the PCR for North American Structural and Architectural Wood Products (FPInnovations 2015) and the ISO 14040/14044 standards (ISO 2006a, 2006b). This report follows data and reporting requirements as outlined in the PCR and contains the LCA components for producing a North American EPD including economic allocation for producing 1 km of composite I-joists in the PNW (ISO 2006c; FPInnovations 2015).

4 INTRODUCTION

Documenting the environmental performance of building products is becoming widespread because of many green marketing claims made without scientific merit (i.e. green washing). Developing EPDs for building products is one way to accomplish scientific documentation and to counter green washing (ISO 2006c; Bergman and Taylor 2011). In addition, developing wood product LCI data helps construct product LCAs that are then incorporated into developing whole-building LCAs for environmental footprint software such as the Athena Impact Estimator for Buildings (ASMI, 2016). Conducting whole-building LCAs provide points that go toward green building certification in rating systems such as LEED v4, Green Globes, and the ICC-700 National Green Building Standard (Ritter et al. 2011). This study can be categorized as a cradle-to-gate LCA and includes forestry operations to manufacturing of OSB, LVL, FJL, and finally composite I-joists ready to be shipped out from the mill gate.

4.1 Life-Cycle Assessment

Life-cycle assessment is an internationally accepted method to analyze complex environmental impacts of a product or process. It is intended to be an objective and holistic examination of a product that identifies and quantifies energy and materials used and emissions and wastes released to the environment and assesses the impact of those energy and material uses and releases on the environment. Life-cycle assessment studies can evaluate full product life cycles, often referred to as cradle-to-grave, or incorporate only a portion of the product life cycle, referred to as cradle-to-gate, or gate-to-gate.

As defined by ISO (ISO 2006a), LCA is a multiphase process consisting of a (1) goal and scope definition, (2) LCI, (3) LCIA, and (4) interpretation (Figure 1). These steps are interconnected, and their outcomes are based on goals of the study.

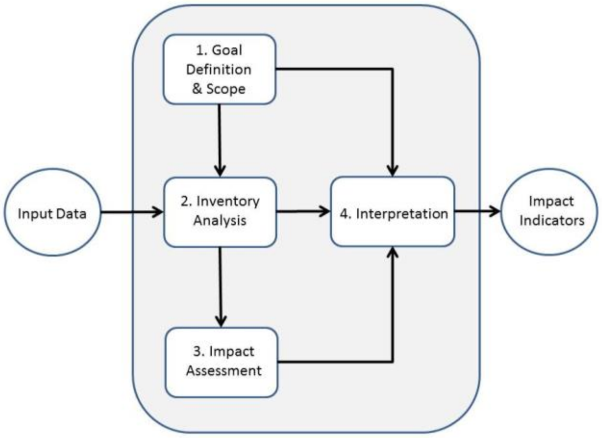

Figure 1. Steps involved in a life-cycle assessment (ISO 2006a).

The key component for conducting an LCA is the LCI step, which is the process of quantifying energy and raw material requirements, air emissions, waterborne effluents, solid waste, and other environmental releases occurring within system boundaries.

The LCIA process characterizes and assesses the effects of environmental releases identified in the LCI into impact categories such as global warming, acidification, carcinogenics, respiratory effects, eutrophication, ozone depletion, ecotoxicity, and smog. For assessing environmental impacts of I-joist production, the TRACI 2.0 impact method was used. The TRACI method is a midpoint-oriented LCIA method developed by the US Environmental Protection Agency (EPA) specifically for North America using input parameters consistent with US locations (Bare 2011). TRACI is available through the LCA software used for modeling the I-joist process (PRé Consultants 2016).

The life-cycle interpretation is the phase in which the findings of the LCI and/or the LCIA are evaluated in relation to the goal of the study to reach conclusions and recommendations. This final step in an LCA involves an investigation of significant environmental aspects (e.g. energy use and greenhouse gases), their contributions to the indicators under consideration, and which unit processes in the system they come from. For example, if the outcomes of an LCIA indicate a particularly high value for GWP, the analyst could refer to the inventory to determine which environmental flows are contributing to the high value and which unit processes those outputs are coming from.

4.2 Description of the Product

Many engineered structural wood products have been developed in the last several decades, e.g., I-joists, OSB, LVL, etc. (Figure 2). I-joists fall into the North American Industry Classification System (NAICS) Code 321213—engineered wood member (except truss) manufacturing, which includes other structural wood engineered products such as FJL, parallel strand lumber, and glued–laminated timbers (USCB 2012; ASTM 2014). A composite I-joist is comprised of a web made from a structural wood panel, usually OSB but sometimes plywood. The web is glued between two flanges that are sometimes made from solid-sawn lumber or FJL but more commonly from LVL (USEPA 2002; Wilson and Dancer 2004a, 2005a; Stark et al. 2010; ASTM 2014). Typical flange size depends on the material. For LVL, the common size is 1.75 by 1.5 in. (44.5 by 38.1 mm), and for lumber flanges, the size is nominal 2 by 3 –in. (50.8 by 76.2 mm). I-joists have an "I" shape and are measured in linear feet in the United States (Figure 2). There are many different dimensions of composite I-joists, but the most common are dimensions that directly replace 2 by 10 in. (50.8 by 254 mm) and 2 by 12 in. (50.8 by 304.8 mm) structural lumber

(Table 1). I-joists are usually made in continuous lengths and then cut to 60-ft (18.29-m) lengths for shipping.

This study focused on large-scale production facilities that are representative of the industry. Production values and study results were reported per linear kilometer with an assumed average depth of 30 cm as shown in Figure 2 (depth goes from the top to the bottom of the 'I'). I-joist depth varies notably, but large quantities of I-joists made in the United States have a depth of 30 cm. These engineered structural wood products are designed to be used in the same manner as solid wood products such as sawn lumber but with different properties. I-joists in the PNW region are primarily made with Douglas-fir (*Pseudotsuga menziesii*) flanges and Canadian aspen (*Populus tremuloides*) webs. For the LVL, the dry veneer comes from other softwood species besides Douglas-fir (*Pseudotsuga menziesii*) including white fir (*Abies concolor*), western hemlock (*Tsuga heterophylla*), lodgepole pine (*Pinus contorta*), and western larch (*Larix occidentalis*).

Production of I-joists is measured on a linear basis (feet, meters) with no measurement for the dimensions of height and width, which is the practice for the I-joist data given in this study. The most common dimensions of I-joists for the PNW can be found in Table 1. This LCA uses a weighted average for producing a generic I-joist (Table 1). This I-joist is slightly larger than you would expect to find in that region because of the small amount of waste and inefficiencies of producing the I-joists included in the product.

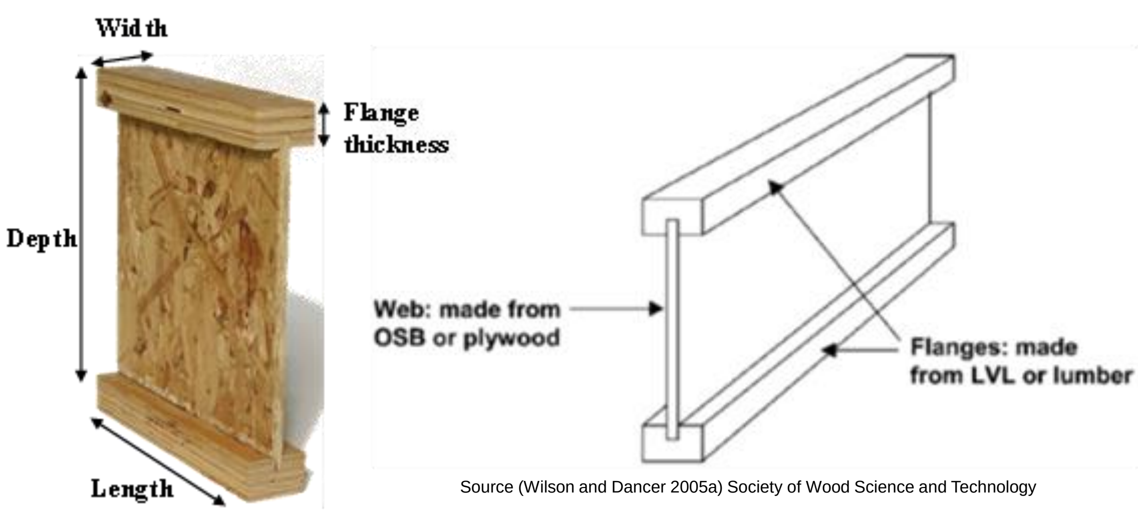

Figure 2. Typical composite I-joist made with laminated veneer lumber (LVL) flanges and an oriented strandboard (OSB) web.

Table 1. Common dimensions for composite I-joists.

Common I–joist dimensions					
Depth	Flange thickness	Width	Height	Flange thickness	Width
millimeters			inches		
241.30	33.34	44.45	9.50	1.31	1.75
301.75	38.10	44.45	11.88	1.50	1.75
301.75	38.10	38.10	11.88	1.50	1.50
301.63	79.38	38.10	11.88	3.13	1.50
Generic I-joists dimension					
298.45	33.34	47.75	11.75	1.31	1.88

5 METHODS

5.1 Goal

The goal of this study was to update the cradle-to-gate LCA of I-joist manufacturing for the PNW. The authors updated the gate-to-gate I-joist manufacturing LCI data developed by Wilson and Dancer (2005a) and developed FJL manufacturing LCI data from collected primary data and secondary data (Milota 2015; Puettmann and Wilson 2005) and linked them to available forest resource LCI data (Johnson et al. 2005; Puettmann et al. 2013) and OSB (Kaestner 2015; Puettmann et al. 2015) and LVL production LCI data (Bergman and Alanya-Rosenbaum 2016).

5.2 Scope

In accordance with ISO 14040 and 14044 standards (ISO 2006a, 2006b; ILCD 2010), the scope of this LCA study was to cover the life-cycle stages of I-joists from forest resource activities through OSB, LVL, and FJL production to the final product: I-joists ready for shipping from the plant. Impacts from OSB and LVL production were included in the analysis using LCI data developed from updating LVL for the PNW and OSB (Bergman and Alanya-Rosenbaum 2016; Kaestner 2015; Puettmann et al. 2015). Analyses included I-joist production CPEC and environmental impacts in several impact categories including GW.

5.2.1 Intended audience

The primary audience for the LCA report includes the American Wood Council, Canadian Wood Council, APA – The Engineered Wood Association, North American wood I-joist manufacturers, and other LCA practitioners.

5.2.2 Comparative assertions

The report does not include product use and end-of-life phases, which are required for comparative assertions relative to substitute products. If future comparative studies are intended and disclosed to the public, the LCA boundary would need to be expanded to include the use and end-of-life phases consistent with the ISO 14040/44:2006 (ISO 2006a) guidelines and principles and compliance with the Wood Products PCR (FPInnovations 2015). If the LCA is used to develop an EPD, internal and/or external critical review would be required.

5.2.3 Allocation procedure

Selecting an allocation approach is an important part of an LCA study. In this study, all primary energy and environmental outputs were assigned to various coproducts by mass allocation. The decision was based on the understanding that the wood residues were coproducts with a value rather than a waste material. In this study, economic allocation was performed in addition to mass allocation, because PCR suggest using economic allocation for a multi-output process when the difference in revenues is more than 10% (FPInnovations 2015) as it was for this study. The results of analysis using economic allocation are provided in Appendix C (Tables 28-33).

5.2.4 Functional and declared unit

In accordance with the PCR developed (FPInnovations 2015), the declared unit for I-joists was one kilometer. A declared unit is used in instances in which the function and the reference scenario for the whole life cycle of a wood building product cannot be stated (FPInnovations 2015). For conversion of units from the US I-joist industry measure, 1 km equals 3.281 thousand feet with an oven-dried moisture content of 6%. All input and output data were allocated to the declared unit of product based on the mass and economics of products and coproducts in accordance with ISO 14044 (ISO 2006b) and the North American Structural and Architectural Wood Products PCR (FPInnovations 2015). Because the analysis did not take the declared unit to the stage of being an installed building product, no service life was assigned.

5.2.5 System boundaries

The system boundary began with regeneration in the forest and ended with the final I-joist product. The system boundary included forest resource management activities such as site preparation and planting seedlings; fertilization and thinning on a subset of hectares; final harvest through transportation of roundwood to the primary breakdown facility; OSB, LVL, and FJL production; transportation to the I-joist facility if needed; and I-joist production (Figure 3). The I-joist production complex was modeled as a single unit approach representing all the steps necessary to make I-joists. Three main unit processes exist in manufacturing I-joists: (1) routing and shaping of web and flanges, (2) assembly of I-joists, and (3) sawing and curing with energy generation as an auxiliary process (USEPA 2002; Wilson and Dancer 2005a; Puettmann et al. 2013). A single unit (i.e. black box) approach was used to model the I-joist process because little wood left the system except as the final product and because of the relative simplicity of the I-joist manufacturing processes. This simply means all process inputs and outputs are grouped into one I-joist process.

Fuel resources used for the cradle-to-gate production of energy and electricity were included within the cumulative system boundary. Off-site emissions include those from grid electricity production; transportation of feedstock; OSB, LVL, and FJL production; transportation to the I-joist facility; and production of fuels off site and consumed both on and off site. Ancillary material consumption data such as motor oil, waxes, paint, and hydraulic fluid were included in the analysis.

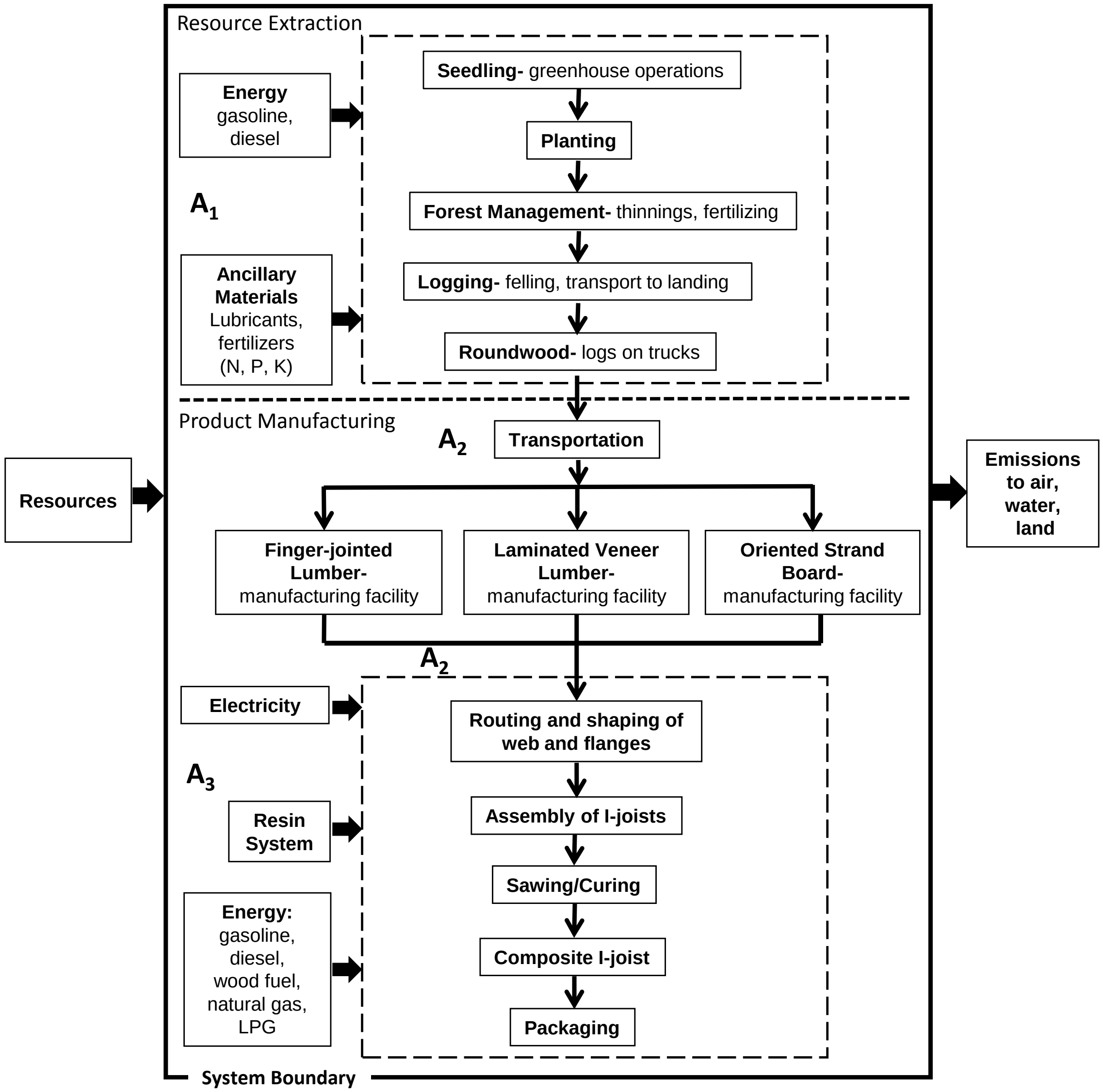

Figure 3. Cradle-to-gate system boundary and process flow for production of I-joists.

5.2.6 Cut-off rules

According to the PCR, if the mass/energy of a flow is less than 1% of the cumulative mass/energy of the model flow, it may be excluded, provided its environmental relevance is minor. This analysis included all energy and mass flows for the primary data collected.

In the primary surveys, manufacturers were asked to report total hazardous air pollutants (HAPs) specific to their wood products manufacturing process, regardless of whether they were less than the 1% cutoff. If applicable to the wood product, HAPs are reported later in the LCI data section and thus are not excluded from this LCI. Under Title III of the Clean Air Act Amendments of 1990, the EPA has designated HAPs that wood products facilities are required to report as surrogates for all HAPs. These are methanol, acetaldehyde, formaldehyde, propionaldehyde (propanal), acrolein, and phenol. All HAPS are included in the LCI (no cut-off rules apply). HAPS are reported in Chapter 8 and were included in the impact assessment. There were no cutoffs used in the impact assessment. Therefore, a complete list of all air emissions (smaller than 10^{-4}) is located in Appendix B (Table 27) of this report.

5.2.7 Data quality requirements

This study collected primary data from representative I-joist manufacturers in the PNW that use average technology for their regions. The raw wood material to produce I-joists comes produced in manufacturing facilities in the PNW in the form LVL and FJL. For OSB, U.S. manufacturing of this material is in the southeast. In the PNW, most I-joist production occurs in conjunction with production of LVL and FJL in the same engineered wood facility or nearby. For the surveyed mills in this study, all LVL and most FJL production occurred at the same site as I-joist production.

Total U.S. I-joist production for 2012 was 109 thousand km (358,900 thousand ft) (APA 2014). Three U.S. I-joist plants representing 30.7% of 2012 U.S. production, 33.6 thousand km (110,346.627 thousand ft) participated in the study by providing primary data for the PNW. The surveyed plants provided detailed annual production data on their facilities, including on-site energy consumption; electrical usage; LVL, OSB, and FJL volumes; and I-joist production for 2012. Wilson and Dancer (2005a) performed a 2000 U.S. I-joist LCI study that covered 33% (21.3 thousand km) of production in the PNW. Production from surveyed facilities for 2012 was an increase of 58%compared with 2000. In addition, unlike the earlier 2000 study, 2012 I-joist production data were not available by region. Therefore, production data by region could not be quantified for 2012.

5.2.8 Assumptions and limitations

All flow analyses of wood and bark in the process were determined on an oven-dry weight basis with a weighted-average green specific gravity of 0.55.

Although small in quantity by mass compared with the wood, impacts from production of the resin system were included in the analysis. Because of the small consumption values for sodium hydroxide, catalyst, and melamine components of the resin system, no transportation data were provided or incorporated into the analysis. However, impacts from cradle-to-gate production of the entire resin system were included in the analysis.

Oriented strandboard is not manufactured in the PNW. Therefore, this study used OSB manufacturing LCI data from Puettmann et al. (2015).

Melamine-urea-formaldehyde (MUF) resin was used as proxy for melamine-formaldehyde (MF) resin, which is used in the FJL production life-cycle stage.

5.2.9 Data collection

Primary data for the LCI were collected through surveys in accordance with CORRIM and ISO 14040 standards along with a site visit at a joint operating LVL/I-joist manufacturing facility. This study relied almost exclusively on production and emissions data provided by I-joist producers in the United States, with some secondary data on electrical grid inputs and resource forest activities from the U.S. LCI database (Goemans 2010; NREL 2012). The survey data represented I-joist production in terms of input materials, electricity and fuel use, and emissions for the 2012 production year. Three production facilities were surveyed and selected to be representative of PNW production practices. Questionnaires were used to survey the I-joist manufacturing processes to collect primary data (Appendix F). The primary data obtained from the surveys were weight-averaged using the formula shown in Milota (2004, Calculation Rules section).

Secondary data sources are shown in Table 2. All nonwood related LCI data came from the U.S. LCI Database (NREL 2012), whereas wood LCI data came from previous or concurrent CORRIM research.

Table 2. Secondary LCI data sources used.

Process	LCI data source	Publication date
Electricity	USLCI data for "Electricity, at Grid, WECC[a], 2008/RNA U"	2008
Diesel truck	USLCI data for "Transport, combination truck, diesel powered/US"	2008
Diesel locomotive	USLCI data for "Transport, train, diesel powered/US"	2008
Forestry and harvesting	CORRIM data for PNW softwood forestry operation; CORRIM data for SE softwood forestry operations	2005, 2010, updated 2013
LVL	CORRIM data for LVL production	2005, updated 2016
OSB	CORRIM data for OSB production	2005, updated 2016
Natural gas	USLCI data for "Natural gas, combusted in industrial boiler/US, Athena"	2008
Resin	CORRIM data resin production obtained from the USLCI	2009
Slack wax	CORRIM data for slack wax obtained from the USLCI	2004
Hardener	USLCI data for "Phenol-resorcinol-formaldehyde hardener, at plant/US"	2008
Gasoline	USLCI data for "Gasoline, combusted in equipment/US"	2008
Hydraulic fluid, lubricants, oil and grease	USLCI data for "Gasoline, at refinery/l/US" without combustion emissions.	2008
Plastic strapping/wrapping material	USLCI data for "Low density polyethylene resin, at plant/RNA[b]"	2008

[a]Western Electricity Coordinating Council
[b]North America

5.2.10 Calculation rules

I-joist production was reported in the surveys in linear feet. These data were converted to 1 kilometer and a weighted average based on production (Eq. 1). This approach resulted in an I-joist complex that represents a composite of the mills surveyed in the PNW but does not represent any mill in particular. The U.S. LCI database was used to assess off-site impacts associated with the materials and energy used. SimaPro, version 8+ (Pré Consultants 2016) was used as the accounting program to track all materials.

$$\bar{P}_{weighted} = \frac{\sum_{i=1}^{n} P_i x_i}{\sum_{i=1}^{n} x_i} \quad (1)$$

Where $\bar{P}_{weighted}$ is the weighted average of the values and is reported by *n* mills, P_i is the reported mill value, and x_i is the fraction of the mill's value to total production of the surveyed mills for that specific value. Because the surveyed mill data varied between facilities, a statistical analysis was conducted. In this study, the weighted coefficient of variation was calculated (NIST ITL 1996) (Eq. 3). The weighted coefficient of variation (CoV_w) is the weighted standard deviation (sd_w) (Eq. 2) divided by the weighted mean ($\bar{P}_{weighted}$) (Eq. 1):

$$CoV_W = \frac{sd_w}{\bar{P}_{weighted}} \tag{2}$$

$$sd_w = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \bar{x}_w)^2}{\frac{(N'-1)\sum_{i=1}^{N} w_i}{N'}}} \tag{3}$$

Where w_i was the weight of the i^{th} observation, N is the number of non-zero weights, and $\bar{x}_w$ is the weighted mean of the observations.

Missing data were defined as data not reported in surveys by the I-joist facilities. Whenever missing data occurred for survey items, they were checked with plant personnel to determine if it was an unknown value or zero. Missing data were carefully noted to ensure that they were not averaged as zeros. Any outliers were resolved by contacting mill personnel. A summary of conversion factors used in calculations can be found in Appendix A, Tables 24-26.

5.2.11 Life-cycle impact assessment method

The LCIA was performed using the TRACI 2 method (Bare 2011). Five impact categories were examined, including GW (kg CO_2-eq), acidification (kg SO_2-eq), eutrophication (kg N-eq), ozone depletion (kg chlorofluorocarbons-11-eq), and photochemical smog (kg NOx-eq).

The LCIA phase establishes links between the life-cycle inventory results and potential environmental impacts. The LCIA calculates impact indicators, such as GWP and smog. These impact indicators provide general, but quantifiable, indications of potential environmental impacts. The target impact indicator, the impact category, and means of characterizing the impacts are summarized in Table 3. The five impact categories reported were consistent with the requirement of the wood products PCR (FPInnovations 2015).

Table 3. Selected impact indicators, characterization models, and impact categories.

Impact indicator	Characterization model	Impact category
Greenhouse gas (GHG) emissions	Calculate total emissions in the reference unit of CO_2 equivalents for CO_2, methane, and nitrous oxide.	Global warming
Releases to air decreasing or thinning of ozone layer	Calculate the total ozone forming chemicals in the stratosphere including CFCs HCFCs, chlorine, and bromine. Ozone depletion values are measured in the reference units of CFC equivalents.	Ozone depletion
Releases to air potentially resulting in acid rain (acidification)	Calculate total hydrogen ion (SO_2) equivalent for released sulfur oxides, nitrogen oxides, hydrochloric acid, and ammonia. Acidification value of SO_2 mole- eq is used as a reference unit.	Acidification
Releases to air potentially resulting in smog	Calculate total substances that can be photo- chemically oxidized. Smog forming potential of O_3 is used as a reference unit.	Photochemical smog
Releases to air potentially resulting in eutrophication of water bodies	Calculate total substances that contain available nitrogen or phosphorus. Eutrophication potential of N-eq is used as a reference unit.	Eutrophication

Each impact indicator is a measure of an aspect of a potential impact. This LCIA does not make value judgments about the impact indicators, meaning that no single indicator is given more or less value than any of the others. Additionally, each impact indicator value is stated in units that are not comparable with others. For the same reasons, indicators should not be combined or added.

6 DETAILED DESCRIPTION OF DATA AND PROCESSES

6.1 Forestry Operations

Logs used in the production of I-joists include in their life cycle the upstream activities associated with establishment, growth, and harvest of trees. This group of activities is collectively referred to as forest resource management. Forest operations modeled as inputs to production processes were based on forest resource LCI data inputs from the PNW softwood forests (Johnson et al. 2005; Puettmann et al. 2013). Forestry operations vary regionally (Johnson et al. 2005) but typically include some combination of growing seedlings, regeneration, site preparation, planting (where applicable), thinning, fertilization (where applicable), and final harvest. Harvesting includes felling, skidding, processing, and loading for both commercial thinning and final harvest operations. For PNW forests, reforestation occurs primarily by planting, which requires inputs from human-related activities (i.e. the technosphere) for seedlings, site preparation, planting, and precommercial thinning (Table 4). Weighted-average allocation to different processes takes into account inherent differences in site productivity and energy usage by different kinds of logging equipment. Inputs to the forest resources management LCI include seed, electricity used during greenhouse operations, fertilizer used during seedling production and stand growth, and the fuel and lubricants needed to power and maintain equipment for thinning, and (final) harvest operations. The primary output product is a log destined for softwood veneer or plywood, OSB, or lumber. The coproduct, nonmerchantable (logging) slash, is generally left at a landing. Slash disposal was not modeled because it was assumed to decay in-situ.

Table 4. Inputs to the regeneration phase and midrotation fertilization per hectare of PNW forest (Puettmann et al. 2013).

Inputs	Unit	Low intensity	Medium intensity	High intensity	Weighted average
		Reforesting 1 ha			
Diesel and gasoline	L	12	12	12	12
Seedlings, at greenhouse	p[a]	988	1,482	1,482	1,275
Nitrogen in fertilizer					
In seedlings	kg	0.04	0.06	0.06	0.05
On site	kg	-	-	396.78	47.61
Phosphorous in fertilizer					
In seedlings	kg	0.07	0.11	0.11	0.09
On site	kg	-	-	67.25	8.07
Potassium in fertilizer					
In seedlings	kg	0.17	0.26	0.26	0.22
On site	kg	-	-	-	-

[a]p = individual seedling.

In the PNW region, most harvested volume comes from forest operations on private lands where investment in timber is the precursor to harvest. For all nonfederal land managers in the PNW region, reforestation is a statutory requirement because harvests are administered under state forest practices acts. Harvested lands are reforested for the next crop cycle with the sequence of treatments from planting to harvest averaging 45 years for the PNW (Johnson et al. 2005; Puettmann et al. 2013). Forestry operations and their associated impacts are not stationary and will change based on both past and prospective technologies, evolving forest management procedures, and market demands. Given that the nature of productivity gains is not confirmed or well developed, this assessment was based on data representing the current state of the art in forest operations: it does not discount future operations or estimate potential productivity gains from future technologies. Outputs representing quantities of product, measures of consumed resources, and emissions associated with those consumed resources were developed as a weighted average across the hectares managed for timber production. These quantities of product are used as inputs to the I-joist manufacturing LCI and the consumed resources and emissions are tracked for inclusion in the cradle-to-gate LCI.

6.2 Product Manufacturing

6.2.1 Resource transport

Wood raw materials were delivered to the I-joist plants by truck and rail; the wood material consists primarily of OSB and FJL purchased from off site. For the surveyed mills, LVL was produced on site in conjunction with the I-joists.

6.2.2 Laminated veneer lumber process

Inputs into composite I-joist manufacturing include LVL. In the PNW, for every kilometer of I-joist produced, 2,318 kg (4.3 m^3) of LVL was incorporated into the final product. Dry veneers and resins are the primary raw materials consumed for the production of PNW LVL. For this study, LVL production included veneer production and transportation but not the forest resource life-cycle stage. This was consistent with OSB and FJL as well. For detailed information on the production of LVL, see Wilson and Dancer (2004b, 2005b) and Bergman and Alanya-Rosenbaum (2016).

6.2.3 Oriented strandboard process

Inputs into composite I-joist manufacturing include OSB. For every kilometer of I-joist produced, 1,583 kg of OSB was incorporated into the final product. Chips and resins are the primary raw materials consumed for the production of SE OSB. See studies by Kline (2005) and Kaestner (2015) for detailed information about SE OSB manufacturing.

6.2.4 Finger-jointed lumber production

Inputs into composite I-joist manufacturing include FJL. For every kilometer of I-joist produced, 847.3 kg of FJL was incorporated into the final product. Finger joints are machined on both ends of softwood lumber with special cutter heads. A structural resin such as MUF is applied, and the joints in successive boards are coupled. The resin is cured with the joint end under pressure and heat. Most manufacturers use a continuous radio-frequency curing system for this step. The surveyed mills provided primary data on FJL production and MUF resin consumption, whereas electrical consumption data for cutting or forming joints for FJL was embedded in the electricity consumed for I-joist production and therefore not noted separately. For this study, FJL production included the impacts of softwood lumber production as well as resin production.

6.2.5 Methylene diphenyl di-isocyanate resin

Methylene diphenyl diisocyanate (MDI) resin[1] is used in the production of I-joists. The LCI for the production of MDI resin was based on a cradle-to-gate study of plastic resins and polyurethane precursors completed by Franklin Associates in 2010 (Franklin Associates 2011). Franklin Associates collected primary data for MDI production including data on the following MDI precursors: olefins, benzene, chlorine/caustic soda, and nitric acid/nitrobenzene/aniline. For MDI production, data was gathered from four North American producers that represent approximately 95% of North American production capacity (Franklin Associates 2011).

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[1] MDI is listed under Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA) of US EPA and subject to reporting requirements according to EPCRA Section 313 Toxic Chemicals.

6.2.6 Phenol resorcinol formaldehyde resin

Phenol-resorcinol-formaldehyde resin is the primary resin used for both web-to-web and web-to-flange joints. The PRF data were collected by survey from eight plants in the United States that represented 63% of total production for the year 2005 (Wilson 2009). Total annual production of PRF was 15,513,000 kg (34,166,667 lb) of neat[2] resin at 60% nonvolatile solids content. PRF resins differ somewhat from other resins in that hardeners are required to help in curing glue-laminated timbers and I-joists.

6.2.7 Melamine urea formaldehyde resin

Melamine-urea-formaldehyde resin is used for FJL. The MUF production data were collected by survey from six plants in the United States that represented 77% of total production for the year 2005 (Wilson 2009). Total annual production was 86,588,000 kg (190,893,000 lb) of neat resin at 60% nonvolatile solids content. Production of MUF is essentially identical to the production of urea formaldehyde resin (these resins are used for particleboard and medium-density fiberboards) with the exception that melamine, about 8% by weight on a neat resin basis, is substituted for a portion of the urea input. The inputs to produce 1.0 kg of neat MUF resin at 60% nonvolatile solids content consist of three primary chemicals on a dry basis (melamine at 0.081 kg, urea at 0.397 kg, and methanol at 0.304 kg); much lesser amounts of formic acid, ammonium sulfate, and sodium hydroxide; and 0.791 kg of water. A significant portion of the processing water is recycled back into the resin. Based on CORRIM Phase I glulam surveys, 0.96 kg of MUF resin was used to produce 1.0 m^3 of FJL (Puettmann and Wilson 2005; Puettmann et al. 2013). In this study, the MUF consumption value in the FJL manufacturing process was quantified as 1.235 kg/m^3 based on primary mill data. The resin was assumed to have a solids content of 65% (Silva et al. 2015).

6.2.8 Energy generation

Energy production for the manufacturing of I-joists comes from electricity, natural gas, diesel, and liquid petroleum gas (LPG). Electricity was used for mechanical pressing during resin application, running the saws and assembly machinery as well as pneumatic and mechanical conveying equipment, fans, and other equipment in the plant. Natural gas was used for generating heat for resin curing. Diesel was used for rolling stock transporting materials outside of the plant, and LPG was used for rolling stock, including forklift trucks, that operated inside the plant. For information on the energy consumption for producing OSB, see Kaestner (2015), and for producing LVL, see Bergman and Alanya-Rosenbaum (2016).

6.2.9 I-joist manufacturing

Routing and shaping of web and flanges is the first step in producing composite I-joists. This process requires machining of the OSB web pieces so they fit together at the ends as well as tapering them on the top and bottom edges so that they can be fitted into the flanges. Flanges are made primarily from LVL along with some FJL. The flanges are routed their entire length to accept the inserted tapered OSB web material. The coproduct created during this process is dry sawdust.

Resin application and pressing of the I-joist web and flanges members is the next step. Resin is applied in web-to-web and web-to-flange joints. Resins can include MDI and PRF. Assembly is done mechanically, pressing web sections end-to-end and into the top and bottom flange, which are also pressed end-to-end; the result is a continuous ribbon of I-beam that can be of infinite length. No coproducts are created during this process. The final step before packaging is sawing the I-joists to length and allowing the joints to cure. In some cases, the I-joist may be heated in a radio-frequency oven to accelerate resin cure time. For more information about composite I-joist manufacturing, see Wilson and Dancer (2004a, 2005a).

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[2] Neat resin means the resin as purchased from the supplier, does not include any inert fillers.

6.2.10 Packaging

Finished I-joists are packaged for transport. Inputs include final product (I-joist), and outputs include packaged I-joist. For this study, it was assumed that only wrapping material was used for each I-joist. Packing materials represent about 1% of the cumulative mass of the model flow. A material list is provided by Puettmann et al. (2013) (Table 5).

Table 5. Materials used in packaging and shipping per kilometer I-joist.

Material	Value	Unit
Wrapping material – HDPE[a]- and LDPE[b]-laminated paper	47.45	kg
PET[c] strapping	-	kg
Cardboard strap protectors	-	kg
Wooden spacers	-	kg
Total	-	kg

[a]High-density polyethylene (HDPE)
[b]Low-density polyethylene (LDPE)
[c]Polyethylene terephthalate (PET)

6.3 Air Emissions

The main emission sources were from hot presses. Baghouses are the primary collectors of particulate matter with all three surveyed plants using the emission control device (ECD). To decrease volatile organic compound (VOC) emissions from dryers, plants reported the use of regenerative catalytic oxidizer (RCOs), which are sometimes referred to as regenerative thermal oxidizers (RTOs) or wet scrubbers. RCOs are designed to destroy VOCs and other emissions including particulate matter (PM) and soot (USEPA 2003a).

7 INPUTS AND OUTPUTS

7.1 Material Transportation

Based on mill surveys, the weighted-average one-way haul distance for feedstock along with the components of the resin system are shown in Table 6. The values for LVL shipping distances were zero for the PNW because the surveyed I-joist plants produced LVL at the same site. All upstream transportation of inputs to LVL, FJL, and OSB production were included in the respective LCI input values. For example, LVL production incorporated not only dry veneer production but transportation as well.

Table 6. Weighted-average delivery distance (one-way) by mode for materials to I-joist plants.

Material delivered to mill	Delivery distance km
OSB to I-joist plant, by truck	1,604
OSB to I-joist plant, by rail	333
LVL to I-joist plant	0
FJL to I-joist plant	40
MDI and PRF resin to I-joist plant	161

7.2 Energy Sources

For I-joist production, thermal energy generated from natural gas was commonly produced in the form of steam and then used in the hot-pressing unit process. The thermal energy was for resin curing.

Electricity (grid) was the main energy source used on site, which was derived from off-site sources. Table 7 shows the electrical grid composition for I-joist production in the PNW region. Natural gas (31.8%) and coal (30.2%) power comprises most of the PNW grid Western Electricity Coordinating Council (WECC), which is the electrical grid comprised of Washington, Idaho, Montana, Portland, British Columbia, Alberta, California, Utah, Nevada, Arizona, New Mexico, Colorado, Wyoming, and parts of Nebraska, Texas, and Mexico.). Outputs included electricity and emissions primarily of fossil CO_2.

Table 7. Percentage of energy source for electricity for producing I-joists in the PNW (NREL 2012).

Energy source	Percentage of total electricity used
Natural gas	31.8
Coal	30.2
Oil	0.3
Nuclear	9.4
Hydro	22.2
Wind	2.4
Biomass	1.0
Geothermal	1.9
Miscellaneous	0.8
Total	100.0

7.3 Gate-to-Gate I-Joist Production

Table 8 gives a detailed description of the material and energy inputs and outputs crossing the system boundary of I-joist production, gate-to-gate. Under materials, wood feedstocks include OSB, LVL, and FJL. Electricity consumed on site for the PNW was calculated to be 377.8 kWh/km. Natural gas was the primary fossil fuel used on site (36.42 m^3/km). Air emissions were derived from the surveyed mills along with pertinent emissions data categorized by the EPA (USEPA 2002, 2003a, 2003b, 2003c, 2015). When available, surveyed air emission data as primary data were selected rather than secondary data.

Table 8. Unit process inputs and outputs to produce 1 km of composite I-joists, PNW, gate-to-gate.

Products	**Unit/km**	**Value**	**Allocation[a] (%)**
I-joist	km	1.000E+00	92.1
Sawdust, sold	kg	3.633E+02	7.6
Panel trim, sold	kg	2.214E+00	0.0
Rejects	kg	9.868E+00	0.2
Resources	**Unit/km**	**Value**	
Water, well, in ground	L	4.631E+00	
Materials/fuels	**Unit/km**	**Value**	
Wood feedstock, LVL, oven-dried	kg	2.318E+03	
Wood feedstock, OSB, oven-dried	kg	1.583E+03	
Wood feedstock, FJL, oven-dried	kg	8.473E+02	
PRF resin	kg	1.568E+01	
Hardener	kg	8.966E+00	
Catalyst	kg	1.957E+00	
Electricity, at grid	kWh	3.778E+02	
Diesel, combusted in industrial equipment	L	2.989E+00	
Gasoline, combusted in equipment	L	5.372E-02	
Propane, combusted in industrial equipment	L	3.865E+00	
Natural gas, combusted in industrial boiler	m^3	3.642E+01	
Transport, combination truck, diesel power, OSB	tkm	2.137E+03	
Transport, rail, diesel power, OSB	tkm	6.521E+00	
Transport, combination truck, diesel power, FJL	tkm	3.759E+01	
Transport, combination truck, diesel powered, PRF resin	tkm	3.888E+00	
Transport, combination truck, diesel powered, hardener	tkm	2.224E+00	
Transport, combination truck, diesel powered, landfill waste	tkm	4.315E+00	
Hydraulic fluid	kg	1.074E-01	
Greases	kg	3.398E-03	
Motor oil	kg	4.296E-02	
Waxes (sealant)	kg	3.583E-02	
Plastic wrapping	kg	2.109E+00	
Steel strapping	kg	1.874E-01	
Potable water	kg	1.113E-01	
Plastic strapping	kg	2.685E-01	
Wrapping material - packaging	kg	4.745E+01	
Emissions to air	**Unit/km**	**Value**	
Acetone[b]	kg	2.083E-04	
Acrolein	kg	not reported	
Carbon monoxide	kg	2.967E-02	
Formaldehyde	kg	1.297E-02	
Methanol	kg	3.085E-02	
Nitrous oxide	kg	3.506E-02	
PM_{10}	kg	4.288E-03	
Phenol	kg	3.521E-01	
Propionaldehyde	kg	not reported	
Sulfur dioxide	kg	2.697E-04	
VOCs	kg	1.819E-01	
Waste to treatment	**Unit/km**	**Value**	
Waste to inert landfill	kg	3.726E+00	
Waste to recycling	kg	2.445E+00	

[a] Mass allocation approach.

[b] Secondary data (EPA 2002).

7.4 Material Flows

To evaluate data quality, a mass balance was performed (Table 9). Input feedstocks of LVL, OSB, and FJL per 1 km of I-joist were 2,318, 1,583, and 847 kg (oven-dry), respectively. The major coproduct produced was sawdust (363 OD kg), whereas I-joist produced constituted about 92% by mass of the total output. Phenol-resorcinol-formaldehyde resin made up most of the additives, which were overall about 0.5% by mass of the total input.

Table 9. Mass balance of I-joist manufacturing per kilometer I-joist, PNW, gate-to-gate.

	(OD kg)	Mass (%)	CoVw[a] (%)
Feedstocks	**Inputs**		
LVL	2,318	48.6	57.7
OSB	1,583	33.2	3.6
FJL	847	17.8	156.6
Total, feedstock	**4,748**	**99.5**	**4.7**
Additives			
PRF resin	15.7	0.3	39.9
Hardener	9.0	0.2	
Catalyst	2.0	0.0	156.6
Total, additives	**25**	**0.5**	**47.1**
Total, in	**4,772**	**100**	
Products	**Outputs**		
I-joist	4,397	92.3	7.5
Coproducts			
Sawdust, sold	363	7.61	99
Panel trim, sold	2	0.05	
Rejects	10	0.21	
Total, coproducts	**375**	**7.86**	**98**
Total, outputs	**4,772**	**100.0**	

[a] Coefficient of variation, production-weighted.

7.5 On-Site Energy Inputs

Weighted-average energy inputs consumed at the I-joist manufacturing site were developed from survey data (Table 10). Electricity and natural gas were the primary energy inputs at 378 kWh and 36.4 m^3 for the PNW per linear kilometer of I-joist.

Table 10. On-site energy inputs for I-joist manufacturing, PNW, gate-to-gate.

	Quantity	Unit	CoVw[a] (%)
Energy inputs			
Electricity	378	kWh	35
Natural gas	36.4	m^3	103
Diesel	2.99	L	76
Propane	3.87	L	4.7
Gasoline	0.054	L	-

[a] Coefficient of variation.

8 LIFE-CYCLE INVENTORY DATA

Cradle-to-gate LCI flows for composite I-joist manufacturing was presented by five life stages, (1) forestry operations, (2) OSB production, (3) FJL production, (4) LVL production, and (5) I-joist production. As noted previously, LVL production included dry veneer production and veneer transportation to LVL plants. Thus, because dry veneer production was captured within LVL production and because LVL is the heaviest component of an I-joist, most raw material energy consumption occurred during LVL production, followed by OSB and I-joist stages with a small portion arising from FJL production and forestry operations (Table 11). In particular, wood fuel consumption was dominated by the LVL stage resulting from veneer input to LVL production. In this study, wood was burned primarily at the veneer production facility to generate thermal energy for log conditioning and drying veneers (Wilson and Dancer 2005b; Bergman and Taylor 2011; Kaestner 2015).

Table 11. Raw material energy consumption per 1 km of I-joist produced, cradle-to-gate, mass allocation.

Fuel	Unit	Forestry operations	OSB production	FJL production	LVL production	I-joist production
Wood fuel	OD kg	0.00E+00	8.46E+01	2.13E+02	9.61E+02	9.28E+00
Gas, natural, in ground	m^3	2.50E+00	1.04E+02	1.64E+01	2.11E+02	1.20E+02
Coal, in ground	kg	1.97E+00	1.10E+02	1.53E+01	1.73E+02	7.45E+01
Uranium oxide, in ore	kg	4.64E-05	3.12E-03	3.33E-04	3.54E-03	1.31E-03
Oil, crude, in ground	kg	3.40E+01	3.15E+01	8.46E+00	6.26E+01	7.23E+01

Primary energy is energy embodied in the original resources, such as crude oil and coal before conversion.

Table 12 shows the CPEC for the cradle-to-gate production of PNW I-joists. The LVL stage consumed the most primary energy at 37.7 GJ/m^3 (55.8%). For LVL production, the wood and natural gas were used to generate thermal energy for log conditioning and for drying and pressing veneers. At the I-joist life-cycle production stage, natural gas was used to generate thermal energy for resin curing, whereas electricity was consumed for sawing, trimming, and the radio-frequency ovens. Cradle-to-gate primary energy was derived from wood fuel at 26.5 GJ/m^3 and natural gas at 17.4 GJ/m^3 with CPEC for all five life-cycle stages at 67.6 GJ/m^3, representing more than 64% of the CPEC. Coal consumption was third with 14.5% contribution from generating electricity. Other renewable energy sources of hydro and wind along with wood fuel comprised 41% of CPEC. Total energy use at the I-joist production stage was dominated by fossil fuels of which the greatest contributor was natural gas (42.2%), unlike the upstream products for which biomass dominated. Other major primary energy sources were coal and crude oil.

Table 12. Cumulative primary energy consumption per 1 km of I-joist produced, cradle-to-gate, mass allocation.

Fuel	Percentage	Total	Forestry operations	OSB production	FJL production	LVL production	I-joist production
		MJ/km					
Wood fuel	39.2	2.65E+04	0.00E+00	1.77E+03	4.46E+03	2.01E+04	1.94E+02
Gas, natural, in ground	25.7	1.74E+04	9.58E+01	3.99E+03	6.28E+02	8.08E+03	4.58E+03
Coal, in ground	14.5	9.80E+03	5.16E+01	2.89E+03	4.00E+02	4.51E+03	1.95E+03
Oil, crude, in ground	14.1	9.50E+03	1.55E+03	1.43E+03	3.85E+02	2.85E+03	3.29E+03
Uranium oxide, in ore	4.7	3.18E+03	1.77E+01	1.19E+03	1.27E+02	1.35E+03	4.99E+02
Hydro	1.5	1.01E+03	1.81E-01	2.29E+01	7.35E+00	6.96E+02	2.80E+02
Wind	0.2	1.12E+02	0.00E+00	3.77E-01	3.34E-03	7.87E+01	3.28E+01
Solar	0.0	5.33E+00	0.00E+00	1.73E-03	4.63E-05	3.79E+00	1.54E+00
Geothermal	0.1	8.45E+01	0.00E+00	1.39E-01	1.32E-05	6.02E+01	2.42E+01
Total	100.0	6.76E+04	1.71E+03	1.13E+04	6.00E+03	3.77E+04	1.09E+04
Total, by percentage		100	2.5	16.7	8.9	55.8	16.06

Air emission data were collected from surveyed mills. The air emission data were augmented by a secondary resource for acetone emissions from I-joist plants (USEPA 2002). As mentioned previously, baghouses are the primary collectors of particulate matter with all three surveyed plants using this ECD. I-joist manufacturers reported on-site air emissions (Table 8) of acetone, carbon monoxide, formaldehyde, methanol, nitrous oxides, particulate matter, phenol, sulfur dioxide, and VOCs. Table 25 lists all air emissions and HAPs generated from I-joist production along with the ones reported by the mills themselves. Fossil and biogenic CO_2 released in the production of 1 km of I-joist were 1,929 and 2,166 kg, respectively. A complete list of all air emissions for the cradle-to-gate production of I-joists can be found in Appendix B.

All waterborne emissions occurred off site for gate-to-gate I-joist production. I-joist plants are zero-discharge facilities. For unspecified suspended solids, most emissions came from natural gas extraction, then crude oil production, followed by production of PRF resin used as a hardener. Most chloride emissions were from the same sources.

Solid emissions were dominated by LVL and I-joist production stages. Solid emissions include ash generated at the wood boiler during veneer production for LVL production, and primarily fuels and resins used (Table 13). A total of 54.2 kg/km solid waste was generated. Overall, 93% of the solid waste generated was landfilled.

Table 13. Waste to treatment per 1 km of I-joist, cradle-to-gate, mass allocation.

Waste to treatment	Total	Forestry operations	OSB production	FJL production	LVL production	I-joist production
	kg/km					
Waste in inert landfill	5.05E+01	0.00E+00	8.40E+00	3.37E-02	3.75E+01	4.48E+00
Waste to recycling	3.76E+00	0.00E+00	0.00E+00	0.00E+00	1.51E+00	2.25E+00
Total waste	5.42E+01	0.00E+00	8.40E+00	3.37E-02	3.91E+01	6.73E+00

9 LIFE-CYCLE IMPACT ASSESSMENT

Table 16 shows environmental performance results for impact categories (GW, acidification, eutrophication, ozone depletion, and smog), primary energy consumption from nonrenewable and renewable sources, consumption of renewable and nonrenewable resources, and solid waste generated. Values in Table 14 are the cumulative impact of all upstream processes required for I-joist production including those from forestry; OSB, FJL, and LVL production; and I-joist production as well as the transportation energy required to move these materials to the I-joist facility. For example, differences between I-joist production data in Table 8 and the values in Table 14 are a result of the resources and fuels used in the upstream processes, e.g. fresh water use. In addition, the contribution of major substances to the overall impact for eutrophication, acidification, smog and global warming impact categories are provided in Appendix D (Tables 30-31). The data on solid waste generated during OSB and LVL production were obtained from Kaestner (2015) and Bergman and Alanya-Rosenbaum (2016), respectively.

Table 14. Environmental performance of 1 km of I-joist, cradle-to-gate, mass allocation.

Impact category	**Unit**	**Total**	**Forestry operations**	**OSB production**	**FJL production**	**LVL production**	**I-joist production**
Global warming	kg CO_2 eq	2.10E+03	1.13E+02	4.55E+02	9.06E+01	8.83E+02	5.57E+02
Acidification	kg SO_2 eq	2.08E+01	1.54E+00	4.48E+00	9.77E-01	9.12E+00	4.71E+00
Eutrophication	kg N eq	7.91E-01	1.05E-01	1.17E-01	3.23E-02	2.85E-01	2.51E-01
Ozone depletion	kg CFC-11 eq	8.65E-05	5.08E-09	1.58E-06	1.15E-07	2.03E-06	8.28E-05
Smog	kg O_3 eq	2.77E+02	4.84E+01	4.58E+01	1.69E+01	1.13E+02	5.27E+01
Total primary energy consumption	**Unit**	**Total**	**Forestry operations**	**OSB production**	**FJL production**	**LVL production**	**I-joist production**
Total	MJ	**6.76E+04**	**1.71E+03**	**1.13E+04**	**6.00E+03**	**3.77E+04**	**1.09E+04**
Nonrenewable fossil	MJ	3.67E+04	1.69E+03	8.31E+03	1.41E+03	1.54E+04	9.83E+03
Nonrenewable nuclear	MJ	3.18E+03	1.77E+01	1.19E+03	1.27E+02	1.35E+03	4.99E+02
Renewable (solar, wind, hydroelectric, and geothermal)	MJ	1.21E+03	1.81E-01	2.35E+01	7.35E+00	8.38E+02	3.39E+02
Renewable, biomass	MJ	2.65E+04	0.00E+00	1.77E+03	4.46E+03	2.01E+04	1.94E+02
Material resources consumption (nonfuel resources)	**Unit**	**Total**	**Forestry operations**	**OSB production**	**FJL production**	**LVL production**	**I-joist production**
Nonrenewable materials	kg	2.70E+01	0.00E+00	4.42E+00	2.24E-02	2.19E+01	6.22E-01
Renewable materials	kg	3.92E+03	0.00E+00	1.37E+01	8.70E+02	3.01E+03	2.00E+01
Fresh water	L	8.99E+03	9.83E+01	1.00E+03	8.09E+02	5.17E+03	1.90E+03
Waste generated	**Unit**	**Total**	**Forestry operations**	**OSB production**	**FJL production**	**LVL production**	**I-joist production**
Solid waste	kg	5.42E+01	1.18E-06	8.40E+00	3.37E-02	3.91E+01	6.73E+00

10 COMPARISON OF UPDATED LIFE-CYCLE INVENTORY WITH A PREVIOUS STUDY

The on-site, industry-average energy inputs reported in 2012 were substantially higher than for Phase I except for the electricity consumption (Wilson and Dancer 2005a; Puettmann et al. 2013). In particular, diesel and natural gas consumption is driving the total impact from energy with changes of 202% and 7,817%, respectively (Table 15). Therefore, a sensitivity analysis investigating the energy inputs into I-joist production was completed in Section 13 to see their overall impact. The CPEC of gate-to-gate I-joist production was quantified as 44.2 GJ/km in the previous CORRIM Phase I study (Wilson and Dancer 2005a), which is about 49% lower than that in this study. Similarly, at the I-joist facilities in the previous study, natural gas was used to generate heat for resin curing although at a much lower consumption. For both studies, energy generated by woody biomass and fossil fuels constituted the majority of the total energy consumed. However, with that being said, no statistical analysis was conducted on the earlier data and different companies provided the primary 2000. Therefore, only speculation can be made on the apparent differences. In this study, the weighted coefficient of variation representing the variability in the collected process data was calculated and presented in the report. In addition, in this study, a sensitivity analysis was performed investigating the impact of the variation of energy inputs into I-joist production to the overall output.

Table 15. Production weighted-average PNW on-site energy inputs for manufacturing 1 km of I-joist.

	PNW Phase I	PNW 2012		
Energy inputs	**Quantity**	**Quantity**	**Unit**	**Change (%)**
Electricity	276	377.8	kWh	37
Natural gas	0.46	36.42	m^3	7,817
Diesel	0.99	2.99	L	202
Propane	2.04	3.87	L	90

11 TREATMENT OF BIOGENIC CARBON

Treatment of biogenic carbon is consistent with the Intergovernmental Panel for Climate Change (IPCC 2006) inventory reporting framework. There is no assumption that biomass combustion is carbon neutral. However, net carbon emissions from biomass combustion are accounted for under the land-use change and forestry (LUCF) sector and are therefore ignored in energy emissions reporting for the product LCA. This prevents double counting. Standards such as ASTM D 7612 (ASTM 2010), which are used in North America to define legal, responsible, and/or certified sources of wood materials, are in place to provide assurances regarding forest regeneration and sustainable harvest rates that serve as proxies to ensure stable carbon balances in the forest sector. They are outside the accounting framework for this LCA.

This approach to the treatment of biogenic carbon was taken from the Norwegian Solid Wood Product PCR (Aasestad 2008), and the North American PCR (FPInnovations 2015) adopted an identical approach to ensure comparability and consistency. The North American PCR approach is followed here for GW impact reporting therefore the default TRACI impact assessment method was used. This default method does not count the CO_2 emissions released during the combustion of woody biomass for production. Other emissions associated from wood combustion, e.g., methane or nitrogen oxides, do contribute to and are included in the GWP impact category. Bare (2011) gives a complete list of emission factors for the GW impact method used. With this method, 2,029 kg CO_2 eq were released in the cradle-to-gate production of 1 km of I-joist for the PNW (Table 14). That same 1 km of I-joist stores 7,255[3] kg CO_2eq (Table 16).

[3] 4,397 OD kg of wood in I-joist x 0.9 × (0.5 kg carbon/1.0 OD kg wood) × (44 kg CO_2/kmole/12 kg carbon/kmole) = 7,255 kg CO_2 eq.

Table 16. Carbon balance per 1 km of I-joist.

Source	kg CO_2 equivalent
Released forestry operations	113
Released manufacturing	1,986
CO_2 eq. stored in product	7,255

12 LIFE-CYCLE INTERPRETATION

As defined by ISO (2006a, 2006b), the term life-cycle interpretation is the phase of the LCA in which the findings of either the LCI or the LCIA, or both, are combined consistent with the defined goal and scope to reach conclusions and recommendations. This phase in the LCA reports the significant issues based on the results presented in the LCI and LCIA of this report. Additional components report an evaluation that considers completeness, sensitivity, and consistency checks of the LCI and LCIA results, conclusions, limitations, and recommendations.

12.1 Identification of the Significant Issues

The objective of this element is to structure the results from the LCI or the LCIA phases to help determine the significant issues found in the results and presented in previous sections of this report. A contribution analysis was applied for the interpretation phase of this LCA study. Contribution analysis examines the contribution of life-cycle stages, unit process contributions in a multi-unit manufacturing process, and specific substances that contribute to particular impact categories.

12.2 Life-Cycle Phase Contribution Analysis

Allocation was performed using both mass and economic methodologies to investigate the influence of the allocation method on the results. The contribution of five life-cycle stages to the LCA results for mass and economic allocation are provided in Table 17 and, respectively. Overall, the cradle-to-gate environmental impacts from I-joist production for the five impact categories resulted in less than a 9% difference between economic and mass allocation. Applying economic allocation resulted in an 9% increase resulting from the I-joist production stage in all impact categories, which was caused by the environmental burdens shifted toward the production of I-joists because economic value of the coproducts was minor.

Table 17. Life-cycle stages contribution analysis of 1 km of I-joist, cradle-to-gate, mass allocation.

Impact category	Unit	Forestry operations	OSB production	FJL production	LVL production	I-joist production
Global warming	kg CO_2 eq	5.4%	21.7%	4.3%	42.1%	26.5%
Acidification	kg SO_2 eq	7.4%	21.5%	4.7%	43.8%	22.6%
Eutrophication	kg N eq	13.3%	14.8%	4.1%	36.0%	31.8%
Ozone depletion	kg CFC-11 eq	0.0%	1.8%	0.1%	2.3%	95.7%
Smog	kg O_3 eq	17.5%	16.5%	6.1%	40.9%	19.0%
Total primary energy consumption	**Unit**	**Forestry operations**	**OSB production**	**FJL production**	**LVL production**	**I-joist production**
Total	MJ	2.5%	16.7%	8.9%	55.8%	16.1%
Nonrenewable fossil	MJ	4.6%	22.7%	3.9%	42.1%	26.8%
Nonrenewable nuclear	MJ	0.6%	37.4%	4.0%	42.4%	15.7%
Renewable (solar, wind, hydroelectric, and geothermal)	MJ	0.0%	1.9%	0.6%	69.4%	28.0%
Renewable, biomass	MJ	0.0%	6.7%	16.8%	75.8%	0.7%
Material resources consumption (nonfuel resources)	**Unit**	**Forestry operations**	**OSB production**	**FJL production**	**LVL production**	**I-joist production**
Nonrenewable materials	kg	0.0%	16.4%	0.1%	81.2%	2.3%
Renewable materials	kg	0.0%	0.4%	22.2%	76.9%	0.5%
Fresh water	L	1.1%	11.2%	9.0%	57.6%	21.2%
Waste generated	**Unit**	**Forestry operations**	**OSB production**	**FJL production**	**LVL production**	**I-joist production**
Solid waste	kg	0.0%	15.5%	0.2%	72.0%	12.4%

Table 18. Life-cycle stages contribution analysis of 1 km of I-joist, cradle-to-gate, economic allocation.

Impact category	Unit	Forestry operations	OSB production	FJL production	LVL production	I-joist production
Global warming	kg CO_2 eq	5.0%	21.8%	6.5%	39.8%	26.8%
Acidification	kg SO_2 eq	6.9%	21.8%	6.8%	41.4%	23.0%
Eutrophication	kg N eq	12.5%	15.0%	6.0%	34.1%	32.4%
Ozone depletion	kg CFC-11 eq	0.0%	1.8%	0.2%	2.4%	95.6%
Smog	kg O_3 eq	16.5%	16.9%	9.0%	38.2%	19.5%
Total primary energy consumption	**Unit**	**Forestry operations**	**OSB production**	**FJL production**	**LVL production**	**I-joist production**
Total	MJ	2.4%	17.2%	12.1%	51.7%	16.6%
Nonrenewable fossil	MJ	4.3%	22.8%	5.7%	40.1%	27.1%
Nonrenewable nuclear	MJ	0.5%	38.0%	5.8%	39.7%	16.0%
Renewable (solar, wind, hydroelectric, and geothermal)	MJ	0.0%	2.0%	0.8%	67.7%	29.4%
Renewable, biomass	MJ	0.0%	7.0%	22.8%	69.4%	0.8%
Material resources consumption (nonfuel resources)	**Unit**	**Forestry operations**	**OSB production**	**FJL production**	**LVL production**	**I-joist production**
Nonrenewable materials	kg	0.0%	18.4%	0.1%	78.9%	2.6%
Renewable materials	kg	0.0%	0.3%	36.0%	63.2%	0.5%
Fresh water	L	1.0%	11.5%	12.0%	53.5%	21.9%
Waste generated	**Unit**	**Forestry operations**	**OSB production**	**FJL production**	**LVL production**	**I-joist production**
Solid waste	kg	0.0%	15.3%	0.1%	71.3%	13.3%

12.3 Substance Contribution Analysis

The contribution of substances released to GWP is presented in Table 19. The major substances that contribute to GWP for the five life-cycle stages of I-joist manufacturing include fossil carbon dioxide (CO_2) and methane (CH_3). The results are presented for both mass and economic allocations; CO_2 emissions had the highest contribution in both methods.

Table 19. Substance contribution analysis to GWP (kg CO_2 eq) by life-cycle stage (total percentage basis and values are displayed per 1 km of I-joist, cradle-to-gate)[a].

		Mass allocation					
Substances	**Compartment type**	**Total (%)**	**Forestry operations**	**OSB production**	**FJL production**	**LVL production**	**I-joist production**
Total of all compartments		**100.00**	5%	22%	4%	42%	27%
Carbon dioxide	Air	91.9	1.09E+02	4.18E+02	8.39E+01	8.07E+02	5.12E+02
Methane	Air	7.7	4.04E+00	3.67E+01	6.25E+00	7.25E+01	4.14E+01
Other substances	Air	<1	5.44E-01	9.90E-01	5.18E-01	3.63E+00	3.69E+00
		Economic allocation					
Substances	**Compartment type**	**Total (%)**	**Forestry operations**	**OSB production**	**FJL production**	**LVL production**	**I-joist production**
Total of all compartments		**100.00**	5%	22%	6%	40%	27%
Carbon dioxide	Air	100.0	1.09E+02	4.51E+02	1.36E+02	8.20E+02	5.56E+02
Methane	Air	91.9	3.71E+00	3.22E+01	8.62E+00	6.70E+01	3.88E+01
Other substances	Air	<1	5.44E-01	1.03E+00	8.04E-01	3.63E+00	4.01E+00

[a] Additional substance contributions for other impact categories can be found in Appendix D.

12.4 Completeness, Sensitivity, and Consistency Checks

Evaluating the completeness, sensitivity, and consistency of the LCA offers confidence in and the reliability of the LCA results. The completeness check process verifies whether information from the life-cycle phases of an LCA are sufficient for reaching the goals, scope, and conclusions of the study and for making sound interpretations of the results. Three life-cycle stages (forestry operations, wood material production, and I-joist production) were checked for data completeness including all input elements such as raw and ancillary materials input, energy input, transportation scenarios, and water consumption and outputs such as products and coproducts, emissions to air, water, land, and final waste disposals. All input and output data were found to be complete, and no data gaps were identified.

The consistency check process verifies that the assumptions, methods, and data are consistently applied throughout the study and are in accordance with the goal and scope of the LCA. A comprehensive review process was completed for this LCA to make certain consistency was applied to the assumptions, methods, models, data quality including data sources, data accuracy, age, time-related coverage, technology, and geographical coverage.

A sensitivity analysis can be applied to the LCA to determine changes in results caused by variations in assumptions, methods, and data. Sensitivity analysis is a systematic approach for estimating the effects of the choices made concerning methods and data on the outcome of a study. Sensitivity analysis is a key component of data quality analysis and can be applied to quantify the impact of changes in assumptions or input data on study results. A sensitivity analysis was completed per ISO 14040 standards (ISO 2006a, 2006b) to model the effects of natural consumption and electricity consumption for I-joist production. Sensitivity analysis can be useful to understand how various process parameters contribute to environmental output factors.

12.5 Cumulative Primary Energy Consumption

During gate-to-gate I-joist manufacturing, natural gas is used for curing resin. Changing the on-site consumption of natural gas may have a significant effect on CPEC and GHG emissions for cradle-to-gate I-joist production. Lower (-20%) and higher (+20%) natural gas consumptions were selected to compare with the baseline fuel mix developed from the mill survey data (Table 20). Although natural gas usage changed by 20%, the outcomes changed less than 1% for both GHG emissions and CPEC.

Table 20. Key parameters on changing on-site natural gas consumption during 1 km of I-joist production, cradle-to-gate, mass allocation.

Parameter	Unit	Natural gas consumption Low (-20%)	Natural gas consumption Surveyed (0%)	Natural gas consumption High (+20%)
GHG emissions	kg CO_2eq	2,083	2,099	2,116
Cumulative primary energy consumption	GJ	67.3	67.6	67.9

12.6 Electricity Consumption

During gate-to-gate I-joist manufacturing, electricity is used in mechanical pressing during resin application, to run the saws and assembly machinery as well as the pneumatic and mechanical conveying equipment, and to run fans, RF ovens, and other equipment in the plant. However, changing the electricity consumption by 20% changed the outcome by less than 2% for both GHG emissions and CPEC for cradle-to-gate I-joist production (Table 21).

Table 21. Key parameters on changing electricity consumption during 1 km of I-joist production, cradle-to-gate, mass allocation.

Parameter	Unit	Electricity consumption Low (-20%)	Electricity consumption Surveyed (0%)	Electricity consumption High (+20%)
GHG emissions	kg CO_2eq	2,060	2,099	2,138
Cumulative primary energy consumption	GJ	66.9	67.6	68.3

Neither natural gas nor electrical consumption on site had a substantial impact on the overall process because on-site I-joist production CPEC contributed roughly 17% of the energy impacts of cradle-to-gate I-joist production.

13 CONCLUSION, LIMITATIONS, AND RECOMMENDATIONS

The cradle-to-gate LCA for I-joists includes the LCI of (1) forest resources, (2) OSB production, (3) FJL production, (4) LVL production, and (5) I-joist production and relies on primary survey data and secondary data for process inputs such as natural gas, diesel, and electricity. The survey results for I-joists were representative of the PNW region of the United States. The survey data were consistent with trade association production data in terms of I-joist sizes and production volumes.

The amount and type of energy used substantially affects the holistic environmental impacts of building material production. For I-joists from the PNW region, from cradle-to-gate, about 39% of the cumulative energy was from biomass (wood fuel) and 54% from nonrenewable fossil fuels, leaving a small portion of energy needs coming from nuclear (4.7%) and the remaining (1.8%) from hydro, wind, solar, and geothermal. Emissions from the forest resources LCI was small relative to other manufacturing emissions (LVL, OSB, FJL, and I-joists).

Cradle-to-gate LCI results showed that 1,929 kg fossil CO_2 were released in the production of 1 km of I-joist. Carbon content for wood products is assumed to be 50% by mass of OD wood. Excluding the resin system (about 10% by mass), the carbon stored in the wood portion of 1 km of I-joist on a production weighted average is equivalent to 7,255 kg CO_2 emissions if left to decay.

Data quality was high. A wood mass balance was performed to verify data quality. Inputs and outputs were consistent for the four surveyed mills on a cubic meter basis. Difference for overall wood mass was less than 2% for both regions. A difference less than 10% would be good. Therefore, tracking of wood mass is excellent for this study.

Specific wood production LCA data such as that for I-joists can be used for several purposes. This cradle-to-gate LCA can be used to compare with LCAs of I-joists manufactured from different materials, e.g., steel I-joists. Also, production companies can explore potential process improvements in conjunction with new conversion technologies to identify potential environmental hotspots. LCA practitioners can use the data for their studies, and customers and building specifiers can use the data (perhaps in the eventual form of an EPD) to assist in product selection, especially if looking for green building products with documentation. Developed wood product LCI data can contribute to product LCAs that are then incorporated into whole-building LCAs in environmental footprint software. Also, gate-to-gate I-joist production data can be included with or update current LCI data found in LCI databases.

Recommendations for future work on LCIA of I-joist manufacturing in the United States include expanding the system boundaries by including the use phase of the I-joist product. The cradle-to-grave analysis will allow a more comprehensive assessment of hotspots in the whole-product life cycle.

14 CRITICAL REVIEW

14.1 Internal Review

An internal critical review of the survey procedures, data, analysis, and report was completed by Dr. Maureen Puettmann, WoodLife Environmental Consultants, Corvallis, Oregon. This review assessed conformance with CORRIM guidelines, the PCR, and ISO 14040 standards and provided assurances that the study methodology, data collection, and analyses were scientifically sound and in conformance with internationally accepted standards and CORRIM research protocol (ISO 2006b; ILCD 2010; CORRIM 2014).

14.2 External Review

If an EPD is to be developed based external review on this LCA, an external review process is required. The external review process is intended to ensure consistency between the completed LCA and the principals and requirements of the International Standards on LCA (ISO 2006a) and the PCR for North American Structural and Architectural Wood Products (FPInnovations 2015). The review must be conducted by an independent third party. Following CORRIM's internal review, documents were submitted to UL Environment (ULE) for independent.

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16 APPENDIX A: CONVERSION FACTORS

Table 22. Common conversions from English to SI units.

To convert from	to	multiply by
Cubic feet (ft^3)	Cubic meters (m^3)	0.02831685
Pounds (avdp) (lb)	Kilograms (kg)	0.4535924
Cubic inches (in^3)	Cubic centimeters (cm^3)	16.393
Btu	Joules (J)	1054
Cubic yards (yd^3)	Cubic meters (m^3)	0.7645549
Feet	Meters (m)	0.305
Gallons (US)	Liters (L)	3.785
Kilowatt - hours (kWh)	Megajoules (MJ)	3.6
Miles	Kilometers (km)	1.609
Ounces (avdp)	Kilograms (kg)	0.028
Square feet	Square meters (m^2)	0.093
Tons (short)	Kilograms (kg)	907.185
Tons (short)	Metric ton (t)	0.9071847
Pounds	Metric ton (t)	0.0004
Watts	Joules/second (J/s)	1
Yards	Meters (m)	0.914
Acres	Hectares (ha)	0.405

Source: Starr (1971).

Table 23. Electricity grids and dataset name by source.

Region	North American grid	Source
Pacific Northwest	Electricity, at grid, WECC, 2008/RNA U	US LCI database

Table 24. Energy contents and densities of various fuels.

Fuel	HHV[a,b] MJ/kg	Density	Density units	HHV[a] Btu/lb
Coal	26.19			11,260
Distillate fuel oil[c]	45.54	0.85	kg/L	19,580
Liquid propane gas	54.05	0.49	kg/L	23,240
Natural gas	54.45	0.70	kg/m^3	23,410
Residual fuel oil	43.45	0.96	kg/L	18,680
Wood	20.93			9,000
Uranium	381,000.00			1.64E+08
Gasoline	48.36	0.72	kg/L	20,810
Diesel	44.00	0.88	kg/L	18,930

[a] Hodgman (1955); Salazar and Meil (2009); Todreas and Kazimi (1990).
[b] Used in this study.
[c] Same as for crude oil.

17 APPENDIX B: PACIFIC NORTHWEST I-JOIST LIFE-CYCLE INVENTORY FLOWS, MASS ALLOCATION

Table 25. Mass allocation inventory.

Substance	Compart-ment	Unit	Forest operations	Oriented strandboard	Finger-jointed lumber	LVL	I-joists
Aluminium, 24% in bauxite, 11% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.07E-06	0.00E+00	4.54E-03
Anhydrite, in ground	Raw	kg	0.00E+00	0.00E+00	1.59E-10	0.00E+00	1.55E-05
Barite, 15% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	3.37E-08	0.00E+00	1.30E-02
Basalt, in ground	Raw	kg	0.00E+00	0.00E+00	9.96E-10	0.00E+00	3.69E-07
Borax, in ground	Raw	kg	0.00E+00	0.00E+00	8.74E-11	0.00E+00	3.42E-08
Bromine, 0.0023% in water	Raw	kg	0.00E+00	0.00E+00	1.90E-11	0.00E+00	1.88E-01
Cadmium, 0.30% in sulfide, Cd 0.18%, Pb, Zn, Ag, In, in ground	Raw	kg	0.00E+00	0.00E+00	3.02E-12	0.00E+00	2.96E-10
Calcite	Raw	kg	0.00E+00	0.00E+00	0.00E+00	4.66E-03	1.50E-02
Calcite, in ground	Raw	kg	0.00E+00	0.00E+00	5.33E-04	0.00E+00	4.06E-01
Carbon dioxide, in air	Raw	kg	1.18E+04	7.18E+01	3.83E-01	3.53E+02	2.51E+00
Carbon, in organic matter, in soil	Raw	kg	0.00E+00	0.00E+00	8.42E-09	0.00E+00	4.82E-05
Carbon, organic, in soil or biomass stock	Raw	kg	0.00E+00	0.00E+00	0.00E+00	4.27E+03	9.72E+03
Chromium, 25.5% in chromite, 11.6% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.21E-07	0.00E+00	5.00E-05
Chrysotile, in ground	Raw	kg	0.00E+00	0.00E+00	3.13E-10	0.00E+00	1.44E-04
Cinnabar, in ground	Raw	kg	0.00E+00	0.00E+00	2.93E-11	0.00E+00	1.32E-05
Clay, bentonite, in ground	Raw	kg	0.00E+00	0.00E+00	1.37E-06	0.00E+00	6.34E-04
Clay, unspecified, in ground	Raw	kg	0.00E+00	0.00E+00	6.95E-05	0.00E+00	9.30E-03
Coal, 26.4 MJ per kg	Raw	kg	1.97E+00	1.07E+02	1.53E+01	1.73E+02	6.96E+01
Coal, bituminous, 24.8 MJ per kg	Raw	kg	0.00E+00	7.87E-06	2.84E-04	1.20E-04	0.00E+00
Coal, bitumous, in ground	Raw	kg	0.00E+00	3.28E+00	0.00E+00	0.00E+00	0.00E+00
Coal, brown	Raw	kg	0.00E+00	7.08E-07	2.56E-05	1.08E-05	0.00E+00
Coal, brown, in ground	Raw	kg	0.00E+00	0.00E+00	7.81E-03	0.00E+00	2.70E+00
Coal, hard, unspecified, in ground	Raw	kg	0.00E+00	0.00E+00	4.48E-03	0.00E+00	2.23E+00
Coal, lignite, in ground	Raw	kg	0.00E+00	2.72E-01	0.00E+00	0.00E+00	0.00E+00
Cobalt, in ground	Raw	kg	0.00E+00	0.00E+00	1.09E-10	0.00E+00	1.10E-05
Colemanite, in ground	Raw	kg	0.00E+00	0.00E+00	2.46E-09	0.00E+00	3.06E-03
Copper ore	Raw	kg	0.00E+00	0.00E+00	0.00E+00	9.38E-03	5.95E-03
Copper, 0.99% in sulfide, Cu 0.36% and Mo 8.2E-3% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	7.68E-10	0.00E+00	5.49E-06
Copper, 1.18% in sulfide, Cu 0.39% and Mo 8.2E-3% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	2.37E-09	0.00E+00	1.73E-05
Copper, 1.42% in sulfide, Cu 0.81% and Mo 8.2E-3% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	6.29E-10	0.00E+00	4.58E-06
Copper, 2.19% in sulfide, Cu 1.83% and Mo 8.2E-3% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	3.14E-09	0.00E+00	2.27E-05
Diatomite, in ground	Raw	kg	0.00E+00	0.00E+00	1.08E-13	0.00E+00	3.81E-11
Dolomite, in ground	Raw	kg	0.00E+00	0.00E+00	4.51E-09	0.00E+00	1.36E-05
Energy, from biomass	Raw	MJ	0.00E+00	5.02E-01	4.72E-05	2.00E-05	0.00E+00
Energy, from gas, natural	Raw	MJ	0.00E+00	2.89E+01	0.00E+00	0.00E+00	1.11E-01
Energy, from hydro power	Raw	MJ	1.81E-01	2.29E+01	7.35E+00	6.96E+02	2.80E+02
Energy, from oil	Raw	MJ	0.00E+00	1.14E+01	0.00E+00	0.00E+00	4.38E-02
Energy, geothermal	Raw	MJ	0.00E+00	1.39E-01	1.32E-05	6.02E+01	2.42E+01
Energy, gross calorific value, in biomass	Raw	MJ	0.00E+00	0.00E+00	5.93E-03	0.00E+00	2.17E+00
Energy, gross calorific value, in biomass, primary forest	Raw	MJ	0.00E+00	0.00E+00	5.84E-07	0.00E+00	3.34E-03
Energy, kinetic (in wind), converted	Raw	MJ	0.00E+00	3.77E-01	3.34E-03	7.87E+01	3.28E+01
Energy, potential (in hydropower reservoir), converted	Raw	MJ	0.00E+00	0.00E+00	3.10E-02	0.00E+00	8.11E+00
Energy, recovered	Raw	MJ	0.00E+00	3.03E+01	3.62E-05	1.53E-05	0.00E+00
Energy, solar, converted	Raw	MJ	0.00E+00	1.73E-03	4.63E-05	3.79E+00	1.54E+00
Feldspar, in ground	Raw	kg	0.00E+00	0.00E+00	5.41E-15	0.00E+00	9.03E-13

Substance	Compart-ment	Unit	Forest operations	Oriented strandboard	Finger-jointed lumber	LVL	I-joists
Fluorine, 4.5% in apatite, 1% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	6.84E-08	0.00E+00	8.03E-03
Fluorine, 4.5% in apatite, 3% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	3.01E-08	0.00E+00	6.11E-03
Fluorspar, 92%, in ground	Raw	kg	0.00E+00	0.00E+00	2.31E-06	0.00E+00	1.31E-01
fuel	Raw	m3	3.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gallium, 0.014% in bauxite, in ground	Raw	kg	0.00E+00	0.00E+00	1.59E-17	0.00E+00	1.65E-15
Gas, mine, off-gas, process, coal mining/m3	Raw	m3	0.00E+00	0.00E+00	4.35E-05	0.00E+00	2.04E-02
Gas, natural, 36.6 MJ per m3	Raw	m3	0.00E+00	3.01E-05	1.09E-03	4.59E-04	0.00E+00
Gas, natural, 36.7 MJ per m3, in ground	Raw	kg	0.00E+00	7.13E+00	0.00E+00	0.00E+00	0.00E+00
Gas, natural, 46.8 MJ per kg	Raw	kg	0.00E+00	1.19E-01	2.25E-03	5.95E-01	1.65E-02
Gas, natural, 49.8 MJ per kg, in ground (EMR)	Raw	kg	0.00E+00	5.14E+00	0.00E+00	0.00E+00	0.00E+00
Gas, natural, in ground	Raw	m3	0.00E+00	0.00E+00	2.08E-01	0.00E+00	4.62E+00
Gas, natural/m3	Raw	m3	2.50E+00	8.66E+01	1.62E+01	2.10E+02	1.15E+02
Gold, Au 1.1E-4%, Ag 4.2E-3%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.35E-14	0.00E+00	1.05E-12
Gold, Au 1.3E-4%, Ag 4.6E-5%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	2.47E-14	0.00E+00	1.92E-12
Gold, Au 1.4E-4%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	2.96E-14	0.00E+00	2.30E-12
Gold, Au 2.1E-4%, Ag 2.1E-4%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	4.52E-14	0.00E+00	3.52E-12
Gold, Au 4.3E-4%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.12E-14	0.00E+00	8.72E-13
Gold, Au 4.9E-5%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	2.69E-14	0.00E+00	2.09E-12
Gold, Au 6.7E-4%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	4.16E-14	0.00E+00	3.23E-12
Gold, Au 7.1E-4%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	4.69E-14	0.00E+00	3.65E-12
Gold, Au 9.7E-4%, Ag 9.7E-4%, Zn 0.63%, Cu 0.38%, Pb 0.014%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	2.81E-15	0.00E+00	2.18E-13
Granite, in ground	Raw	kg	0.00E+00	0.00E+00	3.81E-15	0.00E+00	4.06E-13
Gravel, in ground	Raw	kg	0.00E+00	0.00E+00	2.72E-03	0.00E+00	4.79E-02
Gypsum, in ground	Raw	kg	0.00E+00	0.00E+00	9.24E-09	0.00E+00	8.81E-07
Indium, 0.005% in sulfide, In 0.003%, Pb, Zn, Ag, Cd, in ground	Raw	kg	0.00E+00	0.00E+00	5.11E-14	0.00E+00	4.90E-12
Iodine, 0.03% in water	Raw	kg	0.00E+00	0.00E+00	4.49E-12	0.00E+00	9.77E-02
Iron ore	Raw	kg	0.00E+00	1.37E-07	1.11E-02	1.48E-03	1.65E-03
Iron, 46% in ore, 25% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.29E-06	0.00E+00	7.44E-04
Kaolinite, 24% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	8.75E-08	0.00E+00	8.32E-06
Kieserite, 25% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	2.34E-10	0.00E+00	2.86E-08
Lead, 5.0% in sulfide, Pb 3.0%, Zn, Ag, Cd, In, in ground	Raw	kg	0.00E+00	0.00E+00	6.36E-11	0.00E+00	5.66E-07
Limestone	Raw	kg	0.00E+00	4.42E+00	2.24E-02	2.19E+01	6.22E-01
Lithium, 0.15% in brine, in ground	Raw	kg	0.00E+00	0.00E+00	8.10E-14	0.00E+00	8.93E-12
Magnesite, 60% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	6.93E-08	0.00E+00	1.10E-05
Magnesium, 0.13% in water	Raw	kg	0.00E+00	0.00E+00	7.50E-14	0.00E+00	6.68E-12
Manganese, 35.7% in sedimentary deposit, 14.2% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.54E-09	0.00E+00	1.40E-02
Metamorphous rock, graphite containing, in ground	Raw	kg	0.00E+00	0.00E+00	1.06E-09	0.00E+00	6.51E-06
Molybdenum, 0.010% in sulfide, Mo 8.2E-3% and Cu 1.83% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	5.83E-11	0.00E+00	4.22E-07
Molybdenum, 0.014% in sulfide, Mo 8.2E-3% and Cu 0.81% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	8.27E-12	0.00E+00	6.02E-08
Molybdenum, 0.022% in sulfide, Mo 8.2E-3% and Cu 0.36% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	4.70E-10	0.00E+00	3.71E-06
Molybdenum, 0.025% in sulfide, Mo 8.2E-3% and Cu 0.39% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	3.03E-11	0.00E+00	2.21E-07

Substance	Compart-ment	Unit	Forest operations	Oriented strandboard	Finger-jointed lumber	LVL	I-joists
Molybdenum, 0.11% in sulfide, Mo 4.1E-2% and Cu 0.36% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	9.48E-10	0.00E+00	7.48E-06
Nickel, 1.13% in sulfide, Ni 0.76% and Cu 0.76% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	9.36E-05	0.00E+00	2.10E-04
Nickel, 1.98% in silicates, 1.04% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	2.06E-07	0.00E+00	7.65E-05
Nitrogen	Raw	kg	5.03E-01	5.51E-01	0.00E+00	5.02E-02	4.33E-02
Occupation, arable, conservation tillage	Raw	m2a	0.00E+00	9.68E-04	8.77E-06	1.48E-03	0.00E+00
Occupation, arable, conventional tillage	Raw	m2a	0.00E+00	1.06E-03	9.61E-06	1.62E-03	0.00E+00
Occupation, arable, non-irrigated	Raw	m2a	0.00E+00	0.00E+00	1.84E-07	0.00E+00	2.74E-05
Occupation, arable, reduced tillage	Raw	m2a	0.00E+00	6.50E-04	5.89E-06	9.90E-04	0.00E+00
Occupation, construction site	Raw	m2a	0.00E+00	0.00E+00	5.99E-07	0.00E+00	8.39E-04
Occupation, dump site	Raw	m2a	0.00E+00	0.00E+00	3.32E-05	0.00E+00	1.33E-02
Occupation, dump site, benthos	Raw	m2a	0.00E+00	0.00E+00	6.61E-10	0.00E+00	7.40E-08
Occupation, forest, intensive	Raw	m2a	0.00E+00	0.00E+00	6.24E-06	0.00E+00	2.82E-03
Occupation, forest, intensive, normal	Raw	m2a	0.00E+00	0.00E+00	8.84E-05	0.00E+00	2.79E-02
Occupation, forest, intensive, short-cycle	Raw	m2a	0.00E+00	0.00E+00	1.46E-07	0.00E+00	8.38E-04
Occupation, industrial area	Raw	m2a	0.00E+00	0.00E+00	9.26E-06	0.00E+00	3.68E-03
Occupation, industrial area, benthos	Raw	m2a	0.00E+00	0.00E+00	6.04E-12	0.00E+00	6.77E-10
Occupation, industrial area, built up	Raw	m2a	0.00E+00	0.00E+00	6.68E-09	0.00E+00	6.09E-07
Occupation, industrial area, vegetation	Raw	m2a	0.00E+00	0.00E+00	3.08E-09	0.00E+00	5.25E-07
Occupation, mineral extraction site	Raw	m2a	0.00E+00	0.00E+00	1.84E-05	0.00E+00	9.98E-03
Occupation, permanent crop, fruit, intensive	Raw	m2a	0.00E+00	0.00E+00	2.05E-07	0.00E+00	7.89E-06
Occupation, shrub land, sclerophyllous	Raw	m2a	0.00E+00	0.00E+00	3.07E-07	0.00E+00	2.73E-04
Occupation, traffic area, rail embankment	Raw	m2a	0.00E+00	0.00E+00	2.75E-09	0.00E+00	2.25E-07
Occupation, traffic area, rail network	Raw	m2a	0.00E+00	0.00E+00	3.04E-09	0.00E+00	2.49E-07
Occupation, traffic area, road embankment	Raw	m2a	0.00E+00	0.00E+00	9.75E-07	0.00E+00	3.22E-04
Occupation, traffic area, road network	Raw	m2a	0.00E+00	0.00E+00	8.41E-09	0.00E+00	8.80E-07
Occupation, urban, discontinuously built	Raw	m2a	0.00E+00	0.00E+00	3.38E-13	0.00E+00	3.34E-11
Occupation, water bodies, artificial	Raw	m2a	0.00E+00	0.00E+00	4.64E-05	0.00E+00	1.35E-02
Occupation, water courses, artificial	Raw	m2a	0.00E+00	0.00E+00	1.82E-05	0.00E+00	5.78E-03
Oil, crude	Raw	kg	3.40E+01	1.64E+01	8.41E+00	5.99E+01	6.92E+01
Oil, crude, 41 MJ per kg	Raw	kg	0.00E+00	8.81E+00	0.00E+00	0.00E+00	3.38E-02
Oil, crude, 42 MJ per kg	Raw	kg	0.00E+00	5.36E-01	2.72E-03	2.68E+00	6.63E-02
Oil, crude, 42.7 MJ per kg	Raw	kg	0.00E+00	1.57E-05	5.68E-04	2.40E-04	0.00E+00
Oil, crude, 43.7 MJ per kg, in ground	Raw	kg	0.00E+00	9.98E-01	0.00E+00	0.00E+00	0.00E+00
Oil, crude, 43.7 MJ per kg, in ground (EMR)	Raw	kg	0.00E+00	4.74E+00	0.00E+00	0.00E+00	0.00E+00
Oil, crude, in ground	Raw	kg	0.00E+00	0.00E+00	4.96E-02	0.00E+00	2.98E+00
Olivine, in ground	Raw	kg	0.00E+00	0.00E+00	5.64E-11	0.00E+00	5.41E-06
Oxygen	Raw	kg	0.00E+00	7.72E+00	2.19E-03	6.25E+00	1.43E+00
Pd, Pd 2.0E-4%, Pt 4.8E-4%, Rh 2.4E-5%, Ni 3.7E-2%, Cu 5.2E-2% in ore, in ground	Raw	kg	0.00E+00	0.00E+00	5.86E-11	0.00E+00	1.61E-09
Pd, Pd 7.3E-4%, Pt 2.5E-4%, Rh 2.0E-5%, Ni 2.3E+0%, Cu 3.2E+0% in ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.41E-10	0.00E+00	3.87E-09
Peat, in ground	Raw	kg	0.00E+00	0.00E+00	1.59E-06	0.00E+00	4.25E-04
Pesticides	Raw	kg	0.00E+00	6.39E-07	7.86E-07	9.75E-07	2.43E-05
Phosphate ore	Raw	kg	0.00E+00	6.07E-05	7.47E-05	9.27E-05	3.30E-03
Phosphorus	Raw	kg	8.53E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phosphorus, 18% in apatite, 12% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.21E-07	0.00E+00	2.48E-02
Phosphorus, 18% in apatite, 4% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	2.74E-07	0.00E+00	3.21E-02
Pt, Pt 2.5E-4%, Pd 7.3E-4%, Rh 2.0E-5%, Ni 2.3E+0%, Cu 3.2E+0% in ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.35E-12	0.00E+00	3.71E-11

Substance	Compart-ment	Unit	Forest operations	Oriented strandboard	Finger-jointed lumber	LVL	I-joists
Pt, Pt 4.8E-4%, Pd 2.0E-4%, Rh 2.4E-5%, Ni 3.7E-2%, Cu 5.2E-2% in ore, in ground	Raw	kg	0.00E+00	0.00E+00	4.84E-12	0.00E+00	1.33E-10
resin	Raw	kg	0.00E+00	4.14E+01	0.00E+00	0.00E+00	0.00E+00
Rh, Rh 2.0E-5%, Pt 2.5E-4%, Pd 7.3E-4%, Ni 2.3E+0%, Cu 3.2E+0% in ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.34E-12	0.00E+00	3.68E-11
Rh, Rh 2.4E-5%, Pt 4.8E-4%, Pd 2.0E-4%, Ni 3.7E-2%, Cu 5.2E-2% in ore, in ground	Raw	kg	0.00E+00	0.00E+00	4.20E-12	0.00E+00	1.15E-10
Rhenium, in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.51E-12	0.00E+00	6.92E-11
Roundwood at forest road	Raw	m3	0.00E+00	3.80E+00	0.00E+00	0.00E+00	0.00E+00
Salt, unspecified	Raw	kg	0.00E+00	5.29E+00	0.00E+00	0.00E+00	0.00E+00
Sand, quartz, in ground	Raw	kg	0.00E+00	7.08E-06	8.70E-06	1.08E-05	2.69E-04
Sand, unspecified, in ground	Raw	kg	0.00E+00	0.00E+00	3.59E-08	0.00E+00	2.03E-03
Scrap, external	Raw	kg	0.00E+00	2.48E-01	1.57E-01	3.78E-01	4.82E+00
Seed corn	Raw	kg	0.00E+00	3.42E-06	4.21E-06	5.23E-06	1.30E-04
Shale, in ground	Raw	kg	0.00E+00	0.00E+00	4.51E-10	0.00E+00	4.39E-05
Silver, 0.007% in sulfide, Ag 0.004%, Pb, Zn, Cd, In, in ground	Raw	kg	0.00E+00	0.00E+00	2.99E-13	0.00E+00	2.33E-11
Silver, 3.2ppm in sulfide, Ag 1.2ppm, Cu and Te, in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	2.13E-13	0.00E+00	1.66E-11
Silver, Ag 2.1E-4%, Au 2.1E-4%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.97E-14	0.00E+00	1.54E-12
Silver, Ag 4.2E-3%, Au 1.1E-4%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	4.50E-14	0.00E+00	3.51E-12
Silver, Ag 4.6E-5%, Au 1.3E-4%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	4.41E-14	0.00E+00	3.44E-12
Silver, Ag 9.7E-4%, Au 9.7E-4%, Zn 0.63%, Cu 0.38%, Pb 0.014%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	2.91E-14	0.00E+00	2.27E-12
Sodium carbonate	Raw	kg	0.00E+00	8.26E-04	7.49E-06	1.26E-03	0.00E+00
Sodium chloride	Raw	kg	0.00E+00	1.52E+00	5.47E-03	1.61E+01	3.37E-01
Sodium chloride, in ground	Raw	kg	0.00E+00	0.00E+00	5.92E-04	0.00E+00	5.18E+00
Sodium nitrate, in ground	Raw	kg	0.00E+00	0.00E+00	2.02E-15	0.00E+00	1.64E-13
Sodium sulfate	Raw	kg	0.00E+00	4.49E-03	2.40E-03	6.84E-03	7.35E-02
Sodium sulphate, various forms, in ground	Raw	kg	0.00E+00	0.00E+00	5.70E-07	0.00E+00	1.80E-05
Stibnite, in ground	Raw	kg	0.00E+00	0.00E+00	1.12E-14	0.00E+00	3.96E-12
Sulfur	Raw	kg	0.00E+00	2.42E-04	1.44E-04	3.69E-04	4.36E-02
Sulfur, in ground	Raw	kg	0.00E+00	0.00E+00	1.07E-08	0.00E+00	4.55E-02
Sylvinite, in ground	Raw	kg	0.00E+00	2.99E-05	3.68E-05	4.56E-05	1.14E-03
Sylvite, 25 % in sylvinite, in ground	Raw	kg	0.00E+00	0.00E+00	8.06E-09	0.00E+00	3.95E-02
Talc, in ground	Raw	kg	0.00E+00	0.00E+00	1.12E-08	0.00E+00	1.93E-06
Tantalum, 81.9% in tantalite, 1.6E-4% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	2.36E-13	0.00E+00	1.84E-11
Tellurium, 0.5ppm in sulfide, Te 0.2ppm, Cu and Ag, in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	3.20E-14	0.00E+00	2.50E-12
Tin, 79% in cassiterite, 0.1% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.52E-11	0.00E+00	1.49E-09
TiO2, 54% in ilmenite, 2.6% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.48E-06	0.00E+00	1.80E-04
TiO2, 95% in rutile, 0.40% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	6.76E-15	0.00E+00	6.41E-13
Transformation, from arable	Raw	m2	0.00E+00	0.00E+00	4.09E-10	0.00E+00	1.72E-06
Transformation, from arable, non-irrigated	Raw	m2	0.00E+00	0.00E+00	3.37E-07	0.00E+00	5.04E-05
Transformation, from arable, non-irrigated, fallow	Raw	m2	0.00E+00	0.00E+00	1.30E-10	0.00E+00	5.49E-07
Transformation, from dump site, inert material landfill	Raw	m2	0.00E+00	0.00E+00	6.70E-11	0.00E+00	2.38E-05
Transformation, from dump site, residual material landfill	Raw	m2	0.00E+00	0.00E+00	5.81E-08	0.00E+00	3.02E-05

Substance	Compart-ment	Unit	Forest operations	Oriented strandboard	Finger-jointed lumber	LVL	I-joists
Transformation, from dump site, sanitary landfill	Raw	m2	0.00E+00	0.00E+00	3.09E-09	0.00E+00	3.07E-07
Transformation, from dump site, slag compartment	Raw	m2	0.00E+00	0.00E+00	7.63E-11	0.00E+00	7.18E-08
Transformation, from forest	Raw	m2	0.00E+00	0.00E+00	5.05E-09	0.00E+00	3.72E-05
Transformation, from forest, extensive	Raw	m2	0.00E+00	0.00E+00	7.33E-07	0.00E+00	2.37E-04
Transformation, from forest, intensive, clear-cutting	Raw	m2	0.00E+00	0.00E+00	5.23E-09	0.00E+00	2.99E-05
Transformation, from industrial area	Raw	m2	0.00E+00	0.00E+00	4.25E-08	0.00E+00	8.67E-06
Transformation, from industrial area, benthos	Raw	m2	0.00E+00	0.00E+00	5.56E-14	0.00E+00	6.35E-12
Transformation, from industrial area, built up	Raw	m2	0.00E+00	0.00E+00	9.77E-11	0.00E+00	1.30E-08
Transformation, from industrial area, vegetation	Raw	m2	0.00E+00	0.00E+00	1.67E-10	0.00E+00	2.22E-08
Transformation, from mineral extraction site	Raw	m2	0.00E+00	0.00E+00	3.48E-07	0.00E+00	2.71E-04
Transformation, from pasture and meadow	Raw	m2	0.00E+00	0.00E+00	1.96E-07	0.00E+00	2.08E-04
Transformation, from pasture and meadow, intensive	Raw	m2	0.00E+00	0.00E+00	2.75E-10	0.00E+00	4.11E-08
Transformation, from sea and ocean	Raw	m2	0.00E+00	0.00E+00	6.62E-10	0.00E+00	7.41E-08
Transformation, from shrub land, sclerophyllous	Raw	m2	0.00E+00	0.00E+00	1.75E-07	0.00E+00	9.05E-05
Transformation, from tropical rain forest	Raw	m2	0.00E+00	0.00E+00	5.23E-09	0.00E+00	2.99E-05
Transformation, from unknown	Raw	m2	0.00E+00	0.00E+00	1.12E-06	0.00E+00	3.69E-04
Transformation, to arable	Raw	m2	0.00E+00	0.00E+00	3.21E-07	0.00E+00	1.15E-04
Transformation, to arable, non-irrigated	Raw	m2	0.00E+00	0.00E+00	3.38E-07	0.00E+00	5.04E-05
Transformation, to arable, non-irrigated, fallow	Raw	m2	0.00E+00	0.00E+00	3.95E-10	0.00E+00	6.25E-07
Transformation, to dump site	Raw	m2	0.00E+00	0.00E+00	2.57E-07	0.00E+00	1.00E-04
Transformation, to dump site, benthos	Raw	m2	0.00E+00	0.00E+00	6.61E-10	0.00E+00	7.40E-08
Transformation, to dump site, inert material landfill	Raw	m2	0.00E+00	0.00E+00	6.70E-11	0.00E+00	2.38E-05
Transformation, to dump site, residual material landfill	Raw	m2	0.00E+00	0.00E+00	5.81E-08	0.00E+00	3.02E-05
Transformation, to dump site, sanitary landfill	Raw	m2	0.00E+00	0.00E+00	3.09E-09	0.00E+00	3.07E-07
Transformation, to dump site, slag compartment	Raw	m2	0.00E+00	0.00E+00	7.63E-11	0.00E+00	7.18E-08
Transformation, to forest	Raw	m2	0.00E+00	0.00E+00	8.75E-08	0.00E+00	7.49E-05
Transformation, to forest, intensive	Raw	m2	0.00E+00	0.00E+00	4.15E-08	0.00E+00	1.88E-05
Transformation, to forest, intensive, clear-cutting	Raw	m2	0.00E+00	0.00E+00	5.23E-09	0.00E+00	2.99E-05
Transformation, to forest, intensive, normal	Raw	m2	0.00E+00	0.00E+00	6.81E-07	0.00E+00	2.15E-04
Transformation, to forest, intensive, short-cycle	Raw	m2	0.00E+00	0.00E+00	5.23E-09	0.00E+00	2.99E-05
Transformation, to heterogeneous, agricultural	Raw	m2	0.00E+00	0.00E+00	6.01E-11	0.00E+00	6.47E-09
Transformation, to industrial area	Raw	m2	0.00E+00	0.00E+00	9.86E-08	0.00E+00	3.70E-05
Transformation, to industrial area, benthos	Raw	m2	0.00E+00	0.00E+00	9.65E-13	0.00E+00	9.72E-11
Transformation, to industrial area, built up	Raw	m2	0.00E+00	0.00E+00	5.65E-09	0.00E+00	1.64E-06
Transformation, to industrial area, vegetation	Raw	m2	0.00E+00	0.00E+00	1.40E-10	0.00E+00	1.86E-08
Transformation, to mineral extraction site	Raw	m2	0.00E+00	0.00E+00	4.73E-07	0.00E+00	3.01E-04
Transformation, to pasture and meadow	Raw	m2	0.00E+00	0.00E+00	1.02E-09	0.00E+00	1.35E-04
Transformation, to permanent crop, fruit, intensive	Raw	m2	0.00E+00	0.00E+00	2.88E-09	0.00E+00	1.11E-07
Transformation, to sea and ocean	Raw	m2	0.00E+00	0.00E+00	5.56E-14	0.00E+00	6.35E-12

Substance	Compart-ment	Unit	Forest operations	Oriented strandboard	Finger-jointed lumber	LVL	I-joists
Transformation, to shrub land, sclerophyllous	Raw	m2	0.00E+00	0.00E+00	6.13E-08	0.00E+00	5.45E-05
Transformation, to traffic area, rail embankment	Raw	m2	0.00E+00	0.00E+00	6.40E-12	0.00E+00	5.25E-10
Transformation, to traffic area, rail network	Raw	m2	0.00E+00	0.00E+00	7.03E-12	0.00E+00	5.77E-10
Transformation, to traffic area, road embankment	Raw	m2	0.00E+00	0.00E+00	7.41E-09	0.00E+00	2.43E-06
Transformation, to traffic area, road network	Raw	m2	0.00E+00	0.00E+00	9.39E-11	0.00E+00	9.95E-09
Transformation, to unknown	Raw	m2	0.00E+00	0.00E+00	4.39E-08	0.00E+00	9.09E-06
Transformation, to urban, discontinuously built	Raw	m2	0.00E+00	0.00E+00	6.73E-15	0.00E+00	6.66E-13
Transformation, to water bodies, artificial	Raw	m2	0.00E+00	0.00E+00	3.18E-07	0.00E+00	8.80E-05
Transformation, to water courses, artificial	Raw	m2	0.00E+00	0.00E+00	2.25E-07	0.00E+00	7.15E-05
Ulexite, in ground	Raw	kg	0.00E+00	0.00E+00	8.26E-13	0.00E+00	8.25E-11
Uranium	Raw	kg	0.00E+00	2.33E-08	2.11E-10	7.59E-03	3.47E-03
Uranium oxide, 332 GJ per kg, in ore	Raw	kg	4.64E-05	3.12E-03	3.33E-04	3.54E-03	1.31E-03
Uranium, 2291 GJ per kg	Raw	kg	0.00E+00	1.80E-06	1.15E-08	9.03E-06	2.22E-07
Uranium, in ground	Raw	kg	0.00E+00	0.00E+00	3.12E-07	0.00E+00	1.19E-04
Vermiculite, in ground	Raw	kg	0.00E+00	0.00E+00	5.48E-13	0.00E+00	3.65E-11
Volume occupied, final repository for low-active radioactive waste	Raw	m3	0.00E+00	0.00E+00	6.44E-10	0.00E+00	2.29E-07
Volume occupied, final repository for radioactive waste	Raw	m3	0.00E+00	0.00E+00	1.63E-10	0.00E+00	5.74E-08
Volume occupied, reservoir	Raw	m3y	0.00E+00	0.00E+00	7.10E-04	0.00E+00	1.49E-01
Volume occupied, underground deposit	Raw	m3	0.00E+00	0.00E+00	5.24E-09	0.00E+00	5.00E-07
Water, consumptive use, unspecified origin/m3	Raw	kg	0.00E+00	1.27E-01	0.00E+00	0.00E+00	0.00E+00
Water, cooling, unspecified natural origin/kg	Raw	kg	0.00E+00	4.45E-01	0.00E+00	1.14E+00	0.00E+00
Water, cooling, unspecified natural origin/m3	Raw	m3	0.00E+00	4.21E-01	3.68E-01	1.67E+00	1.60E+00
Water, lake	Raw	m3	0.00E+00	0.00E+00	7.07E-07	0.00E+00	5.23E-04
Water, process, surface	Raw	kg	0.00E+00	1.54E+02	2.99E+02	8.56E+02	0.00E+00
Water, process, unspecified natural origin/kg	Raw	kg	0.00E+00	8.25E+00	1.05E+00	2.12E+01	0.00E+00
Water, process, unspecified natural origin/m3	Raw	m3	0.00E+00	1.26E-05	4.56E-04	1.93E-04	0.00E+00
Water, process, well	Raw	kg	0.00E+00	2.29E+02	1.39E+02	3.73E+02	0.00E+00
Water, process, well, in ground	Raw	kg	0.00E+00	0.00E+00	1.58E-01	0.00E+00	2.82E+00
Water, river	Raw	m3	0.00E+00	1.09E-05	1.77E-04	1.66E-05	5.29E-02
Water, salt, ocean	Raw	m3	0.00E+00	0.00E+00	1.89E-04	0.00E+00	1.01E-02
Water, salt, sole	Raw	m3	0.00E+00	0.00E+00	3.94E-05	0.00E+00	6.28E+01
Water, turbine use, unspecified natural origin	Raw	m3	0.00E+00	0.00E+00	1.93E-01	0.00E+00	6.09E+01
Water, unspecified natural origin, RoW	Raw	m3	0.00E+00	7.05E-05	6.39E-04	1.21E-03	0.00E+00
Water, unspecified natural origin, US	Raw	m3	0.00E+00	5.42E-04	0.00E+00	1.75E+00	0.00E+00
Water, unspecified natural origin/kg	Raw	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.66E+00
Water, unspecified natural origin/m3	Raw	m3	9.83E-02	1.90E-01	1.07E-03	4.90E-01	2.24E-01
Water, well, in ground	Raw	m3	0.00E+00	6.28E-05	4.58E-05	9.58E-05	1.77E-02
Water, well, in ground, US	Raw	m3	0.00E+00	1.01E-04	0.00E+00	1.23E-02	0.00E+00
Wood and wood waste, 20.9 MJ per kg, ovendry basis	Raw	kg	0.00E+00	8.06E+01	2.13E+02	9.61E+02	0.00E+00
Wood and wood waste, 20.9 MJ/kg,ovendry (burned at kiln)	Raw	kg	0.00E+00	1.40E+00	0.00E+00	0.00E+00	0.00E+00
Wood and wood waste, 20.9 MJ/kg,ovendry (burned at sawmill boiler)	Raw	kg	0.00E+00	2.33E+00	0.00E+00	0.00E+00	0.00E+00
Wood and wood waste, 9.5 MJ per kg	Raw	kg	0.00E+00	2.44E-01	3.00E-01	3.73E-01	9.28E+00
Wood for fiber, feedstock	Raw	kg	0.00E+00	5.24E-01	6.45E-01	8.00E-01	1.99E+01
Wood into sawmill logyard	Raw	m3	0.00E+00	2.74E-02	0.00E+00	0.00E+00	0.00E+00

Substance	Compart-ment	Unit	Forest operations	Oriented strandboard	Finger-jointed lumber	LVL	I-joists
Wood, feedstock	Raw	kg	0.00E+00	5.57E-01	5.05E-03	8.49E-01	0.00E+00
Wood, hard, NE-NC, standing	Raw	m3	9.71E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Wood, hard, standing	Raw	m3	0.00E+00	0.00E+00	1.60E-07	0.00E+00	5.03E-05
Wood, primary forest, standing	Raw	m3	0.00E+00	0.00E+00	5.42E-11	0.00E+00	3.10E-07
Wood, soft, standing	Raw	m3	0.00E+00	1.76E-03	2.00E+00	6.94E+00	1.34E-04
Wood, unspecified, standing/kg	Raw	kg	0.00E+00	0.00E+00	0.00E+00	6.70E-02	0.00E+00
Wood, unspecified, standing/m3	Raw	m3	0.00E+00	0.00E+00	1.31E-12	0.00E+00	4.03E-08
Zinc, 9.0% in sulfide, Zn 5.3%, Pb, Ag, Cd, In, in ground	Raw	kg	0.00E+00	0.00E+00	1.61E-08	0.00E+00	6.31E-05
Zirconium, 50% in zircon, 0.39% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	3.23E-13	0.00E+00	2.51E-11
1-Butanol	Air	kg	0.00E+00	0.00E+00	1.62E-16	0.00E+00	4.14E-05
1-Pentanol	Air	kg	0.00E+00	0.00E+00	1.53E-15	0.00E+00	1.69E-13
1-Pentene	Air	kg	0.00E+00	0.00E+00	1.16E-15	0.00E+00	1.28E-13
1-Propanol	Air	kg	0.00E+00	0.00E+00	1.15E-14	0.00E+00	1.37E-12
1,4-Butanediol	Air	kg	0.00E+00	0.00E+00	1.12E-15	0.00E+00	1.91E-04
2-Aminopropanol	Air	kg	0.00E+00	0.00E+00	2.30E-17	0.00E+00	2.42E-05
2-Butene, 2-methyl-	Air	kg	0.00E+00	0.00E+00	2.57E-19	0.00E+00	2.83E-17
2-Chloroacetophenone	Air	kg	1.72E-11	1.70E-09	2.74E-10	3.16E-09	7.76E-09
2-Methyl-1-propanol	Air	kg	0.00E+00	0.00E+00	2.78E-15	0.00E+00	3.69E-05
2-Methyl-4-chlorophenoxyacetic acid	Air	kg	0.00E+00	6.38E-11	5.79E-13	9.73E-11	0.00E+00
2-Nitrobenzoic acid	Air	kg	0.00E+00	0.00E+00	2.30E-17	0.00E+00	9.90E-05
2-Propanol	Air	kg	0.00E+00	0.00E+00	1.47E-12	0.00E+00	7.93E-05
2,4-D	Air	kg	0.00E+00	3.42E-09	3.10E-11	5.22E-09	0.00E+00
5-methyl Chrysene	Air	kg	1.90E-11	1.05E-09	1.46E-10	1.61E-09	6.25E-10
Acenaphthene	Air	kg	4.40E-10	2.43E-08	3.38E-09	3.73E-08	1.45E-08
Acenaphthylene	Air	kg	2.16E-10	1.19E-08	1.66E-09	1.83E-08	7.10E-09
Acetaldehyde	Air	kg	4.54E-04	1.63E-02	3.93E-02	5.26E-02	3.38E-04
Acetic acid	Air	kg	0.00E+00	0.00E+00	2.08E-06	0.00E+00	2.02E-03
Acetochlor	Air	kg	0.00E+00	4.74E-08	4.30E-10	7.23E-08	0.00E+00
Acetone	Air	kg	0.00E+00	4.85E-03	2.65E-07	4.53E-02	2.31E-04
Acetonitrile	Air	kg	0.00E+00	0.00E+00	5.69E-12	0.00E+00	3.25E-08
Acetophenone	Air	kg	3.68E-11	3.65E-09	5.88E-10	6.77E-09	1.66E-08
Acrolein	Air	kg	5.50E-05	4.79E-03	1.78E-03	7.46E-03	8.50E-06
Acrylic acid	Air	kg	0.00E+00	0.00E+00	3.79E-15	0.00E+00	2.95E-13
Actinides, radioactive, unspecified	Air	Bq	0.00E+00	0.00E+00	5.22E-06	0.00E+00	1.89E-03
Aerosols, radioactive, unspecified	Air	Bq	0.00E+00	0.00E+00	1.37E-04	0.00E+00	4.73E-02
Alachlor	Air	kg	0.00E+00	4.67E-09	4.23E-11	7.12E-09	0.00E+00
Aldehydes, unspecified	Air	kg	1.38E-03	7.17E-04	3.50E-04	2.40E-03	2.74E-03
Aluminium	Air	kg	0.00E+00	0.00E+00	2.07E-06	0.00E+00	3.58E-04
Ammonia	Air	kg	8.99E-04	4.89E-03	7.04E-03	1.29E-02	4.28E-03
Ammonium carbonate	Air	kg	0.00E+00	0.00E+00	3.02E-12	0.00E+00	5.48E-08
Ammonium chloride	Air	kg	2.46E-06	1.66E-04	1.77E-05	1.88E-04	6.95E-05
Aniline	Air	kg	0.00E+00	0.00E+00	8.89E-15	0.00E+00	1.51E-04
Anthracene	Air	kg	1.81E-10	1.00E-08	1.39E-09	1.54E-08	5.97E-09
Anthranilic acid	Air	kg	0.00E+00	0.00E+00	1.68E-17	0.00E+00	4.57E-05
Antimony	Air	kg	1.55E-08	8.86E-07	1.20E-07	1.34E-06	5.81E-07
Antimony-124	Air	Bq	0.00E+00	0.00E+00	6.16E-10	0.00E+00	4.08E-07
Antimony-125	Air	Bq	0.00E+00	0.00E+00	6.43E-09	0.00E+00	4.26E-06
Argon-41	Air	Bq	0.00E+00	0.00E+00	7.30E-02	0.00E+00	2.51E+01
Aromatics	Air	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.26E-05
Arsenic	Air	kg	4.93E-07	2.04E-05	2.87E-06	3.12E-05	1.39E-05
Arsine	Air	kg	0.00E+00	0.00E+00	4.42E-20	0.00E+00	3.44E-18
Ash	Air	kg	0.00E+00	7.99E-05	0.00E+00	0.00E+00	3.06E-07
Atrazine	Air	kg	0.00E+00	9.24E-08	8.38E-10	1.41E-07	0.00E+00
Barium	Air	kg	0.00E+00	4.69E-03	6.62E-07	8.15E-07	2.32E-05
Barium-140	Air	Bq	0.00E+00	0.00E+00	4.18E-07	0.00E+00	2.77E-04
Bentazone	Air	kg	0.00E+00	3.77E-10	3.42E-12	5.75E-10	0.00E+00
Benzal chloride	Air	kg	0.00E+00	0.00E+00	8.22E-21	0.00E+00	1.22E-17
Benzaldehyde	Air	kg	0.00E+00	0.00E+00	2.28E-12	0.00E+00	3.12E-10
Benzene	Air	kg	5.54E-04	1.35E-02	8.91E-05	8.37E-02	1.21E-02
Benzene, 1-methyl-2-nitro-	Air	kg	0.00E+00	0.00E+00	1.99E-17	0.00E+00	8.55E-05

Substance	Compart-ment	Unit	Forest operations	Oriented strandboard	Finger-jointed lumber	LVL	I-joists
Benzene, 1,2-dichloro-	Air	kg	0.00E+00	0.00E+00	2.96E-15	0.00E+00	1.11E-04
Benzene, chloro-	Air	kg	5.40E-11	5.35E-09	8.62E-10	9.94E-09	2.44E-08
Benzene, ethyl-	Air	kg	2.31E-10	4.63E-07	9.15E-08	3.54E-06	2.74E-06
Benzene, hexachloro-	Air	kg	0.00E+00	0.00E+00	1.30E-14	0.00E+00	1.05E-11
Benzene, pentachloro-	Air	kg	0.00E+00	0.00E+00	2.25E-14	0.00E+00	2.19E-11
Benzo(a)anthracene	Air	kg	6.90E-11	3.81E-09	5.30E-10	5.86E-09	2.27E-09
Benzo(a)pyrene	Air	kg	3.28E-11	1.81E-09	7.28E-10	2.78E-09	1.38E-07
Benzo(b,j,k)fluoranthene	Air	kg	9.48E-11	5.24E-09	7.29E-10	8.05E-09	3.13E-09
Benzo(g,h,i)perylene	Air	kg	2.33E-11	1.29E-09	1.79E-10	1.98E-09	7.67E-10
Benzyl chloride	Air	kg	1.72E-09	1.70E-07	2.74E-08	3.16E-07	7.76E-07
Beryllium	Air	kg	2.42E-08	1.12E-06	1.50E-07	1.74E-06	8.12E-07
Biphenyl	Air	kg	1.47E-09	8.10E-08	1.13E-08	1.24E-07	4.83E-08
Boron	Air	kg	0.00E+00	0.00E+00	2.02E-07	0.00E+00	7.49E-05
Boron trifluoride	Air	kg	0.00E+00	0.00E+00	6.05E-22	0.00E+00	4.70E-20
Bromine	Air	kg	0.00E+00	0.00E+00	2.21E-08	0.00E+00	7.76E-06
Bromoform	Air	kg	9.58E-11	9.49E-09	1.53E-09	1.76E-08	4.32E-08
Bromoxynil	Air	kg	0.00E+00	8.27E-10	7.50E-12	1.26E-09	0.00E+00
BTEX (Benzene, Toluene, Ethylbenzene, and Xylene), unspecified ratio	Air	kg	6.15E-04	2.13E-02	3.98E-03	5.06E-02	2.61E-02
Butadiene	Air	kg	2.31E-05	1.40E-07	1.53E-06	7.15E-06	1.65E-07
Butane	Air	kg	0.00E+00	0.00E+00	9.66E-06	0.00E+00	1.77E-04
Butene	Air	kg	0.00E+00	0.00E+00	6.67E-08	0.00E+00	5.66E-04
Butyrolactone	Air	kg	0.00E+00	0.00E+00	2.27E-17	0.00E+00	1.77E-15
Cadmium	Air	kg	1.21E-07	4.11E-06	6.76E-07	6.94E-06	3.57E-06
Calcium	Air	kg	0.00E+00	0.00E+00	3.40E-07	0.00E+00	5.50E-05
Carbofuran	Air	kg	0.00E+00	7.07E-10	6.41E-12	1.08E-09	0.00E+00
Carbon-14	Air	Bq	0.00E+00	0.00E+00	5.57E-01	0.00E+00	1.99E+02
Carbon dioxide	Air	kg	2.68E-01	5.92E+00	1.54E-01	8.85E+00	1.46E+01
Carbon dioxide, biogenic	Air	kg	8.06E-02	8.23E+01	3.75E+02	1.70E+03	1.22E+01
Carbon dioxide, fossil	Air	kg	1.08E+02	4.12E+02	8.37E+01	7.98E+02	4.97E+02
Carbon dioxide, land transformation	Air	kg	0.00E+00	0.00E+00	1.69E-06	0.00E+00	9.94E-04
Carbon disulfide	Air	kg	3.19E-10	1.97E-07	6.00E-07	5.87E-08	2.13E-06
Carbon monoxide	Air	kg	3.84E-05	1.14E-01	3.40E-03	1.08E-01	1.38E-01
Carbon monoxide, biogenic	Air	kg	0.00E+00	8.07E-01	6.87E-01	4.31E+00	4.91E-05
Carbon monoxide, fossil	Air	kg	1.30E+00	4.02E-01	2.08E-01	1.32E+00	1.34E+00
Cerium-141	Air	Bq	0.00E+00	0.00E+00	1.01E-07	0.00E+00	6.72E-05
Cesium-134	Air	Bq	0.00E+00	0.00E+00	4.86E-09	0.00E+00	3.22E-06
Cesium-137	Air	Bq	0.00E+00	0.00E+00	8.61E-08	0.00E+00	5.70E-05
Chloramine	Air	kg	0.00E+00	0.00E+00	5.40E-15	0.00E+00	6.18E-05
Chloride	Air	kg	6.18E-11	1.54E-09	2.87E-10	4.44E-09	1.76E-09
Chlorinated fluorocarbons and hydrochlorinated fluorocarbons, unspecified	Air	kg	0.00E+00	3.24E-07	7.95E-08	2.59E-06	4.64E-06
Chlorine	Air	kg	0.00E+00	1.51E-05	1.23E-06	2.59E-05	1.78E-02
Chloroacetic acid	Air	kg	0.00E+00	0.00E+00	1.29E-14	0.00E+00	3.12E-04
Chloroform	Air	kg	1.45E-10	1.44E-08	2.32E-09	2.66E-08	1.06E-03
Chlorosilane, trimethyl-	Air	kg	0.00E+00	0.00E+00	5.60E-16	0.00E+00	1.88E-13
Chlorosulfonic acid	Air	kg	0.00E+00	0.00E+00	1.63E-16	0.00E+00	4.71E-05
Chlorpyrifos	Air	kg	0.00E+00	5.44E-09	4.93E-11	8.29E-09	0.00E+00
Chromium	Air	kg	3.54E-07	1.45E-05	2.12E-06	2.32E-05	1.39E-05
Chromium-51	Air	Bq	0.00E+00	0.00E+00	6.50E-09	0.00E+00	4.30E-06
Chromium VI	Air	kg	6.81E-08	3.76E-06	5.24E-07	5.78E-06	2.35E-06
Chrysene	Air	kg	8.62E-11	4.76E-09	6.62E-10	7.32E-09	2.84E-09
Cobalt	Air	kg	6.80E-07	6.11E-06	1.09E-06	9.53E-06	5.38E-06
Cobalt-58	Air	Bq	0.00E+00	0.00E+00	9.05E-09	0.00E+00	5.99E-06
Cobalt-60	Air	Bq	0.00E+00	0.00E+00	7.99E-08	0.00E+00	5.29E-05
Copper	Air	kg	6.10E-09	8.57E-07	1.52E-07	3.12E-07	1.41E-05
Cumene	Air	kg	1.30E-11	1.82E-02	3.78E-09	4.68E-02	1.14E-02
Cyanazine	Air	kg	0.00E+00	8.15E-10	7.39E-12	1.24E-09	0.00E+00
Cyanide	Air	kg	6.14E-09	6.08E-07	9.82E-08	1.13E-06	6.25E-05
Cyanoacetic acid	Air	kg	0.00E+00	0.00E+00	1.34E-16	0.00E+00	3.86E-05
Dicamba	Air	kg	0.00E+00	4.80E-09	4.35E-11	7.32E-09	0.00E+00

Substance	Compart-ment	Unit	Forest operations	Oriented strandboard	Finger-jointed lumber	LVL	I-joists
Diethylamine	Air	kg	0.00E+00	0.00E+00	3.96E-15	0.00E+00	1.22E-04
Dimethenamid	Air	kg	0.00E+00	1.13E-08	1.03E-10	1.73E-08	0.00E+00
Dimethyl ether	Air	kg	0.00E+00	1.45E-04	3.46E-06	3.38E-04	3.30E-05
Dimethyl malonate	Air	kg	0.00E+00	0.00E+00	1.68E-16	0.00E+00	4.84E-05
Dinitrogen monoxide	Air	kg	1.83E-03	3.19E-03	1.38E-03	1.09E-02	1.15E-02
Dioxin, 2,3,7,8 Tetrachlorodibenzo-p-	Air	kg	2.19E-12	3.69E-09	3.90E-11	5.63E-09	3.15E-11
Dioxins (unspec.)	Air	kg	0.00E+00	9.14E-15	0.00E+00	0.00E+00	0.00E+00
Dipropylamine	Air	kg	0.00E+00	0.00E+00	2.52E-15	0.00E+00	5.44E-05
Dipropylthiocarbamic acid S-ethyl ester	Air	kg	0.00E+00	7.77E-09	7.04E-11	1.18E-08	0.00E+00
Ethane	Air	kg	0.00E+00	0.00E+00	3.50E-05	0.00E+00	5.63E-04
Ethane, 1,1-difluoro-, HFC-152a	Air	kg	0.00E+00	0.00E+00	2.06E-15	0.00E+00	2.14E-13
Ethane, 1,1,1-trichloro-, HCFC-140	Air	kg	3.24E-09	6.40E-09	1.57E-09	1.44E-08	2.83E-08
Ethane, 1,1,1,2-tetrafluoro-, HFC-134a	Air	kg	0.00E+00	5.08E-07	1.87E-08	0.00E+00	3.26E-07
Ethane, 1,1,2-trichloro-1,2,2-trifluoro-, CFC-113	Air	kg	0.00E+00	0.00E+00	1.80E-16	0.00E+00	1.40E-14
Ethane, 1,2-dibromo-	Air	kg	2.95E-12	2.37E-08	4.93E-11	5.43E-10	1.33E-09
Ethane, 1,2-dichloro-	Air	kg	9.83E-11	9.73E-09	4.09E-09	1.81E-08	2.12E-04
Ethane, 1,2-dichloro-1,1,2-trifluoro-, HCFC-123	Air	kg	0.00E+00	5.08E-07	0.00E+00	0.00E+00	0.00E+00
Ethane, 1,2-dichloro-1,1,2,2-tetrafluoro-, CFC-114	Air	kg	0.00E+00	0.00E+00	2.29E-10	0.00E+00	8.29E-08
Ethane, chloro-	Air	kg	1.03E-10	1.02E-08	1.65E-09	1.90E-08	4.66E-08
Ethane, hexafluoro-, HFC-116	Air	kg	0.00E+00	0.00E+00	1.73E-11	0.00E+00	1.06E-07
Ethanol	Air	kg	0.00E+00	0.00E+00	5.28E-07	0.00E+00	2.46E-04
Ethene	Air	kg	0.00E+00	0.00E+00	1.44E-07	0.00E+00	2.76E-03
Ethene, chloro-	Air	kg	0.00E+00	0.00E+00	1.22E-09	0.00E+00	1.16E-07
Ethene, tetrachloro-	Air	kg	4.46E-08	2.08E-06	2.90E-07	3.20E-06	1.27E-06
Ethene, trichloro-	Air	kg	0.00E+00	1.54E-13	3.52E-11	9.59E-13	5.84E-12
Ethyl acetate	Air	kg	0.00E+00	0.00E+00	6.81E-12	0.00E+00	9.98E-07
Ethyl cellulose	Air	kg	0.00E+00	0.00E+00	1.38E-14	0.00E+00	1.07E-12
Ethylamine	Air	kg	0.00E+00	0.00E+00	1.78E-15	0.00E+00	1.12E-04
Ethylene diamine	Air	kg	0.00E+00	0.00E+00	3.71E-14	0.00E+00	3.97E-12
Ethylene oxide	Air	kg	0.00E+00	4.16E-09	1.50E-07	6.35E-08	2.18E-06
Ethyne	Air	kg	0.00E+00	0.00E+00	1.63E-09	0.00E+00	2.08E-04
Fluoranthene	Air	kg	6.12E-10	3.38E-08	4.70E-09	5.20E-08	2.02E-08
Fluorene	Air	kg	7.85E-10	4.33E-08	6.03E-09	6.66E-08	2.59E-08
Fluoride	Air	kg	3.20E-06	1.46E-05	2.14E-06	2.44E-05	5.10E-05
Fluorine	Air	kg	0.00E+00	0.00E+00	1.61E-08	0.00E+00	5.72E-06
Fluosilicic acid	Air	kg	0.00E+00	0.00E+00	2.02E-11	0.00E+00	1.23E-07
Formaldehyde	Air	kg	7.04E-04	3.80E-02	3.38E-03	3.75E-02	1.24E-02
Formamide	Air	kg	0.00E+00	0.00E+00	2.80E-15	0.00E+00	3.09E-13
Formic acid	Air	kg	0.00E+00	0.00E+00	3.80E-11	0.00E+00	2.18E-07
Furan	Air	kg	3.94E-12	2.30E-10	4.25E-11	3.57E-10	6.19E-08
Glyphosate	Air	kg	0.00E+00	1.02E-08	9.25E-11	1.55E-08	0.00E+00
HAPs	Air	kg	0.00E+00	2.81E-04	1.33E-03	4.84E-03	0.00E+00
HAPS, unspecified	Air	kg	0.00E+00	0.00E+00	3.89E-04	4.37E-07	0.00E+00
Heat, waste	Air	MJ	0.00E+00	1.92E+01	1.25E+01	5.18E+01	3.44E+02
Helium	Air	kg	0.00E+00	0.00E+00	1.25E-07	0.00E+00	3.07E-06
Heptane	Air	kg	0.00E+00	0.00E+00	6.60E-07	0.00E+00	1.58E-05
Hexane	Air	kg	1.65E-10	3.97E-07	1.47E-06	8.51E-04	5.53E-05
Hydrazine, methyl-	Air	kg	4.18E-10	4.13E-08	6.66E-09	7.68E-08	1.88E-07
Hydrocarbons, aliphatic, alkanes, cyclic	Air	kg	0.00E+00	0.00E+00	6.02E-11	0.00E+00	6.18E-06
Hydrocarbons, aliphatic, alkanes, unspecified	Air	kg	0.00E+00	0.00E+00	3.20E-06	0.00E+00	2.56E-03
Hydrocarbons, aliphatic, unsaturated	Air	kg	0.00E+00	0.00E+00	1.01E-07	0.00E+00	6.68E-05
Hydrocarbons, aromatic	Air	kg	0.00E+00	0.00E+00	1.32E-06	0.00E+00	6.55E-05
Hydrocarbons, chlorinated	Air	kg	0.00E+00	0.00E+00	2.47E-09	0.00E+00	1.01E-04
Hydrocarbons, unspecified	Air	kg	1.42E-05	9.58E-04	1.02E-04	2.89E-02	3.47E-02
Hydrogen	Air	kg	0.00E+00	1.95E-05	4.76E-07	2.48E-05	4.19E-03
Hydrogen-3, Tritium	Air	Bq	0.00E+00	0.00E+00	3.24E+00	0.00E+00	1.13E+03
Hydrogen chloride	Air	kg	1.11E-03	5.74E-02	8.22E-03	8.91E-02	3.50E-02
Hydrogen fluoride	Air	kg	1.29E-04	7.13E-03	9.92E-04	1.10E-02	4.34E-03

Substance	Compart-ment	Unit	Forest operations	Oriented strandboard	Finger-jointed lumber	LVL	I-joists
Hydrogen peroxide	Air	kg	0.00E+00	0.00E+00	1.02E-14	0.00E+00	7.94E-13
Hydrogen sulfide	Air	kg	2.00E-12	4.97E-11	5.07E-06	1.43E-10	1.10E-04
Indeno(1,2,3-cd)pyrene	Air	kg	5.26E-11	2.91E-09	4.04E-10	4.47E-09	1.73E-09
Iodine	Air	kg	0.00E+00	0.00E+00	1.18E-08	0.00E+00	4.19E-06
Iodine-129	Air	Bq	0.00E+00	0.00E+00	5.66E-04	0.00E+00	1.98E-01
Iodine-131	Air	Bq	0.00E+00	0.00E+00	2.89E-02	0.00E+00	9.89E+00
Iodine-133	Air	Bq	0.00E+00	0.00E+00	1.15E-06	0.00E+00	5.67E-04
Iodine-135	Air	Bq	0.00E+00	0.00E+00	1.41E-06	0.00E+00	5.11E-04
Iron	Air	kg	0.00E+00	5.34E-07	1.27E-06	8.15E-07	1.71E-04
Isocyanic acid	Air	kg	0.00E+00	0.00E+00	5.35E-04	0.00E+00	4.50E-12
Isophorone	Air	kg	1.42E-09	1.41E-07	2.27E-08	2.62E-07	6.43E-07
Isoprene	Air	kg	2.02E-03	5.04E-02	9.41E-03	1.45E-01	5.77E-02
Isopropylamine	Air	kg	0.00E+00	0.00E+00	1.43E-16	0.00E+00	7.02E-05
Kerosene	Air	kg	1.18E-06	7.94E-05	8.46E-06	9.00E-05	3.33E-05
Krypton-85	Air	Bq	0.00E+00	0.00E+00	2.29E-01	0.00E+00	7.85E+01
Krypton-85m	Air	Bq	0.00E+00	0.00E+00	9.69E-03	0.00E+00	5.24E+00
Krypton-87	Air	Bq	0.00E+00	0.00E+00	4.12E-03	0.00E+00	1.84E+00
Krypton-88	Air	Bq	0.00E+00	0.00E+00	3.95E-03	0.00E+00	1.92E+00
Krypton-89	Air	Bq	0.00E+00	0.00E+00	9.34E-04	0.00E+00	5.61E-01
Lactic acid	Air	kg	0.00E+00	0.00E+00	1.97E-15	0.00E+00	4.26E-05
Lanthanum-140	Air	Bq	0.00E+00	0.00E+00	3.57E-08	0.00E+00	2.37E-05
Lead	Air	kg	5.46E-07	3.12E-05	4.05E-05	1.70E-04	2.55E-05
Lead-210	Air	Bq	0.00E+00	0.00E+00	3.14E-03	0.00E+00	1.82E+00
m-Xylene	Air	kg	0.00E+00	0.00E+00	6.47E-10	0.00E+00	2.04E-07
Magnesium	Air	kg	9.48E-06	5.24E-04	7.30E-05	8.05E-04	3.64E-04
Manganese	Air	kg	7.35E-07	3.13E-05	4.86E-06	4.51E-05	5.99E-05
Manganese-54	Air	Bq	0.00E+00	0.00E+00	3.33E-09	0.00E+00	2.20E-06
Mercaptans, unspecified	Air	kg	5.28E-07	5.27E-05	8.49E-06	9.79E-05	2.41E-04
Mercury	Air	kg	9.68E-08	6.27E-06	1.08E-06	1.36E-05	8.42E-06
Metals, unspecified	Air	kg	2.29E-13	9.34E-05	8.47E-07	1.42E-04	4.35E-10
Methacrylic acid	Air	kg	0.00E+00	2.13E-09	0.00E+00	0.00E+00	0.00E+00
Methane	Air	kg	1.48E-01	1.19E+00	2.23E-01	2.60E+00	1.43E+00
Methane, biogenic	Air	kg	0.00E+00	9.97E-04	4.74E-03	1.72E-02	5.30E-04
Methane, bromo-, Halon 1001	Air	kg	3.93E-10	3.90E-08	6.27E-09	7.23E-08	1.77E-07
Methane, bromochlorodifluoro-, Halon 1211	Air	kg	0.00E+00	0.00E+00	1.06E-08	0.00E+00	1.38E-07
Methane, bromotrifluoro-, Halon 1301	Air	kg	0.00E+00	0.00E+00	1.73E-09	0.00E+00	4.16E-08
Methane, chlorodifluoro-, HCFC-22	Air	kg	0.00E+00	6.56E-06	3.66E-08	5.28E-13	5.25E-07
Methane, chlorotrifluoro-, CFC-13	Air	kg	0.00E+00	1.20E-07	1.19E-11	5.01E-12	0.00E+00
Methane, dichloro-, HCC-30	Air	kg	7.56E-07	1.65E-05	2.22E-06	2.54E-05	1.01E-04
Methane, dichlorodifluoro-, CFC-12	Air	kg	3.95E-09	1.90E-09	1.10E-09	6.64E-09	1.99E-06
Methane, dichlorofluoro-, HCFC-21	Air	kg	0.00E+00	0.00E+00	1.20E-18	0.00E+00	9.42E-17
Methane, fossil	Air	kg	1.32E-02	2.77E-01	2.67E-02	2.98E-01	2.28E-01
Methane, monochloro-, R-40	Air	kg	1.30E-09	1.29E-07	2.08E-08	2.39E-07	5.88E-07
Methane, tetrachloro-, CFC-10	Air	kg	3.95E-10	1.49E-06	1.20E-09	2.65E-06	1.08E-04
Methane, tetrafluoro-, CFC-14	Air	kg	0.00E+00	0.00E+00	1.56E-10	0.00E+00	9.50E-07
Methane, trichlorofluoro-, CFC-11	Air	kg	0.00E+00	0.00E+00	1.95E-18	0.00E+00	1.53E-16
Methane, trifluoro-, HFC-23	Air	kg	0.00E+00	0.00E+00	3.83E-16	0.00E+00	3.00E-14
Methanesulfonic acid	Air	kg	0.00E+00	0.00E+00	1.35E-16	0.00E+00	3.90E-05
Methanol	Air	kg	0.00E+00	7.42E-02	3.10E-02	5.18E-01	3.55E-02
Methyl acetate	Air	kg	0.00E+00	0.00E+00	5.32E-18	0.00E+00	2.29E-05
Methyl acrylate	Air	kg	0.00E+00	0.00E+00	4.30E-15	0.00E+00	3.35E-13
Methyl amine	Air	kg	0.00E+00	0.00E+00	6.20E-16	0.00E+00	1.20E-05
Methyl borate	Air	kg	0.00E+00	0.00E+00	5.68E-16	0.00E+00	3.96E-06
Methyl ethyl ketone	Air	kg	9.58E-10	9.49E-08	1.53E-08	1.76E-07	4.33E-07
Methyl formate	Air	kg	0.00E+00	0.00E+00	1.42E-06	0.00E+00	8.29E-14
Methyl lactate	Air	kg	0.00E+00	0.00E+00	2.16E-15	0.00E+00	4.68E-05
Methyl methacrylate	Air	kg	4.91E-11	2.74E-09	7.84E-10	9.03E-09	2.22E-08
Methylene diisocyanate	Air	kg	0.00E+00	2.24E-04	0.00E+00	0.00E+00	0.00E+00
Metolachlor	Air	kg	0.00E+00	3.75E-08	3.40E-10	5.71E-08	0.00E+00
Metribuzin	Air	kg	0.00E+00	1.74E-10	1.58E-12	2.65E-10	0.00E+00
Molybdenum	Air	kg	0.00E+00	0.00E+00	2.92E-08	0.00E+00	4.79E-07

Substance	Compart-ment	Unit	Forest operations	Oriented strandboard	Finger-jointed lumber	LVL	I-joists
Monoethanolamine	Air	kg	0.00E+00	0.00E+00	3.73E-11	0.00E+00	1.32E-03
N-Nitrodimethylamine	Air	kg	0.00E+00	4.18E-03	7.86E-12	2.14E-13	1.61E-05
Naphthalene	Air	kg	1.41E-07	4.72E-06	1.29E-05	4.84E-05	1.25E-05
Nickel	Air	kg	8.61E-06	3.36E-05	7.35E-06	5.40E-05	4.94E-05
Nickel compounds	Air	kg	0.00E+00	6.56E-06	0.00E+00	0.00E+00	0.00E+00
Niobium-95	Air	Bq	0.00E+00	0.00E+00	3.95E-10	0.00E+00	2.62E-07
Nitrate	Air	kg	0.00E+00	0.00E+00	3.06E-09	0.00E+00	1.07E-06
Nitric oxide	Air	kg	0.00E+00	1.24E-04	0.00E+00	0.00E+00	0.00E+00
Nitrobenzene	Air	kg	0.00E+00	0.00E+00	1.19E-14	0.00E+00	4.05E-04
Nitrogen oxides	Air	kg	1.94E+00	1.69E+00	6.05E-01	4.03E+00	1.99E+00
Nitrogen, total	Air	kg	6.05E-05	4.58E-09	4.16E-11	6.99E-09	0.00E+00
Nitrous oxide	Air	kg	0.00E+00	6.46E-06	0.00E+00	0.00E+00	3.23E-02
NMVOC, non-methane volatile organic compounds, unspecified origin	Air	kg	6.69E-02	8.94E-02	2.05E-02	2.05E-01	1.59E-01
Noble gases, radioactive, unspecified	Air	Bq	0.00E+00	0.00E+00	5.43E+03	0.00E+00	1.90E+06
Organic acids	Air	kg	9.05E-09	6.09E-07	6.49E-08	6.91E-07	2.55E-07
Organic substances, unspecified	Air	kg	5.35E-06	3.38E-03	1.65E-03	3.49E-03	1.28E-03
Other Organic	Air	kg	0.00E+00	9.46E-06	4.49E-05	1.63E-04	0.00E+00
Ozone	Air	kg	0.00E+00	0.00E+00	2.06E-07	0.00E+00	6.87E-05
PAH, polycyclic aromatic hydrocarbons	Air	kg	9.34E-05	5.65E-07	6.60E-06	1.26E-04	1.67E-04
Paraquat	Air	kg	0.00E+00	7.59E-10	6.88E-12	1.16E-09	0.00E+00
Parathion, methyl	Air	kg	0.00E+00	5.73E-10	5.20E-12	8.74E-10	0.00E+00
Particulates	Air	kg	0.00E+00	6.42E-05	2.53E-06	1.65E-04	4.35E-05
Particulates, < 10 um	Air	kg	0.00E+00	3.11E-01	1.00E-01	1.08E+00	4.74E-03
Particulates, < 2.5 um	Air	kg	0.00E+00	1.77E-01	4.25E-02	5.60E-01	3.03E-03
Particulates, > 10 um	Air	kg	0.00E+00	1.77E-03	4.03E-02	2.55E-03	6.72E-03
Particulates, > 2.5 um, and < 10um	Air	kg	5.76E-02	2.59E-02	1.02E-02	7.11E-02	4.66E-02
Particulates, unspecified	Air	kg	1.09E-02	1.68E-01	2.43E-02	7.19E-01	1.26E-01
Pendimethalin	Air	kg	0.00E+00	3.90E-09	3.54E-11	5.94E-09	0.00E+00
Pentane	Air	kg	0.00E+00	0.00E+00	1.17E-05	0.00E+00	1.96E-04
Permethrin	Air	kg	0.00E+00	3.50E-10	3.18E-12	5.34E-10	0.00E+00
PFC (perfluorocarbons)	Air	kg	0.00E+00	6.56E-05	0.00E+00	0.00E+00	0.00E+00
Phenanthrene	Air	kg	2.33E-09	1.29E-07	1.79E-08	1.98E-07	7.67E-08
Phenol	Air	kg	3.93E-11	6.23E-03	1.38E-04	1.43E-03	3.25E-01
Phenol, 2,4-dichloro-	Air	kg	0.00E+00	0.00E+00	5.69E-16	0.00E+00	6.20E-05
Phenol, pentachloro-	Air	kg	0.00E+00	0.00E+00	1.56E-10	0.00E+00	5.35E-08
Phenols, unspecified	Air	kg	3.95E-07	2.43E-06	3.26E-07	3.78E-06	2.74E-06
Phorate	Air	kg	0.00E+00	1.80E-10	1.63E-12	2.74E-10	0.00E+00
Phosphate	Air	kg	1.39E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phosphine	Air	kg	0.00E+00	0.00E+00	3.28E-18	0.00E+00	2.55E-16
Phosphorus	Air	kg	0.00E+00	0.00E+00	2.30E-09	0.00E+00	2.72E-05
Phthalate, diisooctyl-	Air	kg	0.00E+00	7.78E-09	0.00E+00	0.00E+00	0.00E+00
Phthalate, dioctyl-	Air	kg	1.79E-10	9.98E-09	2.86E-09	3.30E-08	8.09E-08
Platinum	Air	kg	0.00E+00	0.00E+00	8.22E-15	0.00E+00	2.87E-12
Plutonium-238	Air	Bq	0.00E+00	0.00E+00	7.71E-11	0.00E+00	2.70E-08
Plutonium-alpha	Air	Bq	0.00E+00	0.00E+00	1.77E-10	0.00E+00	6.18E-08
Polonium-210	Air	Bq	0.00E+00	0.00E+00	5.54E-03	0.00E+00	3.03E+00
Polychlorinated biphenyls	Air	kg	0.00E+00	0.00E+00	1.13E-14	0.00E+00	2.89E-12
Polycyclic organic matter, unspecified	Air	kg	0.00E+00	3.05E-07	3.02E-11	1.27E-11	0.00E+00
Potassium	Air	kg	0.00E+00	9.47E-05	1.17E-04	1.44E-04	3.67E-03
Potassium-40	Air	Bq	0.00E+00	0.00E+00	7.12E-04	0.00E+00	3.79E-01
Propanal	Air	kg	9.33E-10	6.13E-06	2.96E-04	1.47E-02	6.62E-05
Propane	Air	kg	0.00E+00	0.00E+00	1.45E-05	0.00E+00	2.90E-04
Propene	Air	kg	1.53E-03	6.70E-03	1.01E-04	1.77E-02	4.51E-03
Propionic acid	Air	kg	0.00E+00	0.00E+00	1.35E-07	0.00E+00	1.96E-04
Propylamine	Air	kg	0.00E+00	0.00E+00	8.87E-16	0.00E+00	9.78E-14
Propylene glycol	Air	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.84E-02
Propylene oxide	Air	kg	0.00E+00	1.86E-07	1.04E-10	3.16E-06	3.34E-05
Protactinium-234	Air	Bq	0.00E+00	0.00E+00	7.68E-05	0.00E+00	2.73E-02
Pyrene	Air	kg	2.85E-10	1.57E-08	2.19E-09	2.42E-08	9.38E-09
Radioactive species, other beta emitters	Air	Bq	0.00E+00	0.00E+00	1.77E-04	0.00E+00	6.23E-02
Radioactive species, unspecified	Air	Bq	4.87E+04	2.68E+06	3.73E+05	4.12E+06	1.55E+06

Substance	Compart-ment	Unit	Forest operations	Oriented strandboard	Finger-jointed lumber	LVL	I-joists
Radionuclides (Including Radon)	Air	kg	6.60E-05	4.44E-03	4.73E-04	5.03E-03	1.86E-03
Radium-226	Air	Bq	0.00E+00	0.00E+00	3.27E-03	0.00E+00	1.84E+00
Radium-228	Air	Bq	0.00E+00	0.00E+00	4.62E-04	0.00E+00	7.95E-01
Radon-220	Air	Bq	0.00E+00	0.00E+00	3.10E-02	0.00E+00	1.06E+01
Radon-222	Air	Bq	0.00E+00	0.00E+00	1.02E+04	0.00E+00	3.61E+06
Ruthenium-103	Air	Bq	0.00E+00	0.00E+00	8.68E-11	0.00E+00	5.75E-08
Scandium	Air	kg	0.00E+00	0.00E+00	9.33E-10	0.00E+00	3.44E-07
Selenium	Air	kg	1.20E-06	6.26E-05	8.71E-06	9.63E-05	3.89E-05
Silicon	Air	kg	0.00E+00	0.00E+00	1.09E-07	0.00E+00	1.95E-04
Silicon tetrafluoride	Air	kg	0.00E+00	0.00E+00	2.07E-12	0.00E+00	2.75E-10
Silver	Air	kg	0.00E+00	0.00E+00	4.82E-11	0.00E+00	1.38E-08
Silver-110	Air	Bq	0.00E+00	0.00E+00	8.60E-10	0.00E+00	5.70E-07
Simazine	Air	kg	0.00E+00	2.46E-09	2.23E-11	3.75E-09	0.00E+00
Sodium	Air	kg	0.00E+00	2.19E-06	4.04E-06	3.33E-06	1.06E-04
Sodium chlorate	Air	kg	0.00E+00	0.00E+00	2.95E-11	0.00E+00	3.21E-09
Sodium dichromate	Air	kg	0.00E+00	0.00E+00	3.02E-14	0.00E+00	1.50E-08
Sodium formate	Air	kg	0.00E+00	0.00E+00	1.41E-12	0.00E+00	6.60E-10
Sodium hydroxide	Air	kg	0.00E+00	0.00E+00	3.80E-14	0.00E+00	2.96E-12
Strontium	Air	kg	0.00E+00	0.00E+00	4.30E-09	0.00E+00	3.37E-06
Styrene	Air	kg	6.14E-11	6.08E-09	9.89E-10	1.13E-08	1.52E-07
Sulfate	Air	kg	0.00E+00	0.00E+00	3.50E-07	0.00E+00	5.98E-03
Sulfur	Air	kg	0.00E+00	1.15E-05	1.04E-07	1.76E-05	0.00E+00
Sulfur dioxide	Air	kg	7.04E-02	3.13E+00	5.00E-01	5.97E+00	3.00E+00
Sulfur hexafluoride	Air	kg	0.00E+00	0.00E+00	2.49E-09	0.00E+00	9.74E-07
Sulfur monoxide	Air	kg	1.03E-01	4.49E-02	9.00E-03	1.26E-01	1.93E-01
Sulfur oxides	Air	kg	7.79E-03	5.23E-02	2.34E-02	8.40E-02	7.88E-02
Sulfur trioxide	Air	kg	0.00E+00	0.00E+00	9.57E-14	0.00E+00	2.31E-03
Sulfur, total reduced	Air	kg	0.00E+00	6.76E-06	8.31E-06	1.03E-05	2.57E-04
Sulfuric acid	Air	kg	0.00E+00	6.56E-08	7.97E-15	0.00E+00	6.20E-13
Sulfuric acid, dimethyl ester	Air	kg	1.18E-10	1.17E-08	1.88E-09	2.17E-08	5.32E-08
t-Butyl methyl ether	Air	kg	8.60E-11	8.52E-09	1.37E-09	1.58E-08	3.91E-08
t-Butylamine	Air	kg	0.00E+00	0.00E+00	2.49E-16	0.00E+00	6.76E-05
Tar	Air	kg	6.95E-11	1.73E-09	3.23E-10	4.99E-09	1.98E-09
Terbufos	Air	kg	0.00E+00	6.13E-09	5.56E-11	9.34E-09	0.00E+00
Terpenes	Air	kg	0.00E+00	0.00E+00	4.74E-12	0.00E+00	2.71E-08
Thallium	Air	kg	0.00E+00	0.00E+00	7.17E-12	0.00E+00	1.75E-08
Thorium	Air	kg	0.00E+00	0.00E+00	6.11E-12	0.00E+00	2.09E-08
Thorium-228	Air	Bq	0.00E+00	0.00E+00	1.54E-04	0.00E+00	1.07E-01
Thorium-230	Air	Bq	0.00E+00	0.00E+00	2.87E-04	0.00E+00	6.48E-01
Thorium-232	Air	Bq	0.00E+00	0.00E+00	2.26E-04	0.00E+00	1.21E-01
Thorium-234	Air	Bq	0.00E+00	0.00E+00	7.68E-05	0.00E+00	2.73E-02
Tin	Air	kg	0.00E+00	0.00E+00	5.08E-10	0.00E+00	3.06E-08
Titanium	Air	kg	0.00E+00	0.00E+00	1.82E-08	0.00E+00	1.02E-05
TOC, Total Organic Carbon	Air	kg	0.00E+00	1.01E-02	8.10E-08	1.36E-05	0.00E+00
Toluene	Air	kg	2.42E-04	1.49E-03	1.81E-05	8.87E-05	1.27E-03
Toluene, 2-chloro-	Air	kg	0.00E+00	0.00E+00	3.55E-15	0.00E+00	1.85E-04
Toluene, 2,4-dinitro-	Air	kg	6.88E-13	6.81E-11	1.10E-11	1.26E-10	3.10E-10
Trichloroethane	Air	kg	0.00E+00	5.19E-08	0.00E+00	0.00E+00	0.00E+00
Trimethylamine	Air	kg	0.00E+00	0.00E+00	9.51E-18	0.00E+00	4.62E-15
Tungsten	Air	kg	0.00E+00	0.00E+00	1.05E-10	0.00E+00	3.73E-08
Uranium	Air	kg	0.00E+00	0.00E+00	8.13E-12	0.00E+00	2.76E-08
Uranium-234	Air	Bq	0.00E+00	0.00E+00	8.96E-04	0.00E+00	8.64E-01
Uranium-235	Air	Bq	0.00E+00	0.00E+00	4.33E-05	0.00E+00	1.54E-02
Uranium-238	Air	Bq	0.00E+00	0.00E+00	1.45E-03	0.00E+00	1.16E+00
Uranium alpha	Air	Bq	0.00E+00	0.00E+00	4.17E-03	0.00E+00	1.48E+00
Vanadium	Air	kg	0.00E+00	0.00E+00	4.55E-06	0.00E+00	2.92E-05
Vinyl acetate	Air	kg	1.87E-11	1.85E-09	2.98E-10	3.43E-09	8.42E-09
VOC, volatile organic compounds	Air	kg	5.69E-02	7.16E-01	4.20E-01	2.81E+00	2.96E-01
Water	Air	kg	0.00E+00	0.00E+00	2.56E-06	0.00E+00	2.27E-04
Wood (dust)	Air	kg	0.00E+00	2.59E-02	1.38E-01	5.06E-01	0.00E+00
Xenon-131m	Air	Bq	0.00E+00	0.00E+00	1.87E-02	0.00E+00	8.66E+00
Xenon-133	Air	Bq	0.00E+00	0.00E+00	5.89E-01	0.00E+00	2.84E+02

Substance	Compart-ment	Unit	Forest operations	Oriented strandboard	Finger-jointed lumber	LVL	I-joists
Xenon-133m	Air	Bq	0.00E+00	0.00E+00	2.71E-03	0.00E+00	1.00E+00
Xenon-135	Air	Bq	0.00E+00	0.00E+00	2.42E-01	0.00E+00	1.16E+02
Xenon-135m	Air	Bq	0.00E+00	0.00E+00	1.42E-01	0.00E+00	6.93E+01
Xenon-137	Air	Bq	0.00E+00	0.00E+00	2.56E-03	0.00E+00	1.54E+00
Xenon-138	Air	Bq	0.00E+00	0.00E+00	2.32E-02	0.00E+00	1.29E+01
Xylene	Air	kg	1.69E-04	8.68E-04	1.17E-05	5.88E-05	5.44E-05
Zinc	Air	kg	1.12E-06	1.31E-06	7.63E-07	1.02E-06	3.50E-05
Zinc-65	Air	Bq	0.00E+00	0.00E+00	1.66E-08	0.00E+00	1.10E-05
Zirconium	Air	kg	0.00E+00	0.00E+00	2.32E-14	0.00E+00	2.60E-09
Zirconium-95	Air	Bq	0.00E+00	0.00E+00	1.62E-08	0.00E+00	1.08E-05
1-Butanol	Water	kg	0.00E+00	0.00E+00	1.51E-07	0.00E+00	1.73E-04
1-Pentanol	Water	kg	0.00E+00	0.00E+00	3.68E-15	0.00E+00	4.05E-13
1-Pentene	Water	kg	0.00E+00	0.00E+00	2.78E-15	0.00E+00	3.06E-13
1-Propanol	Water	kg	0.00E+00	0.00E+00	5.07E-15	0.00E+00	5.84E-13
1,4-Butanediol	Water	kg	0.00E+00	0.00E+00	4.47E-16	0.00E+00	7.63E-05
2-Aminopropanol	Water	kg	0.00E+00	0.00E+00	5.66E-17	0.00E+00	9.80E-05
2-Hexanone	Water	kg	8.41E-07	2.20E-06	5.29E-07	5.58E-06	3.71E-06
2-Methyl-1-propanol	Water	kg	0.00E+00	0.00E+00	6.66E-15	0.00E+00	8.87E-05
2-Methyl-2-butene	Water	kg	0.00E+00	0.00E+00	6.16E-19	0.00E+00	6.79E-17
2-Methyl-4-chlorophenoxyacetic acid	Water	kg	0.00E+00	2.74E-12	2.48E-14	4.17E-12	0.00E+00
2-Propanol	Water	kg	0.00E+00	6.35E-09	7.81E-09	9.69E-09	3.89E-04
2,4-D	Water	kg	0.00E+00	1.47E-10	1.33E-12	2.24E-10	0.00E+00
4-Methyl-2-pentanone	Water	kg	5.41E-07	1.41E-06	3.41E-07	3.59E-06	2.39E-06
Acenaphthene	Water	kg	0.00E+00	0.00E+00	1.96E-11	0.00E+00	4.67E-10
Acenaphthylene	Water	kg	0.00E+00	0.00E+00	1.23E-12	0.00E+00	2.92E-11
Acetaldehyde	Water	kg	0.00E+00	4.38E-09	3.99E-07	6.68E-08	2.79E-03
Acetic acid	Water	kg	0.00E+00	0.00E+00	6.29E-10	0.00E+00	1.05E-02
Acetochlor	Water	kg	0.00E+00	2.03E-09	1.84E-11	3.10E-09	0.00E+00
Acetone	Water	kg	1.29E-06	3.35E-06	8.11E-07	8.54E-06	2.16E-04
Acetonitrile	Water	kg	0.00E+00	0.00E+00	1.12E-16	0.00E+00	3.23E-05
Acetyl chloride	Water	kg	0.00E+00	0.00E+00	2.89E-15	0.00E+00	3.18E-13
Acidity, unspecified	Water	kg	0.00E+00	2.16E-04	1.63E-10	3.47E-14	2.01E-05
Acids, unspecified	Water	kg	1.30E-09	9.05E-06	3.76E-06	1.38E-05	1.14E-04
Acrylate, ion	Water	kg	0.00E+00	0.00E+00	8.98E-15	0.00E+00	6.98E-13
Actinides, radioactive, unspecified	Water	Bq	0.00E+00	0.00E+00	9.19E-04	0.00E+00	3.21E-01
Alachlor	Water	kg	0.00E+00	2.00E-10	1.81E-12	3.05E-10	0.00E+00
Aluminium	Water	kg	1.10E-02	1.20E-02	3.83E-03	3.18E-02	4.26E-02
Ammonia	Water	kg	2.40E-03	4.99E-03	1.31E-03	1.22E-02	8.81E-03
Ammonia, as N	Water	kg	6.52E-10	1.62E-08	1.99E-04	4.68E-08	1.86E-08
Ammonium, ion	Water	kg	5.27E-07	8.68E-05	4.25E-04	9.27E-04	4.05E-02
Aniline	Water	kg	0.00E+00	0.00E+00	2.13E-14	0.00E+00	6.12E-04
Antimony	Water	kg	6.86E-06	6.55E-06	2.28E-06	1.87E-05	3.85E-05
Antimony-122	Water	Bq	0.00E+00	0.00E+00	2.48E-07	0.00E+00	1.65E-04
Antimony-124	Water	Bq	0.00E+00	0.00E+00	1.48E-04	0.00E+00	5.47E-02
Antimony-125	Water	Bq	0.00E+00	0.00E+00	1.36E-04	0.00E+00	5.02E-02
AOX, Adsorbable Organic Halogen as Cl	Water	kg	0.00E+00	0.00E+00	2.81E-09	0.00E+00	8.14E-06
Arsenic	Water	kg	3.78E-05	7.85E-05	1.97E-05	2.01E-04	1.39E-04
Arsenic, ion	Water	kg	0.00E+00	0.00E+00	1.52E-07	0.00E+00	3.60E-05
Atrazine	Water	kg	0.00E+00	3.96E-09	3.59E-11	6.04E-09	0.00E+00
Barite	Water	kg	0.00E+00	0.00E+00	4.12E-10	0.00E+00	4.61E-08
Barium	Water	kg	1.51E-01	1.54E-01	5.13E-02	4.35E-01	3.81E-01
Barium-140	Water	Bq	0.00E+00	0.00E+00	1.09E-06	0.00E+00	7.21E-04
Bentazone	Water	kg	0.00E+00	1.62E-11	1.47E-13	2.46E-11	0.00E+00
Benzene	Water	kg	2.16E-04	3.04E-02	1.36E-04	7.81E-02	3.47E-02
Benzene, 1-methyl-4-(1-methylethyl)-	Water	kg	1.29E-08	3.34E-08	8.10E-09	8.53E-08	5.67E-08
Benzene, 1,2-dichloro-	Water	kg	0.00E+00	0.00E+00	3.05E-14	0.00E+00	9.23E-04
Benzene, chloro-	Water	kg	0.00E+00	0.00E+00	4.90E-13	0.00E+00	1.37E-02
Benzene, ethyl-	Water	kg	1.22E-05	3.16E-05	7.73E-06	8.06E-05	5.55E-05
Benzene, pentamethyl-	Water	kg	9.65E-09	2.51E-08	6.08E-09	6.40E-08	4.26E-08
Benzenes, alkylated, unspecified	Water	kg	6.02E-06	6.27E-06	1.97E-06	1.64E-05	1.47E-05
Benzo(a)pyrene	Water	kg	0.00E+00	5.98E-13	4.86E-08	1.01E-09	0.00E+00
Benzoic acid	Water	kg	1.31E-04	3.41E-04	8.22E-05	8.66E-04	5.76E-04

Substance	Compart-ment	Unit	Forest operations	Oriented strandboard	Finger-jointed lumber	LVL	I-joists
Beryllium	Water	kg	1.96E-06	3.70E-06	1.01E-06	9.67E-06	1.70E-05
Biphenyl	Water	kg	3.90E-07	4.06E-07	1.28E-07	1.06E-06	9.53E-07
BOD5, Biological Oxygen Demand	Water	kg	2.35E-02	3.46E-01	2.63E-02	8.78E-01	4.52E-01
Borate	Water	kg	0.00E+00	0.00E+00	2.80E-13	0.00E+00	5.56E-03
Boron	Water	kg	4.04E-04	1.06E-03	2.57E-04	2.68E-03	2.02E-03
Bromate	Water	kg	0.00E+00	0.00E+00	1.65E-09	0.00E+00	7.57E-04
Bromide	Water	kg	2.76E-02	7.17E-02	1.74E-02	1.83E-01	2.63E-01
Bromine	Water	kg	0.00E+00	0.00E+00	2.22E-06	0.00E+00	7.31E-05
Bromoxynil	Water	kg	0.00E+00	2.14E-11	1.94E-13	3.26E-11	0.00E+00
Butene	Water	kg	0.00E+00	0.00E+00	1.66E-09	0.00E+00	2.79E-04
Butyl acetate	Water	kg	0.00E+00	0.00E+00	1.96E-07	0.00E+00	9.28E-06
Butyrolactone	Water	kg	0.00E+00	0.00E+00	5.45E-17	0.00E+00	4.24E-15
Cadmium	Water	kg	6.07E-06	1.19E-05	2.93E-06	5.38E-05	2.05E-05
Cadmium, ion	Water	kg	0.00E+00	0.00E+00	5.17E-08	0.00E+00	4.76E-06
Calcium	Water	kg	4.14E-01	1.08E+00	2.61E-01	2.74E+00	1.82E+00
Calcium, ion	Water	kg	0.00E+00	0.00E+00	5.67E-04	0.00E+00	1.99E-01
Carbofuran	Water	kg	0.00E+00	3.03E-11	2.75E-13	4.62E-11	0.00E+00
Carbon disulfide	Water	kg	0.00E+00	0.00E+00	1.77E-13	0.00E+00	1.97E-11
Carbonate	Water	kg	0.00E+00	0.00E+00	1.21E-08	0.00E+00	6.72E-02
Carboxylic acids, unspecified	Water	kg	0.00E+00	0.00E+00	1.36E-05	0.00E+00	3.22E-04
Cerium-141	Water	Bq	0.00E+00	0.00E+00	4.35E-07	0.00E+00	2.88E-04
Cerium-144	Water	Bq	0.00E+00	0.00E+00	1.32E-07	0.00E+00	8.77E-05
Cesium	Water	kg	0.00E+00	0.00E+00	3.16E-09	0.00E+00	7.50E-08
Cesium-134	Water	Bq	0.00E+00	0.00E+00	1.27E-04	0.00E+00	4.41E-02
Cesium-136	Water	Bq	0.00E+00	0.00E+00	7.72E-08	0.00E+00	5.11E-05
Cesium-137	Water	Bq	0.00E+00	0.00E+00	1.06E-01	0.00E+00	3.70E+01
CFCs, unspecified	Water	kg	0.00E+00	6.35E-09	7.81E-09	9.69E-09	4.60E-07
Chloramine	Water	kg	0.00E+00	0.00E+00	4.82E-14	0.00E+00	9.31E-04
Chlorate	Water	kg	0.00E+00	0.00E+00	1.41E-08	0.00E+00	5.78E-03
Chloride	Water	kg	4.65E+00	1.21E+01	2.93E+00	3.09E+01	2.33E+01
Chlorinated solvents, unspecified	Water	kg	0.00E+00	0.00E+00	5.55E-11	0.00E+00	3.95E-06
Chlorine	Water	kg	0.00E+00	0.00E+00	3.85E-10	0.00E+00	2.81E-07
Chloroacetic acid	Water	kg	0.00E+00	0.00E+00	2.47E-12	0.00E+00	2.51E-02
Chloroacetyl chloride	Water	kg	0.00E+00	0.00E+00	7.54E-17	0.00E+00	1.31E-04
Chloroform	Water	kg	0.00E+00	1.37E-08	2.04E-15	0.00E+00	1.15E-04
Chlorosulfonic acid	Water	kg	0.00E+00	0.00E+00	4.07E-16	0.00E+00	1.17E-04
Chlorpyrifos	Water	kg	0.00E+00	2.33E-10	2.11E-12	3.55E-10	0.00E+00
Chromate	Water	kg	0.00E+00	8.46E-13	3.34E-11	1.96E-12	3.21E-11
Chromium	Water	kg	2.95E-04	1.68E-04	8.69E-05	6.39E-04	6.29E-04
Chromium-51	Water	Bq	0.00E+00	0.00E+00	1.48E-04	0.00E+00	7.60E-02
Chromium III	Water	kg	2.11E-05	1.29E-04	1.52E-05	2.09E-04	1.33E-04
Chromium VI	Water	kg	1.22E-06	5.85E-07	4.55E-07	2.05E-06	6.62E-05
Chromium, ion	Water	kg	0.00E+00	0.00E+00	8.91E-09	0.00E+00	3.74E-06
Cobalt	Water	kg	2.85E-06	7.45E-06	2.42E-06	1.89E-05	1.62E-04
Cobalt-57	Water	Bq	0.00E+00	0.00E+00	2.45E-06	0.00E+00	1.62E-03
Cobalt-58	Water	Bq	0.00E+00	0.00E+00	1.15E-03	0.00E+00	4.99E-01
Cobalt-60	Water	Bq	0.00E+00	0.00E+00	8.92E-04	0.00E+00	4.01E-01
COD, Chemical Oxygen Demand	Water	kg	4.46E-02	3.98E-01	3.37E-02	1.00E+00	5.56E-01
Copper	Water	kg	3.82E-05	8.93E-05	1.93E-05	1.88E-04	1.28E-04
Copper, ion	Water	kg	0.00E+00	0.00E+00	6.44E-07	0.00E+00	1.24E-04
Cumene	Water	kg	0.00E+00	4.37E-02	8.58E-09	1.12E-01	2.73E-02
Cyanazine	Water	kg	0.00E+00	3.49E-11	3.17E-13	5.33E-11	0.00E+00
Cyanide	Water	kg	9.30E-09	3.80E-08	5.59E-06	1.77E-07	1.30E-04
Decane	Water	kg	3.75E-06	9.80E-06	2.36E-06	2.49E-05	1.66E-05
Detergent, oil	Water	kg	1.09E-04	3.22E-04	7.59E-05	8.18E-04	5.28E-04
Dibenzofuran	Water	kg	2.45E-08	6.36E-08	1.54E-08	1.62E-07	1.08E-07
Dibenzothiophene	Water	kg	2.10E-08	5.27E-08	1.29E-08	1.35E-07	9.04E-08
Dicamba	Water	kg	0.00E+00	2.06E-10	1.87E-12	3.14E-10	0.00E+00
Dichromate	Water	kg	0.00E+00	0.00E+00	3.40E-14	0.00E+00	1.40E-11
Diethylamine	Water	kg	0.00E+00	0.00E+00	9.50E-15	0.00E+00	2.92E-04
Dimethenamid	Water	kg	0.00E+00	4.86E-10	4.41E-12	7.41E-10	0.00E+00
Dimethylamine	Water	kg	0.00E+00	0.00E+00	4.90E-15	0.00E+00	1.28E-03

Substance	Compart-ment	Unit	Forest operations	Oriented strandboard	Finger-jointed lumber	LVL	I-joists
Dipropylthiocarbamic acid S-ethyl ester	Water	kg	0.00E+00	2.01E-10	1.82E-12	3.06E-10	0.00E+00
Dissolved organics	Water	kg	0.00E+00	1.38E-04	0.00E+00	0.00E+00	5.31E-07
Disulfoton	Water	kg	0.00E+00	1.20E-11	1.09E-13	1.83E-11	0.00E+00
Diuron	Water	kg	0.00E+00	3.37E-12	3.05E-14	5.14E-12	0.00E+00
DOC, Dissolved Organic Carbon	Water	kg	3.98E-12	8.05E-02	2.13E-04	2.07E-01	8.83E-02
Docosane	Water	kg	1.38E-07	3.58E-07	8.68E-08	9.14E-07	6.08E-07
Dodecane	Water	kg	7.12E-06	1.86E-05	4.48E-06	4.72E-05	3.14E-05
Eicosane	Water	kg	1.96E-06	5.12E-06	1.23E-06	1.30E-05	8.65E-06
Ethane, 1,2-dichloro-	Water	kg	0.00E+00	0.00E+00	4.79E-11	0.00E+00	5.07E-04
Ethanol	Water	kg	0.00E+00	0.00E+00	3.46E-07	0.00E+00	8.87E-03
Ethene	Water	kg	0.00E+00	0.00E+00	3.34E-09	0.00E+00	8.03E-05
Ethene, chloro-	Water	kg	0.00E+00	0.00E+00	3.73E-13	0.00E+00	1.48E-08
Ethyl acetate	Water	kg	0.00E+00	0.00E+00	1.01E-14	0.00E+00	3.99E-07
Ethylamine	Water	kg	0.00E+00	0.00E+00	4.27E-15	0.00E+00	2.70E-04
Ethylene diamine	Water	kg	0.00E+00	0.00E+00	8.92E-14	0.00E+00	9.55E-12
Ethylene oxide	Water	kg	0.00E+00	0.00E+00	6.79E-14	0.00E+00	4.37E-04
Fluorene	Water	kg	0.00E+00	1.93E-08	2.96E-12	1.25E-12	0.00E+00
Fluorene, 1-methyl-	Water	kg	1.47E-08	3.81E-08	9.23E-09	9.72E-08	6.46E-08
Fluorenes, alkylated, unspecified	Water	kg	3.49E-07	3.63E-07	1.14E-07	9.50E-07	8.53E-07
Fluoride	Water	kg	7.73E-03	5.77E-04	6.70E-05	6.54E-04	7.30E-03
Fluorine	Water	kg	1.72E-07	1.77E-07	5.98E-08	5.13E-07	4.43E-07
Fluosilicic acid	Water	kg	0.00E+00	0.00E+00	3.64E-11	0.00E+00	2.22E-07
Formaldehyde	Water	kg	0.00E+00	0.00E+00	1.20E-04	0.00E+00	5.22E-03
Formamide	Water	kg	0.00E+00	0.00E+00	6.72E-15	0.00E+00	7.41E-13
Formate	Water	kg	0.00E+00	0.00E+00	7.66E-14	0.00E+00	2.08E-02
Formic acid	Water	kg	0.00E+00	0.00E+00	1.95E-15	0.00E+00	2.15E-13
Furan	Water	kg	0.00E+00	2.33E-10	2.86E-10	3.55E-10	8.85E-09
Glutaraldehyde	Water	kg	0.00E+00	0.00E+00	5.08E-14	0.00E+00	5.69E-12
Glyphosate	Water	kg	0.00E+00	4.37E-10	3.96E-12	6.66E-10	0.00E+00
Heat, waste	Water	MJ	0.00E+00	0.00E+00	5.49E-02	0.00E+00	1.10E+01
Hexadecane	Water	kg	7.77E-06	2.03E-05	4.89E-06	5.16E-05	3.43E-05
Hexanoic acid	Water	kg	2.71E-05	7.06E-05	1.70E-05	1.79E-04	1.19E-04
Hydrocarbons, aliphatic, alkanes, unspecified	Water	kg	0.00E+00	0.00E+00	4.10E-07	0.00E+00	9.75E-06
Hydrocarbons, aliphatic, unsaturated	Water	kg	0.00E+00	0.00E+00	3.79E-08	0.00E+00	1.10E-04
Hydrocarbons, aromatic	Water	kg	0.00E+00	0.00E+00	1.67E-06	0.00E+00	3.98E-05
Hydrocarbons, unspecified	Water	kg	4.99E-12	2.33E-07	3.02E-07	3.47E-04	8.16E-05
Hydrogen-3, Tritium	Water	Bq	0.00E+00	0.00E+00	2.42E+02	0.00E+00	8.47E+04
Hydrogen peroxide	Water	kg	0.00E+00	0.00E+00	5.36E-12	0.00E+00	3.79E-06
Hydrogen sulfide	Water	kg	0.00E+00	0.00E+00	7.35E-09	0.00E+00	1.64E-06
Hydroxide	Water	kg	0.00E+00	0.00E+00	2.91E-13	0.00E+00	5.18E-05
Hypochlorite	Water	kg	0.00E+00	0.00E+00	1.31E-08	0.00E+00	4.52E-06
Iodide	Water	kg	0.00E+00	0.00E+00	3.17E-07	0.00E+00	5.54E-02
Iodine-131	Water	Bq	0.00E+00	0.00E+00	2.68E-05	0.00E+00	1.03E-02
Iodine-133	Water	Bq	0.00E+00	0.00E+00	6.83E-07	0.00E+00	4.52E-04
Iron	Water	kg	2.20E-02	2.99E-02	8.64E-03	7.76E-02	6.30E-02
Iron-59	Water	Bq	0.00E+00	0.00E+00	1.88E-07	0.00E+00	1.24E-04
Iron, ion	Water	kg	0.00E+00	0.00E+00	7.06E-05	0.00E+00	1.99E-02
Isopropylamine	Water	kg	0.00E+00	0.00E+00	3.42E-16	0.00E+00	1.69E-04
Lactic acid	Water	kg	0.00E+00	0.00E+00	4.73E-15	0.00E+00	1.02E-04
Lanthanum-140	Water	Bq	0.00E+00	0.00E+00	1.16E-06	0.00E+00	7.68E-04
Lead	Water	kg	7.50E-05	1.28E-04	3.56E-05	3.32E-04	2.68E-04
Lead-210	Water	Bq	0.00E+00	0.00E+00	2.13E-03	0.00E+00	5.68E-01
Lead-210/kg	Water	kg	1.34E-14	3.49E-14	8.42E-15	8.87E-14	5.90E-14
Lithium	Water	kg	8.63E-03	2.96E-01	5.50E-02	6.99E-01	3.60E-01
Lithium, ion	Water	kg	0.00E+00	0.00E+00	1.26E-11	0.00E+00	1.86E-08
m-Xylene	Water	kg	3.90E-06	1.02E-05	2.46E-06	2.59E-05	1.72E-05
Magnesium	Water	kg	8.09E-02	2.10E-01	5.12E-02	5.37E-01	4.29E-01
Manganese	Water	kg	1.44E-04	1.27E-03	2.18E-04	2.15E-03	6.47E-03
Manganese-54	Water	Bq	0.00E+00	0.00E+00	7.07E-05	0.00E+00	3.06E-02
Mercury	Water	kg	1.60E-07	1.65E-07	4.98E-08	3.03E-05	2.77E-05
Metallic ions, unspecified	Water	kg	6.09E-11	6.64E-09	1.60E-08	1.08E-03	7.08E-08

Substance	Compart-ment	Unit	Forest operations	Oriented strandboard	Finger-jointed lumber	LVL	I-joists
Methane, dichloro-, HCC-30	Water	kg	0.00E+00	0.00E+00	7.19E-13	0.00E+00	1.43E-04
Methane, monochloro-, R-40	Water	kg	5.18E-09	1.35E-08	3.26E-09	3.44E-08	2.29E-08
Methanol	Water	kg	0.00E+00	0.00E+00	3.84E-07	0.00E+00	1.31E-03
Methyl acetate	Water	kg	0.00E+00	0.00E+00	1.28E-17	0.00E+00	5.50E-05
Methyl acrylate	Water	kg	0.00E+00	0.00E+00	8.41E-14	0.00E+00	6.54E-12
Methyl amine	Water	kg	0.00E+00	0.00E+00	1.49E-15	0.00E+00	2.87E-05
Methyl ethyl ketone	Water	kg	1.04E-08	2.69E-08	6.53E-09	6.87E-08	4.57E-08
Methyl formate	Water	kg	0.00E+00	0.00E+00	5.67E-07	0.00E+00	3.31E-14
Metolachlor	Water	kg	0.00E+00	1.61E-09	1.46E-11	2.45E-09	0.00E+00
Metribuzin	Water	kg	0.00E+00	7.44E-12	6.75E-14	1.13E-11	0.00E+00
Molybdenum	Water	kg	2.96E-06	7.73E-06	2.00E-06	1.96E-05	5.07E-05
Molybdenum-99	Water	Bq	0.00E+00	0.00E+00	3.99E-07	0.00E+00	2.65E-04
n-Hexacosane	Water	kg	8.60E-08	2.23E-07	5.41E-08	5.70E-07	3.79E-07
Naphthalene	Water	kg	2.35E-06	6.11E-06	1.10E-06	1.55E-05	1.03E-05
Naphthalene, 2-methyl-	Water	kg	2.04E-06	5.32E-06	1.28E-06	1.35E-05	8.99E-06
Naphthalenes, alkylated, unspecified	Water	kg	9.86E-08	1.03E-07	3.23E-08	2.69E-07	2.41E-07
Nickel	Water	kg	3.59E-05	6.50E-05	1.72E-05	1.70E-04	1.23E-04
Nickel, ion	Water	kg	0.00E+00	0.00E+00	2.26E-06	0.00E+00	6.31E-04
Niobium-95	Water	Bq	0.00E+00	0.00E+00	1.15E-05	0.00E+00	4.32E-03
Nitrate	Water	kg	4.37E-13	7.55E-07	2.09E-05	1.15E-06	3.68E-02
Nitrate compounds	Water	kg	1.76E-11	5.75E-10	8.17E-11	1.26E-09	5.01E-10
Nitric acid	Water	kg	3.94E-08	9.83E-07	1.83E-07	2.83E-06	1.12E-06
Nitrite	Water	kg	0.00E+00	0.00E+00	4.19E-09	0.00E+00	1.34E-05
Nitrobenzene	Water	kg	0.00E+00	0.00E+00	4.77E-14	0.00E+00	1.62E-03
Nitrogen	Water	kg	0.00E+00	0.00E+00	2.15E-05	0.00E+00	2.11E-04
Nitrogen, organic bound	Water	kg	0.00E+00	0.00E+00	9.11E-07	0.00E+00	1.82E-05
Nitrogen, total	Water	kg	1.31E-06	1.15E-04	2.24E-05	1.94E-04	3.12E-04
o-Cresol	Water	kg	3.70E-06	9.67E-06	2.33E-06	2.46E-05	1.63E-05
o-Xylene	Water	kg	0.00E+00	4.06E-08	6.28E-12	2.66E-12	3.81E-13
Octadecane	Water	kg	1.92E-06	5.01E-06	1.21E-06	1.27E-05	8.47E-06
Oils, unspecified	Water	kg	2.96E-03	7.40E-03	2.26E-03	1.80E-02	1.82E-02
Organic substances, unspecified	Water	kg	0.00E+00	4.64E-09	1.21E-07	9.47E-09	1.76E-07
p-Cresol	Water	kg	4.00E-06	1.04E-05	2.52E-06	2.65E-05	1.76E-05
p-Xylene	Water	kg	0.00E+00	4.06E-08	6.28E-12	2.66E-12	0.00E+00
PAH, polycyclic aromatic hydrocarbons	Water	kg	0.00E+00	0.00E+00	1.84E-08	0.00E+00	4.42E-07
Paraquat	Water	kg	0.00E+00	3.25E-11	2.95E-13	4.96E-11	0.00E+00
Parathion, methyl	Water	kg	0.00E+00	2.46E-11	2.23E-13	3.74E-11	0.00E+00
Pendimethalin	Water	kg	0.00E+00	1.67E-10	1.52E-12	2.55E-10	0.00E+00
Permethrin	Water	kg	0.00E+00	1.50E-11	1.36E-13	2.29E-11	0.00E+00
Phenanthrene	Water	kg	3.55E-08	5.48E-08	1.51E-08	1.41E-07	1.09E-07
Phenanthrenes, alkylated, unspecified	Water	kg	4.09E-08	4.26E-08	1.34E-08	1.11E-07	1.00E-07
Phenol	Water	kg	5.38E-05	3.03E-05	1.40E-05	9.20E-05	2.72E-03
Phenol, 2,4-dimethyl-	Water	kg	3.61E-06	9.42E-06	2.27E-06	2.39E-05	1.59E-05
Phenols, unspecified	Water	kg	1.11E-05	1.29E-04	2.49E-05	3.05E-04	1.66E-04
Phorate	Water	kg	0.00E+00	4.64E-12	4.21E-14	7.08E-12	0.00E+00
Phosphate	Water	kg	5.81E-03	1.54E-04	9.67E-05	9.27E-05	2.45E-02
Phosphorus	Water	kg	0.00E+00	1.30E-05	2.55E-07	1.99E-05	7.39E-04
Phosphorus compounds, unspecified	Water	kg	0.00E+00	8.61E-08	7.81E-10	1.31E-07	0.00E+00
Phosphorus, total	Water	kg	0.00E+00	7.69E-06	9.45E-06	1.17E-05	2.92E-04
Polonium-210	Water	Bq	0.00E+00	0.00E+00	2.54E-03	0.00E+00	6.27E-01
Potassium-40	Water	Bq	0.00E+00	0.00E+00	1.79E-03	0.00E+00	5.88E-01
Potassium, ion	Water	kg	0.00E+00	0.00E+00	1.48E-04	0.00E+00	6.33E-02
Process solvents, unspecified	Water	kg	0.00E+00	2.33E-08	2.86E-08	3.55E-08	8.85E-07
Propanal	Water	kg	0.00E+00	0.00E+00	5.32E-15	0.00E+00	5.86E-13
Propene	Water	kg	0.00E+00	1.61E-02	9.78E-09	4.14E-02	1.17E-02
Propionic acid	Water	kg	0.00E+00	0.00E+00	1.49E-15	0.00E+00	4.67E-04
Propylamine	Water	kg	0.00E+00	0.00E+00	2.13E-15	0.00E+00	2.35E-13
Propylene oxide	Water	kg	0.00E+00	0.00E+00	2.50E-10	0.00E+00	7.98E-05
Protactinium-234	Water	Bq	0.00E+00	0.00E+00	1.42E-03	0.00E+00	5.03E-01
Radioactive species, alpha emitters	Water	Bq	0.00E+00	0.00E+00	2.37E-06	0.00E+00	3.09E-01
Radioactive species, Nuclides, unspecified	Water	Bq	7.65E+01	5.15E+03	5.49E+02	5.84E+03	2.35E+03

Substance	Compart-ment	Unit	Forest operations	Oriented strandboard	Finger-jointed lumber	LVL	I-joists
Radium-224	Water	Bq	0.00E+00	0.00E+00	1.58E-01	0.00E+00	3.75E+00
Radium-226	Water	Bq	0.00E+00	0.00E+00	1.13E+00	0.00E+00	3.19E+02
Radium-226/kg	Water	kg	4.66E-12	1.22E-11	2.93E-12	3.09E-11	2.05E-11
Radium-228	Water	Bq	0.00E+00	0.00E+00	3.16E-01	0.00E+00	7.50E+00
Radium-228/kg	Water	kg	2.38E-14	6.22E-14	1.50E-14	1.58E-13	1.05E-13
Rubidium	Water	kg	0.00E+00	0.00E+00	3.16E-08	0.00E+00	7.50E-07
Ruthenium-103	Water	Bq	0.00E+00	0.00E+00	8.43E-08	0.00E+00	5.58E-05
Scandium	Water	kg	0.00E+00	0.00E+00	5.90E-08	0.00E+00	1.70E-05
Selenium	Water	kg	1.52E-06	1.37E-05	1.85E-06	1.77E-05	3.11E-05
Silicon	Water	kg	0.00E+00	0.00E+00	4.15E-04	0.00E+00	1.16E-01
Silver	Water	kg	2.71E-04	7.02E-04	1.70E-04	1.79E-03	1.19E-03
Silver-110	Water	Bq	0.00E+00	0.00E+00	8.26E-04	0.00E+00	3.76E-01
Silver, ion	Water	kg	0.00E+00	0.00E+00	5.41E-09	0.00E+00	3.50E-07
Simazine	Water	kg	0.00E+00	1.05E-10	9.57E-13	1.61E-10	0.00E+00
Sodium	Water	kg	1.31E+00	3.41E+00	8.26E-01	8.70E+00	5.78E+00
Sodium-24	Water	Bq	0.00E+00	0.00E+00	3.02E-06	0.00E+00	2.00E-03
Sodium formate	Water	kg	0.00E+00	0.00E+00	3.38E-12	0.00E+00	1.59E-09
Sodium, ion	Water	kg	0.00E+00	0.00E+00	1.16E-03	0.00E+00	1.66E+00
Solids, inorganic	Water	kg	1.00E-10	2.50E-09	3.94E-04	7.20E-09	1.59E-02
Solved solids	Water	kg	0.00E+00	0.00E+00	2.52E-05	0.00E+00	1.72E-03
Strontium	Water	kg	7.02E-03	1.83E-02	4.43E-03	4.66E-02	3.35E-02
Strontium-89	Water	Bq	0.00E+00	0.00E+00	1.47E-05	0.00E+00	7.15E-03
Strontium-90	Water	Bq	0.00E+00	0.00E+00	7.99E-01	0.00E+00	2.73E+02
Styrene	Water	kg	0.00E+00	2.45E-09	3.75E-11	1.44E-09	1.67E-09
Sulfate	Water	kg	1.04E-02	9.65E-02	1.55E-02	1.44E-01	9.02E-01
Sulfide	Water	kg	6.25E-06	8.91E-05	4.70E-05	1.39E-04	1.88E-03
Sulfite	Water	kg	0.00E+00	0.00E+00	3.56E-08	0.00E+00	1.23E-05
Sulfur	Water	kg	3.41E-04	8.90E-04	2.15E-04	2.26E-03	4.50E-03
Sulfuric acid	Water	kg	0.00E+00	2.04E-10	2.54E-08	8.32E-10	7.75E-09
Surfactants	Water	kg	0.00E+00	1.91E-06	2.91E-10	1.23E-10	0.00E+00
Suspended solids, inorganic	Water	kg	0.00E+00	0.00E+00	6.04E-04	0.00E+00	2.41E-03
Suspended solids, unspecified	Water	kg	6.08E+00	1.58E+01	3.73E+00	3.97E+01	2.62E+01
t-Butyl methyl ether	Water	kg	0.00E+00	0.00E+00	6.75E-09	0.00E+00	2.23E-07
t-Butylamine	Water	kg	0.00E+00	0.00E+00	5.97E-16	0.00E+00	1.62E-04
Tar	Water	kg	9.94E-13	2.48E-11	4.62E-12	7.14E-11	2.83E-11
Technetium-99m	Water	Bq	0.00E+00	0.00E+00	9.27E-06	0.00E+00	6.11E-03
Tellurium-123m	Water	Bq	0.00E+00	0.00E+00	1.63E-05	0.00E+00	5.73E-03
Tellurium-132	Water	Bq	0.00E+00	0.00E+00	2.31E-08	0.00E+00	1.53E-05
Terbufos	Water	kg	0.00E+00	1.58E-10	1.44E-12	2.42E-10	0.00E+00
Tetradecane	Water	kg	3.12E-06	8.15E-06	1.97E-06	2.07E-05	1.38E-05
Thallium	Water	kg	1.45E-06	1.38E-06	4.80E-07	3.95E-06	4.24E-06
Thorium-228	Water	Bq	0.00E+00	0.00E+00	6.31E-01	0.00E+00	1.50E+01
Thorium-230	Water	Bq	0.00E+00	0.00E+00	1.93E-01	0.00E+00	6.86E+01
Thorium-232	Water	Bq	0.00E+00	0.00E+00	3.16E-04	0.00E+00	1.07E-01
Thorium-234	Water	Bq	0.00E+00	0.00E+00	1.42E-03	0.00E+00	5.03E-01
Tin	Water	kg	2.80E-05	4.41E-05	1.24E-05	1.17E-04	8.92E-05
Tin, ion	Water	kg	0.00E+00	0.00E+00	4.72E-08	0.00E+00	4.54E-06
Titanium	Water	kg	1.05E-04	1.01E-04	3.46E-05	2.88E-04	2.58E-04
Titanium, ion	Water	kg	0.00E+00	0.00E+00	9.63E-07	0.00E+00	4.13E-04
TOC, Total Organic Carbon	Water	kg	0.00E+00	8.08E-02	2.13E-04	2.07E-01	9.04E-02
Toluene	Water	kg	2.04E-04	5.31E-04	1.29E-04	1.35E-03	1.81E-03
Toluene, 2-chloro-	Water	kg	0.00E+00	0.00E+00	7.40E-15	0.00E+00	3.26E-04
Tributyltin compounds	Water	kg	0.00E+00	0.00E+00	3.14E-09	0.00E+00	1.42E-07
Triethylene glycol	Water	kg	0.00E+00	0.00E+00	1.18E-07	0.00E+00	1.57E-06
Trimethylamine	Water	kg	0.00E+00	0.00E+00	2.28E-17	0.00E+00	1.11E-14
Tungsten	Water	kg	0.00E+00	0.00E+00	6.06E-08	0.00E+00	3.22E-06
Uranium-234	Water	Bq	0.00E+00	0.00E+00	1.70E-03	0.00E+00	6.04E-01
Uranium-235	Water	Bq	0.00E+00	0.00E+00	2.80E-03	0.00E+00	9.96E-01
Uranium-238	Water	Bq	0.00E+00	0.00E+00	5.34E-03	0.00E+00	1.80E+00
Uranium alpha	Water	Bq	0.00E+00	0.00E+00	8.16E-02	0.00E+00	2.90E+01
Urea	Water	kg	0.00E+00	0.00E+00	6.13E-15	0.00E+00	6.80E-13
Vanadium	Water	kg	3.50E-06	9.42E-06	2.20E-06	2.32E-05	1.54E-05

Substance	Compart-ment	Unit	Forest operations	Oriented strandboard	Finger-jointed lumber	LVL	I-joists
Vanadium, ion	Water	kg	0.00E+00	0.00E+00	1.59E-07	0.00E+00	5.76E-05
VOC, volatile organic compounds, unspecified origin	Water	kg	0.00E+00	0.00E+00	1.11E-06	0.00E+00	2.75E-05
Waste water/m3	Water	m3	0.00E+00	1.92E-03	2.22E-03	2.93E-03	0.00E+00
Xylene	Water	kg	1.10E-04	2.77E-04	6.79E-05	7.08E-04	4.82E-04
Yttrium	Water	kg	8.68E-07	2.27E-06	5.46E-07	5.76E-06	3.83E-06
Zinc	Water	kg	2.54E-04	3.20E-04	9.28E-05	8.06E-04	6.82E-04
Zinc-65	Water	Bq	0.00E+00	0.00E+00	4.10E-05	0.00E+00	2.71E-02
Zinc, ion	Water	kg	0.00E+00	0.00E+00	4.18E-06	0.00E+00	7.02E-04
Zirconium-95	Water	Bq	0.00E+00	0.00E+00	4.75E-07	0.00E+00	3.14E-04
Waste in inert landfill	Waste	kg	0.00E+00	0.00E+00	0.00E+00	3.29E+00	3.43E+00
Waste to recycling	Waste	kg	0.00E+00	0.00E+00	0.00E+00	1.51E+00	2.25E+00
Waste, solid	Waste	kg	0.00E+00	2.74E-02	3.37E-02	4.19E-02	1.04E+00
2,4-D	Soil	kg	0.00E+00	0.00E+00	1.91E-12	0.00E+00	1.09E-08
Aclonifen	Soil	kg	0.00E+00	0.00E+00	1.89E-13	0.00E+00	5.02E-11
Aldrin	Soil	kg	0.00E+00	0.00E+00	9.76E-17	0.00E+00	7.59E-15
Aluminium	Soil	kg	0.00E+00	0.00E+00	1.54E-08	0.00E+00	2.53E-05
Antimony	Soil	kg	0.00E+00	0.00E+00	2.20E-16	0.00E+00	7.49E-14
Arsenic	Soil	kg	0.00E+00	0.00E+00	4.79E-12	0.00E+00	4.23E-09
Atrazine	Soil	kg	0.00E+00	0.00E+00	2.56E-17	0.00E+00	1.99E-15
Barium	Soil	kg	0.00E+00	0.00E+00	4.16E-11	0.00E+00	2.01E-09
Benomyl	Soil	kg	0.00E+00	0.00E+00	1.22E-14	0.00E+00	6.96E-11
Bentazone	Soil	kg	0.00E+00	0.00E+00	9.63E-14	0.00E+00	2.56E-11
Boron	Soil	kg	0.00E+00	0.00E+00	8.16E-12	0.00E+00	1.86E-10
Cadmium	Soil	kg	0.00E+00	0.00E+00	2.62E-11	0.00E+00	5.40E-09
Calcium	Soil	kg	0.00E+00	0.00E+00	2.06E-07	0.00E+00	1.34E-04
Carbetamide	Soil	kg	0.00E+00	0.00E+00	7.56E-14	0.00E+00	1.36E-11
Carbofuran	Soil	kg	0.00E+00	0.00E+00	6.67E-12	0.00E+00	3.81E-08
Carbon	Soil	kg	0.00E+00	0.00E+00	1.80E-08	0.00E+00	2.45E-04
Chloride	Soil	kg	0.00E+00	0.00E+00	2.87E-09	0.00E+00	7.72E-07
Chlorothalonil	Soil	kg	0.00E+00	0.00E+00	4.09E-11	0.00E+00	4.43E-09
Chromium	Soil	kg	0.00E+00	0.00E+00	2.19E-10	0.00E+00	1.30E-07
Chromium VI	Soil	kg	0.00E+00	0.00E+00	1.00E-12	0.00E+00	1.11E-10
Cobalt	Soil	kg	0.00E+00	0.00E+00	1.29E-11	0.00E+00	1.52E-08
Copper	Soil	kg	0.00E+00	0.00E+00	1.21E-09	0.00E+00	2.86E-06
Cypermethrin	Soil	kg	0.00E+00	0.00E+00	9.44E-13	0.00E+00	5.38E-09
Fenpiclonil	Soil	kg	0.00E+00	0.00E+00	1.62E-12	0.00E+00	1.76E-10
Fluoride	Soil	kg	0.00E+00	0.00E+00	2.08E-12	0.00E+00	2.28E-10
Glyphosate	Soil	kg	0.00E+00	0.00E+00	1.34E-11	0.00E+00	7.56E-08
Heat, waste	Soil	MJ	0.00E+00	0.00E+00	1.42E-03	0.00E+00	3.21E-01
Iron	Soil	kg	0.00E+00	0.00E+00	2.73E-05	0.00E+00	4.82E-04
Lead	Soil	kg	0.00E+00	0.00E+00	7.00E-10	0.00E+00	1.34E-07
Linuron	Soil	kg	0.00E+00	0.00E+00	1.45E-12	0.00E+00	3.87E-10
Magnesium	Soil	kg	0.00E+00	0.00E+00	2.31E-08	0.00E+00	1.50E-05
Mancozeb	Soil	kg	0.00E+00	0.00E+00	5.31E-11	0.00E+00	5.75E-09
Manganese	Soil	kg	0.00E+00	0.00E+00	1.43E-08	0.00E+00	4.85E-06
Mercury	Soil	kg	0.00E+00	0.00E+00	9.47E-14	0.00E+00	1.96E-09
Metaldehyde	Soil	kg	0.00E+00	0.00E+00	2.47E-14	0.00E+00	3.69E-12
Metolachlor	Soil	kg	0.00E+00	0.00E+00	1.05E-11	0.00E+00	2.80E-09
Metribuzin	Soil	kg	0.00E+00	0.00E+00	1.87E-12	0.00E+00	2.03E-10
Molybdenum	Soil	kg	0.00E+00	0.00E+00	2.67E-12	0.00E+00	7.44E-09
Napropamide	Soil	kg	0.00E+00	0.00E+00	4.37E-14	0.00E+00	6.52E-12
Nickel	Soil	kg	0.00E+00	0.00E+00	2.46E-10	0.00E+00	5.25E-08
Oils, biogenic	Soil	kg	0.00E+00	0.00E+00	1.01E-09	0.00E+00	3.20E-07
Oils, unspecified	Soil	kg	0.00E+00	0.00E+00	2.24E-04	0.00E+00	5.64E-03
Orbencarb	Soil	kg	0.00E+00	0.00E+00	1.01E-11	0.00E+00	1.09E-09
Phosphorus	Soil	kg	0.00E+00	0.00E+00	6.96E-09	0.00E+00	2.19E-06
Pirimicarb	Soil	kg	0.00E+00	0.00E+00	9.11E-15	0.00E+00	2.42E-12
Potassium	Soil	kg	0.00E+00	0.00E+00	3.87E-08	0.00E+00	1.22E-05
Silicon	Soil	kg	0.00E+00	0.00E+00	5.89E-08	0.00E+00	5.97E-05
Sodium	Soil	kg	0.00E+00	0.00E+00	5.92E-11	0.00E+00	6.37E-09
Solids	Soil	kg	0.00E+00	0.00E+00	7.80E-05	0.00E+00	2.38E-03

Substance	**Compart-ment**	**Unit**	**Forest operations**	**Oriented strandboard**	**Finger-jointed lumber**	**LVL**	**I-joists**
Strontium	Soil	kg	0.00E+00	0.00E+00	1.01E-10	0.00E+00	1.81E-09
Sulfur	Soil	kg	0.00E+00	0.00E+00	6.69E-09	0.00E+00	2.37E-05
Sulfuric acid	Soil	kg	0.00E+00	0.00E+00	4.92E-18	0.00E+00	3.82E-16
Tebutam	Soil	kg	0.00E+00	0.00E+00	1.04E-13	0.00E+00	1.55E-11
Teflubenzuron	Soil	kg	0.00E+00	0.00E+00	1.25E-13	0.00E+00	1.35E-11
Thiram	Soil	kg	0.00E+00	0.00E+00	2.16E-14	0.00E+00	1.23E-10
Tin	Soil	kg	0.00E+00	0.00E+00	1.80E-13	0.00E+00	2.77E-08
Titanium	Soil	kg	0.00E+00	0.00E+00	9.80E-10	0.00E+00	3.09E-07
Vanadium	Soil	kg	0.00E+00	0.00E+00	2.81E-11	0.00E+00	8.84E-09
Zinc	Soil	kg	0.00E+00	0.00E+00	4.60E-08	0.00E+00	2.20E-06

18 APPENDIX C: PACIFIC NORTHWEST I-JOIST LIFE-CYCLE IMPACT ASSESSMENT, ECONOMIC ALLOCATION

Cradle-to-gate life-cycle inventory and impact assessment results of economic allocation are presented in this section. The results for PNW I-joists were presented by five life stages: (1) forestry operations, (2) OSB production, (3) FJL production, (4) LVL production, and (5) I-joist production. The overall cumulative energy consumption obtained from impact assessment using economic allocation was about 5% higher compared with the mass allocation method. The difference between the contribution of the life-cycle stages to the CPEC in the economic and mass allocations was minor. For the impact assessment results of selected impact categories, the difference was lower than 9% and ranged between 6% and 9%.

The raw material energy consumption and CPEC for economic allocation are presented in Table 26 and Table 27, respectively. The majority of raw material energy consumption occurs during LVL production followed by OSB and I-joist stages with a small portion arising from FJL production and forestry operations. Wood fuel consumption had the greatest share, about 38%, which was dominated by the LVL stage resulting from veneer input to LVL production. For LVL production, wood and natural gas were used to generate thermal energy for log conditioning and drying and pressing veneers. The LVL stage consumed the most primary energy. Its share in the CPEC was about 52% for the cradle-to-gate production of PNW I-joists. At the I-joist stage, the primary energy source was natural gas, about 42%, which was used to generate thermal energy for resin curing.

Table 26. Raw material energy consumption per 1 km of I-joist produced, cradle-to-gate, economic allocation.

Fuel	Unit	Forestry operations	OSB production	FJL production	LVL production	I-joist production
Wood fuel, oven-dry	kg	0.00E+00	9.09E+01	2.95E+02	8.97E+02	1.01E+01
Gas, natural, in ground	kg	2.50E+00	1.13E+02	2.42E+01	2.19E+02	1.30E+02
Coal, in ground	kg	1.97E+00	1.19E+02	2.38E+01	1.72E+02	8.09E+01
Uranium oxide, in ore	kg	4.64E-05	3.38E-03	5.13E-04	3.53E-03	1.42E-03
Oil, crude, in ground	kg	3.40E+01	3.40E+01	1.54E+01	6.39E+01	7.85E+01

Table 32, Appendix E, lists the emissions greater than 10^{-4} and HAPs generated from I-joist production along with the ones reported by the mills themselves. Fossil and biogenic CO_2 released in the production of 1 km of I-joist were 2,071 and 2,207 kg, respectively. All waterborne emissions occurred off site (Table 32). I-joist plants are zero-discharge facilities.

Table 27. CPEC per 1 km of I-joist produced, cradle-to-gate, economic allocation.

Fuel	Percentage of total	Total	Forestry operations	OSB production	FJL production	LVL production	I-joist production
		MJ/km					
Wood fuel	38.0	2.70E+04	0.00E+00	1.90E+03	6.17E+03	1.88E+04	2.11E+02
Gas, natural, in ground	26.3	1.87E+04	9.58E+01	4.32E+03	9.29E+02	8.41E+03	4.98E+03
Coal, in ground	14.7	1.04E+04	5.16E+01	3.12E+03	6.22E+02	4.51E+03	2.12E+03
Oil, crude, in ground	14.4	1.03E+04	1.55E+03	1.55E+03	7.00E+02	2.91E+03	3.57E+03
Uranium oxide, in ore	4.8	3.38E+03	1.77E+01	1.29E+03	1.96E+02	1.34E+03	5.41E+02
Hydro	1.5	1.04E+03	1.81E-01	2.48E+01	1.04E+01	7.02E+02	3.04E+02
Wind	0.2	1.15E+02	0.00E+00	4.08E-01	4.18E-03	7.93E+01	3.56E+01
Solar	0.0	5.49E+00	0.00E+00	1.87E-03	5.79E-05	3.82E+00	1.67E+00
Geothermal	0.1	8.71E+01	0.00E+00	1.51E-01	2.07E-05	6.07E+01	2.63E+01
Total	100.0	7.11E+04	1.71E+03	1.22E+04	8.62E+03	3.68E+04	1.18E+04
Total, by percentage		100	2.4	17.2	12.1	51.7	16.6

Solid emissions were dominated by LVL and I-joist production stages. Solid emissions include ash generated at the wood boiler during veneer production for LVL production and primarily fuels and resins used (Table 28). Overall, 96% of the solid waste generated is landfilled.

Table 28. Waste to treatment per 1 km of I-joist, cradle-to-gate, economic allocation.

Waste to treatment	Total	Forestry operations	OSB production	FJL production	LVL production	I-joist production
	kg/km					
Waste in inert landfill	5.24E+01	0.00E+00	8.40E+00	4.64E-02	3.91E+01	4.86E+00
Waste to recycling	2.45E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.45E+00
Total waste	5.48E+01	0.00E+00	8.40E+00	4.64E-02	3.91E+01	7.30E+00

Table 29 shows environmental performance results for GWP, acidification, eutrophication, ozone depletion, and smog; total primary energy consumption from nonrenewables and renewables; renewable and nonrenewable material resource consumption; and solid waste generated. In addition, the contribution of major substances to the overall impact for eutrophication, acidification, smog, and GW impact categories are provided in Appendix D. The data on solid waste generated during OSB and LVL production were obtained from Kaestner (2015) and Bergman and Alanya-Rosenbaum (2016), respectively.

Table 29. Environmental performance of 1 km of I-joist, cradle-to-gate, economic allocation.

Impact category	Unit	Total	Forestry operations	OSB production	FJL production	LVL production	I-joist production
Global warming	kg CO_2 eq	2.25E+03	1.13E+02	4.92E+02	1.46E+02	8.98E+02	6.05E+02
Acidification	kg SO_2 eq	2.22E+01	1.54E+00	4.84E+00	1.51E+00	9.21E+00	5.11E+00
Eutrophication	kg N eq	8.42E-01	1.05E-01	1.27E-01	5.07E-02	2.87E-01	2.72E-01
Ozone depletion	kg CFC-11 eq	9.40E-05	5.08E-09	1.71E-06	1.45E-07	2.24E-06	8.99E-05
Smog	kg O_3 eq	2.94E+02	4.84E+01	4.95E+01	2.65E+01	1.12E+02	5.72E+01
Total primary energy consumption	**MJ**	**7.11E+04**	**1.71E+03**	**1.22E+04**	**8.62E+03**	**3.68E+04**	**1.18E+04**
Nonrenewable fossil	MJ	3.94E+04	1.69E+03	8.98E+03	2.25E+03	1.58E+04	1.07E+04
Nonrenewable nuclear	MJ	3.38E+03	1.77E+01	1.29E+03	1.96E+02	1.34E+03	5.41E+02
Renewable (solar, wind, hydroelectric, and geothermal)	MJ	1.25E+03	1.81E-01	2.54E+01	1.04E+01	8.46E+02	3.68E+02
Renewable, biomass	MJ	2.70E+04	0.00E+00	1.90E+03	6.17E+03	1.88E+04	2.11E+02
Material resources consumption (nonfuel resources)	**Unit**	**Total**	**Forestry operations**	**OSB production**	**FJL production**	**LVL production**	**I-joist production**
Nonrenewable materials	kg	2.59E+01	0.00E+00	4.77E+00	3.19E-02	2.04E+01	6.76E-01
Renewable materials	kg	4.74E+03	0.00E+00	1.60E+01	1.71E+03	2.99E+03	2.17E+01
Fresh water	L	9.42E+03	9.83E+01	1.08E+03	1.14E+03	5.04E+03	2.07E+03
Waste generated	**Unit**	**Total**	**Forestry operations**	**OSB production**	**FJL production**	**LVL production**	**I-joist production**
Solid waste	kg	5.48E+01	0.00E+00	8.40E+00	4.64E-02	3.91E+01	7.30E+00

19 APPENDIX D: SUBSTANCE CONTRIBUTION ANALYSIS

Table 30. Substance contribution analysis to acidification (kg SO_2 eq) by life-cycle stage (total percentage basis and values are displayed).

		Mass allocation					
Substances	**Compartment type**	**Total (%)**	**Forestry operations**	**OSB production**	**FJL production**	**LVL production**	**I-joist production**
Total of all compartments, %		**100.00**	7	22	5	44	23
Sulfur dioxide	Air	60.8	7.04E-02	3.13E+00	5.00E-01	5.97E+00	3.00E+00
Nitrogen oxides	Air	34.5	1.36E+00	1.18E+00	4.23E-01	2.82E+00	1.39E+00
Sulfur monoxide	Air	2.3	1.03E-01	4.49E-02	9.00E-03	1.26E-01	1.93E-01
Sulfur oxides	Air	1.2	7.79E-03	5.23E-02	2.34E-02	8.40E-02	7.88E-02
Hydrogen chloride	Air	0.8	9.74E-04	5.05E-02	7.24E-03	7.84E-02	3.08E-02
Other substances	Air	<1	1.90E-03	2.07E-02	1.48E-02	4.19E-02	1.70E-02
		Economic allocation					
Substances	**Compartment type**	**Total (%)**	**Forestry operations**	**OSB production**	**FJL production**	**LVL production**	**I-joist production**
Total of all compartments, %		**100.00**	7	22	7	41	23
Sulfur dioxide	Air	61.0	7.04E-02	3.38E+00	7.54E-01	6.10E+00	3.26E+00
Nitrogen oxides	Air	34.2	1.36E+00	1.28E+00	6.70E-01	2.77E+00	1.51E+00
Sulfur monoxide	Air	2.2	1.03E-01	4.85E-02	1.47E-02	1.24E-01	2.10E-01
Sulfur oxides	Air	1.3	7.79E-03	5.62E-02	4.24E-02	9.05E-02	8.56E-02
Hydrogen chloride	Air	0.8	9.74E-04	5.46E-02	1.12E-02	7.81E-02	3.34E-02
Other substances	Air	<1	1.90E-03	2.24E-02	2.00E-02	4.04E-02	1.85E-02

Table 31. Substance contribution analysis to eutrophication (kg N eq) by life-cycle stage (total percentage basis and values are displayed).

		Mass allocation					
Substances	**Compartment type**	**Total (%)**	**Forestry operations**	**OSB production**	**FJL production**	**LVL production**	**I-joist production**
Total of all compartments, %		**100.00**	13	15	4	36	32
Nitrogen oxides	Air	57.5	8.60E-02	7.50E-02	2.68E-02	1.79E-01	8.80E-02
COD, chemical oxygen demand	Water	12.9	2.23E-03	1.99E-02	1.69E-03	5.01E-02	2.78E-02
BOD_5, biological oxygen demand	Water	10.9	1.18E-03	1.73E-02	1.31E-03	4.39E-02	2.26E-02
Phosphate	Water	9.2	1.38E-02	3.66E-04	2.30E-04	2.21E-04	5.84E-02
Ammonium, ion	Water	4.1	4.10E-07	6.76E-05	3.31E-04	7.23E-04	3.16E-02
Ammonia	Water	2.9	1.87E-03	3.89E-03	1.02E-03	9.50E-03	6.86E-03
Nitrate	Water	1.1	1.03E-13	1.79E-07	4.94E-06	2.73E-07	8.70E-03
Phosphorus	Water	0.7	0.00E+00	9.49E-05	1.86E-06	1.45E-04	5.39E-03
Other substances		<1	1.07E-04	6.13E-04	8.86E-04	1.57E-03	1.68E-03
		Economic allocation					
Substances	**Compartment type**	**Total (%)**	**Forestry operations**	**OSB production**	**FJL production**	**LVL production**	**I-joist production**
Total of all compartments, %		**100.00**	12	15	6	34	32
Nitrogen oxides	Air	57.0	8.60E-02	8.10E-02	4.24E-02	1.75E-01	9.55E-02
COD, chemical oxygen demand	Water	13.0	2.23E-03	2.15E-02	2.63E-03	5.29E-02	3.02E-02
BOD_5, biological oxygen demand	Water	11.0	1.18E-03	1.87E-02	2.18E-03	4.64E-02	2.45E-02
Phosphate	Water	9.3	1.38E-02	3.85E-04	2.95E-04	2.47E-04	6.34E-02
Ammonium, ion	Water	4.2	4.10E-07	7.28E-05	3.81E-04	6.76E-04	3.43E-02
Ammonia	Water	3.0	1.87E-03	4.20E-03	1.65E-03	9.79E-03	7.45E-03
Nitrate	Water	1.1	1.03E-13	1.79E-07	6.19E-06	3.05E-07	9.45E-03
Phosphorus	Water	0.7	0.00E+00	9.49E-05	3.06E-06	1.62E-04	5.85E-03
Other substances		<1	1.08E-04	8.19E-04	8.45E-04	2.33E-03	1.25E-03

20 APPENDIX E: PACIFIC NORTHWEST I-JOIST LIFE-CYCLE INVENTORY FLOWS, ECONOMIC ALLOCATION

Table 32. Economic allocation inventory.

Substance	Compartment	Unit	Forest operations	OSB	FJL	LVL	I-joists
Aluminium, 24% in bauxite, 11% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.34E-06	0.00E+00	4.92E-03
Anhydrite, in ground	Raw	kg	0.00E+00	0.00E+00	1.99E-10	0.00E+00	1.68E-05
Barite, 15% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	4.22E-08	0.00E+00	1.41E-02
Basalt, in ground	Raw	kg	0.00E+00	0.00E+00	1.24E-09	0.00E+00	4.01E-07
Borax, in ground	Raw	kg	0.00E+00	0.00E+00	1.09E-10	0.00E+00	3.71E-08
Bromine, 0.0023% in water	Raw	kg	0.00E+00	0.00E+00	2.38E-11	0.00E+00	2.04E-01
Cadmium, 0.30% in sulfide, Cd 0.18%, Pb, Zn, Ag, In, in ground	Raw	kg	0.00E+00	0.00E+00	3.78E-12	0.00E+00	3.22E-10
Calcite	Raw	kg	0.00E+00	0.00E+00	0.00E+00	5.22E-03	1.62E-02
Calcite, in ground	Raw	kg	0.00E+00	0.00E+00	6.66E-04	0.00E+00	4.40E-01
Carbon dioxide, in air	Raw	kg	1.18E+04	7.76E+01	6.21E-01	3.30E+02	2.73E+00
Carbon, in organic matter, in soil	Raw	kg	0.00E+00	0.00E+00	1.05E-08	0.00E+00	5.23E-05
Carbon, organic, in soil or biomass stock	Raw	kg	0.00E+00	0.00E+00	0.00E+00	4.78E+03	1.06E+04
Chromium, 25.5% in chromite, 11.6% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.51E-07	0.00E+00	5.42E-05
Chrysotile, in ground	Raw	kg	0.00E+00	0.00E+00	3.91E-10	0.00E+00	1.56E-04
Cinnabar, in ground	Raw	kg	0.00E+00	0.00E+00	3.67E-11	0.00E+00	1.44E-05
Clay, bentonite, in ground	Raw	kg	0.00E+00	0.00E+00	1.71E-06	0.00E+00	6.88E-04
Clay, unspecified, in ground	Raw	kg	0.00E+00	0.00E+00	8.68E-05	0.00E+00	1.01E-02
Coal, 26.4 MJ per kg	Raw	kg	1.97E+00	1.15E+02	2.37E+01	1.72E+02	7.56E+01
Coal, bituminous, 24.8 MJ per kg	Raw	kg	0.00E+00	8.48E-06	4.47E-04	1.13E-04	0.00E+00
Coal, bitumous, in ground	Raw	kg	0.00E+00	3.55E+00	0.00E+00	0.00E+00	0.00E+00
Coal, brown	Raw	kg	0.00E+00	7.62E-07	4.02E-05	1.02E-05	0.00E+00
Coal, brown, in ground	Raw	kg	0.00E+00	0.00E+00	9.76E-03	0.00E+00	2.93E+00
Coal, hard, unspecified, in ground	Raw	kg	0.00E+00	0.00E+00	5.60E-03	0.00E+00	2.42E+00
Coal, lignite, in ground	Raw	kg	0.00E+00	2.94E-01	0.00E+00	0.00E+00	0.00E+00
Cobalt, in ground	Raw	kg	0.00E+00	0.00E+00	1.36E-10	0.00E+00	1.19E-05
Colemanite, in ground	Raw	kg	0.00E+00	0.00E+00	3.07E-09	0.00E+00	3.32E-03
Copper ore	Raw	kg	0.00E+00	0.00E+00	0.00E+00	1.05E-02	6.46E-03
Copper, 0.99% in sulfide, Cu 0.36% and Mo 8.2E-3% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	9.60E-10	0.00E+00	5.96E-06
Copper, 1.18% in sulfide, Cu 0.39% and Mo 8.2E-3% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	2.97E-09	0.00E+00	1.88E-05
Copper, 1.42% in sulfide, Cu 0.81% and Mo 8.2E-3% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	7.87E-10	0.00E+00	4.97E-06
Copper, 2.19% in sulfide, Cu 1.83% and Mo 8.2E-3% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	3.92E-09	0.00E+00	2.47E-05
Diatomite, in ground	Raw	kg	0.00E+00	0.00E+00	1.35E-13	0.00E+00	4.14E-11
Dolomite, in ground	Raw	kg	0.00E+00	0.00E+00	5.64E-09	0.00E+00	1.48E-05
Energy, from biomass	Raw	MJ	0.00E+00	5.42E-01	7.42E-05	1.89E-05	0.00E+00
Energy, from gas, natural	Raw	MJ	0.00E+00	3.12E+01	0.00E+00	0.00E+00	1.20E-01
Energy, from hydro power	Raw	MJ	1.81E-01	2.48E+01	1.04E+01	7.02E+02	3.04E+02
Energy, from oil	Raw	MJ	0.00E+00	1.23E+01	0.00E+00	0.00E+00	4.75E-02
Energy, geothermal	Raw	MJ	0.00E+00	1.51E-01	2.07E-05	6.07E+01	2.63E+01
Energy, gross calorific value, in biomass	Raw	MJ	0.00E+00	0.00E+00	7.41E-03	0.00E+00	2.35E+00
Energy, gross calorific value, in biomass, primary forest	Raw	MJ	0.00E+00	0.00E+00	7.30E-07	0.00E+00	3.62E-03
Energy, kinetic (in wind), converted	Raw	MJ	0.00E+00	4.08E-01	4.18E-03	7.93E+01	3.56E+01
Energy, potential (in hydropower reservoir), converted	Raw	MJ	0.00E+00	0.00E+00	3.88E-02	0.00E+00	8.80E+00
Energy, recovered	Raw	MJ	0.00E+00	3.28E+01	5.69E-05	1.45E-05	0.00E+00
Energy, solar, converted	Raw	MJ	0.00E+00	1.87E-03	5.79E-05	3.82E+00	1.67E+00
Feldspar, in ground	Raw	kg	0.00E+00	0.00E+00	6.77E-15	0.00E+00	9.80E-13
Fluorine, 4.5% in apatite, 1% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	8.55E-08	0.00E+00	8.72E-03

Substance	Compartment	Unit	Forest operations	OSB	FJL	LVL	I-joists
Fluorine, 4.5% in apatite, 3% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	3.76E-08	0.00E+00	6.63E-03
Fluorspar, 92%, in ground	Raw	kg	0.00E+00	0.00E+00	2.89E-06	0.00E+00	1.42E-01
fuel	Raw	m3	3.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gallium, 0.014% in bauxite, in ground	Raw	kg	0.00E+00	0.00E+00	1.99E-17	0.00E+00	1.79E-15
Gas, mine, off-gas, process, coal mining/m3	Raw	m3	0.00E+00	0.00E+00	5.44E-05	0.00E+00	2.21E-02
Gas, natural, 36.6 MJ per m3	Raw	m3	0.00E+00	3.24E-05	1.71E-03	4.34E-04	0.00E+00
Gas, natural, 36.7 MJ per m3, in ground	Raw	kg	0.00E+00	7.71E+00	0.00E+00	0.00E+00	0.00E+00
Gas, natural, 46.8 MJ per kg	Raw	kg	0.00E+00	1.28E-01	3.68E-03	5.55E-01	1.79E-02
Gas, natural, 49.8 MJ per kg, in ground (EMR)	Raw	kg	0.00E+00	5.56E+00	0.00E+00	0.00E+00	0.00E+00
Gas, natural, in ground	Raw	m3	0.00E+00	0.00E+00	2.60E-01	0.00E+00	5.01E+00
Gas, natural/m3	Raw	m3	2.50E+00	9.36E+01	2.40E+01	2.19E+02	1.25E+02
Gold, Au 1.1E-4%, Ag 4.2E-3%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.69E-14	0.00E+00	1.14E-12
Gold, Au 1.3E-4%, Ag 4.6E-5%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	3.09E-14	0.00E+00	2.09E-12
Gold, Au 1.4E-4%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	3.70E-14	0.00E+00	2.50E-12
Gold, Au 2.1E-4%, Ag 2.1E-4%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	5.65E-14	0.00E+00	3.82E-12
Gold, Au 4.3E-4%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.40E-14	0.00E+00	9.46E-13
Gold, Au 4.9E-5%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	3.36E-14	0.00E+00	2.27E-12
Gold, Au 6.7E-4%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	5.20E-14	0.00E+00	3.51E-12
Gold, Au 7.1E-4%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	5.86E-14	0.00E+00	3.96E-12
Gold, Au 9.7E-4%, Ag 9.7E-4%, Zn 0.63%, Cu 0.38%, Pb 0.014%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	3.51E-15	0.00E+00	2.37E-13
Granite, in ground	Raw	kg	0.00E+00	0.00E+00	4.76E-15	0.00E+00	4.41E-13
Gravel, in ground	Raw	kg	0.00E+00	0.00E+00	3.40E-03	0.00E+00	5.20E-02
Gypsum, in ground	Raw	kg	0.00E+00	0.00E+00	1.16E-08	0.00E+00	9.57E-07
Indium, 0.005% in sulfide, In 0.003%, Pb, Zn, Ag, Cd, in ground	Raw	kg	0.00E+00	0.00E+00	6.39E-14	0.00E+00	5.31E-12
Iodine, 0.03% in water	Raw	kg	0.00E+00	0.00E+00	5.62E-12	0.00E+00	1.06E-01
Iron ore	Raw	kg	0.00E+00	9.12E-09	2.18E-02	1.77E-03	1.79E-03
Iron, 46% in ore, 25% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.61E-06	0.00E+00	8.08E-04
Kaolinite, 24% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.09E-07	0.00E+00	9.03E-06
Kieserite, 25% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	2.92E-10	0.00E+00	3.11E-08
Lead, 5.0% in sulfide, Pb 3.0%, Zn, Ag, Cd, In, in ground	Raw	kg	0.00E+00	0.00E+00	7.95E-11	0.00E+00	6.14E-07
Limestone	Raw	kg	0.00E+00	4.77E+00	3.19E-02	2.04E+01	6.76E-01
Lithium, 0.15% in brine, in ground	Raw	kg	0.00E+00	0.00E+00	1.01E-13	0.00E+00	9.69E-12
Magnesite, 60% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	8.66E-08	0.00E+00	1.19E-05
Magnesium, 0.13% in water	Raw	kg	0.00E+00	0.00E+00	9.38E-14	0.00E+00	7.25E-12
Manganese, 35.7% in sedimentary deposit, 14.2% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.93E-09	0.00E+00	1.52E-02
Metamorphous rock, graphite containing, in ground	Raw	kg	0.00E+00	0.00E+00	1.32E-09	0.00E+00	7.07E-06
Molybdenum, 0.010% in sulfide, Mo 8.2E-3% and Cu 1.83% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	7.29E-11	0.00E+00	4.58E-07
Molybdenum, 0.014% in sulfide, Mo 8.2E-3% and Cu 0.81% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.03E-11	0.00E+00	6.53E-08
Molybdenum, 0.022% in sulfide, Mo 8.2E-3% and Cu 0.36% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	5.87E-10	0.00E+00	4.03E-06
Molybdenum, 0.025% in sulfide, Mo 8.2E-3% and Cu 0.39% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	3.79E-11	0.00E+00	2.39E-07
Molybdenum, 0.11% in sulfide, Mo 4.1E-2% and Cu 0.36% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.19E-09	0.00E+00	8.12E-06

Substance	Compartment	Unit	Forest operations	OSB	FJL	LVL	I-joists
Nickel, 1.13% in sulfide, Ni 0.76% and Cu 0.76% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.17E-04	0.00E+00	2.28E-04
Nickel, 1.98% in silicates, 1.04% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	2.58E-07	0.00E+00	8.31E-05
Nitrogen	Raw	kg	5.03E-01	5.95E-01	0.00E+00	5.62E-02	4.70E-02
Occupation, arable, conservation tillage	Raw	m2a	0.00E+00	9.68E-04	1.21E-05	1.65E-03	0.00E+00
Occupation, arable, conventional tillage	Raw	m2a	0.00E+00	1.06E-03	1.32E-05	1.81E-03	0.00E+00
Occupation, arable, non-irrigated	Raw	m2a	0.00E+00	0.00E+00	2.29E-07	0.00E+00	2.97E-05
Occupation, arable, reduced tillage	Raw	m2a	0.00E+00	6.50E-04	8.10E-06	1.11E-03	0.00E+00
Occupation, construction site	Raw	m2a	0.00E+00	0.00E+00	7.49E-07	0.00E+00	9.10E-04
Occupation, dump site	Raw	m2a	0.00E+00	0.00E+00	4.15E-05	0.00E+00	1.44E-02
Occupation, dump site, benthos	Raw	m2a	0.00E+00	0.00E+00	8.26E-10	0.00E+00	8.03E-08
Occupation, forest, intensive	Raw	m2a	0.00E+00	0.00E+00	7.80E-06	0.00E+00	3.06E-03
Occupation, forest, intensive, normal	Raw	m2a	0.00E+00	0.00E+00	1.10E-04	0.00E+00	3.03E-02
Occupation, forest, intensive, short-cycle	Raw	m2a	0.00E+00	0.00E+00	1.83E-07	0.00E+00	9.09E-04
Occupation, industrial area	Raw	m2a	0.00E+00	0.00E+00	1.16E-05	0.00E+00	4.00E-03
Occupation, industrial area, benthos	Raw	m2a	0.00E+00	0.00E+00	7.55E-12	0.00E+00	7.34E-10
Occupation, industrial area, built up	Raw	m2a	0.00E+00	0.00E+00	8.35E-09	0.00E+00	6.61E-07
Occupation, industrial area, vegetation	Raw	m2a	0.00E+00	0.00E+00	3.85E-09	0.00E+00	5.70E-07
Occupation, mineral extraction site	Raw	m2a	0.00E+00	0.00E+00	2.30E-05	0.00E+00	1.08E-02
Occupation, permanent crop, fruit, intensive	Raw	m2a	0.00E+00	0.00E+00	2.56E-07	0.00E+00	8.56E-06
Occupation, shrub land, sclerophyllous	Raw	m2a	0.00E+00	0.00E+00	3.84E-07	0.00E+00	2.96E-04
Occupation, traffic area, rail embankment	Raw	m2a	0.00E+00	0.00E+00	3.44E-09	0.00E+00	2.45E-07
Occupation, traffic area, rail network	Raw	m2a	0.00E+00	0.00E+00	3.80E-09	0.00E+00	2.71E-07
Occupation, traffic area, road embankment	Raw	m2a	0.00E+00	0.00E+00	1.22E-06	0.00E+00	3.49E-04
Occupation, traffic area, road network	Raw	m2a	0.00E+00	0.00E+00	1.05E-08	0.00E+00	9.55E-07
Occupation, urban, discontinuously built	Raw	m2a	0.00E+00	0.00E+00	4.22E-13	0.00E+00	3.63E-11
Occupation, water bodies, artificial	Raw	m2a	0.00E+00	0.00E+00	5.81E-05	0.00E+00	1.46E-02
Occupation, water courses, artificial	Raw	m2a	0.00E+00	0.00E+00	2.27E-05	0.00E+00	6.27E-03
Oil, crude	Raw	kg	3.40E+01	1.77E+01	1.53E+01	6.14E+01	7.51E+01
Oil, crude, 41 MJ per kg	Raw	kg	0.00E+00	9.53E+00	0.00E+00	0.00E+00	3.67E-02
Oil, crude, 42 MJ per kg	Raw	kg	0.00E+00	5.79E-01	4.09E-03	2.50E+00	7.19E-02
Oil, crude, 42.7 MJ per kg	Raw	kg	0.00E+00	1.69E-05	8.92E-04	2.27E-04	0.00E+00
Oil, crude, 43.7 MJ per kg, in ground	Raw	kg	0.00E+00	1.08E+00	0.00E+00	0.00E+00	0.00E+00
Oil, crude, 43.7 MJ per kg, in ground (EMR)	Raw	kg	0.00E+00	5.13E+00	0.00E+00	0.00E+00	0.00E+00
Oil, crude, in ground	Raw	kg	0.00E+00	0.00E+00	6.20E-02	0.00E+00	3.23E+00
Olivine, in ground	Raw	kg	0.00E+00	0.00E+00	7.05E-11	0.00E+00	5.87E-06
Oxygen	Raw	kg	0.00E+00	8.34E+00	3.75E-03	6.63E+00	1.56E+00
Pd, Pd 2.0E-4%, Pt 4.8E-4%, Rh 2.4E-5%, Ni 3.7E-2%, Cu 5.2E-2% in ore, in ground	Raw	kg	0.00E+00	0.00E+00	7.33E-11	0.00E+00	1.75E-09
Pd, Pd 7.3E-4%, Pt 2.5E-4%, Rh 2.0E-5%, Ni 2.3E+0%, Cu 3.2E+0% in ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.76E-10	0.00E+00	4.20E-09
Peat, in ground	Raw	kg	0.00E+00	0.00E+00	1.98E-06	0.00E+00	4.61E-04
Pesticides	Raw	kg	0.00E+00	6.39E-07	1.08E-06	1.09E-06	2.64E-05
Phosphate ore	Raw	kg	0.00E+00	6.07E-05	1.03E-04	1.04E-04	3.58E-03
Phosphorus	Raw	kg	8.53E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phosphorus, 18% in apatite, 12% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.51E-07	0.00E+00	2.69E-02
Phosphorus, 18% in apatite, 4% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	3.42E-07	0.00E+00	3.49E-02
Pt, Pt 2.5E-4%, Pd 7.3E-4%, Rh 2.0E-5%, Ni 2.3E+0%, Cu 3.2E+0% in ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.69E-12	0.00E+00	4.03E-11
Pt, Pt 4.8E-4%, Pd 2.0E-4%, Rh 2.4E-5%, Ni 3.7E-2%, Cu 5.2E-2% in ore, in ground	Raw	kg	0.00E+00	0.00E+00	6.05E-12	0.00E+00	1.44E-10
resin	Raw	kg	0.00E+00	4.47E+01	0.00E+00	0.00E+00	0.00E+00

Substance	Compartment	Unit	Forest operations	OSB	FJL	LVL	I-joists
Rh, Rh 2.0E-5%, Pt 2.5E-4%, Pd 7.3E-4%, Ni 2.3E+0%, Cu 3.2E+0% in ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.68E-12	0.00E+00	4.00E-11
Rh, Rh 2.4E-5%, Pt 4.8E-4%, Pd 2.0E-4%, Ni 3.7E-2%, Cu 5.2E-2% in ore, in ground	Raw	kg	0.00E+00	0.00E+00	5.25E-12	0.00E+00	1.25E-10
Rhenium, in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.89E-12	0.00E+00	7.51E-11
Roundwood at forest road	Raw	m3	0.00E+00	4.10E+00	0.00E+00	0.00E+00	0.00E+00
Salt, unspecified	Raw	kg	0.00E+00	5.72E+00	0.00E+00	0.00E+00	0.00E+00
Sand, quartz, in ground	Raw	kg	0.00E+00	7.08E-06	1.20E-05	1.21E-05	2.92E-04
Sand, unspecified, in ground	Raw	kg	0.00E+00	0.00E+00	4.48E-08	0.00E+00	2.20E-03
Scrap, external	Raw	kg	0.00E+00	2.48E-01	2.16E-01	4.24E-01	5.24E+00
Seed corn	Raw	kg	0.00E+00	3.42E-06	5.79E-06	5.85E-06	1.41E-04
Shale, in ground	Raw	kg	0.00E+00	0.00E+00	5.64E-10	0.00E+00	4.77E-05
Silver, 0.007% in sulfide, Ag 0.004%, Pb, Zn, Cd, In, in ground	Raw	kg	0.00E+00	0.00E+00	3.74E-13	0.00E+00	2.53E-11
Silver, 3.2ppm in sulfide, Ag 1.2ppm, Cu and Te, in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	2.67E-13	0.00E+00	1.81E-11
Silver, Ag 2.1E-4%, Au 2.1E-4%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	2.46E-14	0.00E+00	1.67E-12
Silver, Ag 4.2E-3%, Au 1.1E-4%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	5.63E-14	0.00E+00	3.81E-12
Silver, Ag 4.6E-5%, Au 1.3E-4%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	5.52E-14	0.00E+00	3.73E-12
Silver, Ag 9.7E-4%, Au 9.7E-4%, Zn 0.63%, Cu 0.38%, Pb 0.014%, in ore, in ground	Raw	kg	0.00E+00	0.00E+00	3.64E-14	0.00E+00	2.46E-12
Sodium carbonate	Raw	kg	0.00E+00	8.26E-04	1.03E-05	1.41E-03	0.00E+00
Sodium chloride	Raw	kg	0.00E+00	1.64E+00	7.55E-03	1.78E+01	3.65E-01
Sodium chloride, in ground	Raw	kg	0.00E+00	0.00E+00	7.39E-04	0.00E+00	5.62E+00
Sodium nitrate, in ground	Raw	kg	0.00E+00	0.00E+00	2.53E-15	0.00E+00	1.78E-13
Sodium sulfate	Raw	kg	0.00E+00	4.49E-03	3.30E-03	7.66E-03	7.97E-02
Sodium sulphate, various forms, in ground	Raw	kg	0.00E+00	0.00E+00	7.12E-07	0.00E+00	1.96E-05
Stibnite, in ground	Raw	kg	0.00E+00	0.00E+00	1.40E-14	0.00E+00	4.30E-12
Sulfur	Raw	kg	0.00E+00	2.42E-04	1.99E-04	4.13E-04	4.73E-02
Sulfur, in ground	Raw	kg	0.00E+00	0.00E+00	1.34E-08	0.00E+00	4.94E-02
Sylvinite, in ground	Raw	kg	0.00E+00	2.99E-05	5.06E-05	5.11E-05	1.23E-03
Sylvite, 25 % in sylvinite, in ground	Raw	kg	0.00E+00	0.00E+00	1.01E-08	0.00E+00	4.29E-02
Talc, in ground	Raw	kg	0.00E+00	0.00E+00	1.40E-08	0.00E+00	2.09E-06
Tantalum, 81.9% in tantalite, 1.6E-4% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	2.95E-13	0.00E+00	2.00E-11
Tellurium, 0.5ppm in sulfide, Te 0.2ppm, Cu and Ag, in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	4.00E-14	0.00E+00	2.71E-12
Tin, 79% in cassiterite, 0.1% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.90E-11	0.00E+00	1.62E-09
TiO2, 54% in ilmenite, 2.6% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	1.85E-06	0.00E+00	1.96E-04
TiO2, 95% in rutile, 0.40% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	8.44E-15	0.00E+00	6.96E-13
Transformation, from arable	Raw	m2	0.00E+00	0.00E+00	5.11E-10	0.00E+00	1.87E-06
Transformation, from arable, non-irrigated	Raw	m2	0.00E+00	0.00E+00	4.22E-07	0.00E+00	5.47E-05
Transformation, from arable, non-irrigated, fallow	Raw	m2	0.00E+00	0.00E+00	1.62E-10	0.00E+00	5.96E-07
Transformation, from dump site, inert material landfill	Raw	m2	0.00E+00	0.00E+00	8.37E-11	0.00E+00	2.59E-05
Transformation, from dump site, residual material landfill	Raw	m2	0.00E+00	0.00E+00	7.26E-08	0.00E+00	3.28E-05
Transformation, from dump site, sanitary landfill	Raw	m2	0.00E+00	0.00E+00	3.86E-09	0.00E+00	3.34E-07
Transformation, from dump site, slag compartment	Raw	m2	0.00E+00	0.00E+00	9.54E-11	0.00E+00	7.79E-08
Transformation, from forest	Raw	m2	0.00E+00	0.00E+00	6.31E-09	0.00E+00	4.04E-05
Transformation, from forest, extensive	Raw	m2	0.00E+00	0.00E+00	9.16E-07	0.00E+00	2.57E-04

Substance	Compartment	Unit	Forest operations	OSB	FJL	LVL	I-joists
Transformation, from forest, intensive, clear-cutting	Raw	m2	0.00E+00	0.00E+00	6.54E-09	0.00E+00	3.25E-05
Transformation, from industrial area	Raw	m2	0.00E+00	0.00E+00	5.31E-08	0.00E+00	9.41E-06
Transformation, from industrial area, benthos	Raw	m2	0.00E+00	0.00E+00	6.95E-14	0.00E+00	6.90E-12
Transformation, from industrial area, built up	Raw	m2	0.00E+00	0.00E+00	1.22E-10	0.00E+00	1.41E-08
Transformation, from industrial area, vegetation	Raw	m2	0.00E+00	0.00E+00	2.08E-10	0.00E+00	2.41E-08
Transformation, from mineral extraction site	Raw	m2	0.00E+00	0.00E+00	4.36E-07	0.00E+00	2.94E-04
Transformation, from pasture and meadow	Raw	m2	0.00E+00	0.00E+00	2.45E-07	0.00E+00	2.26E-04
Transformation, from pasture and meadow, intensive	Raw	m2	0.00E+00	0.00E+00	3.44E-10	0.00E+00	4.46E-08
Transformation, from sea and ocean	Raw	m2	0.00E+00	0.00E+00	8.27E-10	0.00E+00	8.04E-08
Transformation, from shrub land, sclerophyllous	Raw	m2	0.00E+00	0.00E+00	2.19E-07	0.00E+00	9.83E-05
Transformation, from tropical rain forest	Raw	m2	0.00E+00	0.00E+00	6.54E-09	0.00E+00	3.25E-05
Transformation, from unknown	Raw	m2	0.00E+00	0.00E+00	1.40E-06	0.00E+00	4.00E-04
Transformation, to arable	Raw	m2	0.00E+00	0.00E+00	4.01E-07	0.00E+00	1.25E-04
Transformation, to arable, non-irrigated	Raw	m2	0.00E+00	0.00E+00	4.22E-07	0.00E+00	5.47E-05
Transformation, to arable, non-irrigated, fallow	Raw	m2	0.00E+00	0.00E+00	4.94E-10	0.00E+00	6.79E-07
Transformation, to dump site	Raw	m2	0.00E+00	0.00E+00	3.22E-07	0.00E+00	1.09E-04
Transformation, to dump site, benthos	Raw	m2	0.00E+00	0.00E+00	8.26E-10	0.00E+00	8.03E-08
Transformation, to dump site, inert material landfill	Raw	m2	0.00E+00	0.00E+00	8.37E-11	0.00E+00	2.59E-05
Transformation, to dump site, residual material landfill	Raw	m2	0.00E+00	0.00E+00	7.26E-08	0.00E+00	3.28E-05
Transformation, to dump site, sanitary landfill	Raw	m2	0.00E+00	0.00E+00	3.86E-09	0.00E+00	3.34E-07
Transformation, to dump site, slag compartment	Raw	m2	0.00E+00	0.00E+00	9.54E-11	0.00E+00	7.79E-08
Transformation, to forest	Raw	m2	0.00E+00	0.00E+00	1.09E-07	0.00E+00	8.13E-05
Transformation, to forest, intensive	Raw	m2	0.00E+00	0.00E+00	5.19E-08	0.00E+00	2.04E-05
Transformation, to forest, intensive, clear-cutting	Raw	m2	0.00E+00	0.00E+00	6.54E-09	0.00E+00	3.25E-05
Transformation, to forest, intensive, normal	Raw	m2	0.00E+00	0.00E+00	8.51E-07	0.00E+00	2.33E-04
Transformation, to forest, intensive, short-cycle	Raw	m2	0.00E+00	0.00E+00	6.54E-09	0.00E+00	3.25E-05
Transformation, to heterogeneous, agricultural	Raw	m2	0.00E+00	0.00E+00	7.51E-11	0.00E+00	7.02E-09
Transformation, to industrial area	Raw	m2	0.00E+00	0.00E+00	1.23E-07	0.00E+00	4.02E-05
Transformation, to industrial area, benthos	Raw	m2	0.00E+00	0.00E+00	1.21E-12	0.00E+00	1.05E-10
Transformation, to industrial area, built up	Raw	m2	0.00E+00	0.00E+00	7.07E-09	0.00E+00	1.79E-06
Transformation, to industrial area, vegetation	Raw	m2	0.00E+00	0.00E+00	1.75E-10	0.00E+00	2.02E-08
Transformation, to mineral extraction site	Raw	m2	0.00E+00	0.00E+00	5.91E-07	0.00E+00	3.26E-04
Transformation, to pasture and meadow	Raw	m2	0.00E+00	0.00E+00	1.28E-09	0.00E+00	1.46E-04
Transformation, to permanent crop, fruit, intensive	Raw	m2	0.00E+00	0.00E+00	3.60E-09	0.00E+00	1.21E-07
Transformation, to sea and ocean	Raw	m2	0.00E+00	0.00E+00	6.95E-14	0.00E+00	6.90E-12
Transformation, to shrub land, sclerophyllous	Raw	m2	0.00E+00	0.00E+00	7.66E-08	0.00E+00	5.91E-05
Transformation, to traffic area, rail embankment	Raw	m2	0.00E+00	0.00E+00	8.00E-12	0.00E+00	5.69E-10
Transformation, to traffic area, rail network	Raw	m2	0.00E+00	0.00E+00	8.79E-12	0.00E+00	6.26E-10
Transformation, to traffic area, road embankment	Raw	m2	0.00E+00	0.00E+00	9.26E-09	0.00E+00	2.64E-06
Transformation, to traffic area, road network	Raw	m2	0.00E+00	0.00E+00	1.17E-10	0.00E+00	1.08E-08
Transformation, to unknown	Raw	m2	0.00E+00	0.00E+00	5.48E-08	0.00E+00	9.87E-06

Substance	Compartment	Unit	Forest operations	OSB	FJL	LVL	I-joists
Transformation, to urban, discontinuously built	Raw	m2	0.00E+00	0.00E+00	8.41E-15	0.00E+00	7.23E-13
Transformation, to water bodies, artificial	Raw	m2	0.00E+00	0.00E+00	3.97E-07	0.00E+00	9.55E-05
Transformation, to water courses, artificial	Raw	m2	0.00E+00	0.00E+00	2.82E-07	0.00E+00	7.76E-05
Ulexite, in ground	Raw	kg	0.00E+00	0.00E+00	1.03E-12	0.00E+00	8.96E-11
Uranium	Raw	kg	0.00E+00	2.33E-08	2.91E-10	8.50E-03	3.77E-03
Uranium oxide, 332 GJ per kg, in ore	Raw	kg	4.64E-05	3.38E-03	5.13E-04	3.53E-03	1.42E-03
Uranium, 2291 GJ per kg	Raw	kg	0.00E+00	1.95E-06	1.83E-08	8.42E-06	2.41E-07
Uranium, in ground	Raw	kg	0.00E+00	0.00E+00	3.90E-07	0.00E+00	1.29E-04
Vermiculite, in ground	Raw	kg	0.00E+00	0.00E+00	6.85E-13	0.00E+00	3.96E-11
Volume occupied, final repository for low-active radioactive waste	Raw	m3	0.00E+00	0.00E+00	8.05E-10	0.00E+00	2.48E-07
Volume occupied, final repository for radioactive waste	Raw	m3	0.00E+00	0.00E+00	2.04E-10	0.00E+00	6.23E-08
Volume occupied, reservoir	Raw	m3y	0.00E+00	0.00E+00	8.87E-04	0.00E+00	1.62E-01
Volume occupied, underground deposit	Raw	m3	0.00E+00	0.00E+00	6.56E-09	0.00E+00	5.43E-07
Water, consumptive use, unspecified origin/m3	Raw	kg	0.00E+00	1.37E-01	0.00E+00	0.00E+00	0.00E+00
Water, cooling, unspecified natural origin/kg	Raw	kg	0.00E+00	4.81E-01	0.00E+00	1.21E+00	0.00E+00
Water, cooling, unspecified natural origin/m3	Raw	m3	0.00E+00	4.55E-01	4.86E-01	1.69E+00	1.74E+00
Water, lake	Raw	m3	0.00E+00	0.00E+00	8.83E-07	0.00E+00	5.68E-04
Water, process, surface	Raw	kg	0.00E+00	1.66E+02	4.42E+02	8.01E+02	0.00E+00
Water, process, unspecified natural origin/kg	Raw	kg	0.00E+00	8.92E+00	1.32E+00	2.25E+01	0.00E+00
Water, process, unspecified natural origin/m3	Raw	m3	0.00E+00	1.36E-05	7.16E-04	1.82E-04	0.00E+00
Water, process, well	Raw	kg	0.00E+00	2.48E+02	2.02E+02	3.49E+02	0.00E+00
Water, process, well, in ground	Raw	kg	0.00E+00	0.00E+00	1.97E-01	0.00E+00	3.06E+00
Water, river	Raw	m3	0.00E+00	1.09E-05	2.21E-04	1.85E-05	5.75E-02
Water, salt, ocean	Raw	m3	0.00E+00	0.00E+00	2.36E-04	0.00E+00	1.10E-02
Water, salt, sole	Raw	m3	0.00E+00	0.00E+00	4.93E-05	0.00E+00	6.82E+01
Water, turbine use, unspecified natural origin	Raw	m3	0.00E+00	0.00E+00	2.41E-01	0.00E+00	6.61E+01
Water, unspecified natural origin, RoW	Raw	m3	0.00E+00	7.57E-05	8.44E-04	1.13E-03	0.00E+00
Water, unspecified natural origin, US	Raw	m3	0.00E+00	2.03E-04	0.00E+00	1.64E+00	0.00E+00
Water, unspecified natural origin/kg	Raw	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.23E+00
Water, unspecified natural origin/m3	Raw	m3	9.83E-02	2.06E-01	1.34E-03	5.20E-01	2.43E-01
Water, well, in ground	Raw	m3	0.00E+00	6.28E-05	5.73E-05	1.07E-04	1.92E-02
Water, well, in ground, US	Raw	m3	0.00E+00	3.79E-05	0.00E+00	1.16E-02	0.00E+00
Wood and wood waste, 20.9 MJ per kg, ovendry basis	Raw	kg	0.00E+00	8.71E+01	2.94E+02	8.97E+02	0.00E+00
Wood and wood waste, 20.9 MJ/kg,ovendry (burned at kiln)	Raw	kg	0.00E+00	1.35E+00	0.00E+00	0.00E+00	0.00E+00
Wood and wood waste, 20.9 MJ/kg,ovendry (burned at sawmill boiler)	Raw	kg	0.00E+00	2.25E+00	0.00E+00	0.00E+00	0.00E+00
Wood and wood waste, 9.5 MJ per kg	Raw	kg	0.00E+00	2.44E-01	4.13E-01	4.17E-01	1.01E+01
Wood for fiber, feedstock	Raw	kg	0.00E+00	5.24E-01	8.87E-01	8.95E-01	2.16E+01
Wood into sawmill logyard	Raw	m3	0.00E+00	3.36E-02	0.00E+00	0.00E+00	0.00E+00
Wood, feedstock	Raw	kg	0.00E+00	5.57E-01	6.95E-03	9.50E-01	0.00E+00
Wood, hard, NE-NC, standing	Raw	m3	9.71E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Wood, hard, standing	Raw	m3	0.00E+00	0.00E+00	2.00E-07	0.00E+00	5.46E-05
Wood, primary forest, standing	Raw	m3	0.00E+00	0.00E+00	6.77E-11	0.00E+00	3.36E-07
Wood, soft, standing	Raw	m3	0.00E+00	7.03E-04	3.93E+00	6.89E+00	1.45E-04
Wood, unspecified, standing/kg	Raw	kg	0.00E+00	0.00E+00	0.00E+00	7.50E-02	0.00E+00
Wood, unspecified, standing/m3	Raw	m3	0.00E+00	0.00E+00	1.63E-12	0.00E+00	4.38E-08
Zinc, 9.0% in sulfide, Zn 5.3%, Pb, Ag, Cd, In, in ground	Raw	kg	0.00E+00	0.00E+00	2.02E-08	0.00E+00	6.85E-05
Zirconium, 50% in zircon, 0.39% in crude ore, in ground	Raw	kg	0.00E+00	0.00E+00	4.04E-13	0.00E+00	2.73E-11
1-Butanol	Air	kg	0.00E+00	0.00E+00	2.02E-16	0.00E+00	4.49E-05
1-Pentanol	Air	kg	0.00E+00	0.00E+00	1.91E-15	0.00E+00	1.83E-13

Substance	Compartment	Unit	Forest operations	OSB	FJL	LVL	I-joists
1-Pentene	Air	kg	0.00E+00	0.00E+00	1.45E-15	0.00E+00	1.38E-13
1-Propanol	Air	kg	0.00E+00	0.00E+00	1.43E-14	0.00E+00	1.49E-12
1,4-Butanediol	Air	kg	0.00E+00	0.00E+00	1.40E-15	0.00E+00	2.07E-04
2-Aminopropanol	Air	kg	0.00E+00	0.00E+00	2.87E-17	0.00E+00	2.63E-05
2-Butene, 2-methyl-	Air	kg	0.00E+00	0.00E+00	3.21E-19	0.00E+00	3.07E-17
2-Chloroacetophenone	Air	kg	1.72E-11	1.79E-09	3.81E-10	3.48E-09	8.42E-09
2-Methyl-1-propanol	Air	kg	0.00E+00	0.00E+00	3.47E-15	0.00E+00	4.01E-05
2-Methyl-4-chlorophenoxyacetic acid	Air	kg	0.00E+00	6.38E-11	7.96E-13	1.09E-10	0.00E+00
2-Nitrobenzoic acid	Air	kg	0.00E+00	0.00E+00	2.87E-17	0.00E+00	1.07E-04
2-Propanol	Air	kg	0.00E+00	0.00E+00	1.83E-12	0.00E+00	8.61E-05
2,4-D	Air	kg	0.00E+00	3.42E-09	4.27E-11	5.84E-09	0.00E+00
5-methyl Chrysene	Air	kg	1.90E-11	1.13E-09	2.26E-10	1.61E-09	6.79E-10
Acenaphthene	Air	kg	4.40E-10	2.62E-08	5.24E-09	3.72E-08	1.58E-08
Acenaphthylene	Air	kg	2.16E-10	1.29E-08	2.57E-09	1.83E-08	7.71E-09
Acetaldehyde	Air	kg	4.54E-04	1.76E-02	5.41E-02	5.02E-02	3.67E-04
Acetic acid	Air	kg	0.00E+00	0.00E+00	2.60E-06	0.00E+00	2.20E-03
Acetochlor	Air	kg	0.00E+00	4.74E-08	5.92E-10	8.09E-08	0.00E+00
Acetone	Air	kg	0.00E+00	5.24E-03	3.31E-07	4.19E-02	2.51E-04
Acetonitrile	Air	kg	0.00E+00	0.00E+00	7.11E-12	0.00E+00	3.53E-08
Acetophenone	Air	kg	3.68E-11	3.84E-09	8.17E-10	7.45E-09	1.80E-08
Acrolein	Air	kg	5.50E-05	5.17E-03	2.44E-03	6.67E-03	9.22E-06
Acrylic acid	Air	kg	0.00E+00	0.00E+00	4.74E-15	0.00E+00	3.20E-13
Actinides, radioactive, unspecified	Air	Bq	0.00E+00	0.00E+00	6.52E-06	0.00E+00	2.06E-03
Aerosols, radioactive, unspecified	Air	Bq	0.00E+00	0.00E+00	1.72E-04	0.00E+00	5.14E-02
Alachlor	Air	kg	0.00E+00	4.67E-09	5.82E-11	7.97E-09	0.00E+00
Aldehydes, unspecified	Air	kg	1.38E-03	7.75E-04	6.35E-04	2.45E-03	2.97E-03
Aluminium	Air	kg	0.00E+00	0.00E+00	2.59E-06	0.00E+00	3.88E-04
Ammonia	Air	kg	8.99E-04	5.28E-03	9.32E-03	1.22E-02	4.64E-03
Ammonium carbonate	Air	kg	0.00E+00	0.00E+00	3.78E-12	0.00E+00	5.95E-08
Ammonium chloride	Air	kg	2.46E-06	1.79E-04	2.72E-05	1.87E-04	7.54E-05
Aniline	Air	kg	0.00E+00	0.00E+00	1.11E-14	0.00E+00	1.64E-04
Anthracene	Air	kg	1.81E-10	1.08E-08	2.16E-09	1.53E-08	6.48E-09
Anthranilic acid	Air	kg	0.00E+00	0.00E+00	2.10E-17	0.00E+00	4.96E-05
Antimony	Air	kg	1.55E-08	9.56E-07	1.86E-07	1.34E-06	6.30E-07
Antimony-124	Air	Bq	0.00E+00	0.00E+00	7.70E-10	0.00E+00	4.43E-07
Antimony-125	Air	Bq	0.00E+00	0.00E+00	8.04E-09	0.00E+00	4.62E-06
Argon-41	Air	Bq	0.00E+00	0.00E+00	9.13E-02	0.00E+00	2.72E+01
Aromatics	Air	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.97E-05
Arsenic	Air	kg	4.93E-07	2.20E-05	4.44E-06	3.12E-05	1.51E-05
Arsine	Air	kg	0.00E+00	0.00E+00	5.53E-20	0.00E+00	3.73E-18
Ash	Air	kg	0.00E+00	8.63E-05	0.00E+00	0.00E+00	3.33E-07
Atrazine	Air	kg	0.00E+00	9.24E-08	1.15E-09	1.58E-07	0.00E+00
Barium	Air	kg	0.00E+00	5.07E-03	9.10E-07	9.12E-07	2.52E-05
Barium-140	Air	Bq	0.00E+00	0.00E+00	5.23E-07	0.00E+00	3.01E-04
Bentazone	Air	kg	0.00E+00	3.77E-10	4.70E-12	6.44E-10	0.00E+00
Benzal chloride	Air	kg	0.00E+00	0.00E+00	1.03E-20	0.00E+00	1.33E-17
Benzaldehyde	Air	kg	0.00E+00	0.00E+00	2.86E-12	0.00E+00	3.39E-10
Benzene	Air	kg	5.54E-04	1.46E-02	1.34E-04	8.27E-02	1.32E-02
Benzene, 1-methyl-2-nitro-	Air	kg	0.00E+00	0.00E+00	2.48E-17	0.00E+00	9.28E-05
Benzene, 1,2-dichloro-	Air	kg	0.00E+00	0.00E+00	3.70E-15	0.00E+00	1.21E-04
Benzene, chloro-	Air	kg	5.40E-11	5.63E-09	1.20E-09	1.09E-08	2.65E-08
Benzene, ethyl-	Air	kg	2.31E-10	4.98E-07	1.22E-07	3.41E-06	2.97E-06
Benzene, hexachloro-	Air	kg	0.00E+00	0.00E+00	1.63E-14	0.00E+00	1.14E-11
Benzene, pentachloro-	Air	kg	0.00E+00	0.00E+00	2.81E-14	0.00E+00	2.38E-11
Benzo(a)anthracene	Air	kg	6.90E-11	4.12E-09	8.23E-10	5.84E-09	2.47E-09
Benzo(a)pyrene	Air	kg	3.28E-11	1.96E-09	9.87E-10	2.77E-09	1.50E-07
Benzo(b,j,k)fluoranthene	Air	kg	9.48E-11	5.66E-09	1.13E-09	8.03E-09	3.39E-09
Benzo(g,h,i)perylene	Air	kg	2.33E-11	1.39E-09	2.78E-10	1.97E-09	8.33E-10
Benzyl chloride	Air	kg	1.72E-09	1.79E-07	3.81E-08	3.48E-07	8.42E-07
Beryllium	Air	kg	2.42E-08	1.21E-06	2.33E-07	1.74E-06	8.81E-07
Biphenyl	Air	kg	1.47E-09	8.75E-08	1.75E-08	1.24E-07	5.24E-08
Boron	Air	kg	0.00E+00	0.00E+00	2.52E-07	0.00E+00	8.13E-05
Boron trifluoride	Air	kg	0.00E+00	0.00E+00	7.56E-22	0.00E+00	5.10E-20

Substance	Compartment	Unit	Forest operations	OSB	FJL	LVL	I-joists
Bromine	Air	kg	0.00E+00	0.00E+00	2.77E-08	0.00E+00	8.42E-06
Bromoform	Air	kg	9.58E-11	9.99E-09	2.12E-09	1.94E-08	4.69E-08
Bromoxynil	Air	kg	0.00E+00	8.27E-10	1.03E-11	1.41E-09	0.00E+00
BTEX (Benzene, Toluene, Ethylbenzene, and Xylene), unspecified ratio	Air	kg	6.15E-04	2.31E-02	5.90E-03	5.26E-02	2.83E-02
Butadiene	Air	kg	2.31E-05	1.50E-07	2.52E-06	7.07E-06	1.79E-07
Butane	Air	kg	0.00E+00	0.00E+00	1.21E-05	0.00E+00	1.92E-04
Butene	Air	kg	0.00E+00	0.00E+00	8.34E-08	0.00E+00	6.14E-04
Butyrolactone	Air	kg	0.00E+00	0.00E+00	2.84E-17	0.00E+00	1.92E-15
Cadmium	Air	kg	1.21E-07	4.44E-06	1.02E-06	7.06E-06	3.87E-06
Calcium	Air	kg	0.00E+00	0.00E+00	4.25E-07	0.00E+00	5.97E-05
Carbofuran	Air	kg	0.00E+00	7.07E-10	8.82E-12	1.21E-09	0.00E+00
Carbon-14	Air	Bq	0.00E+00	0.00E+00	6.96E-01	0.00E+00	2.16E+02
Carbon dioxide	Air	kg	2.68E-01	6.40E+00	2.03E-01	9.82E+00	1.59E+01
Carbon dioxide, biogenic	Air	kg	8.06E-02	8.83E+01	5.19E+02	1.59E+03	1.33E+01
Carbon dioxide, fossil	Air	kg	1.08E+02	4.45E+02	1.36E+02	8.10E+02	5.40E+02
Carbon dioxide, land transformation	Air	kg	0.00E+00	0.00E+00	2.11E-06	0.00E+00	1.08E-03
Carbon disulfide	Air	kg	3.19E-10	1.92E-07	7.50E-07	6.46E-08	2.32E-06
Carbon monoxide	Air	kg	3.84E-05	1.23E-01	4.70E-03	1.14E-01	1.49E-01
Carbon monoxide, biogenic	Air	kg	0.00E+00	8.71E-01	9.50E-01	4.04E+00	5.32E-05
Carbon monoxide, fossil	Air	kg	1.30E+00	4.35E-01	3.64E-01	1.34E+00	1.46E+00
Cerium-141	Air	Bq	0.00E+00	0.00E+00	1.27E-07	0.00E+00	7.29E-05
Cesium-134	Air	Bq	0.00E+00	0.00E+00	6.07E-09	0.00E+00	3.49E-06
Cesium-137	Air	Bq	0.00E+00	0.00E+00	1.08E-07	0.00E+00	6.19E-05
Chloramine	Air	kg	0.00E+00	0.00E+00	6.76E-15	0.00E+00	6.71E-05
Chloride	Air	kg	6.18E-11	1.66E-09	4.67E-10	4.43E-09	1.91E-09
Chlorinated fluorocarbons and hydrochlorinated fluorocarbons, unspecified	Air	kg	0.00E+00	3.45E-07	1.09E-07	2.86E-06	5.03E-06
Chlorine	Air	kg	0.00E+00	1.61E-05	1.70E-06	2.85E-05	1.93E-02
Chloroacetic acid	Air	kg	0.00E+00	0.00E+00	1.61E-14	0.00E+00	3.39E-04
Chloroform	Air	kg	1.45E-10	1.51E-08	3.22E-09	2.93E-08	1.15E-03
Chlorosilane, trimethyl-	Air	kg	0.00E+00	0.00E+00	7.00E-16	0.00E+00	2.04E-13
Chlorosulfonic acid	Air	kg	0.00E+00	0.00E+00	2.04E-16	0.00E+00	5.11E-05
Chlorpyrifos	Air	kg	0.00E+00	5.44E-09	6.78E-11	9.28E-09	0.00E+00
Chromium	Air	kg	3.54E-07	1.56E-05	3.27E-06	2.33E-05	1.51E-05
Chromium-51	Air	Bq	0.00E+00	0.00E+00	8.12E-09	0.00E+00	4.67E-06
Chromium VI	Air	kg	6.81E-08	4.07E-06	8.13E-07	5.77E-06	2.56E-06
Chrysene	Air	kg	8.62E-11	5.15E-09	1.03E-09	7.30E-09	3.08E-09
Cobalt	Air	kg	6.80E-07	6.61E-06	1.67E-06	9.57E-06	5.84E-06
Cobalt-58	Air	Bq	0.00E+00	0.00E+00	1.13E-08	0.00E+00	6.50E-06
Cobalt-60	Air	Bq	0.00E+00	0.00E+00	9.99E-08	0.00E+00	5.75E-05
Copper	Air	kg	6.10E-09	9.27E-07	1.95E-07	3.30E-07	1.53E-05
Cumene	Air	kg	1.30E-11	1.96E-02	4.75E-09	4.96E-02	1.24E-02
Cyanazine	Air	kg	0.00E+00	8.15E-10	1.02E-11	1.39E-09	0.00E+00
Cyanide	Air	kg	6.14E-09	6.41E-07	1.36E-07	1.24E-06	6.78E-05
Cyanoacetic acid	Air	kg	0.00E+00	0.00E+00	1.67E-16	0.00E+00	4.19E-05
Dicamba	Air	kg	0.00E+00	4.80E-09	5.99E-11	8.20E-09	0.00E+00
Diethylamine	Air	kg	0.00E+00	0.00E+00	4.95E-15	0.00E+00	1.32E-04
Dimethenamid	Air	kg	0.00E+00	1.13E-08	1.41E-10	1.94E-08	0.00E+00
Dimethyl ether	Air	kg	0.00E+00	1.57E-04	4.33E-06	3.59E-04	3.59E-05
Dimethyl malonate	Air	kg	0.00E+00	0.00E+00	2.10E-16	0.00E+00	5.25E-05
Dinitrogen monoxide	Air	kg	1.83E-03	3.33E-03	2.21E-03	1.10E-02	1.25E-02
Dioxin, 2,3,7,8 Tetrachlorodibenzo-p-	Air	kg	2.19E-12	3.69E-09	5.48E-11	6.29E-09	3.41E-11
Dioxins (unspec.)	Air	kg	0.00E+00	8.82E-15	0.00E+00	0.00E+00	0.00E+00
Dipropylamine	Air	kg	0.00E+00	0.00E+00	3.15E-15	0.00E+00	5.90E-05
Dipropylthiocarbamic acid S-ethyl ester	Air	kg	0.00E+00	7.77E-09	9.69E-11	1.33E-08	0.00E+00
Ethane	Air	kg	0.00E+00	0.00E+00	4.38E-05	0.00E+00	6.11E-04
Ethane, 1,1-difluoro-, HFC-152a	Air	kg	0.00E+00	0.00E+00	2.58E-15	0.00E+00	2.32E-13
Ethane, 1,1,1-trichloro-, HCFC-140	Air	kg	3.24E-09	6.78E-09	2.53E-09	1.54E-08	3.07E-08
Ethane, 1,1,1,2-tetrafluoro-, HFC-134a	Air	kg	0.00E+00	5.50E-07	2.33E-08	0.00E+00	3.54E-07
Ethane, 1,1,2-trichloro-1,2,2-trifluoro-, CFC-113	Air	kg	0.00E+00	0.00E+00	2.25E-16	0.00E+00	1.52E-14

Substance	Compartment	Unit	Forest operations	OSB	FJL	LVL	I-joists
Ethane, 1,2-dibromo-	Air	kg	2.95E-12	2.56E-08	6.90E-11	5.97E-10	1.44E-09
Ethane, 1,2-dichloro-	Air	kg	9.83E-11	1.03E-08	5.34E-09	1.99E-08	2.30E-04
Ethane, 1,2-dichloro-1,1,2-trifluoro-, HCFC-123	Air	kg	0.00E+00	5.50E-07	0.00E+00	0.00E+00	0.00E+00
Ethane, 1,2-dichloro-1,1,2,2-tetrafluoro-, CFC-114	Air	kg	0.00E+00	0.00E+00	2.86E-10	0.00E+00	9.00E-08
Ethane, chloro-	Air	kg	1.03E-10	1.08E-08	2.29E-09	2.09E-08	5.05E-08
Ethane, hexafluoro-, HFC-116	Air	kg	0.00E+00	0.00E+00	2.16E-11	0.00E+00	1.15E-07
Ethanol	Air	kg	0.00E+00	0.00E+00	6.60E-07	0.00E+00	2.67E-04
Ethene	Air	kg	0.00E+00	0.00E+00	1.80E-07	0.00E+00	2.99E-03
Ethene, chloro-	Air	kg	0.00E+00	0.00E+00	1.53E-09	0.00E+00	1.26E-07
Ethene, tetrachloro-	Air	kg	4.46E-08	2.25E-06	4.50E-07	3.19E-06	1.38E-06
Ethene, trichloro-	Air	kg	0.00E+00	1.54E-13	6.90E-11	1.41E-12	6.34E-12
Ethyl acetate	Air	kg	0.00E+00	0.00E+00	8.51E-12	0.00E+00	1.08E-06
Ethyl cellulose	Air	kg	0.00E+00	0.00E+00	1.72E-14	0.00E+00	1.16E-12
Ethylamine	Air	kg	0.00E+00	0.00E+00	2.22E-15	0.00E+00	1.22E-04
Ethylene diamine	Air	kg	0.00E+00	0.00E+00	4.64E-14	0.00E+00	4.31E-12
Ethylene oxide	Air	kg	0.00E+00	4.48E-09	2.36E-07	5.99E-08	2.37E-06
Ethyne	Air	kg	0.00E+00	0.00E+00	2.04E-09	0.00E+00	2.26E-04
Fluoranthene	Air	kg	6.12E-10	3.65E-08	7.30E-09	5.18E-08	2.19E-08
Fluorene	Air	kg	7.85E-10	4.68E-08	9.36E-09	6.64E-08	2.81E-08
Fluoride	Air	kg	3.20E-06	1.54E-05	3.04E-06	2.64E-05	5.54E-05
Fluorine	Air	kg	0.00E+00	0.00E+00	2.01E-08	0.00E+00	6.21E-06
Fluosilicic acid	Air	kg	0.00E+00	0.00E+00	2.53E-11	0.00E+00	1.34E-07
Formaldehyde	Air	kg	7.04E-04	4.11E-02	4.69E-03	3.76E-02	1.35E-02
Formamide	Air	kg	0.00E+00	0.00E+00	3.50E-15	0.00E+00	3.35E-13
Formic acid	Air	kg	0.00E+00	0.00E+00	4.76E-11	0.00E+00	2.36E-07
Furan	Air	kg	3.94E-12	2.49E-10	6.29E-11	3.56E-10	6.72E-08
Glyphosate	Air	kg	0.00E+00	1.02E-08	1.27E-10	1.74E-08	0.00E+00
HAPs	Air	kg	0.00E+00	3.02E-04	1.85E-03	4.51E-03	0.00E+00
HAPS, unspecified	Air	kg	0.00E+00	0.00E+00	5.35E-04	3.54E-07	0.00E+00
Heat, waste	Air	MJ	0.00E+00	2.08E+01	1.58E+01	5.46E+01	3.74E+02
Helium	Air	kg	0.00E+00	0.00E+00	1.56E-07	0.00E+00	3.33E-06
Heptane	Air	kg	0.00E+00	0.00E+00	8.25E-07	0.00E+00	1.71E-05
Hexane	Air	kg	1.65E-10	3.85E-07	1.84E-06	9.53E-04	6.00E-05
Hydrazine, methyl-	Air	kg	4.18E-10	4.35E-08	9.26E-09	8.45E-08	2.05E-07
Hydrocarbons, aliphatic, alkanes, cyclic	Air	kg	0.00E+00	0.00E+00	7.53E-11	0.00E+00	6.71E-06
Hydrocarbons, aliphatic, alkanes, unspecified	Air	kg	0.00E+00	0.00E+00	4.00E-06	0.00E+00	2.78E-03
Hydrocarbons, aliphatic, unsaturated	Air	kg	0.00E+00	0.00E+00	1.26E-07	0.00E+00	7.25E-05
Hydrocarbons, aromatic	Air	kg	0.00E+00	0.00E+00	1.65E-06	0.00E+00	7.11E-05
Hydrocarbons, chlorinated	Air	kg	0.00E+00	0.00E+00	3.09E-09	0.00E+00	1.09E-04
Hydrocarbons, unspecified	Air	kg	1.42E-05	1.03E-03	1.57E-04	3.22E-02	3.76E-02
Hydrogen	Air	kg	0.00E+00	2.10E-05	6.46E-07	2.64E-05	4.55E-03
Hydrogen-3, Tritium	Air	Bq	0.00E+00	0.00E+00	4.05E+00	0.00E+00	1.22E+03
Hydrogen chloride	Air	kg	1.11E-03	6.20E-02	1.27E-02	8.87E-02	3.80E-02
Hydrogen fluoride	Air	kg	1.29E-04	7.71E-03	1.54E-03	1.09E-02	4.71E-03
Hydrogen peroxide	Air	kg	0.00E+00	0.00E+00	1.28E-14	0.00E+00	8.61E-13
Hydrogen sulfide	Air	kg	2.00E-12	5.38E-11	6.34E-06	1.43E-10	1.19E-04
Indeno(1,2,3-cd)pyrene	Air	kg	5.26E-11	3.14E-09	6.27E-10	4.45E-09	1.88E-09
Iodine	Air	kg	0.00E+00	0.00E+00	1.47E-08	0.00E+00	4.55E-06
Iodine-129	Air	Bq	0.00E+00	0.00E+00	7.07E-04	0.00E+00	2.15E-01
Iodine-131	Air	Bq	0.00E+00	0.00E+00	3.61E-02	0.00E+00	1.07E+01
Iodine-133	Air	Bq	0.00E+00	0.00E+00	1.44E-06	0.00E+00	6.15E-04
Iodine-135	Air	Bq	0.00E+00	0.00E+00	1.76E-06	0.00E+00	5.55E-04
Iron	Air	kg	0.00E+00	5.34E-07	1.67E-06	9.12E-07	1.86E-04
Isocyanic acid	Air	kg	0.00E+00	0.00E+00	6.69E-04	0.00E+00	4.88E-12
Isophorone	Air	kg	1.42E-09	1.49E-07	3.16E-08	2.88E-07	6.98E-07
Isoprene	Air	kg	2.02E-03	5.45E-02	1.53E-02	1.45E-01	6.26E-02
Isopropylamine	Air	kg	0.00E+00	0.00E+00	1.78E-16	0.00E+00	7.62E-05
Kerosene	Air	kg	1.18E-06	8.58E-05	1.31E-05	8.97E-05	3.61E-05
Krypton-85	Air	Bq	0.00E+00	0.00E+00	2.86E-01	0.00E+00	8.52E+01
Krypton-85m	Air	Bq	0.00E+00	0.00E+00	1.21E-02	0.00E+00	5.69E+00

Substance	Compartment	Unit	Forest operations	OSB	FJL	LVL	I-joists
Krypton-87	Air	Bq	0.00E+00	0.00E+00	5.15E-03	0.00E+00	1.99E+00
Krypton-88	Air	Bq	0.00E+00	0.00E+00	4.93E-03	0.00E+00	2.08E+00
Krypton-89	Air	Bq	0.00E+00	0.00E+00	1.17E-03	0.00E+00	6.09E-01
Lactic acid	Air	kg	0.00E+00	0.00E+00	2.46E-15	0.00E+00	4.62E-05
Lanthanum-140	Air	Bq	0.00E+00	0.00E+00	4.47E-08	0.00E+00	2.57E-05
Lead	Air	kg	5.46E-07	3.36E-05	5.66E-05	1.61E-04	2.77E-05
Lead-210	Air	Bq	0.00E+00	0.00E+00	3.92E-03	0.00E+00	1.97E+00
m-Xylene	Air	kg	0.00E+00	0.00E+00	8.09E-10	0.00E+00	2.22E-07
Magnesium	Air	kg	9.48E-06	5.66E-04	1.13E-04	8.03E-04	3.95E-04
Manganese	Air	kg	7.35E-07	3.32E-05	7.31E-06	4.59E-05	6.50E-05
Manganese-54	Air	Bq	0.00E+00	0.00E+00	4.16E-09	0.00E+00	2.39E-06
Mercaptans, unspecified	Air	kg	5.28E-07	5.55E-05	1.18E-05	1.08E-04	2.61E-04
Mercury	Air	kg	9.68E-08	6.76E-06	1.59E-06	1.41E-05	9.14E-06
Metals, unspecified	Air	kg	2.29E-13	9.34E-05	1.17E-06	1.59E-04	4.72E-10
Methacrylic acid	Air	kg	0.00E+00	2.30E-09	0.00E+00	0.00E+00	0.00E+00
Methane	Air	kg	1.48E-01	1.29E+00	3.45E-01	2.68E+00	1.55E+00
Methane, biogenic	Air	kg	0.00E+00	1.07E-03	6.56E-03	1.60E-02	5.75E-04
Methane, bromo-, Halon 1001	Air	kg	3.93E-10	4.10E-08	8.71E-09	7.95E-08	1.93E-07
Methane, bromochlorodifluoro-, Halon 1211	Air	kg	0.00E+00	0.00E+00	1.33E-08	0.00E+00	1.50E-07
Methane, bromotrifluoro-, Halon 1301	Air	kg	0.00E+00	0.00E+00	2.16E-09	0.00E+00	4.51E-08
Methane, chlorodifluoro-, HCFC-22	Air	kg	0.00E+00	7.09E-06	4.57E-08	4.99E-13	5.70E-07
Methane, chlorotrifluoro-, CFC-13	Air	kg	0.00E+00	1.30E-07	1.86E-11	4.73E-12	0.00E+00
Methane, dichloro-, HCC-30	Air	kg	7.56E-07	1.78E-05	3.46E-06	2.56E-05	1.09E-04
Methane, dichlorodifluoro-, CFC-12	Air	kg	3.95E-09	2.05E-09	1.94E-09	6.77E-09	2.16E-06
Methane, dichlorofluoro-, HCFC-21	Air	kg	0.00E+00	0.00E+00	1.50E-18	0.00E+00	1.02E-16
Methane, fossil	Air	kg	1.32E-02	2.99E-01	3.95E-02	3.09E-01	2.48E-01
Methane, monochloro-, R-40	Air	kg	1.30E-09	1.36E-07	2.89E-08	2.63E-07	6.38E-07
Methane, tetrachloro-, CFC-10	Air	kg	3.95E-10	1.61E-06	1.72E-09	2.92E-06	1.17E-04
Methane, tetrafluoro-, CFC-14	Air	kg	0.00E+00	0.00E+00	1.95E-10	0.00E+00	1.03E-06
Methane, trichlorofluoro-, CFC-11	Air	kg	0.00E+00	0.00E+00	2.44E-18	0.00E+00	1.66E-16
Methane, trifluoro-, HFC-23	Air	kg	0.00E+00	0.00E+00	4.78E-16	0.00E+00	3.25E-14
Methanesulfonic acid	Air	kg	0.00E+00	0.00E+00	1.69E-16	0.00E+00	4.23E-05
Methanol	Air	kg	0.00E+00	8.01E-02	4.27E-02	5.63E-01	3.85E-02
Methyl acetate	Air	kg	0.00E+00	0.00E+00	6.66E-18	0.00E+00	2.49E-05
Methyl acrylate	Air	kg	0.00E+00	0.00E+00	5.38E-15	0.00E+00	3.63E-13
Methyl amine	Air	kg	0.00E+00	0.00E+00	7.75E-16	0.00E+00	1.30E-05
Methyl borate	Air	kg	0.00E+00	0.00E+00	7.10E-16	0.00E+00	4.30E-06
Methyl ethyl ketone	Air	kg	9.58E-10	9.99E-08	2.12E-08	1.94E-07	4.70E-07
Methyl formate	Air	kg	0.00E+00	0.00E+00	1.78E-06	0.00E+00	9.00E-14
Methyl lactate	Air	kg	0.00E+00	0.00E+00	2.71E-15	0.00E+00	5.08E-05
Methyl methacrylate	Air	kg	4.91E-11	2.82E-09	1.09E-09	9.94E-09	2.41E-08
Methylene diisocyanate	Air	kg	0.00E+00	2.42E-04	0.00E+00	0.00E+00	0.00E+00
Metolachlor	Air	kg	0.00E+00	3.75E-08	4.68E-10	6.40E-08	0.00E+00
Metribuzin	Air	kg	0.00E+00	1.74E-10	2.17E-12	2.97E-10	0.00E+00
Molybdenum	Air	kg	0.00E+00	0.00E+00	3.65E-08	0.00E+00	5.20E-07
Monoethanolamine	Air	kg	0.00E+00	0.00E+00	4.66E-11	0.00E+00	1.44E-03
N-Nitrodimethylamine	Air	kg	0.00E+00	4.52E-03	1.54E-11	3.14E-13	1.74E-05
Naphthalene	Air	kg	1.41E-07	5.04E-06	1.79E-05	4.55E-05	1.36E-05
Nickel	Air	kg	8.61E-06	3.63E-05	1.13E-05	5.50E-05	5.36E-05
Nickel compounds	Air	kg	0.00E+00	7.09E-06	0.00E+00	0.00E+00	0.00E+00
Niobium-95	Air	Bq	0.00E+00	0.00E+00	4.94E-10	0.00E+00	2.84E-07
Nitrate	Air	kg	0.00E+00	0.00E+00	3.83E-09	0.00E+00	1.16E-06
Nitric oxide	Air	kg	0.00E+00	1.34E-04	0.00E+00	0.00E+00	0.00E+00
Nitrobenzene	Air	kg	0.00E+00	0.00E+00	1.49E-14	0.00E+00	4.40E-04
Nitrogen oxides	Air	kg	1.94E+00	1.83E+00	9.57E-01	3.96E+00	2.16E+00
Nitrogen, total	Air	kg	6.05E-05	4.58E-09	5.72E-11	7.83E-09	0.00E+00
Nitrous oxide	Air	kg	0.00E+00	6.99E-06	0.00E+00	0.00E+00	3.51E-02
NMVOC, non-methane volatile organic compounds, unspecified origin	Air	kg	6.69E-02	9.66E-02	3.56E-02	2.12E-01	1.73E-01
Noble gases, radioactive, unspecified	Air	Bq	0.00E+00	0.00E+00	6.79E+03	0.00E+00	2.06E+06
Organic acids	Air	kg	9.05E-09	6.59E-07	1.00E-07	6.88E-07	2.77E-07
Organic substances, unspecified	Air	kg	5.35E-06	3.66E-03	2.18E-03	3.30E-03	1.39E-03

Substance	Compartment	Unit	Forest operations	OSB	FJL	LVL	I-joists
Other Organic	Air	kg	0.00E+00	1.02E-05	6.22E-05	1.52E-04	0.00E+00
Ozone	Air	kg	0.00E+00	0.00E+00	2.57E-07	0.00E+00	7.45E-05
PAH, polycyclic aromatic hydrocarbons	Air	kg	9.34E-05	6.05E-07	1.09E-05	1.37E-04	1.81E-04
Paraquat	Air	kg	0.00E+00	7.59E-10	9.46E-12	1.30E-09	0.00E+00
Parathion, methyl	Air	kg	0.00E+00	5.73E-10	7.15E-12	9.78E-10	0.00E+00
Particulates	Air	kg	0.00E+00	6.94E-05	3.16E-06	1.75E-04	4.72E-05
Particulates, < 10 um	Air	kg	0.00E+00	3.36E-01	1.39E-01	1.06E+00	5.14E-03
Particulates, < 2.5 um	Air	kg	0.00E+00	1.91E-01	6.26E-02	5.41E-01	3.28E-03
Particulates, > 10 um	Air	kg	0.00E+00	1.85E-03	6.61E-02	2.65E-03	7.29E-03
Particulates, > 2.5 um, and < 10um	Air	kg	5.76E-02	2.79E-02	1.67E-02	7.21E-02	5.05E-02
Particulates, unspecified	Air	kg	1.09E-02	1.82E-01	3.82E-02	7.74E-01	1.37E-01
Pendimethalin	Air	kg	0.00E+00	3.90E-09	4.86E-11	6.65E-09	0.00E+00
Pentane	Air	kg	0.00E+00	0.00E+00	1.47E-05	0.00E+00	2.12E-04
Permethrin	Air	kg	0.00E+00	3.50E-10	4.37E-12	5.98E-10	0.00E+00
PFC (perfluorocarbons)	Air	kg	0.00E+00	7.09E-05	0.00E+00	0.00E+00	0.00E+00
Phenanthrene	Air	kg	2.33E-09	1.39E-07	2.78E-08	1.97E-07	8.33E-08
Phenol	Air	kg	3.93E-11	6.73E-03	1.91E-04	1.29E-03	3.53E-01
Phenol, 2,4-dichloro-	Air	kg	0.00E+00	0.00E+00	7.11E-16	0.00E+00	6.73E-05
Phenol, pentachloro-	Air	kg	0.00E+00	0.00E+00	1.95E-10	0.00E+00	5.81E-08
Phenols, unspecified	Air	kg	3.95E-07	2.61E-06	5.21E-07	3.91E-06	2.98E-06
Phorate	Air	kg	0.00E+00	1.80E-10	2.24E-12	3.07E-10	0.00E+00
Phosphate	Air	kg	1.39E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phosphine	Air	kg	0.00E+00	0.00E+00	4.10E-18	0.00E+00	2.77E-16
Phosphorus	Air	kg	0.00E+00	0.00E+00	2.88E-09	0.00E+00	2.96E-05
Phthalate, diisooctyl-	Air	kg	0.00E+00	8.41E-09	0.00E+00	0.00E+00	0.00E+00
Phthalate, dioctyl-	Air	kg	1.79E-10	1.03E-08	3.98E-09	3.63E-08	8.78E-08
Platinum	Air	kg	0.00E+00	0.00E+00	1.03E-14	0.00E+00	3.12E-12
Plutonium-238	Air	Bq	0.00E+00	0.00E+00	9.64E-11	0.00E+00	2.93E-08
Plutonium-alpha	Air	Bq	0.00E+00	0.00E+00	2.21E-10	0.00E+00	6.71E-08
Polonium-210	Air	Bq	0.00E+00	0.00E+00	6.92E-03	0.00E+00	3.29E+00
Polychlorinated biphenyls	Air	kg	0.00E+00	0.00E+00	1.42E-14	0.00E+00	3.14E-12
Polycyclic organic matter, unspecified	Air	kg	0.00E+00	3.29E-07	4.74E-11	1.20E-11	0.00E+00
Potassium	Air	kg	0.00E+00	9.47E-05	1.60E-04	1.62E-04	3.98E-03
Potassium-40	Air	Bq	0.00E+00	0.00E+00	8.90E-04	0.00E+00	4.11E-01
Propanal	Air	kg	9.33E-10	6.18E-06	4.07E-04	1.64E-02	7.18E-05
Propane	Air	kg	0.00E+00	0.00E+00	1.82E-05	0.00E+00	3.14E-04
Propene	Air	kg	1.53E-03	7.25E-03	1.67E-04	1.88E-02	4.89E-03
Propionic acid	Air	kg	0.00E+00	0.00E+00	1.69E-07	0.00E+00	2.13E-04
Propylamine	Air	kg	0.00E+00	0.00E+00	1.11E-15	0.00E+00	1.06E-13
Propylene glycol	Air	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.59E-02
Propylene oxide	Air	kg	0.00E+00	1.99E-07	1.30E-10	3.04E-06	3.62E-05
Protactinium-234	Air	Bq	0.00E+00	0.00E+00	9.60E-05	0.00E+00	2.96E-02
Pyrene	Air	kg	2.85E-10	1.70E-08	3.39E-09	2.41E-08	1.02E-08
Radioactive species, other beta emitters	Air	Bq	0.00E+00	0.00E+00	2.21E-04	0.00E+00	6.76E-02
Radioactive species, unspecified	Air	Bq	4.87E+04	2.90E+06	5.79E+05	4.10E+06	1.68E+06
Radionuclides (Including Radon)	Air	kg	6.60E-05	4.80E-03	7.30E-04	5.01E-03	2.02E-03
Radium-226	Air	Bq	0.00E+00	0.00E+00	4.09E-03	0.00E+00	1.99E+00
Radium-228	Air	Bq	0.00E+00	0.00E+00	5.78E-04	0.00E+00	8.62E-01
Radon-220	Air	Bq	0.00E+00	0.00E+00	3.88E-02	0.00E+00	1.16E+01
Radon-222	Air	Bq	0.00E+00	0.00E+00	1.27E+04	0.00E+00	3.91E+06
Ruthenium-103	Air	Bq	0.00E+00	0.00E+00	1.08E-10	0.00E+00	6.24E-08
Scandium	Air	kg	0.00E+00	0.00E+00	1.17E-09	0.00E+00	3.73E-07
Selenium	Air	kg	1.20E-06	6.76E-05	1.35E-05	9.60E-05	4.22E-05
Silicon	Air	kg	0.00E+00	0.00E+00	1.36E-07	0.00E+00	2.12E-04
Silicon tetrafluoride	Air	kg	0.00E+00	0.00E+00	2.59E-12	0.00E+00	2.99E-10
Silver	Air	kg	0.00E+00	0.00E+00	6.02E-11	0.00E+00	1.50E-08
Silver-110	Air	Bq	0.00E+00	0.00E+00	1.07E-09	0.00E+00	6.18E-07
Simazine	Air	kg	0.00E+00	2.46E-09	3.07E-11	4.20E-09	0.00E+00
Sodium	Air	kg	0.00E+00	2.19E-06	5.39E-06	3.73E-06	1.15E-04
Sodium chlorate	Air	kg	0.00E+00	0.00E+00	3.69E-11	0.00E+00	3.49E-09
Sodium dichromate	Air	kg	0.00E+00	0.00E+00	3.77E-14	0.00E+00	1.63E-08
Sodium formate	Air	kg	0.00E+00	0.00E+00	1.76E-12	0.00E+00	7.17E-10
Sodium hydroxide	Air	kg	0.00E+00	0.00E+00	4.76E-14	0.00E+00	3.21E-12

Substance	Compartment	Unit	Forest operations	OSB	FJL	LVL	I-joists
Strontium	Air	kg	0.00E+00	0.00E+00	5.37E-09	0.00E+00	3.65E-06
Styrene	Air	kg	6.14E-11	6.41E-09	1.37E-09	1.24E-08	1.64E-07
Sulfate	Air	kg	0.00E+00	0.00E+00	4.37E-07	0.00E+00	6.49E-03
Sulfur	Air	kg	0.00E+00	1.15E-05	1.44E-07	1.97E-05	0.00E+00
Sulfur dioxide	Air	kg	7.04E-02	3.38E+00	7.54E-01	6.10E+00	3.26E+00
Sulfur hexafluoride	Air	kg	0.00E+00	0.00E+00	3.12E-09	0.00E+00	1.06E-06
Sulfur monoxide	Air	kg	1.03E-01	4.85E-02	1.47E-02	1.24E-01	2.10E-01
Sulfur oxides	Air	kg	7.79E-03	5.62E-02	4.24E-02	9.05E-02	8.56E-02
Sulfur trioxide	Air	kg	0.00E+00	0.00E+00	1.20E-13	0.00E+00	2.51E-03
Sulfur, total reduced	Air	kg	0.00E+00	6.76E-06	1.14E-05	1.15E-05	2.79E-04
Sulfuric acid	Air	kg	0.00E+00	7.09E-08	9.96E-15	0.00E+00	6.73E-13
Sulfuric acid, dimethyl ester	Air	kg	1.18E-10	1.23E-08	2.61E-09	2.39E-08	5.78E-08
t-Butyl methyl ether	Air	kg	8.60E-11	8.97E-09	1.91E-09	1.74E-08	4.25E-08
t-Butylamine	Air	kg	0.00E+00	0.00E+00	3.11E-16	0.00E+00	7.34E-05
Tar	Air	kg	6.95E-11	1.87E-09	5.25E-10	4.98E-09	2.15E-09
Terbufos	Air	kg	0.00E+00	6.13E-09	7.64E-11	1.05E-08	0.00E+00
Terpenes	Air	kg	0.00E+00	0.00E+00	5.92E-12	0.00E+00	2.94E-08
Thallium	Air	kg	0.00E+00	0.00E+00	8.96E-12	0.00E+00	1.90E-08
Thorium	Air	kg	0.00E+00	0.00E+00	7.63E-12	0.00E+00	2.26E-08
Thorium-228	Air	Bq	0.00E+00	0.00E+00	1.93E-04	0.00E+00	1.16E-01
Thorium-230	Air	Bq	0.00E+00	0.00E+00	3.59E-04	0.00E+00	7.03E-01
Thorium-232	Air	Bq	0.00E+00	0.00E+00	2.82E-04	0.00E+00	1.31E-01
Thorium-234	Air	Bq	0.00E+00	0.00E+00	9.60E-05	0.00E+00	2.96E-02
Tin	Air	kg	0.00E+00	0.00E+00	6.35E-10	0.00E+00	3.33E-08
Titanium	Air	kg	0.00E+00	0.00E+00	2.27E-08	0.00E+00	1.10E-05
TOC, Total Organic Carbon	Air	kg	0.00E+00	1.09E-02	1.11E-07	1.52E-05	0.00E+00
Toluene	Air	kg	2.42E-04	1.61E-03	2.91E-05	8.73E-05	1.38E-03
Toluene, 2-chloro-	Air	kg	0.00E+00	0.00E+00	4.43E-15	0.00E+00	2.01E-04
Toluene, 2,4-dinitro-	Air	kg	6.88E-13	7.17E-11	1.52E-11	1.39E-10	3.37E-10
Trichloroethane	Air	kg	0.00E+00	5.01E-08	0.00E+00	0.00E+00	0.00E+00
Trimethylamine	Air	kg	0.00E+00	0.00E+00	1.19E-17	0.00E+00	5.01E-15
Tungsten	Air	kg	0.00E+00	0.00E+00	1.31E-10	0.00E+00	4.05E-08
Uranium	Air	kg	0.00E+00	0.00E+00	1.02E-11	0.00E+00	3.00E-08
Uranium-234	Air	Bq	0.00E+00	0.00E+00	1.12E-03	0.00E+00	9.38E-01
Uranium-235	Air	Bq	0.00E+00	0.00E+00	5.42E-05	0.00E+00	1.67E-02
Uranium-238	Air	Bq	0.00E+00	0.00E+00	1.82E-03	0.00E+00	1.25E+00
Uranium alpha	Air	Bq	0.00E+00	0.00E+00	5.22E-03	0.00E+00	1.61E+00
Vanadium	Air	kg	0.00E+00	0.00E+00	5.69E-06	0.00E+00	3.17E-05
Vinyl acetate	Air	kg	1.87E-11	1.95E-09	4.14E-10	3.78E-09	9.14E-09
VOC, volatile organic compounds	Air	kg	5.69E-02	7.72E-01	5.84E-01	2.95E+00	3.21E-01
Water	Air	kg	0.00E+00	0.00E+00	3.20E-06	0.00E+00	2.47E-04
Wood (dust)	Air	kg	0.00E+00	2.79E-02	2.00E-01	4.52E-01	0.00E+00
Xenon-131m	Air	Bq	0.00E+00	0.00E+00	2.34E-02	0.00E+00	9.40E+00
Xenon-133	Air	Bq	0.00E+00	0.00E+00	7.36E-01	0.00E+00	3.08E+02
Xenon-133m	Air	Bq	0.00E+00	0.00E+00	3.39E-03	0.00E+00	1.09E+00
Xenon-135	Air	Bq	0.00E+00	0.00E+00	3.02E-01	0.00E+00	1.26E+02
Xenon-135m	Air	Bq	0.00E+00	0.00E+00	1.77E-01	0.00E+00	7.52E+01
Xenon-137	Air	Bq	0.00E+00	0.00E+00	3.20E-03	0.00E+00	1.67E+00
Xenon-138	Air	Bq	0.00E+00	0.00E+00	2.91E-02	0.00E+00	1.40E+01
Xylene	Air	kg	1.69E-04	9.38E-04	1.92E-05	5.80E-05	5.90E-05
Zinc	Air	kg	1.12E-06	1.37E-06	1.04E-06	1.13E-06	3.79E-05
Zinc-65	Air	Bq	0.00E+00	0.00E+00	2.08E-08	0.00E+00	1.19E-05
Zirconium	Air	kg	0.00E+00	0.00E+00	2.91E-14	0.00E+00	2.83E-09
Zirconium-95	Air	Bq	0.00E+00	0.00E+00	2.03E-08	0.00E+00	1.17E-05
1-Butanol	Water	kg	0.00E+00	0.00E+00	1.88E-07	0.00E+00	1.88E-04
1-Pentanol	Water	kg	0.00E+00	0.00E+00	4.59E-15	0.00E+00	4.40E-13
1-Pentene	Water	kg	0.00E+00	0.00E+00	3.47E-15	0.00E+00	3.32E-13
1-Propanol	Water	kg	0.00E+00	0.00E+00	6.34E-15	0.00E+00	6.34E-13
1,4-Butanediol	Water	kg	0.00E+00	0.00E+00	5.59E-16	0.00E+00	8.28E-05
2-Aminopropanol	Water	kg	0.00E+00	0.00E+00	7.07E-17	0.00E+00	1.06E-04
2-Hexanone	Water	kg	8.41E-07	2.37E-06	8.51E-07	5.77E-06	4.02E-06
2-Methyl-1-propanol	Water	kg	0.00E+00	0.00E+00	8.33E-15	0.00E+00	9.62E-05
2-Methyl-2-butene	Water	kg	0.00E+00	0.00E+00	7.70E-19	0.00E+00	7.37E-17

Substance	Compartment	Unit	Forest operations	OSB	FJL	LVL	I-joists
2-Methyl-4-chlorophenoxyacetic acid	Water	kg	0.00E+00	2.74E-12	3.41E-14	4.67E-12	0.00E+00
2-Propanol	Water	kg	0.00E+00	6.35E-09	1.07E-08	1.09E-08	4.22E-04
2,4-D	Water	kg	0.00E+00	1.47E-10	1.83E-12	2.50E-10	0.00E+00
4-Methyl-2-pentanone	Water	kg	5.41E-07	1.52E-06	5.48E-07	3.71E-06	2.59E-06
Acenaphthene	Water	kg	0.00E+00	0.00E+00	2.45E-11	0.00E+00	5.06E-10
Acenaphthylene	Water	kg	0.00E+00	0.00E+00	1.53E-12	0.00E+00	3.17E-11
Acetaldehyde	Water	kg	0.00E+00	4.71E-09	5.50E-07	6.31E-08	3.03E-03
Acetic acid	Water	kg	0.00E+00	0.00E+00	7.87E-10	0.00E+00	1.14E-02
Acetochlor	Water	kg	0.00E+00	2.03E-09	2.54E-11	3.47E-09	0.00E+00
Acetone	Water	kg	1.29E-06	3.61E-06	1.30E-06	8.84E-06	2.35E-04
Acetonitrile	Water	kg	0.00E+00	0.00E+00	1.40E-16	0.00E+00	3.50E-05
Acetyl chloride	Water	kg	0.00E+00	0.00E+00	3.61E-15	0.00E+00	3.45E-13
Acidity, unspecified	Water	kg	0.00E+00	2.34E-04	2.05E-10	4.48E-14	2.18E-05
Acids, unspecified	Water	kg	1.30E-09	9.05E-06	5.17E-06	1.55E-05	1.24E-04
Acrylate, ion	Water	kg	0.00E+00	0.00E+00	1.12E-14	0.00E+00	7.58E-13
Actinides, radioactive, unspecified	Water	Bq	0.00E+00	0.00E+00	1.15E-03	0.00E+00	3.49E-01
Alachlor	Water	kg	0.00E+00	2.00E-10	2.50E-12	3.42E-10	0.00E+00
Aluminium	Water	kg	1.10E-02	1.29E-02	6.59E-03	3.26E-02	4.63E-02
Ammonia	Water	kg	2.40E-03	5.39E-03	2.12E-03	1.26E-02	9.56E-03
Ammonia, as N	Water	kg	6.52E-10	1.75E-08	2.49E-04	4.67E-08	2.02E-08
Ammonium, ion	Water	kg	5.27E-07	9.35E-05	4.89E-04	8.68E-04	4.40E-02
Aniline	Water	kg	0.00E+00	0.00E+00	2.67E-14	0.00E+00	6.64E-04
Antimony	Water	kg	6.86E-06	7.08E-06	3.94E-06	1.92E-05	4.18E-05
Antimony-122	Water	Bq	0.00E+00	0.00E+00	3.10E-07	0.00E+00	1.79E-04
Antimony-124	Water	Bq	0.00E+00	0.00E+00	1.86E-04	0.00E+00	5.94E-02
Antimony-125	Water	Bq	0.00E+00	0.00E+00	1.70E-04	0.00E+00	5.45E-02
AOX, Adsorbable Organic Halogen as Cl	Water	kg	0.00E+00	0.00E+00	3.51E-09	0.00E+00	8.83E-06
Arsenic	Water	kg	3.78E-05	8.49E-05	3.20E-05	2.08E-04	1.51E-04
Arsenic, ion	Water	kg	0.00E+00	0.00E+00	1.90E-07	0.00E+00	3.90E-05
Atrazine	Water	kg	0.00E+00	3.96E-09	4.94E-11	6.76E-09	0.00E+00
Barite	Water	kg	0.00E+00	0.00E+00	5.15E-10	0.00E+00	5.00E-08
Barium	Water	kg	1.51E-01	1.67E-01	8.84E-02	4.47E-01	4.14E-01
Barium-140	Water	Bq	0.00E+00	0.00E+00	1.36E-06	0.00E+00	7.82E-04
Bentazone	Water	kg	0.00E+00	1.62E-11	2.02E-13	2.76E-11	0.00E+00
Benzene	Water	kg	2.16E-04	3.28E-02	2.18E-04	8.29E-02	3.77E-02
Benzene, 1-methyl-4-(1-methylethyl)-	Water	kg	1.29E-08	3.61E-08	1.30E-08	8.83E-08	6.16E-08
Benzene, 1,2-dichloro-	Water	kg	0.00E+00	0.00E+00	3.81E-14	0.00E+00	1.00E-03
Benzene, chloro-	Water	kg	0.00E+00	0.00E+00	6.13E-13	0.00E+00	1.49E-02
Benzene, ethyl-	Water	kg	1.22E-05	3.42E-05	1.24E-05	8.34E-05	6.03E-05
Benzene, pentamethyl-	Water	kg	9.65E-09	2.71E-08	9.77E-09	6.62E-08	4.62E-08
Benzenes, alkylated, unspecified	Water	kg	6.02E-06	6.77E-06	3.42E-06	1.68E-05	1.60E-05
Benzo(a)pyrene	Water	kg	0.00E+00	3.98E-14	9.53E-08	1.58E-09	0.00E+00
Benzoic acid	Water	kg	1.31E-04	3.69E-04	1.32E-04	8.96E-04	6.25E-04
Beryllium	Water	kg	1.96E-06	3.99E-06	1.65E-06	9.99E-06	1.84E-05
Biphenyl	Water	kg	3.90E-07	4.38E-07	2.22E-07	1.09E-06	1.03E-06
BOD5, Biological Oxygen Demand	Water	kg	2.35E-02	3.73E-01	4.36E-02	9.28E-01	4.90E-01
Borate	Water	kg	0.00E+00	0.00E+00	3.51E-13	0.00E+00	6.04E-03
Boron	Water	kg	4.04E-04	1.14E-03	4.12E-04	2.77E-03	2.19E-03
Bromate	Water	kg	0.00E+00	0.00E+00	2.07E-09	0.00E+00	8.22E-04
Bromide	Water	kg	2.76E-02	7.75E-02	2.79E-02	1.89E-01	2.86E-01
Bromine	Water	kg	0.00E+00	0.00E+00	2.78E-06	0.00E+00	7.94E-05
Bromoxynil	Water	kg	0.00E+00	2.14E-11	2.67E-13	3.65E-11	0.00E+00
Butene	Water	kg	0.00E+00	0.00E+00	2.08E-09	0.00E+00	3.03E-04
Butyl acetate	Water	kg	0.00E+00	0.00E+00	2.45E-07	0.00E+00	1.01E-05
Butyrolactone	Water	kg	0.00E+00	0.00E+00	6.81E-17	0.00E+00	4.60E-15
Cadmium	Water	kg	6.07E-06	1.28E-05	4.76E-06	5.76E-05	2.23E-05
Cadmium, ion	Water	kg	0.00E+00	0.00E+00	6.46E-08	0.00E+00	5.16E-06
Calcium	Water	kg	4.14E-01	1.16E+00	4.19E-01	2.84E+00	1.98E+00
Calcium, ion	Water	kg	0.00E+00	0.00E+00	7.09E-04	0.00E+00	2.16E-01
Carbofuran	Water	kg	0.00E+00	3.03E-11	3.78E-13	5.17E-11	0.00E+00
Carbon disulfide	Water	kg	0.00E+00	0.00E+00	2.21E-13	0.00E+00	2.14E-11
Carbonate	Water	kg	0.00E+00	0.00E+00	1.51E-08	0.00E+00	7.29E-02
Carboxylic acids, unspecified	Water	kg	0.00E+00	0.00E+00	1.70E-05	0.00E+00	3.49E-04

Substance	Compartment	Unit	Forest operations	OSB	FJL	LVL	I-joists
Cerium-141	Water	Bq	0.00E+00	0.00E+00	5.44E-07	0.00E+00	3.13E-04
Cerium-144	Water	Bq	0.00E+00	0.00E+00	1.66E-07	0.00E+00	9.52E-05
Cesium	Water	kg	0.00E+00	0.00E+00	3.95E-09	0.00E+00	8.14E-08
Cesium-134	Water	Bq	0.00E+00	0.00E+00	1.58E-04	0.00E+00	4.79E-02
Cesium-136	Water	Bq	0.00E+00	0.00E+00	9.65E-08	0.00E+00	5.55E-05
Cesium-137	Water	Bq	0.00E+00	0.00E+00	1.32E-01	0.00E+00	4.01E+01
CFCs, unspecified	Water	kg	0.00E+00	6.35E-09	1.07E-08	1.09E-08	5.00E-07
Chloramine	Water	kg	0.00E+00	0.00E+00	6.03E-14	0.00E+00	1.01E-03
Chlorate	Water	kg	0.00E+00	0.00E+00	1.77E-08	0.00E+00	6.28E-03
Chloride	Water	kg	4.65E+00	1.31E+01	4.71E+00	3.19E+01	2.52E+01
Chlorinated solvents, unspecified	Water	kg	0.00E+00	0.00E+00	6.93E-11	0.00E+00	4.28E-06
Chlorine	Water	kg	0.00E+00	0.00E+00	4.81E-10	0.00E+00	3.05E-07
Chloroacetic acid	Water	kg	0.00E+00	0.00E+00	3.09E-12	0.00E+00	2.72E-02
Chloroacetyl chloride	Water	kg	0.00E+00	0.00E+00	9.43E-17	0.00E+00	1.42E-04
Chloroform	Water	kg	0.00E+00	1.48E-08	2.55E-15	0.00E+00	1.24E-04
Chlorosulfonic acid	Water	kg	0.00E+00	0.00E+00	5.09E-16	0.00E+00	1.27E-04
Chlorpyrifos	Water	kg	0.00E+00	2.33E-10	2.91E-12	3.98E-10	0.00E+00
Chromate	Water	kg	0.00E+00	8.46E-13	6.48E-11	2.50E-12	3.49E-11
Chromium	Water	kg	2.95E-04	1.81E-04	1.53E-04	6.61E-04	6.83E-04
Chromium-51	Water	Bq	0.00E+00	0.00E+00	1.85E-04	0.00E+00	8.25E-02
Chromium III	Water	kg	2.11E-05	1.39E-04	2.38E-05	2.10E-04	1.45E-04
Chromium VI	Water	kg	1.22E-06	6.32E-07	7.40E-07	2.09E-06	7.19E-05
Chromium, ion	Water	kg	0.00E+00	0.00E+00	1.11E-08	0.00E+00	4.06E-06
Cobalt	Water	kg	2.85E-06	8.05E-06	3.67E-06	1.96E-05	1.76E-04
Cobalt-57	Water	Bq	0.00E+00	0.00E+00	3.06E-06	0.00E+00	1.76E-03
Cobalt-58	Water	Bq	0.00E+00	0.00E+00	1.43E-03	0.00E+00	5.41E-01
Cobalt-60	Water	Bq	0.00E+00	0.00E+00	1.11E-03	0.00E+00	4.35E-01
COD, Chemical Oxygen Demand	Water	kg	4.46E-02	4.29E-01	5.25E-02	1.06E+00	6.04E-01
Copper	Water	kg	3.82E-05	9.65E-05	3.18E-05	1.92E-04	1.39E-04
Copper, ion	Water	kg	0.00E+00	0.00E+00	8.05E-07	0.00E+00	1.35E-04
Cumene	Water	kg	0.00E+00	4.72E-02	1.07E-08	1.19E-01	2.97E-02
Cyanazine	Water	kg	0.00E+00	3.49E-11	4.36E-13	5.96E-11	0.00E+00
Cyanide	Water	kg	9.30E-09	4.10E-08	1.09E-05	2.45E-07	1.41E-04
Decane	Water	kg	3.75E-06	1.06E-05	3.80E-06	2.58E-05	1.80E-05
Detergent, oil	Water	kg	1.09E-04	3.48E-04	1.21E-04	8.47E-04	5.73E-04
Dibenzofuran	Water	kg	2.45E-08	6.87E-08	2.48E-08	1.68E-07	1.17E-07
Dibenzothiophene	Water	kg	2.10E-08	5.70E-08	2.08E-08	1.39E-07	9.81E-08
Dicamba	Water	kg	0.00E+00	2.06E-10	2.57E-12	3.51E-10	0.00E+00
Dichromate	Water	kg	0.00E+00	0.00E+00	4.25E-14	0.00E+00	1.52E-11
Diethylamine	Water	kg	0.00E+00	0.00E+00	1.19E-14	0.00E+00	3.17E-04
Dimethenamid	Water	kg	0.00E+00	4.86E-10	6.06E-12	8.30E-10	0.00E+00
Dimethylamine	Water	kg	0.00E+00	0.00E+00	6.13E-15	0.00E+00	1.39E-03
Dipropylamine	Water	kg	0.00E+00	0.00E+00	7.55E-15	0.00E+00	1.42E-04
Dipropylthiocarbamic acid S-ethyl ester	Water	kg	0.00E+00	2.01E-10	2.51E-12	3.43E-10	0.00E+00
Dissolved organics	Water	kg	0.00E+00	1.49E-04	0.00E+00	0.00E+00	5.76E-07
Disulfoton	Water	kg	0.00E+00	1.20E-11	1.50E-13	2.05E-11	0.00E+00
Diuron	Water	kg	0.00E+00	3.37E-12	4.20E-14	5.75E-12	0.00E+00
DOC, Dissolved Organic Carbon	Water	kg	3.98E-12	8.70E-02	2.66E-04	2.20E-01	9.58E-02
Docosane	Water	kg	1.38E-07	3.87E-07	1.39E-07	9.45E-07	6.60E-07
Dodecane	Water	kg	7.12E-06	2.01E-05	7.21E-06	4.89E-05	3.41E-05
Eicosane	Water	kg	1.96E-06	5.53E-06	1.98E-06	1.35E-05	9.39E-06
Ethane, 1,2-dichloro-	Water	kg	0.00E+00	0.00E+00	5.99E-11	0.00E+00	5.50E-04
Ethanol	Water	kg	0.00E+00	0.00E+00	4.33E-07	0.00E+00	9.63E-03
Ethene	Water	kg	0.00E+00	0.00E+00	4.17E-09	0.00E+00	8.72E-05
Ethene, chloro-	Water	kg	0.00E+00	0.00E+00	4.67E-13	0.00E+00	1.61E-08
Ethyl acetate	Water	kg	0.00E+00	0.00E+00	1.26E-14	0.00E+00	4.33E-07
Ethylamine	Water	kg	0.00E+00	0.00E+00	5.33E-15	0.00E+00	2.93E-04
Ethylene diamine	Water	kg	0.00E+00	0.00E+00	1.12E-13	0.00E+00	1.04E-11
Ethylene oxide	Water	kg	0.00E+00	0.00E+00	8.49E-14	0.00E+00	4.74E-04
Fluorene	Water	kg	0.00E+00	2.08E-08	4.64E-12	1.18E-12	0.00E+00
Fluorene, 1-methyl-	Water	kg	1.47E-08	4.11E-08	1.48E-08	1.01E-07	7.01E-08
Fluorenes, alkylated, unspecified	Water	kg	3.49E-07	3.92E-07	1.98E-07	9.76E-07	9.26E-07
Fluoride	Water	kg	7.73E-03	6.23E-04	1.03E-04	6.51E-04	7.92E-03

Substance	Compartment	Unit	Forest operations	OSB	FJL	LVL	I-joists
Fluorine	Water	kg	1.72E-07	1.92E-07	1.03E-07	5.27E-07	4.81E-07
Fluosilicic acid	Water	kg	0.00E+00	0.00E+00	4.55E-11	0.00E+00	2.41E-07
Formaldehyde	Water	kg	0.00E+00	0.00E+00	1.50E-04	0.00E+00	5.66E-03
Formamide	Water	kg	0.00E+00	0.00E+00	8.40E-15	0.00E+00	8.04E-13
Formate	Water	kg	0.00E+00	0.00E+00	9.58E-14	0.00E+00	2.26E-02
Formic acid	Water	kg	0.00E+00	0.00E+00	2.44E-15	0.00E+00	2.33E-13
Furan	Water	kg	0.00E+00	2.33E-10	3.94E-10	3.98E-10	9.61E-09
Glutaraldehyde	Water	kg	0.00E+00	0.00E+00	6.35E-14	0.00E+00	6.18E-12
Glyphosate	Water	kg	0.00E+00	4.37E-10	5.45E-12	7.46E-10	0.00E+00
Heat, waste	Water	MJ	0.00E+00	0.00E+00	6.86E-02	0.00E+00	1.19E+01
Hexadecane	Water	kg	7.77E-06	2.19E-05	7.87E-06	5.33E-05	3.72E-05
Hexanoic acid	Water	kg	2.71E-05	7.63E-05	2.74E-05	1.86E-04	1.29E-04
Hydrocarbons, aliphatic, alkanes, unspecified	Water	kg	0.00E+00	0.00E+00	5.13E-07	0.00E+00	1.06E-05
Hydrocarbons, aliphatic, unsaturated	Water	kg	0.00E+00	0.00E+00	4.73E-08	0.00E+00	1.19E-04
Hydrocarbons, aromatic	Water	kg	0.00E+00	0.00E+00	2.08E-06	0.00E+00	4.32E-05
Hydrocarbons, unspecified	Water	kg	4.99E-12	2.33E-07	4.14E-07	3.88E-04	8.86E-05
Hydrogen-3, Tritium	Water	Bq	0.00E+00	0.00E+00	3.03E+02	0.00E+00	9.19E+04
Hydrogen peroxide	Water	kg	0.00E+00	0.00E+00	6.70E-12	0.00E+00	4.12E-06
Hydrogen sulfide	Water	kg	0.00E+00	0.00E+00	9.19E-09	0.00E+00	1.78E-06
Hydroxide	Water	kg	0.00E+00	0.00E+00	3.64E-13	0.00E+00	5.62E-05
Hypochlorite	Water	kg	0.00E+00	0.00E+00	1.64E-08	0.00E+00	4.91E-06
Iodide	Water	kg	0.00E+00	0.00E+00	3.96E-07	0.00E+00	6.01E-02
Iodine-131	Water	Bq	0.00E+00	0.00E+00	3.36E-05	0.00E+00	1.11E-02
Iodine-133	Water	Bq	0.00E+00	0.00E+00	8.54E-07	0.00E+00	4.91E-04
Iron	Water	kg	2.20E-02	3.23E-02	1.46E-02	7.98E-02	6.84E-02
Iron-59	Water	Bq	0.00E+00	0.00E+00	2.35E-07	0.00E+00	1.35E-04
Iron, ion	Water	kg	0.00E+00	0.00E+00	8.83E-05	0.00E+00	2.16E-02
Isopropylamine	Water	kg	0.00E+00	0.00E+00	4.28E-16	0.00E+00	1.83E-04
Lactic acid	Water	kg	0.00E+00	0.00E+00	5.91E-15	0.00E+00	1.11E-04
Lanthanum-140	Water	Bq	0.00E+00	0.00E+00	1.45E-06	0.00E+00	8.33E-04
Lead	Water	kg	7.50E-05	1.38E-04	5.93E-05	3.42E-04	2.91E-04
Lead-210	Water	Bq	0.00E+00	0.00E+00	2.66E-03	0.00E+00	6.17E-01
Lead-210/kg	Water	kg	1.34E-14	3.78E-14	1.35E-14	9.18E-14	6.40E-14
Lithium	Water	kg	8.63E-03	3.20E-01	8.15E-02	7.26E-01	3.91E-01
Lithium, ion	Water	kg	0.00E+00	0.00E+00	1.58E-11	0.00E+00	2.02E-08
m-Xylene	Water	kg	3.90E-06	1.10E-05	3.95E-06	2.68E-05	1.87E-05
Magnesium	Water	kg	8.09E-02	2.27E-01	8.22E-02	5.55E-01	4.66E-01
Manganese	Water	kg	1.44E-04	1.38E-03	3.37E-04	2.17E-03	7.02E-03
Manganese-54	Water	Bq	0.00E+00	0.00E+00	8.84E-05	0.00E+00	3.32E-02
Mercury	Water	kg	1.60E-07	1.79E-07	8.28E-08	3.38E-05	3.01E-05
Metallic ions, unspecified	Water	kg	6.09E-11	6.76E-09	2.99E-08	1.20E-03	7.68E-08
Methane, dichloro-, HCC-30	Water	kg	0.00E+00	0.00E+00	8.99E-13	0.00E+00	1.55E-04
Methane, monochloro-, R-40	Water	kg	5.18E-09	1.45E-08	5.25E-09	3.56E-08	2.48E-08
Methanol	Water	kg	0.00E+00	0.00E+00	4.81E-07	0.00E+00	1.42E-03
Methyl acetate	Water	kg	0.00E+00	0.00E+00	1.60E-17	0.00E+00	5.97E-05
Methyl acrylate	Water	kg	0.00E+00	0.00E+00	1.05E-13	0.00E+00	7.10E-12
Methyl amine	Water	kg	0.00E+00	0.00E+00	1.86E-15	0.00E+00	3.11E-05
Methyl ethyl ketone	Water	kg	1.04E-08	2.91E-08	1.05E-08	7.11E-08	4.96E-08
Methyl formate	Water	kg	0.00E+00	0.00E+00	7.09E-07	0.00E+00	3.59E-14
Metolachlor	Water	kg	0.00E+00	1.61E-09	2.00E-11	2.74E-09	0.00E+00
Metribuzin	Water	kg	0.00E+00	7.44E-12	9.29E-14	1.27E-11	0.00E+00
Molybdenum	Water	kg	2.96E-06	8.35E-06	3.17E-06	2.03E-05	5.51E-05
Molybdenum-99	Water	Bq	0.00E+00	0.00E+00	4.99E-07	0.00E+00	2.87E-04
n-Hexacosane	Water	kg	8.60E-08	2.41E-07	8.70E-08	5.90E-07	4.11E-07
Naphthalene	Water	kg	2.35E-06	6.60E-06	1.64E-06	1.60E-05	1.12E-05
Naphthalene, 2-methyl-	Water	kg	2.04E-06	5.75E-06	2.06E-06	1.40E-05	9.76E-06
Naphthalenes, alkylated, unspecified	Water	kg	9.86E-08	1.11E-07	5.61E-08	2.76E-07	2.62E-07
Nickel	Water	kg	3.59E-05	7.02E-05	2.83E-05	1.75E-04	1.33E-04
Nickel, ion	Water	kg	0.00E+00	0.00E+00	2.83E-06	0.00E+00	6.84E-04
Niobium-95	Water	Bq	0.00E+00	0.00E+00	1.44E-05	0.00E+00	4.69E-03
Nitrate	Water	kg	4.37E-13	7.55E-07	2.62E-05	1.29E-06	3.99E-02
Nitrate compounds	Water	kg	1.76E-11	6.21E-10	1.33E-10	1.26E-09	5.44E-10

Substance	Compartment	Unit	Forest operations	OSB	FJL	LVL	I-joists
Nitric acid	Water	kg	3.94E-08	1.06E-06	2.98E-07	2.83E-06	1.22E-06
Nitrite	Water	kg	0.00E+00	0.00E+00	5.23E-09	0.00E+00	1.46E-05
Nitrobenzene	Water	kg	0.00E+00	0.00E+00	5.96E-14	0.00E+00	1.76E-03
Nitrogen	Water	kg	0.00E+00	0.00E+00	2.69E-05	0.00E+00	2.29E-04
Nitrogen, organic bound	Water	kg	0.00E+00	0.00E+00	1.14E-06	0.00E+00	1.97E-05
Nitrogen, total	Water	kg	1.31E-06	1.22E-04	3.59E-05	2.05E-04	3.38E-04
o-Cresol	Water	kg	3.70E-06	1.05E-05	3.75E-06	2.54E-05	1.77E-05
o-Xylene	Water	kg	0.00E+00	4.39E-08	9.87E-12	2.51E-12	4.14E-13
Octadecane	Water	kg	1.92E-06	5.42E-06	1.94E-06	1.32E-05	9.19E-06
Oils, unspecified	Water	kg	2.96E-03	7.99E-03	3.63E-03	1.86E-02	1.98E-02
Organic substances, unspecified	Water	kg	0.00E+00	4.64E-09	2.34E-07	1.17E-08	1.91E-07
p-Cresol	Water	kg	4.00E-06	1.13E-05	4.05E-06	2.74E-05	1.91E-05
p-Xylene	Water	kg	0.00E+00	4.39E-08	9.87E-12	2.51E-12	0.00E+00
PAH, polycyclic aromatic hydrocarbons	Water	kg	0.00E+00	0.00E+00	2.30E-08	0.00E+00	4.80E-07
Paraquat	Water	kg	0.00E+00	3.25E-11	4.06E-13	5.55E-11	0.00E+00
Parathion, methyl	Water	kg	0.00E+00	2.46E-11	3.06E-13	4.19E-11	0.00E+00
Pendimethalin	Water	kg	0.00E+00	1.67E-10	2.08E-12	2.85E-10	0.00E+00
Permethrin	Water	kg	0.00E+00	1.50E-11	1.87E-13	2.56E-11	0.00E+00
Phenanthrene	Water	kg	3.55E-08	5.92E-08	2.53E-08	1.46E-07	1.19E-07
Phenanthrenes, alkylated, unspecified	Water	kg	4.09E-08	4.60E-08	2.32E-08	1.14E-07	1.09E-07
Phenol	Water	kg	5.38E-05	3.27E-05	2.51E-05	9.39E-05	2.96E-03
Phenol, 2,4-dimethyl-	Water	kg	3.61E-06	1.02E-05	3.65E-06	2.47E-05	1.73E-05
Phenols, unspecified	Water	kg	1.11E-05	1.39E-04	3.75E-05	3.17E-04	1.81E-04
Phorate	Water	kg	0.00E+00	4.64E-12	5.79E-14	7.93E-12	0.00E+00
Phosphate	Water	kg	5.81E-03	1.62E-04	1.24E-04	1.04E-04	2.66E-02
Phosphorus	Water	kg	0.00E+00	1.30E-05	4.20E-07	2.22E-05	8.02E-04
Phosphorus compounds, unspecified	Water	kg	0.00E+00	8.61E-08	1.07E-09	1.47E-07	0.00E+00
Phosphorus, total	Water	kg	0.00E+00	7.69E-06	1.30E-05	1.31E-05	3.17E-04
Polonium-210	Water	Bq	0.00E+00	0.00E+00	3.18E-03	0.00E+00	6.80E-01
Potassium-40	Water	Bq	0.00E+00	0.00E+00	2.24E-03	0.00E+00	6.38E-01
Potassium, ion	Water	kg	0.00E+00	0.00E+00	1.85E-04	0.00E+00	6.87E-02
Process solvents, unspecified	Water	kg	0.00E+00	2.33E-08	3.94E-08	3.98E-08	9.61E-07
Propanal	Water	kg	0.00E+00	0.00E+00	6.65E-15	0.00E+00	6.37E-13
Propene	Water	kg	0.00E+00	1.74E-02	1.22E-08	4.39E-02	1.27E-02
Propionic acid	Water	kg	0.00E+00	0.00E+00	1.86E-15	0.00E+00	5.07E-04
Propylamine	Water	kg	0.00E+00	0.00E+00	2.66E-15	0.00E+00	2.55E-13
Propylene oxide	Water	kg	0.00E+00	0.00E+00	3.13E-10	0.00E+00	8.66E-05
Protactinium-234	Water	Bq	0.00E+00	0.00E+00	1.77E-03	0.00E+00	5.46E-01
Radioactive species, alpha emitters	Water	Bq	0.00E+00	0.00E+00	2.97E-06	0.00E+00	3.36E-01
Radioactive species, Nuclides, unspecified	Water	Bq	7.65E+01	5.57E+03	8.47E+02	5.81E+03	2.55E+03
Radium-224	Water	Bq	0.00E+00	0.00E+00	1.97E-01	0.00E+00	4.07E+00
Radium-226	Water	Bq	0.00E+00	0.00E+00	1.42E+00	0.00E+00	3.47E+02
Radium-226/kg	Water	kg	4.66E-12	1.31E-11	4.71E-12	3.19E-11	2.23E-11
Radium-228	Water	Bq	0.00E+00	0.00E+00	3.95E-01	0.00E+00	8.14E+00
Radium-228/kg	Water	kg	2.38E-14	6.72E-14	2.41E-14	1.63E-13	1.14E-13
Rubidium	Water	kg	0.00E+00	0.00E+00	3.95E-08	0.00E+00	8.14E-07
Ruthenium-103	Water	Bq	0.00E+00	0.00E+00	1.05E-07	0.00E+00	6.06E-05
Scandium	Water	kg	0.00E+00	0.00E+00	7.38E-08	0.00E+00	1.85E-05
Selenium	Water	kg	1.52E-06	1.48E-05	2.91E-06	1.78E-05	3.38E-05
Silicon	Water	kg	0.00E+00	0.00E+00	5.19E-04	0.00E+00	1.26E-01
Silver	Water	kg	2.71E-04	7.58E-04	2.73E-04	1.85E-03	1.29E-03
Silver-110	Water	Bq	0.00E+00	0.00E+00	1.03E-03	0.00E+00	4.08E-01
Silver, ion	Water	kg	0.00E+00	0.00E+00	6.77E-09	0.00E+00	3.80E-07
Simazine	Water	kg	0.00E+00	1.05E-10	1.32E-12	1.80E-10	0.00E+00
Sodium	Water	kg	1.31E+00	3.68E+00	1.33E+00	9.00E+00	6.28E+00
Sodium-24	Water	Bq	0.00E+00	0.00E+00	3.78E-06	0.00E+00	2.17E-03
Sodium formate	Water	kg	0.00E+00	0.00E+00	4.22E-12	0.00E+00	1.72E-09
Sodium, ion	Water	kg	0.00E+00	0.00E+00	1.44E-03	0.00E+00	1.80E+00
Solids, inorganic	Water	kg	1.00E-10	2.70E-09	4.92E-04	7.19E-09	1.73E-02
Solved solids	Water	kg	0.00E+00	0.00E+00	3.15E-05	0.00E+00	1.86E-03
Strontium	Water	kg	7.02E-03	1.98E-02	7.12E-03	4.82E-02	3.64E-02
Strontium-89	Water	Bq	0.00E+00	0.00E+00	1.84E-05	0.00E+00	7.76E-03
Strontium-90	Water	Bq	0.00E+00	0.00E+00	9.99E-01	0.00E+00	2.97E+02

Substance	Compartment	Unit	Forest operations	OSB	FJL	LVL	I-joists
Styrene	Water	kg	0.00E+00	2.64E-09	5.18E-11	1.54E-09	1.81E-09
Sulfate	Water	kg	1.04E-02	1.04E-01	2.37E-02	1.46E-01	9.79E-01
Sulfide	Water	kg	6.25E-06	9.04E-05	7.49E-05	1.54E-04	2.04E-03
Sulfite	Water	kg	0.00E+00	0.00E+00	4.45E-08	0.00E+00	1.33E-05
Sulfur	Water	kg	3.41E-04	9.62E-04	3.46E-04	2.34E-03	4.88E-03
Sulfuric acid	Water	kg	0.00E+00	2.04E-10	4.97E-08	1.17E-09	8.41E-09
Surfactants	Water	kg	0.00E+00	2.07E-06	4.57E-10	1.16E-10	0.00E+00
Suspended solids, inorganic	Water	kg	0.00E+00	0.00E+00	7.54E-04	0.00E+00	2.62E-03
Suspended solids, unspecified	Water	kg	6.08E+00	1.70E+01	6.01E+00	4.11E+01	2.84E+01
t-Butyl methyl ether	Water	kg	0.00E+00	0.00E+00	8.44E-09	0.00E+00	2.42E-07
t-Butylamine	Water	kg	0.00E+00	0.00E+00	7.46E-16	0.00E+00	1.76E-04
Tar	Water	kg	9.94E-13	2.68E-11	7.51E-12	7.13E-11	3.07E-11
Technetium-99m	Water	Bq	0.00E+00	0.00E+00	1.16E-05	0.00E+00	6.63E-03
Tellurium-123m	Water	Bq	0.00E+00	0.00E+00	2.04E-05	0.00E+00	6.22E-03
Tellurium-132	Water	Bq	0.00E+00	0.00E+00	2.89E-08	0.00E+00	1.66E-05
Terbufos	Water	kg	0.00E+00	1.58E-10	1.98E-12	2.71E-10	0.00E+00
Tetradecane	Water	kg	3.12E-06	8.80E-06	3.16E-06	2.14E-05	1.49E-05
Thallium	Water	kg	1.45E-06	1.50E-06	8.30E-07	4.06E-06	4.61E-06
Thorium-228	Water	Bq	0.00E+00	0.00E+00	7.89E-01	0.00E+00	1.63E+01
Thorium-230	Water	Bq	0.00E+00	0.00E+00	2.41E-01	0.00E+00	7.45E+01
Thorium-232	Water	Bq	0.00E+00	0.00E+00	3.95E-04	0.00E+00	1.16E-01
Thorium-234	Water	Bq	0.00E+00	0.00E+00	1.77E-03	0.00E+00	5.46E-01
Tin	Water	kg	2.80E-05	4.77E-05	2.06E-05	1.21E-04	9.68E-05
Tin, ion	Water	kg	0.00E+00	0.00E+00	5.90E-08	0.00E+00	4.93E-06
Titanium	Water	kg	1.05E-04	1.09E-04	5.99E-05	2.95E-04	2.80E-04
Titanium, ion	Water	kg	0.00E+00	0.00E+00	1.20E-06	0.00E+00	4.48E-04
TOC, Total Organic Carbon	Water	kg	0.00E+00	8.74E-02	2.66E-04	2.20E-01	9.82E-02
Toluene	Water	kg	2.04E-04	5.74E-04	2.07E-04	1.40E-03	1.97E-03
Toluene, 2-chloro-	Water	kg	0.00E+00	0.00E+00	9.25E-15	0.00E+00	3.54E-04
Tributyltin compounds	Water	kg	0.00E+00	0.00E+00	3.92E-09	0.00E+00	1.54E-07
Triethylene glycol	Water	kg	0.00E+00	0.00E+00	1.48E-07	0.00E+00	1.70E-06
Trimethylamine	Water	kg	0.00E+00	0.00E+00	2.85E-17	0.00E+00	1.20E-14
Tungsten	Water	kg	0.00E+00	0.00E+00	7.57E-08	0.00E+00	3.49E-06
Uranium-234	Water	Bq	0.00E+00	0.00E+00	2.12E-03	0.00E+00	6.55E-01
Uranium-235	Water	Bq	0.00E+00	0.00E+00	3.50E-03	0.00E+00	1.08E+00
Uranium-238	Water	Bq	0.00E+00	0.00E+00	6.67E-03	0.00E+00	1.95E+00
Uranium alpha	Water	Bq	0.00E+00	0.00E+00	1.02E-01	0.00E+00	3.15E+01
Urea	Water	kg	0.00E+00	0.00E+00	7.66E-15	0.00E+00	7.38E-13
Vanadium	Water	kg	3.50E-06	1.02E-05	3.54E-06	2.40E-05	1.67E-05
Vanadium, ion	Water	kg	0.00E+00	0.00E+00	1.99E-07	0.00E+00	6.25E-05
VOC, volatile organic compounds, unspecified origin	Water	kg	0.00E+00	0.00E+00	1.39E-06	0.00E+00	2.99E-05
Waste water/m3	Water	m3	0.00E+00	1.92E-03	3.07E-03	3.28E-03	0.00E+00
Xylene	Water	kg	1.10E-04	2.99E-04	1.09E-04	7.33E-04	5.23E-04
Yttrium	Water	kg	8.68E-07	2.45E-06	8.78E-07	5.95E-06	4.15E-06
Zinc	Water	kg	2.54E-04	3.46E-04	1.58E-04	8.26E-04	7.40E-04
Zinc-65	Water	Bq	0.00E+00	0.00E+00	5.12E-05	0.00E+00	2.95E-02
Zinc, ion	Water	kg	0.00E+00	0.00E+00	5.22E-06	0.00E+00	7.62E-04
Zirconium-95	Water	Bq	0.00E+00	0.00E+00	5.93E-07	0.00E+00	3.41E-04
Waste in inert landfill	Waste	kg	0.00E+00	0.00E+00	0.00E+00	3.69E+00	3.73E+00
Waste to recycling	Waste	kg	0.00E+00	0.00E+00	0.00E+00	1.69E+00	2.45E+00
Waste, solid	Waste	kg	0.00E+00	2.74E-02	4.64E-02	4.69E-02	1.13E+00
2,4-D	Soil	kg	0.00E+00	0.00E+00	2.38E-12	0.00E+00	1.18E-08
Aclonifen	Soil	kg	0.00E+00	0.00E+00	2.36E-13	0.00E+00	5.45E-11
Aldrin	Soil	kg	0.00E+00	0.00E+00	1.22E-16	0.00E+00	8.23E-15
Aluminium	Soil	kg	0.00E+00	0.00E+00	1.92E-08	0.00E+00	2.75E-05
Antimony	Soil	kg	0.00E+00	0.00E+00	2.76E-16	0.00E+00	8.13E-14
Arsenic	Soil	kg	0.00E+00	0.00E+00	5.99E-12	0.00E+00	4.59E-09
Atrazine	Soil	kg	0.00E+00	0.00E+00	3.20E-17	0.00E+00	2.16E-15
Barium	Soil	kg	0.00E+00	0.00E+00	5.20E-11	0.00E+00	2.18E-09
Benomyl	Soil	kg	0.00E+00	0.00E+00	1.52E-14	0.00E+00	7.55E-11
Bentazone	Soil	kg	0.00E+00	0.00E+00	1.20E-13	0.00E+00	2.78E-11
Boron	Soil	kg	0.00E+00	0.00E+00	1.02E-11	0.00E+00	2.01E-10

Substance	Compartment	Unit	Forest operations	OSB	FJL	LVL	I-joists
Cadmium	Soil	kg	0.00E+00	0.00E+00	3.27E-11	0.00E+00	5.86E-09
Calcium	Soil	kg	0.00E+00	0.00E+00	2.57E-07	0.00E+00	1.45E-04
Carbetamide	Soil	kg	0.00E+00	0.00E+00	9.44E-14	0.00E+00	1.47E-11
Carbofuran	Soil	kg	0.00E+00	0.00E+00	8.33E-12	0.00E+00	4.14E-08
Carbon	Soil	kg	0.00E+00	0.00E+00	2.25E-08	0.00E+00	2.66E-04
Chloride	Soil	kg	0.00E+00	0.00E+00	3.58E-09	0.00E+00	8.38E-07
Chlorothalonil	Soil	kg	0.00E+00	0.00E+00	5.11E-11	0.00E+00	4.81E-09
Chromium	Soil	kg	0.00E+00	0.00E+00	2.73E-10	0.00E+00	1.41E-07
Chromium VI	Soil	kg	0.00E+00	0.00E+00	1.25E-12	0.00E+00	1.20E-10
Cobalt	Soil	kg	0.00E+00	0.00E+00	1.61E-11	0.00E+00	1.65E-08
Copper	Soil	kg	0.00E+00	0.00E+00	1.52E-09	0.00E+00	3.11E-06
Cypermethrin	Soil	kg	0.00E+00	0.00E+00	1.18E-12	0.00E+00	5.84E-09
Fenpiclonil	Soil	kg	0.00E+00	0.00E+00	2.02E-12	0.00E+00	1.91E-10
Fluoride	Soil	kg	0.00E+00	0.00E+00	2.60E-12	0.00E+00	2.47E-10
Glyphosate	Soil	kg	0.00E+00	0.00E+00	1.68E-11	0.00E+00	8.21E-08
Heat, waste	Soil	MJ	0.00E+00	0.00E+00	1.77E-03	0.00E+00	3.48E-01
Iron	Soil	kg	0.00E+00	0.00E+00	3.41E-05	0.00E+00	5.23E-04
Lead	Soil	kg	0.00E+00	0.00E+00	8.74E-10	0.00E+00	1.45E-07
Linuron	Soil	kg	0.00E+00	0.00E+00	1.82E-12	0.00E+00	4.20E-10
Magnesium	Soil	kg	0.00E+00	0.00E+00	2.89E-08	0.00E+00	1.63E-05
Mancozeb	Soil	kg	0.00E+00	0.00E+00	6.64E-11	0.00E+00	6.24E-09
Manganese	Soil	kg	0.00E+00	0.00E+00	1.78E-08	0.00E+00	5.26E-06
Mercury	Soil	kg	0.00E+00	0.00E+00	1.18E-13	0.00E+00	2.13E-09
Metaldehyde	Soil	kg	0.00E+00	0.00E+00	3.09E-14	0.00E+00	4.00E-12
Metolachlor	Soil	kg	0.00E+00	0.00E+00	1.32E-11	0.00E+00	3.04E-09
Metribuzin	Soil	kg	0.00E+00	0.00E+00	2.34E-12	0.00E+00	2.20E-10
Molybdenum	Soil	kg	0.00E+00	0.00E+00	3.34E-12	0.00E+00	8.08E-09
Napropamide	Soil	kg	0.00E+00	0.00E+00	5.46E-14	0.00E+00	7.08E-12
Nickel	Soil	kg	0.00E+00	0.00E+00	3.07E-10	0.00E+00	5.69E-08
Oils, biogenic	Soil	kg	0.00E+00	0.00E+00	1.26E-09	0.00E+00	3.48E-07
Oils, unspecified	Soil	kg	0.00E+00	0.00E+00	2.80E-04	0.00E+00	6.13E-03
Orbencarb	Soil	kg	0.00E+00	0.00E+00	1.26E-11	0.00E+00	1.19E-09
Phosphorus	Soil	kg	0.00E+00	0.00E+00	8.70E-09	0.00E+00	2.38E-06
Pirimicarb	Soil	kg	0.00E+00	0.00E+00	1.14E-14	0.00E+00	2.63E-12
Potassium	Soil	kg	0.00E+00	0.00E+00	4.84E-08	0.00E+00	1.32E-05
Silicon	Soil	kg	0.00E+00	0.00E+00	7.37E-08	0.00E+00	6.48E-05
Sodium	Soil	kg	0.00E+00	0.00E+00	7.41E-11	0.00E+00	6.91E-09
Solids	Soil	kg	0.00E+00	0.00E+00	9.75E-05	0.00E+00	2.59E-03
Strontium	Soil	kg	0.00E+00	0.00E+00	1.27E-10	0.00E+00	1.96E-09
Sulfur	Soil	kg	0.00E+00	0.00E+00	8.36E-09	0.00E+00	2.57E-05
Sulfuric acid	Soil	kg	0.00E+00	0.00E+00	6.15E-18	0.00E+00	4.15E-16
Tebutam	Soil	kg	0.00E+00	0.00E+00	1.29E-13	0.00E+00	1.68E-11
Teflubenzuron	Soil	kg	0.00E+00	0.00E+00	1.56E-13	0.00E+00	1.47E-11
Thiram	Soil	kg	0.00E+00	0.00E+00	2.70E-14	0.00E+00	1.34E-10
Tin	Soil	kg	0.00E+00	0.00E+00	2.25E-13	0.00E+00	3.01E-08
Titanium	Soil	kg	0.00E+00	0.00E+00	1.23E-09	0.00E+00	3.35E-07
Vanadium	Soil	kg	0.00E+00	0.00E+00	3.51E-11	0.00E+00	9.60E-09
Zinc	Soil	kg	0.00E+00	0.00E+00	5.75E-08	0.00E+00	2.38E-06

21 APPENDIX F: PRODUCTION FACILITY SURVEY QUESTIONNAIRES

CORRIM SURVEY

The Consortium for Research on Renewable Industrial Materials (CORRIM)

Laminated Veneer Lumber (LVL) and Composite I-Joist Plants
2014

The information from this survey will be used in a project by CORRIM, a consortium of universities, industry, and government groups. In collaboration with the USDA Forest Service Forest Products Laboratory, APA-The Engineered Wood Association, and the American Wood Council, CORRIM is updating life-cycle assessment data that describes environmental impacts of building materials. This CORRIM survey is designed specifically for LVL and composite I-joist plants. There are three sections for this survey. The three sections are the LVL plant (pg. 3-11), the veneer mill (pg. 12-19), and the I-joist plant (pg. 20-29). Please complete the section(s) that apply to your facilities. Emission data are requested for each section.

Questions will be concentrated on **annual production**, electricity production and usage, fuel consumption, material flows, and environmental emissions. We realize that you may not have all the information requested, especially when it comes to specific equipment/processing groups or what we call 'machine centers'. The data you are able to provide will be appreciated.

Your data will be confidential; only weight-averaged values based on production for the industry will be reported.

Company: ______________________________

Facility Site (city, state): ______________________________

Should we have a follow-up question about the data, please provide the name and the following information for the contact in your company.

Name: ______________ Title: ______________

Telephone: ______________ Email: ______________

Please send the complete survey to the following email or address by March 3rd. If you have questions about the survey, contact:

Rick Bergman
Research Forest Products Technologist,
USDA Forest Service Forest Products Laboratory
One Gifford Pinchot Dr,
Madison, WI 53726-2398
(608) 231-9477 (ph) / (608) 231-9508 (fax)
rbergman@fs.fed.us

General Plant Information

Yes	No	Equipment in mill
O	O	Veneer dryer (for redry)
O	O	conventional steam, #: _________
O	O	high temp (>212F) steam # _____
O	O	direct fire, # ___________
O	O	continuous, # ___________
O	O	other:____________________
O	O	Hot pressing
O	O	Hot press(es), #_____________
		year built or updated:_______
O	O	heating system
O	O	hot oil (fired by nat. gas)
O	O	microwave
O	O	radio-frequency
		pressure (psig) ________
		temperature (°F) ________
		press time (min:sec) ________
O	O	Precipitator
O	O	Bag house
O	O	Other pollution controls?
O	O	Layup of LVL billets
O	O	Resin
O	O	phenol-formaldehyde
O	O	other ___________
O	O	other ___________
		Inputs
O	O	PLV
O	O	veneer
O	O	Sawing/trimming of LVL
O	O	Resaw
O	O	Rip saw
O	O	In-line moisture meter
O	O	Automatic grading (visual grades)
O	O	Manual grading (visual grades)
O	O	Machine grading (MSR grades)
O	O	End Trim
O	O	Wrap LVL, material ____________
O	O	Steel strapping
O	O	Plastic strapping
O	O	Cardboard corners
O	O	other:___________________
O	O	other:___________________
O	O	other:___________________
O	O	Bag house
O	O	Other pollution control

Yes	No	Equipment in mill (continued)
O	O	Boiler / cogen
O	O	wood boiler(s), #_______
O	O	gas boiler(s), #_________
O	O	oil boiler(s), #_________
O	O	propane boiler(s), #_________
O	O	Cogeneration unit
O	O	Bag house
O	O	Other pollution control?
O	O	Precipitator
O	O	other:_____________
O	O	other:___________________
O	O	other:___________________
O	O	Buy steam
O	O	Sell electricity
O	O	Routing/shaping of web and flanges
O	O	Router(s), # ___________
		Flanges
O	O	LSL
O	O	LVL
O	O	Lumber
O	O	Lumber (finger-jointed)
O	O	Assembly of I-joist
O	O	Resin
O	O	phenol-resorcinol-formaldehyde
O	O	emulsified polyurethane
O	O	other ______________________
		% MC (dry basis) ___________
O	O	Sawing/curing of I-joists
O	O	Ripsaw
O	O	Oven(s), # ___________
		Fuel source_______________
O	O	Wrap LVL, material ____________
O	O	Steel strapping
O	O	Plastic strapping
O	O	Cardboard corners
O	O	other:___________________
O	O	Bag house
O	O	Other pollution control

LVL Plant Annual Wood Production Data

Reporting year __________ Starting month __________ Ending month ______________

LVL Annual Production			
(Please provide units of measurement if different than stated)			Total Production
1.	Annual LVL production, 2012	ft^3	
	Annual LVL production, 2012	MSF 3/8 in. basis	
	Annual LVL production, 2012	Tons (%MC)	
2.	Veneer		
	a. Produced Veneer:		
	i. Used in Mill	MSF 3/8 in. basis	
	ii. Sold	MSF 3/8 in. basis	
	b. Purchased Veneer:		
	i. Dry	MSF 3/8 in. basis	
	ii. Green	MSF 3/8 in. basis	
	c. Sold Veneer		
	i. Dry	MSF 3/8 in. basis	
	ii. Green	MSF 3/8 in. basis	
	d. Purchased Parallel Laminated Veneer (PLV)	MSF 3/8 in. basis	

Transportation method(s) and average delivery distance for purchased veneer				
	Truck (% of total)		Average delivery miles	
	Rail (% of total)		Average delivery miles	
	Other (% of total)		Average delivery miles	
	Total (%)	100%		
Transportation method(s) and average delivery distance for purchased PLV				
	Truck (% of total)		Average delivery miles	
	Rail (% of total)		Average delivery miles	
	Other (% of total)		Average delivery miles	
	Total (%)	100%		

3. If you either peel/dry or dry veneer on-site, please be sure to complete the next section on veneer mills.

LVL Plant Annual Power and Fuel Consumption

If you have completed a 2012 Annual Fuel and Energy Survey for AF&PA, you may want to attach the survey and skip to the next section entitled “Other Annual Production.” The first section refers to energy generation (non-transport fuel). (Please provide units of measurement if different)

Fuel	Unit	Quantity
Purchased electricity	kWh	
Purchased steam	lbs (°F)	
Wood Fuel *Self-generated*	Tons / (%MC)	/
Wood Fuel *Purchased*	Tons / (%MC)	/
Natural Gas	1000 ft^3	
Kerosene (fuel oil #1)	Gallons	
Fuel oil #2	Gallons	
Residual fuel oil #6 (Bunker C)	Gallons	
Diesel	Gallons	
Gasoline	Gallons	
Liquid Propane Gas	Gallons	
Total electricity for LVL plant	kWh	

If your facility produces any of the following for use on-site or for sale, please fill out the table. Enter N/A if not applicable.

Energy	Unit	Quantity (used on-site)	Quantity (sold off-site)
Electricity	kWh		
Steam	lbs (°F)		

If your facility has a boiler, please provide the following. Otherwise, enter N/A as applicable.

Boiler	Boiler size (million BTU/hr)	Boiler fuel	Boiler fuel unit	Quantity	Electricity to operate boiler (kWh)
#1					
#2					
#3					
#4					

LVL Plant Annual Transportation Fuel Use On-site

(includes all fuels for yard equipment, forklifts, and carriers)

Type	Total Quantity	Percent of total by unit process (percentage or volume)					Units	
		Veneer / PLV prep	Layup	Boiler	Hot press	Saw/ trimmer	Support vehicles	
Off-road diesel								Gallons
On-road diesel								Gallons
Propane								Gallons
Gasoline								Gallons
Electricity								kWh
Other								

Other LVL Plant Annual Use Data

Formulation and usage of resin, fillers, and other components		
Component Type	Percent of Solid by Weight (range is ok)	Total annual use (lbs.)
Phenol formaldehyde		
Extender and filler		
Catalyst (NaOH)		
Water		
Other (please specify)		
Other (please specify)		

Transportation method and distance for resin			
Truck (% of total)		Average delivery miles	
Rail (% of total)		Average delivery miles	
Other (% of total)		Average delivery miles	
Total (%)	100%		

Transportation method and distance for extender and filler			
Truck (% of total)		Average delivery miles	
Rail (% of total)		Average delivery miles	
Other (% of total)		Average delivery miles	
Total (%)	100%		

Transportation method and distance for catalysts			
Truck (% of total)		Average delivery miles	
Rail (% of total)		Average delivery miles	

Other (% of total)		Average delivery miles	
Total (%)	100%		

Source of Heat for Press: direct or in-direct (circle one)			
Thermal Fluid (Hot Oil) heated by	Units		
Natural Gas	1000 ft^3		
Electricity	kWh		
Steam	lbs		
Radio Frequency	kWh		
Microwave Frequency	kWh		
Other	?		

LVL Plant Annual Wood Residue Production

Wood residues are any wood material produced in conjunction with making LVL and are called co-products in this survey. For each of the co-products produced at your plant, please indicate the weight (tons) of **annual** wood residue production for the reporting period that are shipped to other users, used internally as fuel or for the production of another co-product at your facility, stockpiled for future use or land filled (estimates are acceptable). If zero, enter a dash (-). Please state units if other than tons like cubic yards. The final column (Total Quantity) should equal the sum of the individual rows.

Estimate amount of wood residue produced per Msf of LVL ___________tons/Msf LVL

Wood residue	Moisture Content (wet basis)	Sold (Shipped)	Used Internally (as fuel)	Used Internally (other uses)	Landfill	Inventory	Total Quantity
	(%)	tons	tons	tons	tons	tons	Tons
Veneer loss							
PLV loss							
Lay-up scrap							
Panel trim							
Sawdust (sawing and trimming)							
Sawdust (rip saw)							
Tested LVL, used							
Other							

LVL Plant Ancillary Material Inputs

Ancillary Material	Used		Amount	How amount was found? **Mark one**[1]		Where the ancillary material is emitted as a percent (estimation is ok)					
	Yes	No		M	E	Veneer / PLV prep	Layup	Boiler	Hot press	Saw/ trimmer	Comments
Hydraulic fluids	O	O	lb/yr	O	O	%	%	%	%	%	
Greases	O	O	lb/yr	O	O	%	%	%	%	%	
Motor Oil	O	O	lb/yr	O	O	%	%	%	%	%	
Plastic wrapping	O	O	lb/yr	O	O	%	%	%	%	%	
Cardboard packaging	O	O	lb/yr	O	O	%	%	%	%	%	
Steel strapping	O	O	lb/yr	O	O	%	%	%	%	%	
Plastic strapping	O	O	lb/yr	O	O	%	%	%	%	%	
Potable water	O	O	gal/yr	O	O	%	%	%	%	%	
Paints	O	O	lb/yr	O	O	%	%	%	%	%	
Waxes	O	O	lb/yr	O	O	%	%	%	%	%	
Other: ____________	O	O	lb/yr	O	O	%	%	%	%	%	
Other: ____________	O	O	lb/yr	O	O	%	%	%	%	%	
Other: ____________	O	O	lb/yr	O	O	%	%	%	%	%	

[1] Estimated (E) / Measured (M)

LVL Plant Air Emissions

If air emission inventories are available, please provide as an alternative to the following table. Check here if inventory is attached ☐

	Emit			How amount was found?[1]			Sampling method or source[2]	Where the substance is emitted as a percent (estimation is ok)				
Substance	**Yes**	**No**	**Amount**	**M**	**E**	**PV**		**Veneer / PLV prep**	**Layup**	**Boiler**	**Hot press**	**Saw/ trimmer**
Dust	O	O	lb/yr	O	O	O		%	%	%	%	%
Particulate	O	O	lb/yr	O	O	O		%	%	%	%	%
Particulate, PM10[3]	O	O	lb/yr	O	O	O		%	%	%	%	%
Particulate, PM2.5[4]	O	O	lb/yr	O	O	O		%	%	%	%	%
VOC	O	O	lb/yr	O	O	O		%	%	%	%	%
Sulfur dioxide	O	O	lb/yr	O	O	O		%	%	%	%	%
Carbon monoxide	O	O	lb/yr	O	O	O		%	%	%	%	%
Nitrous oxide	O	O	lb/yr	O	O	O		%	%	%	%	%
HAP: Total	O	O	lb/yr	O	O	O		%	%	%	%	%
HAP: Methanol	O	O	lb/yr	O	O	O		%	%	%	%	%
HAP: Formaldehyde	O	O	lb/yr	O	O	O		%	%	%	%	%
HAP: Acetaldehyde	O	O	lb/yr	O	O	O		%	%	%	%	%
HAP: Propionaldehyde	O	O	lb/yr	O	O	O		%	%	%	%	%
HAP: Acrolein	O	O	lb/yr	O	O	O		%	%	%	%	%
HAP: Phenol	O	O	lb/yr	O	O	O		%	%	%	%	%
HAP: Acetone	O	O	lb/yr	O	O	O		%	%	%	%	%
HAP: ____________	O	O	lb/yr	O	O	O		%	%	%	%	%
HAP: ____________	O	O	lb/yr	O	O	O		%	%	%	%	%
Other organic[5]: _______	O	O	lb/yr	O	O	O		%	%	%	%	%
Other inorganic[6]: _____	O	O	lb/yr	O	O	O		%	%	%	%	%
Other: ______________	O	O	lb/yr	O	O	O		%	%	%	%	%

[1] Estimated (E) / Measured (M)/ Permit value (PV): For example, from landfill fees, a permit, or measurement
[2] Sampling methods might be Method 25A, Method 5, NCASI 105. Estimates might be based on AP42, Standard Air Contaminate Discharge Permit or other source.
[3] PM10 is particulate matter up to 10 micrometers in size
[4] PM2.5 is particulate matter up to 2.5 micrometers in size
[5] Non-HAP organics that are not included in VOC value.
[6] Inorganics such as chlorine, mercury sulfur.

LVL Plant Water Emissions

If water emission inventories are available, please provide as an alternative to the following table. Check here if inventory is attached □

Substance	Emit		Amount[2]	How amount was found Mark one[3]			Sampling method or source[1]	Where the substance is emitted as a percent (estimation is ok)				
	Yes	No		M	E	PV		Veneer / PLV prep	Layup	Boiler	Hot press	Saw/ trimmer
Suspended solids	O	O	lb/yr	O	O	O		%	%	%	%	%
BOD	O	O	lb/yr	O	O	O		%	%	%	%	%
COD	O	O	lb/yr	O	O	O		%	%	%	%	%
Oil and grease	O	O	lb/yr	O	O	O		%	%	%	%	%
HAPs	O	O	lb/yr	O	O	O		%	%	%	%	%
Chemicals in boiler blowdown (if not included above)	O	O	lb/yr	O	O	O		%	%	%	%	%
Other: ______________	O	O	lb/yr	O	O	O		%	%	%	%	%
Other: ______________	O	O	lb/yr	O	O	O		%	%	%	%	%
Other: ______________	O	O	lb/yr	O	O	O		%	%	%	%	%
Other: ______________	O	O	lb/yr	O	O	O		%	%	%	%	%
Other: ______________	O	O	lb/yr	O	O	O		%	%	%	%	%

[1] Sampling methods is type of water test or how estimate was obtained.

[2] Report the mass of material, not the mass of material and water.

[3] Estimated (E) / Measured (M)/ Permit value (PV): For example, from landfill fees, a permit, or measurement.

LVL Plant Solid Waste Production

If annual solid waste summary is available, please provide as an alternative to the following table. Check here if summary is attached □

Material	Amount[2] (lb/yr)	Where material is going? Landfill (L) or recycled (R) Mark one	How amount was found? Mark one[1]			Where the solid waste is emitted as a percent (estimation is ok)				
			M	E	PV	Veneer / LVL prep	Layup	Boiler	Hot press	Saw/ trimmer
Discarded Wood		L / R	O	O	O	%	%	%	%	%
Discarded Bark		L / R	O	O	O	%	%	%	%	%
Dirt and rocks		L / R	O	O	O	%	%	%	%	%
Ash		L / R	O	O	O	%	%	%	%	%
Plastic wrap		L / R	O	O	O	%	%	%	%	%
Metal strapping		L / R	O	O	O	%	%	%	%	%
Plastic strapping		L / R	O	O	O	%	%	%	%	%
Other metals		L / R	O	O	O	%	%	%	%	%
Other organics		L / R	O	O	O	%	%	%	%	%
Other non-organics		L / R	O	O	O	%	%	%	%	%
Other: ____________		L / R	O	O	O	%	%	%	%	%
Other: ____________		L / R	O	O	O	%	%	%	%	%
Other: ____________		L / R	O	O	O	%	%	%	%	%

[1] Estimated (E) / Measured (M)/ Permit value (PV): For example, from landfill fees, a permit, or measurement.

[2] Report the mass of material, for example, report wood separately from dirt and rocks.

LVL Plant Annual Water Use

Type	Total Quantity	Percent of total by unit process (percentage or volume; estimation is ok)					Units
		Veneer / LVL prep	Layup	Boiler	Hot press	Saw/ trimmer	
Input							
Surface water							Gallons
Groundwater							Gallons
Municipal water							Gallons
Output							
Water discharged							Gallons
Water recycled							Gallons

Recycling rate of water helps reduce the water footprint.

What percent of water is recycled?		%
Was water measured or estimated?		

LVL Plant Emission Control Device (ECD)

The following is a chart of emission control devices. Please fill in all information related to the control devices.

Emission Control Device (ECD)- Type, Electricity, Fuel Usage					
	ECD 1	ECD 2	ECD 3	ECD 4	ECD 5
Equipment controlled (i.e., boiler, press, dryer, etc.)					
Type					
Model					
Year Installed					
Electricity used to operate ECD; either kWh or % of total plant use					
Natural Gas used to operate ECD; either $ft.^3$ or % of total plant use					

Machine Center Breakdown for Electricity and Fuel Use

Fill in all that apply and for which you have data. If you **do not** have given machines center such as the co-generator, either draw **a line** through that row and **write N/A**.

Machine Center	**Model/Type**	**Annual electricity**	**Fuel Usage**
	Year Installed	**kWh or % of the total use for mill**	**% of total use for mill**
Co-generator			
Lay-up			
Press(es)			
#1			
#2			
#3			
#4			
Billet Cuts			
Rip Saw			

If you do not peel or dry veneer or produce I-joists, congratulations you have completed the survey! However, if you do, please complete the following pages.

Veneer Mill Annual Wood Production Data

Please fill in all the information that pertains just to your plant.

Type of veneer dryer: Longitudinal, Cross flow, Jet, Rotary (circle one)

Log scale: Dolye, International, Scribner, Weight base (circle one)

Total volume of incoming softwood logs	____________	thousand BF/year
Total volume of incoming green veneer	____________	thousand ft^2 3/8" basis/year
Total volume of veneer produced on-site	____________	thousand ft^2 3/8" basis/year
Total volume of veneer produced on-site used on-site	____________	thousand ft^2 3/8" basis/year

Please complete the following table showing the breakdown of the ***individual tree species*** and approximate ***sizes*** processed by your mill by species and the average log diameter. If less than 2% of total, use category labeled "Other".

Species	% of total log input into veneer mill	Log Diameter* (in)
Total	100%	

*Please provide individual log diameters if known otherwise please state the average or range of logs processed at your facility in bottom row under Log Diameter

Wood species processed into veneer and approximate percentage of total:			
Species	Volume (Msf 3/8")	%MC (wet basis)	Percent
Total			100%

MILEAGE: Over the Road _______% By Rail_______%

Total number of log deliveries made to this facility annually	____________	# per year
Average one-way mileage travel to this facility to deliver logs	____________	miles

Veneer Mill Annual Transportation Fuel Use On-site

(includes all fuels for yard equipment, forklifts, and carriers)

Type	Total Quantity	Percent of total by unit process (percentage or volume)					Units
		Bucking & Debarking	Block Conditioning	Peeling & Clipping	Drying	Support Vehicle	
Off-road diesel							Gallons
On-road diesel							Gallons
Propane							Gallons
Gasoline							Gallons
Electricity							kWh
Other							

Veneer Mill Annual (Non-Transportation) Fuel Use

(boilers, cogeneration units, etc.)

Fuel	Unit	Quantity
Total electricity for veneer mill	kWh	
Purchased steam	lbs (°F)	
Wood Fuel *Self-generated*	Tons / (%MC)	/
Wood Fuel *Purchased*	Tons / (%MC)	/
Natural Gas	1000 ft^3	
Kerosene (fuel oil #1)	Gallons	
Fuel oil #2	Gallons	
Residual fuel oil #6 (Bunker C)	Gallons	
Diesel	Gallons	
Gasoline	Gallons	
Liquid Propane Gas	Gallons	

If your facility has a boiler, please provide the following. Otherwise, enter N/A as applicable.

Boiler	Boiler size (million BTU/hr)	Boiler Fuel	Boiler Fuel Unit	Quantity	Electricity to operate boiler (kWh)
#1					
#2					
#3					
#4					

Veneer Mill Machine Center Breakdown

Fill in all that apply and for which you have data. If you do not have a given machine center, draw a line through that row and write None. Please provide units.

Machine Center	Model/Type Year Installed	Annual Electricity Usage kWh or % of total electricity use for mill **(Estimation is ok)**	Fuel Usage % of total use for mill **(Estimation is ok)**
Bucking & Debarking			
Log Conditioning			
Peeling & Clipping			
Drying			
Energy Generation			
Emissions control			
Total veneer mill			

Veneer Mill Annual Wood Residue Production

This is a general material flow survey for veneer mills. Wood residues are any wood material produced in conjunction with making LVL and are called co-products in this survey. This survey is designed to trace all wood components generated during production.

Estimate amount of wood residue produced per Msf of veneer ___________tons/Msf veneer

Wood residue	Moisture Content (wet basis) (%)	Sold (Shipped) tons	Used Internally (as fuel) tons	Used Internally (other uses) tons	Landfill tons	Total Quantity Tons
Bark, green						
Roundup wood, green						
Peeler core, green						
Clippings, green						
Veneer downfall						
Trim , green						
Chips, green						
Hogged material						
Waste gate material						
Clippings, green						
Other						

For dryer(s), check heat source and give the annual fuel consumption: **indirect or direct (circle one)**		
Heat source		
☐ Steam	lbs	
☐ Natural gas direct-fired	ft^3	
☐ Wood fuel	Tons (%MC)	/
☐ Other		
Veneer moisture content information		
Average moisture content into dryer	% ovendry basis	
Average moisture content out of dryer	% ovendry basis	
Redry rate	%	

Transportation method and distance for veneer logs			
Truck (% of total)		Average delivery miles	
Rail (% of total)		Average delivery miles	
Other (% of total)		Average delivery miles	
Total (%)	100%		

Veneer Mill Ancillary Material Inputs

Ancillary Material	Used		Amount	How amount was found? Mark one[1]		Where the ancillary material is emitted as a percent (estimation is ok)				
	Yes	No		M	E	Bucking & Debarking	Block Conditioning	Peeling & Clipping	Drying	Comments
Hydraulic fluids	O	O	lb/yr	O	O	%	%	%	%	
Greases	O	O	lb/yr	O	O	%	%	%	%	
Motor Oil	O	O	lb/yr	O	O	%	%	%	%	
Plastic wrapping	O	O	lb/yr	O	O	%	%	%	%	
Cardboard packaging	O	O	lb/yr	O	O	%	%	%	%	
Steel strapping	O	O	lb/yr	O	O	%	%	%	%	
Plastic strapping	O	O	lb/yr	O	O	%	%	%	%	
Potable water	O	O	gal/yr	O	O	%	%	%	%	
Paints	O	O	lb/yr	O	O	%	%	%	%	
Waxes	O	O	lb/yr	O	O	%	%	%	%	
Runners	O	O	lb/yr	O	O	%	%	%	%	
Boiler chemicals	O	O	lb/yr	O	O	%	%	%	%	
Other: ____________	O	O	lb/yr	O	O	%	%	%	%	
Other: ____________	O	O	lb/yr	O	O	%	%	%	%	
Other: ____________	O	O	lb/yr	O	O	%	%	%	%	

[1] Estimated (E) / Measured (M)

Veneer Mill Air Emissions

If air emission inventories are available, please provide as an alternative to the following table. Check here if inventory is attached □

Substance	Emit		Amount	How amount was found? Mark one[1]			Sampling method or source[2]	Where the substance is emitted as a percent (estimation is ok)			
	Yes	No		M	E	PV		Bucking & Debarking	Block Conditioning	Peeling & Clipping	Drying
Dust	O	O	lb/yr	O	O	O		%	%	%	%
Particulate	O	O	lb/yr	O	O	O		%	%	%	%
Particulate, PM10[3]	O	O	lb/yr	O	O	O		%	%	%	%
Particulate, PM2.5[4]	O	O	lb/yr	O	O	O		%	%	%	%
VOC	O	O	lb/yr	O	O	O		%	%	%	%
Sulfur dioxide	O	O	lb/yr	O	O	O		%	%	%	%
Carbon monoxide	O	O	lb/yr	O	O	O		%	%	%	%
Nitrous oxide	O	O	lb/yr	O	O	O		%	%	%	%
HAP: Total	O	O	lb/yr	O	O	O		%	%	%	%
HAP: Methanol	O	O	lb/yr	O	O	O		%	%	%	%
HAP: Formaldehyde	O	O	lb/yr	O	O	O		%	%	%	%
HAP: Acetaldehyde	O	O	lb/yr	O	O	O		%	%	%	%
HAP: Propionaldehyde	O	O	lb/yr	O	O	O		%	%	%	%
HAP: Acrolein	O	O	lb/yr	O	O	O		%	%	%	%
HAP: Phenol	O	O	lb/yr	O	O	O		%	%	%	%
HAP: Acetone	O	O	lb/yr	O	O	O		%	%	%	%
HAP: ____________	O	O	lb/yr	O	O	O		%	%	%	%
Other organic[5]: _______	O	O	lb/yr	O	O	O		%	%	%	%
Other inorganic[6]: _____	O	O	lb/yr	O	O	O		%	%	%	%
Other: __________	O	O	lb/yr	O	O	O		%	%	%	%

[1] Estimated (E) / Measured (M)/ Permit value (PV): For example, from landfill fees, a permit, or measurement
[2] Sampling methods might be Method 25A, Method 5, NCASI 105. Estimates might be based on AP42, Standard Air Contaminate Discharge Permit or other source.
[3] PM10 is particulate matter up to 10 micrometers in size
[4] PM2.5 is particulate matter up to 2.5 micrometers in size
[5] Non-HAP organics that are not included in VOC value.
[6] Inorganics such as chlorine, mercury sulfur.

Veneer Mill Water Emissions

If water emission inventories are available, please provide as an alternative to the following table. Check here if inventory is attached ☐

Substance	Emit		Amount[2]	How amount was found? Mark one[3]			Sampling method or source[1]	Where the substance is emitted as a percent (Estimation is ok)			
	Yes	No		M	E	PV		Bucking & Debarking	Block Conditioning	Peeling & Clipping	Drying
Suspended solids	O	O	lb/yr	O	O	O		%	%	%	%
BOD	O	O	lb/yr	O	O	O		%	%	%	%
COD	O	O	lb/yr	O	O	O		%	%	%	%
Oil and grease	O	O	lb/yr	O	O	O		%	%	%	%
HAPs	O	O	lb/yr	O	O	O		%	%	%	%
Chemicals in boiler blowdown (if not included above)	O	O	lb/yr	O	O	O		%	%	%	%
Other: ______________	O	O	lb/yr	O	O	O		%	%	%	%
Other: ______________	O	O	lb/yr	O	O	O		%	%	%	%
Other: ______________	O	O	lb/yr	O	O	O		%	%	%	%
Other: ______________	O	O	lb/yr	O	O	O		%	%	%	%
Other: ______________	O	O	lb/yr	O	O	O		%	%	%	%

[1] Sampling methods is type of water test or how estimate was obtained.

[2] Report the mass of material, not the mass of material and water.

[3] Estimated (E) / Measured (M)/ Permit value (PV): For example, from landfill fees, a permit, or measurement.

Veneer Mill Solid waste

If annual solid waste summary is available, please provide as an alternative to the following table.
Check here if summary is attached ☐

Material	Amount[2] (lb/yr)	Where material is going? Landfill (L) or recycled (R)	How amount was found? Mark one[1]	Where the solid waste is emitted as a percent (estimation is ok)			
				Bucking & Debarking	Block Conditioning	Peeling & Clipping	Drying
Discarded Wood		L / R	M / E / PV	%	%	%	%
Discarded Bark		L / R	M / E / PV	%	%	%	%
Dirt and rocks		L / R	M / E / PV	%	%	%	%
Ash		L / R	M / E / PV	%	%	%	%
Plastic wrap		L / R	M / E / PV	%	%	%	%
Plastic strapping		L / R	M / E / PV	%	%	%	%
Metal strapping		L / R	M / E / PV	%	%	%	%
Plastic bags		L / R	M / E / PV	%	%	%	%
Other metals		L / R	M / E / PV	%	%	%	%
Other organics		L / R	M / E / PV	%	%	%	%
Other non organics		L / R	M / E / PV	%	%	%	%
Other: ___________		L / R	M / E / PV	%	%	%	%
Other: ___________		L / R	M / E / PV	%	%	%	%
Other: ___________		L / R	M / E / PV	%	%	%	%

[1] Estimated (E) / Measured (M)/ Permit value (PV): For example, from landfill fees, a permit, or measurement.
[2] Report the mass of material, for example, report wood separately from dirt and rocks.

Veneer Mill Annual Water Use

Type	Total Quantity	Percent of total by unit process (percentage or volume)				Units
		Bucking & Debarking	Block Conditioning	Peeling & Clipping	Drying	
Input						
Surface water						Gallons
Groundwater						Gallons
Municipal water						Gallons
Output						
Water discharged						Gallons
Water recycled						Gallons

Recycling rate of water helps reduce the water footprint.

What percent of water is recycled?		%
Was water measured or estimated?		

2012 Composite I-joists Annual Production Plant Data

Please fill in all information relevant to producing I-joists. Please provide the data on an annual basis for the year which the data is reported.

Annual I-Joists Production for 2012			
Product (Series)	Amount (lin.ft.)	Joist Depth (in.)	Flange dim. (in. x in.)

I-joists Construction-Web		
Material	Percent of total	Annual consumption (MSF 3/8")
OSB		
Plywood		
Total	100%	

Transportation Method and Delivery Distance for OSB			
Truck (% of total)		Average delivery miles	
Rail (% of total)		Average delivery miles	
Other (% of total)		Average delivery miles	
Total (%)	100%		

Transportation Method and Delivery Distance for plywood			
Truck (% of total)		Average delivery miles	
Rail (% of total)		Average delivery miles	
Other (% of total)		Average delivery miles	
Total (%)	100%		

Estimate amount of wood residue produced per Msf of I-joist ___________tons/Msf I-joist

Wood residue	**Moisture Content (wet basis)** (%)	**Sold (Shipped)** tons	**Used Internally (as fuel)** tons	**Used Internally (other uses)** tons	**Landfill** tons	**Inventory** tons	**Total Quantity** Tons
Sawdust, dry							
Other							
Other							

I-joists Construction-Flange		
Material	Percent of total	Annual consumption (MSF 3/8”)
LVL		
LSL		
Lumber (finger-jointed)		
Total	100%	

Transportation Method and Delivery Distance for LVL			
Truck (% of total)		Average delivery miles	
Rail (% of total)		Average delivery miles	
Other (% of total)		Average delivery miles	
Total (%)	100%		

Transportation Method and Delivery Distance for LSL			
Truck (% of total)		Average delivery miles	
Rail (% of total)		Average delivery miles	
Other (% of total)		Average delivery miles	
Total (%)	100%		

Transportation Method and Delivery Distance for lumber (finger-jointed)			
Truck (% of total)		Average delivery miles	
Rail (% of total)		Average delivery miles	
Other (% of total)		Average delivery miles	
Total (%)	100%		

Annual Resin Consumption Data

Resin consumption is comprised of three different scenarios: 1) web-joint, 2) flange finger-joint, and 3) I-joist (web to flange)

1. Web-joint resin consumption	
Resin type	
Percent water	

Transportation Method and Delivery Distance for web-joint resin			
Truck (% of total)		Average delivery miles	
Rail (% of total)		Average delivery miles	
Other (% of total)		Average delivery miles	
Total (%)	100%		

- Please include the amount of resin used in the web-joints of the I-joist in this section. Please state whether weight is given as wet or dry weight.
- If you use the same resin for the web-joint, finger-joint, and web to flange-joint, complete the following table with total resin use and check this box ☐ ☐
- Otherwise, fill in resin use for web-joint only and then proceed to fill out resin data for flange finger-joints and I-joist (web to flange).

Formulation and usage of web-joint resin, fillers, and other components			
Component Type	Range % of Solid by Weight	Total Annual Use (lbs.)	Circle one
Resin			Wet or dry
Extender and filler			Wet or dry
Catalyst (NaOH)			Wet or dry
Water			
Other (please specify)			Wet or dry
Resin loss (lbs)			Wet or dry

2. Flange finger-joint resin consumption			
Resin type			
Percent water			
Transportation Method and Delivery Distance for flange finger-joint resin			
Truck (% of total)		Average delivery miles	
Rail (% of total)		Average delivery miles	
Other (% of total)		Average delivery miles	
Total (%)	100%		

Formulation and usage of flange finger-joint resin, fillers, and other components			
Component Type	Range % of Solid by Weight	Total Annual Use (lbs.)	Circle one
Resin			Wet or dry
Extender and filler			Wet or dry
Catalyst (NaOH)			Wet or dry
Water			
Other (please specify)			Wet or dry
Resin loss (lbs)			Wet or dry

3. I-joist (web-to-flange) resin consumption	
Resin type	
Percent water	

Transportation Method and Delivery Distance for I-joist (web-to-flange) resin			
Truck (% of total)		Average delivery miles	
Rail (% of total)		Average delivery miles	
Other (% of total)		Average delivery miles	
Total (%)	100%		

Formulation and usage of I-joist (web-to-flange) resin, fillers, and other components

Component Type	Range % of Solid by Weight	Total Annual Use (lbs.)	Circle one
Resin			Wet or dry
Extender and filler			Wet or dry
Catalyst (NaOH)			Wet or dry
Water			
Other (please specify)			Wet or dry
Resin loss (lbs)			Wet or dry

I-joist Plant Annual (Non-Transportation) Fuel Use

(boilers, cogeneration units, etc.)

Fuel	Unit	Quantity
Total electricity for I-joist plant	kWh	
Purchased steam	lbs (°F)	
Wood Fuel *Self-generated*	Tons / (%MC)	/
Wood Fuel *Purchased*	Tons / (%MC)	/
Natural Gas	1000 ft^3	
Kerosene (fuel oil #1)	Gallons	
Fuel oil #2	Gallons	
Residual fuel oil #6 (Bunker C)	Gallons	
Diesel	Gallons	
Gasoline	Gallons	
Liquid Propane Gas	Gallons	

If your facility has a boiler, please provide the following. Otherwise, enter N/A as applicable.

Boiler	Boiler size (million BTU/hr)	Boiler Fuel	Boiler Fuel Unit	Quantity	Electricity to operate boiler (kWh)
#1					
#2					
#3					

For oven(s), check heat source and give the annual fuel consumption: indirect or direct (circle one)		
Heat source		
☐ Steam	lbs	
☐ Natural gas direct-fired	ft^3	
☐ Wood fuel	Tons (%MC)	/
☐ Other		

I-Joist Plant Annual Transportation Fuel Use On-site

(includes all fuels for yard equipment, forklifts, and carriers)

Type	Total Quantity	Percent of total by unit process (percentage or volume)					Units
		Routing / shaping	Assembly	Sawing	Curing	Support vehicles	
Off-road diesel							Gallons
On-road diesel							Gallons
Propane							Gallons
Gasoline							Gallons
Electricity							kWh
Other							

Machine Center Breakdown for Electricity and Fuel Use

Fill in all that apply and for which you have data. If you **do not** have a given machine center that is listed here, either **draw a line** through that row and **write N/A**.

Machine Center	Model/Type Year Installed	Annual Electricity kWh or % of the Total Use for Mill	Fuel Usage % of Total Use for Mill
OSB/Plywood saws			
LVL/FJ lumber saws			
Web joint shaper/router			
I-joist assembler			
I-joist saw			
Other (please specify)			
Curing Oven			
Steam			
Electricity			
Natural Gas			

I-joist Plant Ancillary Material Inputs

Ancillary Material	Used		Amount	How amount was found? Circle one[1]	Where the ancillary material is emitted as a percent (estimation is ok)				
	Yes	No			Routing / shaping	Assembly	Sawing	Curing	Comments
Hydraulic fluids	O	O	lb/yr	M / E	%	%	%	%	
Greases	O	O	lb/yr	M / E	%	%	%	%	
Motor Oil	O	O	lb/yr	M / E	%	%	%	%	
Plastic wrapping	O	O	lb/yr	M / E	%	%	%	%	
Cardboard packaging	O	O	lb/yr	M / E	%	%	%	%	
Steel strapping	O	O	lb/yr	M / E	%	%	%	%	
Plastic strapping	O	O	lb/yr	M / E	%	%	%	%	
Potable water	O	O	gal/yr	M / E	%	%	%	%	
Paints	O	O	lb/yr	M / E	%	%	%	%	
Waxes	O	O	lb/yr	M / E	%	%	%	%	
Plastic strapping	O	O	lb/yr	M / E	%	%	%	%	
Runners	O	O	lb/yr	M / E	%	%	%	%	
Boiler chemicals	O	O	lb/yr	M / E	%	%	%	%	
Other: _____________	O	O	lb/yr	M / E	%	%	%	%	
Other: _____________	O	O	lb/yr	M / E	%	%	%	%	
Other: _____________	O	O	lb/yr	M / E	%	%	%	%	

[1] Estimated (E) / Measured (M)

I-joist Plant Air Emissions

If air emission inventories are available, please provide as an alternative to the following table. Check here if inventory is attached □

Substance	Emit		Amount	How amount was found? Circle one[1]	Sampling method or source[2]	Where the substance is emitted as a percent (estimation is ok)			
	Yes	No				Routing / shaping	Assembly	Sawing	Curing
Dust	O	O	lb/yr	M / E / PV		%	%	%	%
Particulate	O	O	lb/yr	M / E / PV		%	%	%	%
Particulate, PM10[3]	O	O	lb/yr	M / E / PV		%	%	%	%
Particulate, PM2.5[4]	O	O	lb/yr	M / E / PV		%	%	%	%
VOC	O	O	lb/yr	M / E / PV		%	%	%	%
Sulfur dioxide	O	O	lb/yr	M / E / PV		%	%	%	%
Carbon monoxide	O	O	lb/yr	M / E / PV		%	%	%	%
Nitrous oxide	O	O	lb/yr	M / E / PV		%	%	%	%
HAP: Total	O	O	lb/yr	M / E / PV		%	%	%	%
HAP: Methanol	O	O	lb/yr	M / E / PV		%	%	%	%
HAP: Formaldehyde	O	O	lb/yr	M / E / PV		%	%	%	%
HAP: Acetaldehyde	O	O	lb/yr	M / E / PV		%	%	%	%
HAP: Propionaldehyde	O	O	lb/yr	M / E / PV		%	%	%	%
HAP: Acrolein	O	O	lb/yr	M / E / PV		%	%	%	%
HAP: Phenol	O	O	lb/yr	M / E / PV		%	%	%	%
HAP: Acetone	O	O	lb/yr	M / E / PV		%	%	%	%
HAP: ___________	O	O	lb/yr	M / E / PV		%	%	%	%
HAP: ___________	O	O	lb/yr	M / E / PV		%	%	%	%
Other organic[5]: ______	O	O	lb/yr	M / E / PV		%	%	%	%
Other inorganic[6]: ____	O	O	lb/yr	M / E / PV		%	%	%	%
Other: _____________	O	O	lb/yr	M / E / PV		%	%	%	%

[1] Estimated (E) / Measured (M)/ Permit value (PV): For example, from landfill fees, a permit, or measurement
[2] Sampling methods might be Method 25A, Method 5, NCASI 105. Estimates might be based on AP42, Standard Air Contaminate Discharge Permit or other source.
[3] PM10 is particulate matter up to 10 micrometers in size
[4] PM2.5 is particulate matter up to 2.5 micrometers in size
[5] Non-HAP organics that are not included in VOC value.
[6] Inorganics such as chlorine, mercury sulfur.

I-joist Plant Water Emissions

If water emission inventories are available, please provide as an alternative to the following table. Check here if inventory is attached ☐

Substance	Emit		Amount[2]	How amount was found? Circle one[3]	Sampling method or source[1]	Where the substance is emitted as a percent (estimation is ok)			
	Yes	No				Routing / shaping	Assembly	Sawing	Curing
Suspended solids	O	O	lb/yr	M / E / PV		%	%	%	%
BOD	O	O	lb/yr	M / E / PV		%	%	%	%
COD	O	O	lb/yr	M / E / PV		%	%	%	%
Oil and grease	O	O	lb/yr	M / E / PV		%	%	%	%
HAPs	O	O	lb/yr	M / E / PV		%	%	%	%
Chemicals in boiler blowdown (if not included above)	O	O	lb/yr	M / E / PV		%	%	%	%
Other: ______________	O	O	lb/yr	M / E / PV		%	%	%	%
Other: ______________	O	O	lb/yr	M / E / PV		%	%	%	%
Other: ______________	O	O	lb/yr	M / E / PV		%	%	%	%
Other: ______________	O	O	lb/yr	M / E / PV		%	%	%	%
Other: ______________	O	O	lb/yr	M / E / PV		%	%	%	%

[1] Sampling methods is type of water test or how estimate was obtained.

[2] Report the mass of material, not the mass of material and water.

[3] Estimated (E) / Measured (M)/ Permit value (PV): For example, from landfill fees, a permit, or measurement.

I-joist Plant Solid waste

If annual solid waste summary is available, please provide as an alternative to the following table. Check here if summary is attached ☐

Material	Amount[2] (lb/yr)	Where material is going? Landfill (L) or recycled (R)	How amount was found? Circle one[1]	Where the solid waste is emitted as a percent (estimation is ok)			
				Routing / shaping	Assembly	Sawing	Curing
Discarded Wood		L / R	M / E / PV	%	%	%	%
Discarded Bark		L / R	M / E / PV	%	%	%	%
Dirt and rocks		L / R	M / E / PV	%	%	%	%
Ash		L / R	M / E / PV	%	%	%	%
Plastic wrap		L / R	M / E / PV	%	%	%	%
Metal strapping		L / R	M / E / PV	%	%	%	%
Cardboard packaging		L / R	M / E / PV	%	%	%	%
Plastic bags		L / R	M / E / PV	%	%	%	%
Other metals		L / R	M / E / PV	%	%	%	%
Other organics		L / R	M / E / PV	%	%	%	%
Other non organics		L / R	M / E / PV	%	%	%	%
Other: ____________		L / R	M / E / PV	%	%	%	%
Other: ____________		L / R	M / E / PV	%	%	%	%
Other: ____________		L / R	M / E / PV	%	%	%	%

[1] Estimated (E) / Measured (M)/ Permit value (PV): For example, from landfill fees, a permit, or measurement.

[2] Report the mass of material, for example, report wood separately from dirt and rocks.

I-joist Plant Annual Water Use

Type	Total Quantity	Percent of total by unit process (percentage or volume)				Units
		Routing / shaping	Assembly	Sawing	Curing	
Input						
Surface water						Gallons
Groundwater						Gallons
Municipal water						Gallons
Output						
Water discharged						Gallons
Water recycled						Gallons

Recycling rate of water helps reduce the water footprint.

What percent of water is recycled?		%
Was water measured or estimated? M/E		

Annual Emission Control Device and Environmental Emission

The following is a chart of emission control devices and a listing of chemical compounds that are observed and/or permitted. Please fill in all information related to the control devices. Then list all compounds that are collected and known for the mill for all control device sources. If you recently applied for air permit, use those numbers. Fill in all that apply and for which you have data.

Annual Emission Control Device (ECD)- Electricity and Fuel Usage					
	ECD 1	ECD 2	ECD 3	ECD 4	ECD 5
Equipment controlled (i.e., boiler, press, dryer, etc.)					
Type					
Model					
Year Installed					
Electricity used to operate ECD; either kWh or % of total plant use					
Natural gas used to operate ECD; either ft^3 or % of total plant use					

Bergman, R.D.; Alanya-Rosenbaum, S.; Puettmann, P. 2020. Life cycle assessment for the production of PNW engineered I-joist. Revised for 2019 PCR. Corvallis, OR: CORRIM, Consortium for Research on Renewable Industrial Materials. 154 p. https://corrim.org/wp-content/uploads/2020/06/CORRIM-AWC-PNW-Ijoist.pdf