Juken New Zealand Limited, Masterton

APPLICATION FOR AIR DISCHARGE PEMIT: TECHNICAL REPORT

- Final Version
- 12 September 2008

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Sinclair Knight Merz
Level 12, Mayfair House
54 The Terrace
PO Box 10-283
Wellington New Zealand
Tel: +64 4 473 4265
Fax: +64 4 473 3369
Web: www.skmconsulting.com

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1. Summary

1.1 Introduction

Juken New Zealand Limited, Masterton (JNL) operate a laminated timber products plant and associated sawmill on their premises at Waingawa, Masterton. The Company has been operating at their Waingawa site since 1992.

JNL's site is adjacent to Norfolk Road and State Highway 2. The area of the site is around 11Ha. Additional to the mill site is the Company's staff parking area off Norfolk Road opposite the Mill entrance, and a 10 ha rural block immediately to the north-west of the Mill site. This block, which is leased out for grazing, provides a buffer zone for Mill activities.

JNL employs about 350 people on the site and operates on a three shift and up to seven days per week basis.

Neighbours are industrial and commercial activities, railway land, rural land, and public roads. The nearest residential development is about 800m to the north-east. Solway School is about 1.1 km towards the north-east.

1.2 Overview of Activities

The maximum realistic capacity of the site is 210,000 tonnes/annum of logs, of which about 75% are processed in the Laminated Veneer Lumber line, and some 19% are processed through the Sawmill to provide clear lumber and laminated solid lumber.

Manufacture of Laminated Veneer Lumber (LVL)

The manufacture of LVL (which includes 'plywood' as a minor product) involves the following steps. Logs are de-barked, conditioned, docked to form bolts approximately 1.3 to 3 metres long, then pealed in lathes to form veneer. Veneer is sorted then dried in the continuous veneer driers. Heat to the driers is provided by high pressure steam from the wood-fired boiler. Dry veneer is then coated with gap-filling adhesive resin, sandwiched into multi-ply sheets then pressed and heated. Heat for the hot presses is also provided by the wood-fired boiler. Following curing of the resin in the presses the laminated sheets are removed from the press, air cooled, cut to size, sanded, and packaged for export.

Solid Wood Processes

This consists of a specialist product saw-mill producing solid timber and laminated solid lumber. The operation is carried out in two separate buildings - the Sawmill Building, and in the Solid Wood Building. The sawmill cuts logs to size. Green sawn timber is dried in ten timber drying kilns operated on a conventional drying schedule. Dried timber for further processing is sorted and docked, machined to size, and laminated to form a range of products including beams, stair-treads, and other speciality products.

Steam Boiler

Heat for drying veneer, for the hot presses, for the seven Windsor Engineering timber drying kilns and three Hildebrand kilns, is provided by the 38MW (gross) boiler burning mainly wood residues with coal available as an emergency fuel if wood fuel feed problems occur. At maximum continuous rating the boiler can generate 42 tonnes of high pressure steam/hour. Condensate from steam heating the veneer driers and the kilns is recycled back to the boiler. The timber drying kilns are also able to be heated by steam generated by their associated diesel oil-fired steam boiler should the main boiler not be operating.

Wastewater Treatment Plant

The wastewater treatment plant receives all contaminated process water and treats this to a standard suitable for discharge into the river. Log yard run-off is directed to a sedimentation pond before discharge. Treatment of stormwater has been significantly improved since retention of sediment for extended periods generated anaerobic conditions which caused odour complaints. Aerators are to be installed in the two stormwater ponds and monitoring for dissolved oxygen and pH carried out. A long-term disposal route for treated effluent is being investigated and spray irrigating treated water onto the Company’s 25 acre farmland to the north-west of the railway line appears a viable approach.

Review of Activities since February 1992

The Company's mill commenced production in February 1992. Initially, the Company was production oriented. However, over the past 12 years there has been increasing development in the quality of operation. Not only has increasing emphasis been placed on purchase of good quality new equipment, and operating processes to maximise reliability, a commitment was made to achieving and then maintaining good environmental and occupational hygiene standards.

Installation of the third veneer drier in 1996 enabled better scheduling of production with more even throughput, a significant reduction of re-dry veneer, and surplus capacity to prevent overloading of driers when one drier goes down for maintenance. The effect of this was a noticeable reduction in the discharge to atmosphere of blue haze and acrid odours. In addition, increasing the elevation of the drier vents and removing restrictive rain caps permitted more efficient drier operation (less blue haze and acrid odours), and has also reduced the downwash problems.

Additional timber drying kilns have also been installed, not only to provide for increased production but to be able to operate kilns at conventional (low) temperatures for long drying periods to improve product quality. This also reduces the mass discharge of aldehydes and other contaminants, and reduces the rate of discharge.

The wood-fired boiler has been upgraded to fully automatic control. Since then, progressive improvements have been made to the boiler management system, and the upgrading programme is continuing.

Steam demand has been evened out, not only by installing the third veneer drier and additional timber drying kilns, but by improving production schedules. This reduces rapid changes in steam demand which permits more stable boiler combustion conditions and significantly reduces the frequency of upset combustion conditions which at times are apparent as periods of excessive smoke from the boiler chimney.

The ventilation of woodworking machinery has been upgraded at various times from that originally installed.

Not withstanding the improvements made over the past few years, the operation of an industry of the scale of the Wairarapa plant is still not without problems. Unforeseen mechanical and electrical breakdowns still (and always will) occur and some of these events may result in increased discharges to atmosphere. This is particularly the case if problems occur with air pollution control equipment such as bag filters and cyclones, and also with operation of the wood-fired boiler where some breakdowns may result in increased dust, smoke, and odour discharges.

1.3 Emission of Contaminants into Air

LVL Processes

Discharges of contaminants to air include emissions from mobile machinery and truck internal combustion engines, and dust from the yard (mainly finely ground bark and soil) during dry weather especially when windy. These discharges are minimised by proper vehicle maintenance, and by keeping the yards and roadways reasonably free of accumulated debris during dry weather and by limiting truck and mobile machinery speeds. In addition, water is applied from permanently mounted sprinklers to minimise dust during dry conditions.

The log conditioners generate steam to saturate de-barked logs prior to veneer processing. Although these conditioners are sealed, fugitive steam emissions occur that contain wood extractives that have a pine odour.

Veneer produced is continuously dried in three veneer driers. The moisture generated is discharged with air to atmosphere through vents above the building roofs. These steamy discharges also contain wood extractives and other volatile organic compounds such as aldehydes, acetic acid, and alcohols, and have a pine-like odour. If over-heating of veneer occurs (limited to re-drying of veneer) the discharges also contains ‘blue haze’ and this may at times have a burnt odour down wind and may irritate the eyes and nose.

Following gluing of veneer the multi-ply sheets are then hot pressed to cure the glue. This process results in the emission of some steam and volatile organic compounds having a pine-like odour. The constituents of the emissions are similar to the emissions from the veneer driers but have a low volumetric flow and no ‘blue haze’ is generated.

LVL sections are then air cooled, cut to size, sanded, and packaged for export. Sawdust, sander dust, and wood trimmings are conveyed in saw and sander ventilation air to bag filters, with collected dust used as a part of the boiler fuel. A small amount of wood dust is emitted to atmosphere with ventilation air.

Solid Wood Processes

Sawdust generated in the sawmill is separated from ventilation air in a large cyclone. While some sawdust is emitted to atmosphere this will mainly be deposited within the Company's premises.

Sawn timber is dried in the timber drying kilns which emit a substantial quantity of water vapour to atmosphere through the multiple kiln vents. These discharges have a similar composition to discharges from veneer driers, and also have a pine-like odour. However, 'blue haze' is never generated from kiln drying.

Laminated lumber processes includes machining dried timber, gluing operations, and finishing. Woodworking machinery generates sawdust and planer residues which are pneumatically conveyed to bag filters with collected wood residues used as part of the boiler fuel. A small quantity of wood dust is discharged to atmosphere with ventilation air.

Wood-Fired Boiler

Fuel for the boiler is mainly pneumatically conveyed to the wood fuel silo, with pneumatic conveying air then discharged to atmosphere through three bag filters located on top of the silo. Some wood dust is discharged with ventilation air.

Wood fuel is burnt in the boiler firebox and products of combustion are discharged to atmosphere from the 30 m high boiler chimney. Products of combustion include: carbon dioxide and carbon monoxide, oxides of nitrogen, limited products of incomplete combustion, particulate matter (mainly wood ash but also some 'smoke' during upset firing conditions), sulphur dioxide (low rate of emission when burning wood fuel, and a higher emission when occasionally burning coal as an emergency fuel), and water vapour.

Rates of Contaminant Emissions

Rates of emission are presented in the various sections of this document.

Emission Control Equipment

The emission of green (damp) sawdust is controlled by cyclones which are effective for the purpose. The emission of dry wood dust is controlled by fabric filtration (bag filters) which is best available technology.

The emission of contaminants from drying veneer is minimised by appropriate process control but no specific emission control equipment is fitted to the driers. While it is technically possible to substantially reduce the emission of contaminants from the veneer drier vents, this would be prohibitively expensive. The option of venting veneer drier discharges to the boiler firebox (retro-fitting) is not practicable because the boiler is not designed to act as a drier gases incinerator. In addition, although this method of control was included in a Northland mill as a part of the original design, this approach places considerable constraints on boiler operation.

The rate of emission of contaminants from the hot presses is low and does not warrant emission control.

The emission of organic contaminants from the timber drying kilns is minimised by good kiln design and particularly by the Company operating these at relatively low temperatures with correspondingly long drying times. It is technically possible to fit condensers to the vents which will remove virtually all of the water discharge and the condensable and water soluble contaminants. However, there are significant issues extracting the waste heat, and, in particular, treating then disposing of collected condensate (for every tonne of word dried around ½ is water). Unfortunately, while there is a large quantity heat emitted from the kilns, it is low grade (low temperature) thus difficult to effectively use (it would have to be wasted to atmosphere through cooling towers).

The wood-fired boiler is now equipped with a high quality combustion management system to optimise combustion conditions which minimises the generation of products of incomplete combustion. Combustion gas particulate arrestment is carried out using a multicyclone and while this is highly effective (particulate emission concentration generally less than 250 mg/Sm^3), it does not approach the performance of high efficiency particulate emission control such as a bag filter. Appropriately designed and maintained bag filters are best available technology (and best industry practice) and are expected to achieve a particulate emission concentration of less than 50 mg/Sm^3. However, not only are they expensive, there is a significant risk of damage to filter bags from sparks and hot particles when fitted to solid fuel boilers, especially as a retrofit. A high efficiency water scrubber is expected to achieve a particulate emission of 100 mg/Sm^3 or less with no fire risk, but they are very expensive, produce a dense white cool steam plume, and require very good water treatment to enable effective recycle of water back to the scrubber. We regard the current boiler as good industry practice and appropriate for the location.

1.4 Assessment of Effects on the Environment

Emission of Particulate

The highest predicted ground level concentration off-site from the ground-mounted wood dust-handling bag filters (two laminated veneer lumber filters and three solid wood filters) is 12 µg/m^3 (25% of the AirNES standard) and is predicted to occur just outside of the site boundary on Norfolk Road.

The highest predicted ground level concentration of particulate as PM_{10} from the combined fuel silo and boiler stack discharge is 32 µg/m^3 as a 24-hour average which is predicted to occur close to the site boundary in the vicinity of State Highway 2. The boiler emissions dominate, especially more than 1 km or so from the plant. The highest predicted concentrations at Solway are around 2 - 4 µg/m^3, and over the remainder of the Masterton urban area less than around 2 μg/m^3. These concentrations are predicted to occur during south-westerly and westerly wind directions.

GWRC requested an analysis of potential impact of the boiler stack plume over the Masterton urban area during the cooler months to see if emissions were potentially cumulatively contributing to exceedence of the PM_{10} standard. Our analysis does not indicate, except possibly for one day during the year evaluated, that the contribution by JNL of particulate matter into the Masterton urban area during the cooler months of year 2000 was appreciably adding to PM_{10} discharges into the airshed from domestic solid space heaters and other low-level particulate emitters to cumulatively cause the AirNES to be breached. Because there was no ambient air monitoring data for the year in question, this analysis could not be compared with actual PM_{10} monitoring data.

An assessment of the combined effects of particulate emitted from the Kiwi Lumber boiler and Oldfield's hot mix asphalt plant does not indicate that these emissions cumulatively with JNL's particulate emissions are significant.

Emission of Minor Combustion Contaminants

The predicted downwind concentrations from the emission of carbon monoxide, dioxins and furans, oxides of nitrogen, polycyclic aromatic hydrocarbons, sulphur dioxide, and combustion odour when burning wood fuel in the boiler, are low and will not have any adverse effects on the environment that are more than minor.

Emission of Sulphur Dioxide when Burning Coal

We assessed the emission of sulphur dioxide when burning 1,500 kg of coal as an emergency fuel for a continuous period of 24-hours.

The highest ground level concentrations are predicted to occur within the Company's premises as a consequence of downwash from adjacent buildings.

The highest predicted of-site 1-hour average is 95 μg/m^3, which is predicted to occur just south of the boiler stack. This is 55% of our assessment criterion or around ¼ of the 1-hour AirNES standard.

The highest predicted off-site 24-hour average is 40 μg/m^3 for continuous operation, and is predicted to occur north-east of the stack. It is 2/3^{rds} of our assessment criterion and 1/3rd of the MfE ambient air guideline level. Reduced operation indicates highest off-site concentrations of SO_2 of around ½ of the continuous operation off-site prediction.

Given that background concentrations of sulphur dioxide will be low, these predicted concentrations are not an issue in respect to current standards and guidelines.

It is possible that under adverse meteorological conditions that the concentration of SO_2 just outside of the Company's site but probably still within the industrial zone could exceed the new 20 µg/m^3 WHO guideline if coal was burnt for 24-hours or more.

Emission of Formaldehyde from Veneer Driers and Timber Drying Kilns

The highest maximum ground level concentrations of formaldehyde are all predicted to occur within the Company's site. The highest concentration predicted to occur outside of land owned by JNL is 6 µg/m^3 – on Oldfield's site to the north-east, and on Norfolk Road and land further south-west. (The land to the north-west of the Company's site is owned by JNL.) On this basis, the emission of formaldehyde from the Company's activities will not cause adverse effects in the community, nor cause adverse effects on vegetation.

Emission of other VOC's from Veneer Driers, Veneer Presses, and from Timber Drying Kilns

The emission of aldehydes, except for acrolein, have been assessed as formaldehyde equivalents. Since the concentration of aldehydes reported as formaldehyde are predicted to occur at relatively low concentrations beyond the boundary of the Company's site (the highest being about 6 µg/m^3 as a 1-hour average), the emission of aldehydes will not cause adverse effects on the environment that are more than minor. It is also unlikely that acrolein from the veneer driers and the presses will cause adverse effects on the environment providing the emission of 'blue haze' is minimised.

The emission of the other VOC's are unlikely to cause adverse effects in the area even through the emission of pinenes and other terpenes will add to the pine-like odour.

Wastewater Treatment Plant

Odour issues resulting from the Company's stormwater ponds caused, in late 2007, objectionable odour issues resulting in an abatement notice being served by GWRC.

Evaluations suggested remedial action which included de-sludging the ponds and modifications to operating procedures and the fitting of weirs to minimise carryover of solids into the ponds, a sludge sump for Pond 1, and aeration of the ponds.

In addition, a long-term disposal route for treated effluent from the wastewater treatment plant is being investigated including negotiations with the Masterton District Council for a Trade Wastes Consent and other disposal routes. Spray irrigating treated water onto the Company's 10 ha farmland to the north-west of the railway line is also a promising disposal option.

1.5 Consultation

People who may be affected by or interested in the discharge of contaminants from the Company's activities are neighbours and other who live or work in the area, including people in Solway. While community consultation specific to this application for resource consent has not been carried out, this will be done during the period following submitting the AEE. The Company will meet with interested people and discuss any concerns they have, and will then report comments with the Company's response to GWRC.

1.6 Duration of Air Discharge Consent

The Company is seeking a discharge permit of at least 20 years duration.

2. Introduction

Juken New Zealand Limited, Masterton (JNL) operate a laminated timber products plant and associated sawmill on their premises at Waingawa, Masterton.

The plant consists of the following operations:

- Log yard;
- De-barker and log sizing;
- Log conditioning before log peeling;
- Laminated Veneer Lumber manufacturing process;
- Specialist sawmill;
- Air drying yard and timber drying kilns;
- Lumber Solid Lumber processes;
- Thermal energy plant; and
- Wastewater treatment plant.

The JNL plant commenced operation in February 1992.

JNL employs about 350 people on the site and operates on a three shift and up to seven days per week basis. The maximum realistic capacity of the site is 210,000 tonnes/annum of logs.

This assessment is based on current operation, and any currently proposed changes to the existing operations which can be identified at this time.

This application and associated documents give a detailed overview of JNL's activities, itemise significant discharges of contaminants to atmosphere, present discharge testing results, and discuss the actual and potential affects on the environment of the discharges. There is sufficient information in the application for any person (with specialist assistance as necessary) to carry out their own assessment of activities and to determine actual or potential impacts.

Since the Company has been operating at their Waingawa site since 1992 and source their logs from the Ngamu Forest and other locations in the region, alternative locations are neither relevant nor practicable.

3. Resource Management Act Requirements

3.1 Introduction

Juken New Zealand Limited is an "industrial and trade premise" as defined in the Resource Management Act. Section 15(1) (c) prohibits the discharge of any contaminant into air unless the discharge is allowed by a rule of a regional plan or relevant proposed plan, a resource consent, or by regulations.

3.2 Land Use Planning

The location is zoned Rural Industrial pursuant to the Carterton District Plan (March 2000). The Company's activities carried out are permitted activities subject to compliance with the specified conditions of the Plan.

3.3 Discharges to Air

The Regional Air Quality Management Plan became operative on 8 May 2000. Change 1 to this Plan became operative on 1 September 2003.

The Regional Air Quality Plan provides for the following activities that are carried on by the Company as discretionary activities or as controlled activities:

- Medium sized heating appliances (100kW to 5MW gross) (controlled) (Rule 8);
- Pneumatic conveyancing of powdered and bulk materials (Rule 11);
- Trade waste conveyance, treatment, and disposal (Rule 22); and
- Any activity explicitly excluded from or not covered by Rules 1 - 23 inclusive (Rule 24.

The above rules, therefore, include as discretionary activities or controlled activities operation of the wood-fired thermal energy plant; laminated veneer lumber processes; saw milling activities and the associated solid wood manufacturing processes by virtue of the associated pneumatic conveying of shavings and sawdust; and the timber drying kilns and associated oil-fired boiler.;

The following activities are permitted activities subject to compliance with conditions of the appropriate rules:

- The use of di-isocyanates at a rate less than 10kg/hour (Rule 15);
- Forced air ventilation from in-door working spaces unless otherwise covered by other rules (Rule 18); and
- Laboratory fume cupboards (Rule 23).

On this basis very few activities carried out by the Company are permitted activities.

3.4 Processing of Application

At the discretion of the Greater Wellington Regional Council, the application for an air discharge permit can be processed as non-notified, as limited notification, or full notification.

The Application can be processed as an application not requiring notification if the Council believe that any adverse effects of the proposal on the environment will only be minor and that people who may be affected give their approval. Processing applications as non-notified significantly reduces the time taken to approve the application from about three months to one month and also reduces the administrative costs.

Limited notification involves the Council notifying only those people it considers to be actually or potentially affected.

The Company is currently consulting with immediate neighbours - see Section 18. If consent is forthcoming from neighbours that the applications can be processed without notification, we recommend that this application be either non-notified or to notify the application under the limited notification requirements of the Act.

3.5 Duration of Consent

The Company is seeking a discharge permit of at least 20 years duration. Section 123(a) of the Act provides for issuing discharge permits for a period not exceeding 35 years. Section 128 provides for reviewing conditions of resource consents:

- To deal with any adverse effect on the environment which may arise from the exercise of the consent which is appropriate to deal with at later stage; or
- To require the holder of a discharge permit to adopt the best practical option to remove or reduce any adverse effects on the environment; or for any other purpose specified in the consent.

Therefore, conditions can be reviewed at any time irrespective of the duration of the consent although any change to the consent cannot stop the Company’s operations.

The principal advantages for the Company for a discharge permit of at least 20 years are:

- It provides more security for the initial investment;
- It provides more security for any further investment to increase capacity or to improve emission control systems as a consequence of the Company's policy of progressive improvement or as a consequence of tightening of emission control requirements; and
- It will provide a substantial saving in cost of preparing Applications and supporting documentation on a more frequent basis.

The economic life of the processes as currently proposed, given normal preventative maintenance, and upgrading from time to time, exceeds 20 years.

3.6 Masterton Air Quality

A permanent ambient air monitoring station was established at Wairarapa College in October 2002. Contaminants monitored are carbon monoxide, oxides of nitrogen, and fine particulate matter (PM_{10}).

The most recent ambient monitoring report on the GWRC's website is dated June 2005 and includes monitoring results for 2003 and 2004, and September 2007 which covers 2006. [1]

3.6.1 Carbon Monoxide

In 2003, the highest measured concentrations of carbon monoxide was 6.8 mg/m^3 as a 1-hour average (around 25% of the Ministry for the Environment's (MfE's) ambient air guideline of 30 mg/m^3), and the highest 8-hour average was 3.3 mg/m^3 (33% of the AirNES standard of 10 mg/m^3).

In 2004, the highest measured concentrations of carbon monoxide was 5.4 mg/m^3 as a 1-hour average (around 20% of the MfE's ambient air guideline), and the highest 8-hour average was 3.6 mg/m^3 (36% of the AirNES standard).

In 2006, the highest measured concentration of carbon monoxide 4.3 mg/m^3 as an 8-hour average, which was43% of the AirNES standard.

3.6.2 Nitrogen Dioxide

In 2003, the highest measured concentrations of nitrogen dioxide was 67 µg/m^3 as a 1-hour average (around 33% of the AirNES standard of 200 µg/m^3 as a 1-hour average), and the highest 24-hour average was 27 µg/m^3 (27% of the Ministry for the Environment's (MfE's) ambient air guideline of 100µmg/m^3).

In 2004, the highest measured concentrations of nitrogen dioxide was 64 µg/m^3 as a 1-hour average (32% of the AirNES standard of 200 µg/m^3 as a 1-hour average), and the highest 24-hour average was 27 µg/m^3 (27% of the MfE's ambient air guideline).

In 2006, the highest measured concentration of nitrogen dioxide was 58 µg/m^3 as a 1-hour average, which was 29% of the AirNES standard.

3.6.3 Fine Particulate (PM_{10})

In 2003, the highest measured concentrations of PM_{10} was 82 µg/m^3 as a 24-hour average and the 50 µg/m^3 threshold concentration set in the AirNES was exceeded three times.

In 2004, the highest measured concentrations of PM_{10} was 60 µg/m^3 as a 24-hour average and the 50 µg/m^3 threshold concentration set in the AirNES was exceeded three times.

In 2005, the highest measured concentrations of PM_{10} was 54 µg/m^3 as a 24-hour average and the 50 µg/m^3 threshold concentration set in the AirNES was also exceeded three times.

GWRC states that domestic solid fuel fires are the primary contributor to winter-time PM_{10} pollution episodes which occur under cold and calm weather conditions (GWRC 2006 – page 21, Section 7.5).

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[1] Greater Wellington Regional Council. 2003; 2004; and 2006: Annual Air Quality Monitoring Reports for the Wellington Region. Available from the GWRC Website.

In its report for2006, the GWRC presents a pie graph (Section 3.4.3, page 9) illustrating as an example source apportionment of PM_{10} measured in Masterton on 12 July 2004 as determined by GNS Science using ‘fingerprinting’ techniques. For that filter, domestic heating contributed 77%; soil was 14%; sea salt spray was 5%; and secondary particulate and transportation was 2% each. Any contribution from industrial sources was not recorded (presumed to be nil?) although in any case how fine particulate from wood and coal-burning industrial sources is differentiated from wood and coal-fired domestic heaters is not stated.

3.6.4 Sulphur Dioxide

Monitoring of sulphur dioxide is not carried out in Masterton. Sources of this contaminant will be diesel-fuelled motor vehicles and presumably some commercial and industrial thermal plant; coal-firing of the Masterton Hospital boilers and in the boilers of at least one other industry, and possibly from some coal being burnt in domestic solid fuel space heaters.

JNL has the option of burning coal as an emergency fuel in their wood-fired boiler although this is seldom necessary except on a routine basis to ensure that the coal feed system remains operational. Coal is occasionally been used as supplementary fuel in Kiwi Lumber’s wood-fired boiler.

Automotive diesel oil now has low sulphur content, and the sulphur content of automotive gasoline is very low. Coal burnt in the Masterton area in all probability is limited to Waikato sub-bituminous coal from Solid Energy, which has low sulphur content (less than 0.25% by weight).

Consequently, we expect that ambient air concentrations of sulphur dioxide to be less than 30 $\mu g/m^3$ as a 24-hour average, and overall the airshed concentrations will be low.

3.7 National Environmental Standards for Air Quality

The Government has gazetted National Environment Standards for air (AirNES) under the RMA[2]. The intent of the AirNES is to increase consistency across New Zealand, yet there is still a large amount of uncertainty over how the regulations may be interpreted, particularly in regard to fine particulate discharges (PM_{10}). There have also been a number of amendments to the Regulations, most notably the Amendment Regulations of 25 July 2005.

There are 27 different regulations, but the most relevant regulations for the proposed development relate to the ambient air quality standards i.e. Regulations 13 to 24 which came into effect on 1 September 2005, and those covering resource consents for discharges of PM_{10} and other contaminants. The ambient air quality standards relevant to JNL's activities are presented in Table 3.1.

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[2] Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins and Other Toxics) Regulation 2004, 2004/309 www.mfe.govt.nz.

Table 3.1: Ambient Air Quality Standards for New Zealand (AirNES)

Contaminant	Threshold Concentration ($\mu g/m^3$)	Averaging Time	Permissible Excess
Particulate matter (PM_{10})	50	24-hour	One 24-hour period in a 12-month period
Carbon monoxide	10,000	8-hour	One 8-hour period in a 12-month period
Nitrogen dioxide (NO_2)	200	1-hour	9 hours in a 12-month period
Sulphur dioxide (SO_2)	350	1-hour	9 hours in a 12-month period
	570	1-hour	Not to exceed

The standards have a particular emphasis managing fine particulate (PM_{10}) discharges, with specific requirements as follows:

- **Regulation 17 -** Applies to an application for resource consent to discharge PM_{10} into an airshed before 2013. If after 1 September 2005, the PM_{10} standard is breached in an *airshed*, and if the activity is likely to increase *significantly* the concentration of PM_{10} in the airshed then Regulations 17A to 17C apply;
- **Regulations 17A to 17C -** The application must be declined if the discharge is likely to cause an increase above the *straight line path* or the *curved line path*, depending on how this is described in the regional plan.
- **Regulation 18 –** If, after 1 September 2005, the PM_{10} standard is not breached in an *airshed*, the consent authority must decline a consent application if the activity is likely to cause a breach of the standard.
- **Regulation 19 –** After 2013 no consents may be granted if the standard is breached, or if the activity is likely to cause a breach of the standard.

Two key concepts form the basis for managing air quality under the AirNES: the definition of *airsheds*; and the definition of *curved or straight line path.* Airsheds for the Wellington Region have been notified in the Gazette and include for the Wairarapa which includes the Masterton area. When allowing for the one exceedence provided in the AirNES, there have been two exceedences of the AirNES at the Masterton monitoring site each year during the winters of 2003, 2004, and 2006. Therefore regulations 17A to 17C apply to this application. The monitored concentrations of nitrogen dioxide and carbon monoxide are satisfactorily lower than the respective AirNES.

The meaning of the word “significantly” in regulation 17 is also important. In a summary of advice on legal questions prepared by the Auckland Regional Council dated July 2006, the ARC provided the legal advice by Chen & Palmer in respect to the meaning of the word “significantly” in respect to regulation 17. The advice was **“**Significant” connotes important or major, not just a few percent”.

3.8 Section 7 of the RMA

Section 7 of the Resource Management Act 1991 requires that, "In achieving the purpose of this Act, all persons exercising the functions and powers under it, in relation to managing the use, development, and protection of natural physical resources, shall have particular regard to ... – (ba) the efficiency of the end use of energy, and (j) the benefits to be derived from the use and development of renewable energy."

The burning of wood fuels that would otherwise be waste materials requiring disposal satisfies sub-sections (ba) and (j) of section 7 of the RMA.

3.9 Identification of Matters - Fourth Schedule of the Act

Matters discussed in this document are identified below in respect to the requirements of the Fourth Schedule of the Act.

Fourth Schedule Reference	Document References
Clause 1(a) [*Description of proposal*]	Sections 5, 6, 7, 8, 9, & 10
Clause 1(b) [*Alternative locations*]	Section 2
Clause 1(c) [*Best Practicable Options*] (Including alternative methods of discharge)	Sections 6.4, 7.4.5, 8.9, 9.8, & 9.9
Clause 1(d) [*Actual/potential effects*]	Sections 11, 12, 13, & 14
Clause 1(e) [*Hazardous substances & installations*]	Section 17
Clause 1(f) (I) [*Nature of discharges/sensitivity of environment*]	Sections 3, 4, 11, 12, 13, & 14
Clause 1(f) (ii) [*Alternative methods of discharge*]	Section 6.4, 7.3.6, 8.9, & 9.9
Clause 1(g) [*Mitigation measures*]	Sections various sections
Clause 1(h) [*Identification of interested/affected persons*]	Section 18
Clause 1(I) [*Monitoring of activities*]	Sections 6.3.8, 7.3.7, 8.8, 9.7, 10.3, & 16
Clause 2(a) [*Wider community effects etc.*]	Sections 11, 12, 13, & 14
Clause 2(b) [*Physical and visual effects*]	Sections 11, 12, 13, & 14
Clauses 2(c) &(d) [*Effects continued*]	As above
Clause 2(e) [*Discharge of contaminants continued*]	As above
Clause 2(f) [*Hazardous substances & installations*]	See Clause 1(e) above

4. Location, Topography and Meteorology and Ambient Air Quality

4.1 Location

The land occupied by JNL is located adjacent to Norfolk Road and State Highway 2, Waingawa. The site comprises some 11 ha. The legal description is Part of Lot 1 DP51137. Additional to the mill site is the Company's staff parking area off Norfolk Road opposite the Mill entrance, and a 10 ha rural block immediately to the north-west of the Mill site. The 10 ha block, which is leased out for grazing, provides a buffer zone for Mill activities. Aerial photographs of the area are attached as Figures 4.1A and 4.1B.

- **Figure 4.1A: Aerial Photograph of Area (Google Earth)**

JNL are located just left of centre of the aerial photograph. North is up the page.

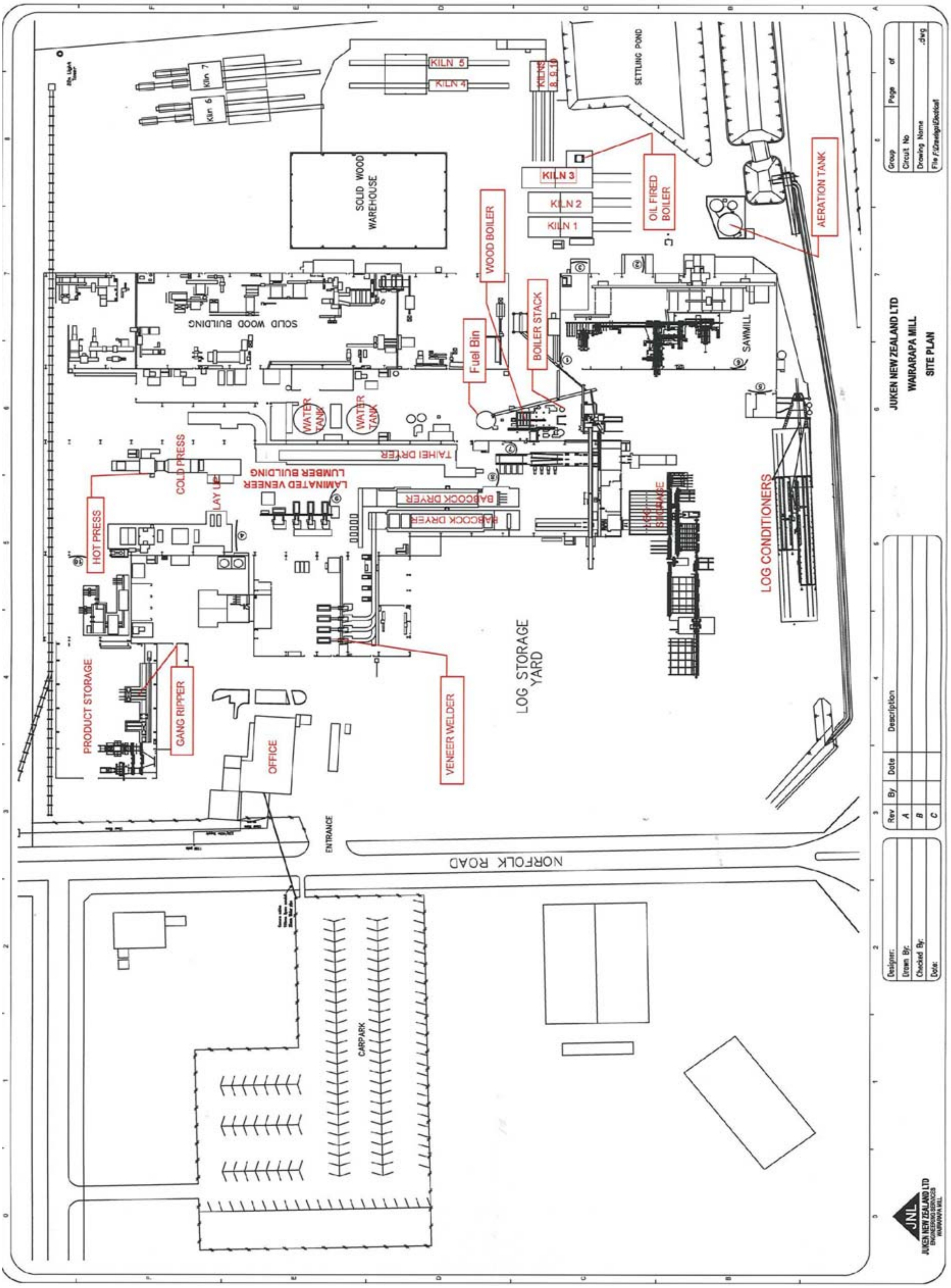
- **Figure 4.1B: Large Scale Aerial Photograph of Area (Google Earth)**

JNL is located towards the south-west corner of the aerial photograph. North is up the page.

Neighbours are industrial and commercial activities, land occupied by OnTrack, rural land, and public roads. The nearest residential development is about 800m to the north-east. Solway School is about 1.1 km towards the north-east. Activities in the immediate area are identified in Section 18.

A site diagram is presented as Figure 4.2.

- **Figure 4.2: Site Diagram – JNL, Masterton**



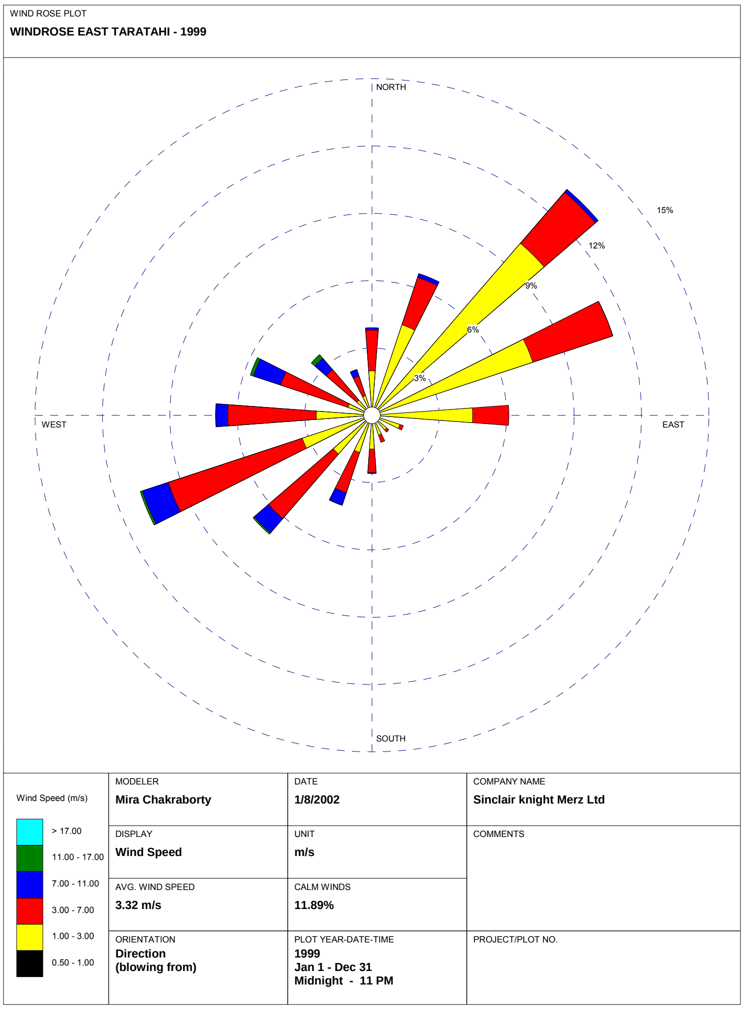
4.2 Topography and Meteorology

The topography of the area is of low relief.

According to Thompson[3] (1982), the prevailing daytime wind is from the north-west (24%) and from the south-west (23%). On occasions, strong turbulent winds that cross the ranges result in strong gusty surface winds with adiabatic compression increasing the air temperature.

A windrose from East Taratahi for 1999 is presented as Figure 4.3.

- **Figure 4.3: Windrose – East Taratahi 1999**



WIND ROSE PLOT
WINDROSE EAST TARATAHI - 1999

MODELER
Mira Chakraborty

DATE
1/8/2002

COMPANY NAME
Sinclair knight Merz Ltd

DISPLAY
Wind Speed

UNIT
m/s

COMMENTS

AVG. WIND SPEED
3.32 m/s

CALM WINDS
11.89%

ORIENTATION
Direction
(blowing from)

PLOT YEAR-DATE-TIME
1999
Jan 1 - Dec 31
Midnight - 11 PM

PROJECT/PLOT NO.

WRPLOT View 3.5 by Lakes Environmental Software - www.lakes-environmental.com

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[3] Thompson, C.S. The Weather and Climate of the Wairarapa Region. NZMS Met.S.Misc. Pub. 115(11), 1982. NZ Meteorological Service, Wellington.

The predominant wind directions during 1999 were from the north-east and south-west. The frequency of north-westerly winds were significantly less than the long term trend indicates.

The area is also subject to radiation (ground) temperature inversions enhanced by katabatic (cold air) drainage off the ranges and down the valley during relatively calm and clear conditions, and during such periods atmospheric dispersion is limited. Radiation temperature inversions are generally more pronounced during autumn, winter and early spring, but they occur all year around when there is clear skies to partial cloud and light wind during night-time.

During radiation temperature inversions conditions, katabatic drainage will flow down the Wairarapa valley generally towards the south but air flow direction will vary depending on local relief. In the Waingawa area we expect katabatic flow generally to drain towards and in the flow direction of the Waingawa River. However, this katabatic flow is not demonstrated as a predominant flow when the year 2000 CALMET file is examined except for the lower air layer during moderately inverted conditions (Stability F).

Meteorological data used in the dispersion modelling using CALPUFF was a CALMET (output) data set for the Wellington Region which was obtained from the Greater Wellington Regional Council. This meteorological data set was developed by the National Institute of Water and Atmospheric Research. It provides a three-dimensional pattern of winds, temperature and atmospheric stability over the Wellington Region with a 1-kilometre grid resolution. However, this dataset lacks the CALMET input file.

Without the CALMET input data file we used another NIWA input file and re-jigged the settings to correspond to the Wairarapa. We then re-ran the CALPUFF modelling using an earlier version that allowed PRTMET to interrogate the year 2000 CALMET set. This enabled us to interrogate the output data to correlate the meteorological conditions corresponding to the predicted modelling ground level concentrations. Our analysis is reported in Section 11.

In addition we used a meteorological dataset for East Taratahi for evaluations using the Australian dispersion model, AUPLUME. AUSPLUME was used to determine the concentration of contaminants that have only local effects such as total particulate expressed as PM_{10} emitted from wood processing bag filters located at ground level discharging ventilation air to atmosphere through short vents, and the emission of aldehydes from the veneer drier and timber drying kiln vents.

These dispersion models are described in Section 11.

4.3 Ambient Air Quality

Background concentrations of contaminants will vary depending on land use activities and seasonal variations. The surrounding area is generally rural with pockets of industrial activities and sporadic residential dwellings.

Greater Wellington Regional Council has undertaken monitoring at Wairarapa College and the results of ambient air monitoring are indicated in Section 3. While the concentrations of carbon monoxide and nitrogen dioxide are relatively low, the concentration of fine particulate (PM_{10}) are elevated at times during winter (the NES was exceeded during 2003, 2004, and 2006).

While the Wairarapa College ambient air monitoring data is not directly applicable to Waingawa, the Company's site is within the designated airshed thus the results of ambient air monitoring in the Masterton urban area are applicable. We expect that the concentration of PM_{10} in the ambient air of Waingawa to be less than the relevant NES and the N.Z. Ambient Air Guideline levels, and the concentrations of the other contaminants to be substantially less.

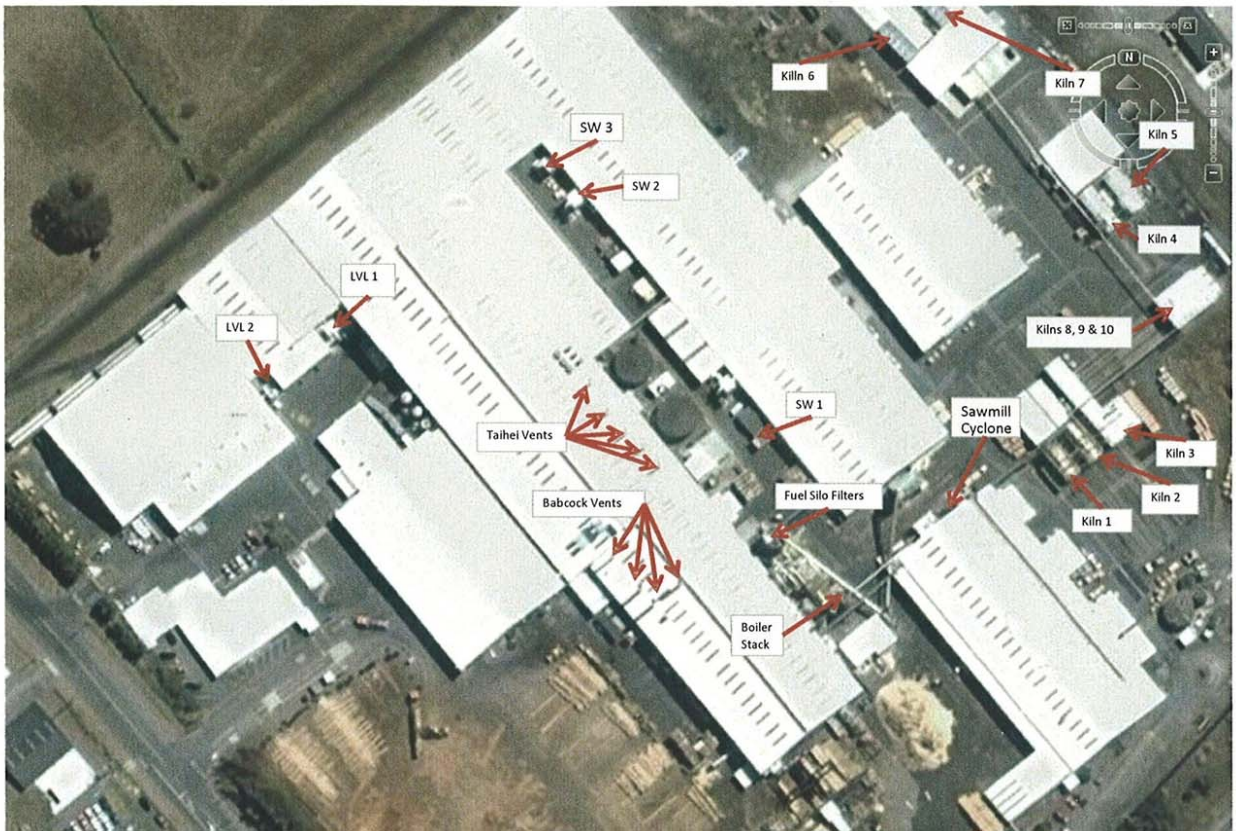
5. Overview of Manufacturing Processes

5.1 Introduction

The site diagram is presented as Figure 4.2 in Section 4.

The location of assessed emission sources into air (which exclude the wastewater treatment plant, green sawdust cyclones, and diffuse fugitive emissions in building ventilation air, etc.) are indicated in Figure 5.1.

- **Figure 5.1: Location of Assessed Emission Sources into Air**



LVL 1 and 2 are the Laminated Veneer Lumber pneumatic dust conveying bag filters. SW 1, 2, and 3 are the Solid Wood pneumatic dust conveying bag filters. The Taihei and Babcock are veneer driers with vents penetrating the roof of the associated building. Kilns 1 to 10 inclusive are timber drying kilns. The boiler stack is the stack of the wood-fired boiler.

The maximum realistic capacity of the site is 210,000tonnes/annum of logs, of which about 75% are processed in the Laminated Veneer Lumber Line, and some 19% are processed through the sawmill to provide clear lumber and laminated solid lumber.

5.2 Manufacture of Laminated Veneer Lumber (LVL)

The manufacture of LVL (which includes ‘plywood’ as a minor product) involves the following steps. Logs are de-barked, conditioned, docked to form bolts approximately 1.3 to 3 metres long, then pealed in a lathe to form veneer. Veneer is sorted then dried in the continuous veneer driers. Heat to the driers is provided by high pressure steam produced in the wood-fired boiler. Dry veneer is then coated with gap-filling adhesive resin, sandwiched into multi-ply sheets then pressed and heated. Heat for the hot presses is also provided by the wood-fired boiler plant. Following curing of the resin in the presses the laminated sheets are removed from the press, air cooled, cut to size, sanded, and packaged for export.

5.3 Solid Wood Processes

This consists of a specialist product saw-mill producing laminated solid lumber. The operation is carried out in two separate buildings - the Sawmill Building, and in the Solid Wood Building. Logs are cut to size in the sawmill. Green sawn timber is dried in ten timber drying kilns operated on a conventional drying schedule. Dried timber for further processing is sorted and docked, machined to size, and some is laminated to form a range of products including beams, stair-treads, and other speciality products.

5.4 Steam Boiler

Heat for drying veneer, for the hot presses, for the seven Windsor Engineering timber drying kilns and three Hildebrand kilns, is provided by the 38MW (gross) boiler burning mainly wood residues with coal burnt as an emergency fuel if wood fuel feed problems occur. At maximum continuous rating (MCR) the boiler can generate 42 tonnes of steam/hour. Condensate from steam heating the three veneer driers and the kilns is recycled back to the boiler. The timber drying kilns are also able to be heated by steam generated by their associated diesel oil-fired steam boiler should the main boiler not be operating.

5.5 Wastewater Treatment Plant

The wastewater treatment plant receives all contaminated process water and treats this to a standard suitable for discharge into the river. Log yard run-off is directed to a sedimentation pond before discharge. A long-term disposal route for treated effluent is being investigated and spray irrigating treated water onto the Company’s 10 ha farmland to the north-west of the railway line appears a viable approach.

5.6 Review of Activities since February 1992

The Company's mill commenced production in February 1992. It was a new industry on a greenfield site, built to a price, and with new staff, the majority of whom had no experience in the manufacture of laminated timber products or in similar industries.

For the first years the Company was production oriented. Consequently, operating standards were less than expected and upset operation and breakdowns were common. However, over the past 12 years there has been increasing development in quality of operation. Not only has increasing emphasis been placed on purchase of good quality new equipment, and operating processes to maximise reliability, a commitment was made to achieving and then maintaining good environmental and occupational hygiene standards.

Installation of the third veneer drier in 1996 enabled better scheduling of production with more even throughput, a significant reduction of re-dry veneer, and surplus capacity to prevent overloading of driers when one drier goes down for maintenance. The effect of this was a noticeable reduction in the discharge to atmosphere of blue haze and acrid odours. In addition, increasing the elevation of the drier vents and removing restrictive rain caps permitted more efficient drier operation (less blue haze and acrid odours), and has also reduced the downwash problems.

Additional timber drying kilns have also been installed in stages, not only to provide for increased production but to overcome limitations with the original kilns and to operate kilns at conventional (low) temperatures for long drying periods to improve product quality. This also reduces the mass discharge of aldehydes and other contaminants, and reduces the rate of discharge.

The wood-fired boiler, which was poorly instrumented, has been upgraded to fully automatic control. This upgrade was not without problems - it was at the time the largest boiler of its type in New Zealand to be fully automated and both the N.Z. agents and the Company’s staff were on a steep learning curve. Consequently, progressive improvements have been made to the control system (including changes to software and to hardware). The Company has a programme of upgrading boiler equipment, and this programme is discussed in Section 9.

An oil-fired boiler was installed prior to issuing the current consent to provide steam to the timber drying kilns when the wood-fired boiler is off line. Not only does this permit continuous production, it enables the wood-fired boiler to be shut down for essential maintenance without being compromised by production demands.

The operation of both boilers fully comply with OSH requirements for unmanned boilers, and are ISO 9002 certified by Telarc. Audits to date confirm compliance.

Steam demand has been evened out, not only by installing the third veneer drier and additional timber drying kilns, but by improving production schedules. This reduces rapid changes in steam demand which permits more stable boiler combustion conditions. Steam wastage has also been reduced which reduces the boiler loading especially during periods of high steam demand. These measures reduce the frequency of upset combustion conditions which may be visually apparent as periods of excessive smoke from the boiler chimney.

The ventilation of woodworking machinery has been upgraded at various times from that originally installed. In part this has resulted from expansion of production, but upgrading has also occurred to improve workplace hygiene and to improve system reliability.

Not withstanding the improvements effected over the past few years, the operation of an industry of the scale of the Wairarapa plant is still not without problems. Unforeseen mechanical and electrical breakdowns still (and always will) occur and some of these events may result in increased discharges to atmosphere. This is particularly the case if problems occur with air pollution control equipment such as bag filters and cyclones, and also with operation of the wood-fired boiler where some breakdowns may result in increased dust, smoke, and odour discharges. Normal and abnormal operation of the JNL plant is discussed in the following Sections.

6. Laminated Veneer Lumber (LVL) Processes

6.1 Log Yard, Debarking, and Related Activities

6.1.1 Process Operations

Logs are received by road or rail transport, weighed, then stored using mobile log stackers in the log yard. The log yard and roads are hard paved with heavy duty hotmix asphalt. Logs are debarked and either routed to the sawmill, or, following conditioning, cut to 2.6 metre bolt lengths for making veneer. The use of antisapstain treatments is minimise as far as practicable but they are used when necessary (generally during warm and humid conditions) to prevent staining of de-barked logs and sawn timber when delays in processing may occur. The current antisapstain treatment is Bazooka® supplied by Kop Coat. The antisapstain process and related matters are discussed in Section 7. Sawdust from the cut-to-size saws is pneumatically conveyed to a separating cyclone then transported to the wood-fired boiler fuel silo as a part of the boiler fuel load. Bark is mainly disposed off-site - the balance as necessary is burnt in the thermal plant.

6.1.2 Discharges of Contaminants to Air

Discharges of contaminants to air include emissions from mobile machinery and truck internal combustion engines, and dust from the yard (mainly finely ground bark and soil) during dry weather especially when windy. These discharges are minimised by proper vehicle maintenance; and by keeping the yards and roadways reasonably free of accumulated debris during dry weather and by limiting truck and mobile machinery speeds. Excess deposits in accessible areas are scrapped up. The frequency of yard cleaning depends on circumstances. During periods of low rainfall, scraping of exposed yard areas each working day is carried out. In addition, water is applied from permanently mounted sprinklers to minimise dust during dry conditions.

De-barking and docking operations have minimal air impact. The pneumatic conveying system is discussed in Section 7.

6.2 LVL Manufacture

6.2.1 Process Operations

Debarked log bolts are first transported to log conditioners where they are steamed within enclosed chambers then transported to the veneer lathes and then peeled into veneer. The resulting veneer ribbons are trimmed into selected widths and pre-graded before drying. Veneer to the Taihei drier is first treated in a Shiborei continuous press to reduce free moisture.

6.2.2 Log Conditioning

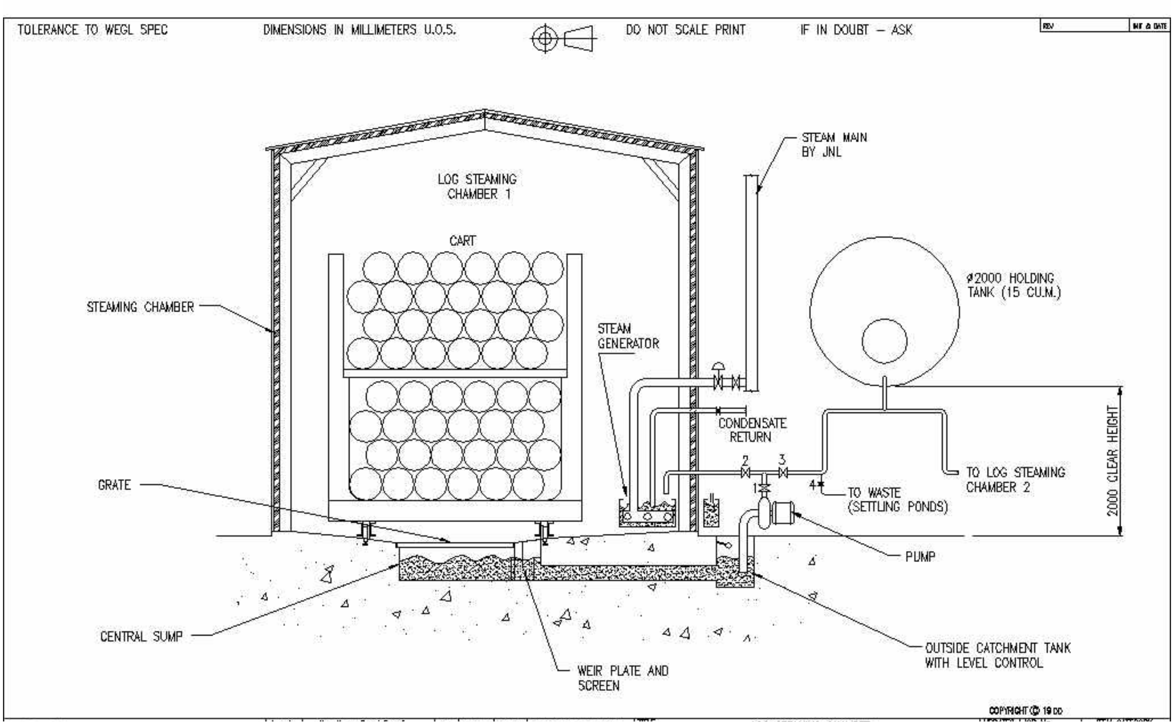
Log conditioning evens out the moisture content of the logs through their diameter and length, and to make the logs more supple and the resulting veneer from the lathe less prone to cracking. An additional benefit of having veneer with relatively even moisture content throughout the sap wood and heart wood is that, to avoid under-drying of veneer in the veneer drier, veneer with lower than normal moisture content is not over-dried. Over-drying of veneer significantly increases the discharge of pyrolysis products including ‘blue haze’ and generates poor quality product.

The Windsor Engineering log conditioning process uses standard timber reconditioning chambers. Reconditioning of timber is a practice carried out in the industry following kiln drying of timber to uniformly bring up the timber moisture content to equilibrium moisture content for the intended duty.

The Company operates two log conditioners.

Conditioning chambers are sealed and are constructed of fully insulated aluminium panels over a structural frame. A small pressure relief vent is incorporated into each chamber to permit air to escape at the start of each conditioning schedule. A schematic diagram of a Windsor Engineering log conditioner is presented as Figure 6.1.

- **Figure 6.1: Schematic Diagram of a Windsor Engineering Log Conditioner**



Logs are loaded onto special carts and moved on rail tracks into each conditioning chamber. Following closing of access doors, saturated steam at 98-99°C is generated in water boiling troughs (steam generators). Heat to the steam generators is provided via heat exchangers by steam from the wood-fired boiler. Steam condenses on the log surfaces and over a steaming period of 8 to 10 hours logs heat through to about 50-55°C and wood fibres become saturated.

Conditioning chambers are equipped with process controls to regulate the fully modulating boiler steam valves upstream of the steam generator heat exchangers to the required output to maintain a fully steam saturated atmosphere.

Condensate, and log leachate containing lignin and resins, is drained via a concrete foundation to an enclosed sump. The sump contents are pumped to an adjacent enclosed settling tank where water and condensate is then returned to the boiling troughs. Solids settling in the tanks and in the steam generators is removed to a waste skip and disposed off-site.

6.2.3 Veneer Drying

Three veneer driers are used; two Babcock continuous driers, and one Taihei continuous drier. Veneer sheets are continuously feed into the three driers where hot air is passed over them to dry to a pre-determined moisture content. The drying process stabilises the veneer dimensions, strengthens the fibres, and prepares the wood for gluing. The driers also processes re-dry veneer (off-specification recycled veneer). Re-drying, especially when re-dry is mixed with green veneer, can cause problems through over-drying of the re-dry veneer. Target moisture content of veneer is 8 -10%

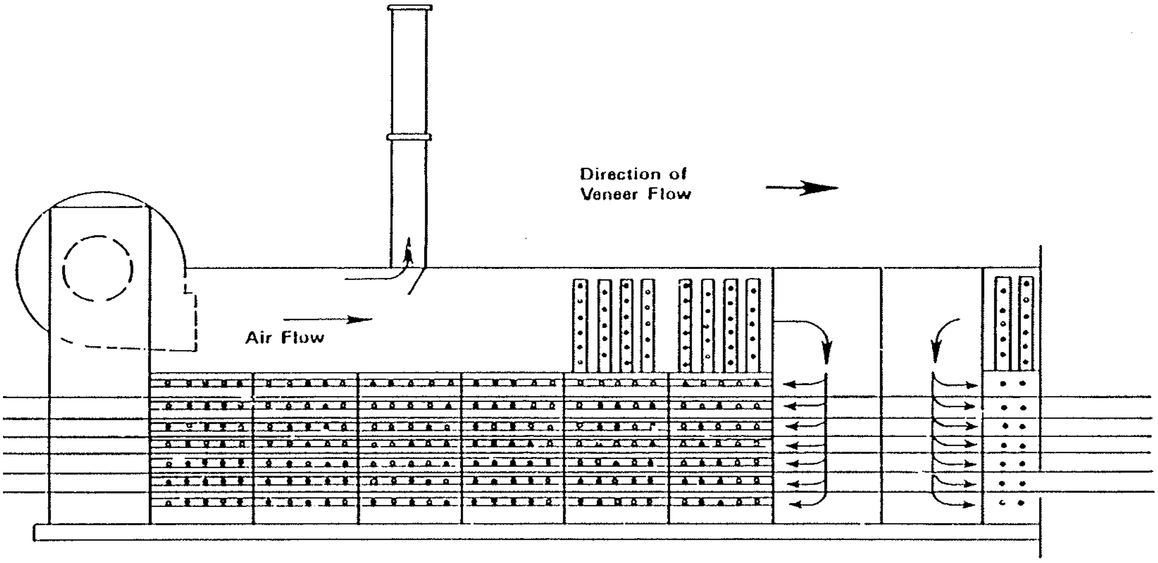
The existing driers are all indirect-heated units. They are designed to process radiata pine having an initial moisture content of 50 to 180% (dry basis). Babcock No.1 has a design processing capacity of about 10-12 m^3 of veneer per hour (generally operated at around 9 m^3/hour) and uses 8 – 9 tonnes of high pressure steam per hour. The Taihei drier has a design capacity of 12 m^3/hour (actual capacity around 9-9.5 m^3/hour), and uses around 15 tonnes of steam per hour. Babcock No.2 has a design processing rate of 10 m^3/hour, and uses 6 – 7 tonnes of steam per hour. Veneer is indirectly heated by high pressure steam at 24 Bar. The maximum drying (air) temperature in the Babcock driers is 195°C, and 205°C in the Taihei drier. Maximum heat demand for each drier is about 7MW net depending on duty.

The drying section of each drier is divided into three heating (drying) zones fitted with independent heating control circuits; independent moisture detection systems and controllers; and a high pressure steam fire extinguishing system. Drying air is drawn from outside and heated by steam heating coils. To maximise drier thermal efficiency the heated air is blended with a large volume of re-circulated air within the drying chamber (about 90% recycle). As the veneer dries, moisture releases into the hot air until saturated and then it is discharged through automatically modulating vents to atmosphere above the drier section roof. Diagrams illustrating typical modern indirect steam-heated veneer driers are presented as Figure 6.2.

Figure 6.2 illustrates in plan and cross-section a typical indirect drier (drier zone vent configurations is dependent on actual design).

All driers are designed to achieve a high degree of control by indirect veneer drying using remote veneer moisture sensing and programmable logic controllers (PLC's) (see below). Precise control is essential as a high degree of drying air recycle is employed to maximise thermal efficiency.

- **Figure 6.2: Diagram of a Typical Indirect Steam-Heated Veneer Drier**



Wet end of a steam-heated longitudinal-flow dryer.

6.2.4 Venting of Contaminants to Atmosphere.

Babcock No.1 Drier

The drying zones vent to atmosphere through three thermally insulated circular vents. Vents 1 and 2 are 1.0m internal diameter and terminate 5m above the adjacent 14.9m high building ridge (about 20m above ground level). Vent 3 is 0.6m diameter and terminates about 2m higher than the building ridge (about 17m above ground level). The drier is also fitted with induced draught ventilation at the veneer inlet, and between the third drying section and the cooling section, with ventilation air discharging above the roof (but these are not drier zone vents).

Taihei Drier

Drying zones are vented through five vents, all being initially 650x650mm rectangular section and fitted into thermally insulated circular vents. These vents have an internal diameter of 0.75m and terminate 2m above the adjacent 16.8m high building ridge (about 18.8m above ground level). The veneer inlet section is also vented but this is not a drier zone vent.

Babcock No.2 Drier

The first and second drying zones are fitted with three vents directed to a single discharge chimney having an internal diameter of 1.0 m terminating about 5.5m above the adjacent 14.9m high ridge (about

20.5m above ground level). The third drying zone is not directly vented to atmosphere but drying air is directed back towards the second zone vents. The first section of the first drying zone is fitted with a ventilation vent to maintain negative pressure at the veneer inlet.

All Driers

The third drying zone for each drier is followed by the cooling section which discharges cooling air to atmosphere above the mill building roof through two vents for No.1 Babcock, through three vents for the Taihei drier, and through two vents for Babcock No.2 drier. Cooling section vents are fitted with silencers and terminate about 17m above grade.

Recent Improvements to Veneer Driers

A new humidity controller has been fitted to the Taihei drier to improve product quality and this improvement in operating efficiency has also reduced the emission of 'blue haze' by improving processing quality. Drier trend monitoring to maximise drier efficiency has also been installed.

A Shiborei press has been installed in the Taihei drier line to reduce the moisture content of + 3.5 mm green veneer (moisture is squeezed from the veneer sheets prior to drying and this removes around 15% of the moisture).

An autostacker has been installed on the Taihei drier which eliminates its stop-start operation. The driers are water blasted once per month to clean heat radiators and internal panels to minimise smoke generation (which also reduces the fire risk). Cleaning water contains sodium carbonate (washing soda) as a detergent. Defective veneer drier radiators and old and/or damaged panels have been replaced. The Company now only peels one grade of veneer (4.5 mm) and segregates these into high and low moisture variants to maximise consistency. This approach makes drying a much more uniform process. High moisture veneer is routed to the Taihei drier and low moisture veneer is dried in Babcock No.2. All of the small veneers (1/2 size, etc.) are processed by Babcock No.1 drier.

The Babcock drier panel has also been replaced to enable more fine control of these driers to maximise their operating efficiency.

Re-drying veneer is the main cause of 'blue haze' because veneer to be re-dried has reduced moisture and can be easily over-dried. Since over-dried veneer is rejected, there are economic reasons to prevent over-drying. Over-drying can be minimised by ensuring drier temperature is low before starting redry but this slows down the process. The percentage of re-dry varies with the season. The Company prefers to use Babcock No.2 for redry as this drier provides better control than the older driers. Further management initiatives are being examined to minimise issues with redrying.

6.2.5 Veneer Gluing

Dry veneer leaves the drier through a cooling section and then is sorted by width and grade ready for gluing. Resins used for LVL are melamine urea-formaldehyde resin (MUF) and phenol melamine-formaldehyde resin (PMF). At present only a limited volume of PMF is used. These resins are in common use throughout the New Zealand reconstituted wood industry. All resins contain low concentrations of free formaldehyde and phenol (free formaldehyde content <1%, free phenol <0.8%). Resins are transported to the site by road tankers and the contents are pumped into resin storage tanks which are appropriately bunded to insure any spills are controlled. Wheat starch or similar is used in the glue mix as filler to enhance gap-filling and spreading characteristics. Veneer is fed through the glue spreader where a thin layer is applied. Glued veneers are then stacked and set-up for pressing. The resin application stage has low air emission potential.

Waste glue is collected by a chemical waste agency and is disposed off-site. ‘Pink water’, which is wash-down water which is a light pink in colour from the glues is disposed of into the Company’s wastewater treatment plant.

6.2.6 LVL Pressing

The Company operates two LVL veneer presses. They are "multi-daylight" units, one having 30 platens (Press 1), and the other 40 platens (Press 2). Presses subject the LVL sections to a pressure of around 1000-1200kPa to ensure intimate contact of veneer, and heat is applied to cure the glue. Heat is obtained as low pressure steam from the wood waste-fired thermal plant.

Press 1 is hooded and vented to atmosphere by a fan and a short 0.90m diameter vent above the building roof terminating about 2m below the 18.5m high roof ridge vent (height about 16.5m above ground. Press 2 is not vented but discharges direct into the building with contaminants discharging to atmosphere through the building roof ridge vent.

6.2.7 Finishing

Following curing of the glues in the presses, LVL sections are removed from their respective presses, air cooled, cut to size, sanded, and packaged for export.

6.3 Discharges to Air

6.3.1 Log Conditioners

This process is carried out in enclosures thus the emission of wood extractives (VOC’s naturally present in the wood such as pinenes) is minimised but not entirely prevented during operation. The pine odour is apparent in the vicinity when the log conditioners are operating due to leakage from capped vents and around doors, and when the conditioners are opened to remove a steamed charge and to load a new charge. This pine odour adds to the pine-like odour of the Company’s activities which is characteristic of *pinus radiata* processing facilities.

A photograph of the log conditions is presented in Figure 6.3

- **Figure 6.3: Log Conditioners**

6.3.2 Veneer Driers

The method of veneer drying is important in respect to potential emission of significant contaminants. The water content of the veneer is discharged from the drier as steam and contains wood extractives and other volatile organic compounds (VOC's). Aldehydes are generated from partial decomposition of wood lignin and carbohydrates at elevated temperatures. Other volatile organic compounds such as turpenes, resin and fatty acids, and alcohols are also discharged. 'Blue haze', which is a visual effect resulting from operation of wood drying processes at elevated drying temperatures, may also be significant under extreme conditions.

The driers are designed to achieve a high degree of control by indirect veneer drying using remote veneer moisture sensing and programmable logic controllers (PLC's). The drier is compartmentalised into three zones (plus a cooling section) to permit temperature, humidity, and drying air velocity to be independently adjusted to ensure veneer has close final moisture tolerances. Veneer moisture is continuously determined using electro-conductive detection while taking into account air humidity and temperature. To achieve high product specification the Veneer Drier Operating System (VDOS) operates through a programmable logic controller (master computer) which automatically computes set points for the various control loops and co-ordinates their actuators. In addition, operating parameters and data is automatically logged. Operators are guided by a display menu prompt system, and the process (measured values/ set points/ fault indication) is also displayed on a VDU screen. Precise control is essential as a high degree of drying air recycle is employed to maximise thermal efficiency. Under most circumstances the discharge of blue haze is limited, and odour is low. However, variation in veneer moisture content does make operation of the driers difficult at times without the discharge of some blue haze.

The rate of generation and emission of aldehydes and other VOC's that are generated by decomposition of wood generally increases with increasing temperature but this is moderated by decreasing the time veneer is subject to elevated temperature. The rate of emission of VOC's naturally present in wood such as turpenes and ethanol also increases with increasing temperature but this evolution is again tempered by the time veneer is exposed to elevated temperatures.

How veneer is dried is also important in respect to potential discharge of 'blue haze' and acrid odours. The discharge of VOC's depends on the species being dried, the drier type, the time and temperature relationship, the degree of recycle to maximise drier efficiency, and the final veneer moisture content. The water content of the veneer is discharged from the drier as steam. In general the VOC discharge concentration, blue haze potential, aldehydes discharge, and acrid odour discharge, are more significant when combustion products are used directly to dry the veneer (which is not employed by the Company); with increasing recycle of drier air to maximise thermal efficiency; and by over-drying of veneer.

Typical operating schedules for the veneer drier are: Taihei Drier 24 hours per day and 7 days per week; and Babcock No.1 and 2 24 hours per day for 5 days per week. A day for maintenance for each drier is included in the schedule.

6.3.3 Quantification of Discharges

Aldehydes and Volumetric Flow

Aldehyde discharges and specific vent volumetric flows have been determined at various times, and most recently by SKM in February 2008. These tests results, which quantify the emission of formaldehyde, acetaldehyde, and propionaldehyde, are presented in Table 6.1.

- **Table 6.1: Rates of Emission of Aldehydes – February 2008 Testing Programme**

Sampling Run	Sampling Date	Sampling Period	Stack Flow Rate (Sm^3/hour)	Tot. Aldehydes As Formaldehyde Conc. (mg/Sm^3)	Tot. Aldehydes As Formaldehyde Emission Rate g/hour
Babcock No 2 Aldehydes Run 1	12/02/2008	14:44 - 15:54	27,945	1.761	49.21 [0.050 kg/hr]
Babcock No 2 Aldehydes Run 2	13/02/2008	8:54 - 9.57	25,055	0.568	14.24
Babcock No 2 Aldehydes Run 3	13/02/2008	10:03 - 11:06	24,826	0.530	13.16
Mean Aldehydes as HCHO					[0.026 kg/hour]
Mean actual flow rates	45,240 Am^3/hour at 118^{o}C = 16 m/s through a 1.0 m diameter stack				

Sampling Run	Sampling Date	Sampling Period	Stack Flow Rate (Sm^3/h)	Tot. Aldehydes As Formaldehyde Conc. (mg/Sm^3)	Tot. Aldehydes As Formaldehyde Emission Rate (g/hr)
Babcock No 1 Vent 1 Run 1	12/02/2008	14:42 - 15:42	1,839	1.15	2.12 [0.0021 kg/hr]
Babcock No 1 Vent 1 Run 2	12/02/2008	16:02-17:02	1,807	1.05	1.90
Mean actual flow rates	4,722 Am^3/hour at 127^{o}C = 1.7 m/s through a 1.0 m diameter stack				
Babcock No 1 Vent 2 Run 1	12/02/2008	9:09 - 10:09	10,726	4.03	43.17 [0.043 kg/hr]
Babcock No 1 Vent 2 Run 2	12/02/2008	12:50 - 13:50	11,787	1.64	19.29
Mean actual flow rates	36,757 Am^3/hour at 156^{o}C = 13 m/s through a 1.0 m diameter stack				
Babcock No 1 Vent 3 Run 1	12/02/2008	9:02 - 10:18	9,508	3.58	34.08 [0.034 kg/hr]
Babcock No 1 Vent 3 Run 2	12/02/2008	12:50 - 14:04	10,456	1.98	20.75
Mean Aldehydes as HCHO					[0.061 kg/hour]
Mean actual flow rates	17,304 Am^3/hour at 151^{o}C = 17 m/s through a 0.60 m diameter stack				

Sampling Run	Sampling Date	Sampling Period	Stack Flow Rate (Sm^3/h)	Tot. Aldehydes As Formaldehyde Conc. (mg/Sm^3)	Tot. Aldehydes As Formaldehyde Emission Rate (g/hr)
Taihei Vent 1 Run 1	6/02/2008	9:06 – 10:06	3,031	9.648	29.24 [0.029 kg/hr]
Taihei Vent 1 Run 2	6/02/2008	10:38 – 11:54	3,682	5.832	21.48
Mean actual flow rates	10,338 Am^3/hour at 145^{o}C = 6.5 m/s through a 0.75 m diameter stack				
Taihei Vent 2 Run 1	6/02/2008	8:48 – 9:55	3,318	20.123	66.77 [0.067 kg/hr]
Taihei Vent 2 Run 2	6/02/2008	11:06 – 12:18	3,577	8.522	30.48
Mean actual flow rates	7,952 Am^3/hour at 153^{o}C = 5 m/s through a 0.75 m diameter stack				
Taihei Vent 3 Run 1	6/02/2008	14:32 – 15:42	3,939	10.151	39.98 [0.040 kg/hr]
Taih3i Vent 3 Run 2	6/02/2008	14:32 – 15:42	868	9.543	8.28
Mean actual flow rates	9,543 Am^3/hour at 170^{o}C = 6 m/s through a 0.75 m diameter stack				
Taihei Vent 4 Run 1	6/02/2008	14:32 – 15:32	4,677	5.186	24.25 [0.024 kg/hr]
Taihei Vent 4 Run 2	7/02/2008	8:11 – 9:32	5,798	4.162	24.13
Mean actual flow rates	16,860 Am^3/hour at 172^{o}C = 10.6 m/s through a 0.75 m diameter stack				
Taihei Vent 5 Run 1	7/02/2008	8:04 – 9:04	31,022	0.399	12.38
Taihei Vent 5 Run 2	7/02/2008	9:32 – 10:27	27,012	0.578	15.62 [0.016 kg/hr]
Mean Aldehydes as HCHO					[0.136 kg/hour]
Mean actual flow rates	28,629 Am^3/hour at 86^{o}C = 18 m/s through a 0.75 m diameter stack				

Notes: The grey highlighted data is that used for assessments. In the table Sm^3 means standardised to 0^{o}C, standard atmospheric pressure and on a dry gas basis. Actual flow rates are at measured emission temperature and on a wet gas basis (includes water vapour).

The total volumetric vent flow is around 131,100 Am^3/hour adjusted to 25°C.

The total mass discharge of aldehydes from the driers based on the maximum measured rate of emission, and assuming that all driers are operating and assuming that maxima correspond, is 255 g/hour (0.255 kg/hour) reported as formaldehyde. This is the data used in the dispersion modelling assessment.

Rates of emission of organic compounds from indirect-heated veneer driers and hot presses when processing softwood are presented in Table 6.2.[4]

- **Table 6.2: Rates of Emission of Organics – USEPA AP-42 Softwood**

Compound	AP-42 Emission Factor - Softwood	Total Emission based on 28 m^3/hour Veneer
Three Veneer Driers (Indirect Heated) Operating at Maximum Rate of Production		
3-Carene	0.040 lb/1000 ft^2 of 3/8th veneer	0.56 kg/hour
Acetaldehyde	0.017	0.238 kg/hour
Acetone	0.013	0.182 kg/hour
Acrolein	0.0013	0.018 kg/hour
α--pinene	0.96	13.4 kg/hour
β-pinene	0.27	3.8 kg/hour
Formaldehyde	0.014	0.196 kg/hour
Limonene	0.080	1.12 kg/hour
Methanol	0.039	0.546
p-Metha-1,5-diene	0.017	0.238 kg/hour
Phenol	0.0034	0.0476 kg/hour
Propionaldehyde	0.0024	0.0336 kg/hour
Two Multi-daylight Batch Presses		
Acetaldehyde	0.0042 lb/1000 ft^2 of 3/8th veneer	0.059 kg/hour
α--pinene	0.098	1.4 kg/hour
β-pinene	0.038	0.53 kg/hour
Formaldehyde	0.0019	0.027 kg/hour
Methanol	0.14	1.95 kg/hour
Phenol	0.0014	0.02 kg/hour

The rate of emission of organic compounds from the three driers operating simultaneously at maximum normal rate of operation is not high. Of these compounds the most odorous (pine-like odour) are the wood extractives such as the pinenes, carene, and limonene. The aldehydes (acetaldehyde, formaldehyde, propionaldehyde, and acrolein, which equate to a combined mass emission from the driers of 0.38 kg/hour expressed as formaldehyde) give the odour a sharper tone. Rate of emission of the aldehydes increases substantially when 'blue haze' is significant.

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[4] USEPA AP-42 Emission factors for Plywood Manufacturing. AirChief, Version 12, 2005.

The rate of emission of organic compounds, except for methanol, from the hot presses is low. The emission of methanol, which is present in the glue, is of no issue.

6.3.4 Veneer Gluing

Veneer gluing operations have essentially no air emissions potential.

Melamine urea formaldehyde (MUF) glue contains ammonium sulphate as the hardener. Ammonium chloride as a hardener is no longer used so that wood residues containing glues that are burnt as fuel in the wood-fired boiler do not contain added chlorides. No hardener is used in phenol formaldehyde (PF) glue.

Urea as a formaldehyde scavenger could be applied in the glue depending on client requirements. The use of urea as a scavenger has no negative effects on emissions into air.

6.3.5 Veneer Pressing and Curing

Hot pressing and curing of the LVL sections results in driving off the water content of the glue and residual formaldehyde and phenol, and the generation of other wood extractives including limited pyrolysis products. The discharge from Press 1 is substantially contained by the press hood, and ventilated to atmosphere through the associated vent.

The hot press discharges were not assessed during this sampling programme. The rate of discharge of aldehydes from LVL presses is typically low – for example around 7 g/hour assuming the discharge occurs over an hour. Since these presses are batch processes, emission into air is not continuous – for example, the rate of emission when the platens are being loaded-up is negligible.

6.3.6 LVL Trimming and Sanding

Wood working machinery generating sawdust and sander dust etc, to reduce occupational exposure, is ventilated to appropriate fabric filtration equipment to ensure that emission of dust to atmosphere is reduced to practicable minimum. Appropriate bag filtration reduce dust emissions to atmosphere to a low level generally less than 10 mg/Sm^3 and, from our testing at Nelson Pine Industries, to less than 5 mg/Sm^3 when sampled over 3 to 4 hours. The Company's bag filters have not been tested but since they are the same type as used at Nelson Pine, we have assumed an emission concentration of 5 mg/Sm^3.

LVL operates for 24 hours per day for 5 days per week.

6.3.7 Biocide Treatments

Any biocide application such as permethrin (a synthetic pyrethroid insecticide) and moldicides and wax is carried out by spraying onto the finished LVL. This activity has minimal discharges of contaminants into air.

6.3.8 Emission Monitoring

Access is available in each discharge duct determine volumetric flows and the concentration of VOC's such as aldehydes. Each veneer drier duct was tested in late 2007 and early 2008 for aldehydes emissions.

No ambient monitoring is carried out or proposed.

6.4 Alternative Methods of Discharge

6.4.1 Introduction

The emissions from the drying of veneer are discharged direct to atmosphere through the respective drier vents. The only form of emission control practiced is operating the driers as efficiently as possible which also maximises product quality. This is a practicable method because if the emission of 'blue haze' is minimised then re-dry veneer is not over-dried.

Enhancing the efficiency of drier operation does not reduce the emission of wood extractives such as turpenes (pine odour) but will reduce the generation of VOC's that result from the degradation of wood and pyrolysis of wood extractives such as aldehydes and resin acids.

Various forms of emission control have been adopted at some plants with various degrees of capital and running costs and with variable success.

The most common methods of controlling the emissions of 'blue haze' and other VOC's are outlined below.

6.4.2 Veneer Drying Refinements

The most cost-effective method is to refine operations to minimise over-drying of veneer. This also optimises product quality. However, it requires well designed process-limiting parameters to be installed and commitment from well-trained operators. Operating the driers at appropriate temperatures for the moisture content of the veneer reduces production, so there is a fine line between maximising production with acceptable product quality and minimising the emission of 'blue haze' and other VOC's.

Conditioning of logs prior to peeling evens out moisture content and minimises the need for re-drying, and improves the flexibility of the wood.

Processing the veneer by continuous roller pressing (Shiborei) to remove some moisture prior to drying improves rate of production but if the temperatures in the first zones of the veneer drier are not adequately regulated over-drying may occur.

6.4.3 Incineration of Drier Drying Zone Discharges in Boiler Firebox

Incineration of drier discharges in thermal energy plant is the lowest cost control method providing the boiler is able to accept sufficient volume of drier gases to be practicable. An alternative is to only collect from the most significant vents, which are generally the last vents before the veneer cooling section.

The issues are:

- Having sufficient boiler capacity to accept veneer drying zone ‘air’.
- Ensuring that the quantity of drier air will not cause too excessive excess air conditions over the boiler operating range.
- Ensuring that drier air will not upset combustion by depletion of combustion oxygen (due to high moisture content under certain conditions).
- Condensation and fouling problems in the transfer duct and in the boiler air distribution system (reduced by insulating the transfer duct and this duct should be as short as practicable by appropriate location of the thermal plant). Alternatively, drier gases may be condensed down to about 50°C or less by direct water scrubbing with non-condensable gases incinerated, but a large volume of waste heat and contaminated water requires disposal.

Drier gases at the JNL Northland Mill and at the CHH Marsden Point mill are incinerated in the boiler fireboxes. We have no direct experience with the CHH mill, but the method practiced at the JNL Northland Mill causes issues with boiler combustion and has been a significant factor with boiler particulate bag filter problems including bag fires. Upset combustion caused by the, at times, high moisture levels in veneer drier gases and also the resulting high excess air in the boiler fireboxes has generated excessive VOC’s. The condensable VOC’s have, especially when the boilers were operating at relatively low firing rates, coated bag filter fabric and caused filter bag burn-out and fires.

Limiting drier air combustion to the most significant vents would reduce problems but this approach would not substantially collect most of the odour generated (much of the wood extractives are discharged from first drying zones).

6.4.4 Filtration

Drier gases can be filtered through fibreglass or similar by an induced draught fan before discharge to atmosphere. Condensed material is claimed to be substantially retained in the glass fibre filters and the following mist eliminators. Although such a system was apparently successfully trialled in the USA with acceptable results, the operating costs were reported as high.

6.4.5 Water Scrubbing

Purpose-designed scrubbers employ a sheet or mist of water to trap condensable and condensed contaminants as the discharge gases circulated through the scrubber. Water scrubbing was a popular control method in the USA during the 1970's to mid-1980's, and a variety of systems were employed. Some models used a separate scrubber for each drier with gases scrubbed in a wet cyclone then discharged to atmosphere, while other units used a wet scrubber for the primary filtering and then secondary filtering of discharges through sand beds for final clean-up.

The removal of ‘blue haze’ by water scrubbing is expensive because very high efficiencies (pressure differentials) are required.

The cooling then cleaning-up of contaminated water before re-use or disposal is also a significant issue.

6.4.6 Condensation using Water-Cooled Condensers

It is practicable to condense water vapour and condensable VOC's using appropriate condensing technologies. This method will also remove to some degree fine condensed particulate ('blue haze') depending on the technology used, but it does not remove non-condensable VOC's, some of which are odorous. However, it may be practicable to burn at least part of the volume of scrubbed gases as combustion air in the boiler.

Other than capital cost, the principal issue is utilisation of the large amount of low grade waste heat recovered and the treatment of a large volume of recovered contaminated condensate before disposal of wastewater off-site. For every tonne of green veneer processed, around ½ tonne of water is generated. This is discussed in respect to timber drying kilns in Section 7.

6.4.7 Wet Electrostatic Precipitation (WESP)

A wet electrostatic precipitator attracts water-saturated (pre-scrubbed) gases to a charged irrigated collecting surface which discharges collected material as a slurry to a trough. The wet stage also is effective in reducing aldehydes concentration (by either using alkaline water or alkaline hydrogen peroxide solution or relatively higher volumetric flow rates of water). However, the liquid effluent must be effectively treated in a purpose-designed wastewater treatment plant to substantially remove wood extractives including aldehydes with recycle of treated water to the WESP. This option has a high capital cost but has some major advantages - low maintenance; low energy requirements; can achieve low particulate loading; and has universal application. However, the capital cost of an appropriate system is very high, especially given the large volume of drier gases to be treated.

A WESP will not remove non-condensable VOC's.

6.4.8 Direct-Fired Supplementary Incineration

An alternative to thermal plant incineration is direct-fired supplementary incineration in a fume incinerator. The cost of this method is very high even when full heat recovery is employed as additional thermal plant over that necessary for normal operation is required. The best available technology is appropriately designed regenerative thermal oxidisers (RTO's).

Either natural gas or LPG is the preferred fuel.

Catalytic systems are also available but the capital cost is significantly higher than the direct-flame type of RTO.

6.4.9 Application to JNL Masterton

The JNL Masterton plant was installed without taking into account the possibility of future control of veneer drier gases. Consequently, the retrofitting of a suitable control system (if otherwise practicable) is also limited in this respect.

Full treatment of the veneer drier vent gases involves treating around 131,000 m^3/hour of exhaust gases.

The boiler was not designed to combust veneer drier gases and this option (JNL Kaitaia and CHH Marsden Point) is not practicable. Nor can the Masterton boiler be modified to suit.

As far as we can determine, filtration or water scrubbing of veneer drier gases is not a method that is now currently used in the industry.

Condensation is a practicable but costly method to substantially reduce condensable gases. Although condensation does not remove non-condensable gases, at least part of the cleaned-up gases could be used as combustion air in the wood-fired boiler. The principle issue is disposal or use of a large amount of low grade heat, and the treatment of a large volume of contaminated condensate before discharge from the site.

Wet electrostatic precipitation (WESP) that is preceded by gas cooling/scrubbing will substantially remove condensable material but not non-condensable contaminants. Some of the cleaned-up gases could be routed to the boiler firebox as combustion air. Again, there is the issue of disposing of a large volume of contaminated condensate. The capital cost of large WESP's is very high – probably in excess of NZD 6 million plus operating costs.

Best available technology is incineration of drier gases with heat recovery in a regenerative thermal oxidiser (RTO). This would need to be fired on LPG since natural gas is not available. The capital cost would be very high and the operating cost even with heat recovery significant.

The best approach for the Company at this stage is to continue to optimise drier operation to minimise the generation of 'blue haze' and other odorous contaminants and to disperse discharges from the existing drier vents.

7. Solid Wood Processes

7.1 Sawmill

The saw mill takes green, debarked logs and cuts them down for further processing. Green sawn timber is dried in kilns operating on a conventional drying schedule. Some clear sawn lumber is also produced.

Wood dust conveyed from various saws to a cyclone that discharges to atmosphere – discharge height to be advised. Chipper ventilates to a bag filter which discharges to air from a short duct.

The sawmill and the solid wood processes typically operate for 10 hours per day (6 am to 4 pm) and 4 days per week.

7.2 Antisapstain Treatment

7.2.1 Need for Antisapstain Treatment

Sawmillers may surface treat de-barked logs and green sawn timber with antisapstain solution to protect the wood against unsightly blackening if it is not processed (in the log conditioner, or, for swan timber, kiln dried) within a short period of time, especially during warm and humid conditions. The Company uses the Bazooka$^{(R)}$ treatment. Treatment is limited to 'when required'. The treatment is expensive and does not increase long-term durability of timber, and, in fact, most of the antisapstain treatment remaining on the timber is either degraded during the log conditioning and kiln drying process with the remainder removed during down-stream processing. (Surface wood residues containing antisapstain compounds are used as fuel by the wood-fired boiler.) Consequently, the rate of application of the treatment is closely controlled and is only is applied at the minimum necessary rate. The Company has a policy of minimising antisapstain use as far as practicable to do so.

7.2.2 Treatment Formulations – Bazooka^{TM}

The Company currently use BAZOOKA™ Sapstain and Mould Control imported by Kop-Coat New Zealand Limited. The treatment is a combination of three fungicides (3.5% w/w 3-iodo-2-propynyl butyl carbamate (IPBC), 3.5% w/w propiconazole, and 1.0% w/w diiodomethyl-p-tolysulphone (iodofon)) formulated as an emulsifiable concentrate. The concentrate is diluted with water and applied in a purpose-designed spray system.

While the concentrate is moderately toxic, the active ingredients after application to timber have relatively low mammalian toxicity. The actives, which are all fungicides, are also commonly found in a variety of commercial and domestic applications. IPBC is widely used in surface coatings such as in acrylic paints and in glues, and is a preservative in some cosmetics. Propiconazole is also an agricultural fungicide used to protect cereals such as barley, wheat, oats, and ryegrass seed crops. Iodofon is now widely used industrially and commercially in adhesives, in paints and other surface coatings, for protection of pulp and paper, in leather tanning, and in plastics such as PVC, polyurethane, silicones, and other polymers to prevent staining and odours. A recent patent describes the use of Iodofon as a microbial agent in adhesives used for surgical wound dressings and tapes.

The empirical formula of IPBC is $C_8H_{12}NO_2I$. Rapid thermal degradation of IPBC is initiated at around 245°C. The combustion end products under excess air conditions at heat plant (boiler) firebox temperature are hydrogen iodide, oxides of carbon, oxides of nitrogen, and water.

The empirical formula of propiconazole is $C_{15}H_{17}Cl_2N_3O_2$. It is slightly combustible. In the boiler it will decompose at around 250°C to carbon dioxide, carbon monoxide, oxides of nitrogen, hydrogen chloride, and water. Any amines generated during combustion rapidly decompose in the presence of excess oxygen to water and oxides of nitrogen when burnt.

The empirical formula of Iodofon is $C_8H_8I_2O_2S$. Decomposition temperature is not stated but we expect this fungicide will, in common with most organic compounds, degrade at temperatures less than 400°C into the oxidation products oxides of carbon (mainly carbon dioxide and some carbon monoxide), hydrogen iodide, sulphur dioxide, and water. Under poor combustion conditions the concentration of carbon monoxide will increase.

The three active ingredients in Bazooka™ are registered by the USEPA for their intended purpose and are registered active ingredients in formulations approved under the N.Z. Pesticides Act 1979. Kop-Coat New Zealand Limited state in their application for approval by ERMA that the formulation meets the California Code of Regulation Section 66261.2.Appendix A, Section 13, which allows burning of sawdust, shavings, and off-cuts treated with biocides in Bazooka™.

7.2.3 Other Treatments

Antisapstain formulations such used by Juken New Zealand are in common use throughout New Zealand. Many of these formulations have been approved by various regional councils as residues in wood fuel. While the Company is very satisfied with the performance and cost-effectiveness of Bazooka, it may in time wish to use other antisapstain treatments. A large variety of treatments are on the market and new formulations regularly appear. Typical alternatives to Bazooka are currently:

- NP-1® - marketed by Kop-Coat New Zealand Limited;
- Hylite Clear® marketed by Osmose New Zealand.
- Taratek IG® - formulated and marketed by Taranaki Nuchem Ltd;
- Taratek IP® - formulated by Taranaki Nuchem Ltd and marketed by Koppers Arch Wood Protection (NZ) Ltd; and
- Hylite Excell® marketed by Osmose New Zealand.

7.2.4 Approvals to Burn Antisapstain Treated Wood Residues

The most comprehensive approval to burn wood fuels containing antisapstain residues to date was that granted by Environment Waikato in June 2004 for the Blue Mountain Lumber mill proposed to be installed in the northern Coromandel. The application for consent for this large plant (the proposed boiler had a gross heat release of 20 MW) included drying of antisapstain-containing timber in kilns and the burning of wood fuel containing antisapstain residues and treatment plant sludge in there boiler. The antisapstain options (see bullet points above) were submitted as possible antisapstain systems. This consent was appealed to the Environment Court. The appellants commissioned Dr Craig Stevenson of Air & Environmental Sciences Limited, Auckland, to review the air discharge technical report prepared by SKM. Dr Stevenson confirmed that any adverse effects on the environment of discharges into air would only be minor. While the Court declined to grant the resource consents[5], the discharge of contaminants into air from the wood-fired boiler was not a reason for reversing the regional council's decision.

We request that GWRC accept the occasional burning of wood fuel containing residues of antisapstain treatments registered for use in New Zealand irrespective of the formulation.

7.3 Timber Drying Kilns

7.3.1 Process Description

Ten kilns are installed.

The three low temperature Hildebrand kilns are incorporated as one building, each having a nominal wood volume of 25 m^3. Each kiln has 12 vents (six discharging and six as air inlets at any one time) with a discharge elevation of around 6 m above ground level. The target drying temperature is 75^{o}C dry bulb and 55^{o}C wet bulb, with a drying time of typically 120 hours.

Five Windsor Engineering Group kilns are operated at conventional drying temperatures (90^{o}C dry bulb and 60^{o}C wet bulb) to produce appearance grade timber. These five kilns are individually located. Each kiln has a maximum nominal wood volume of 80 m^3, but probably average 70 m^3 each. Kilns 1, 2, and 3 are equipped with 10 modulating vents each (five inlet and 5 exhaust), and kilns 4 and 5 are fitted with 8 vents each (four inlet and 4 exhaust), and discharge around 6 m above ground level. Drying time is typically 72 hours.

Two Windsor kilns (Kilns 6 and 7), which were installed in 2001, are large low temperature kilns having a nominal wood drying capacity of up to around 130 m^3 per kiln operating on an accelerated low temperature schedule of 70/40^{o}C over a 6-day period. Each kiln is each equipped with two rows of five vents each having a diameter of around 0.52 m and terminate around 7.5 m above ground level. The slow drying schedule controls formation of 'brown stain'.

The kilns operate for 24 hours per day and 7 days per week except when being loaded and unloaded.

Heat for kiln drying is either provided by high pressure steam from the wood-fired boiler, or when this is shut down, from a dedicated 5MW (gross) diesel oil-fired steam boiler located adjacent to the kilns.

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[5] Environment Court ENV A0251/04, July 2005.

The kilns are also used as a heat dump when the wood-fired boiler is starting-up from cold or warm. This provides a consistent and controllable load for the boiler during the start-up phase.

7.3.2 Operation of Timber Drying Kilns

Kiln drying reduces the moisture content of green (wet) timber to around 12% dry basis and is a much more rapid, certain, and controllable process than air drying. Kiln drying gives product having uniform properties, the cost of large inventories of air drying timber are avoided, the area of land needed for effective timber drying is substantially reduced, and a large expanse of covered storage is not required.

Kilns are thermally insulated rectangular chambers with doors at each end. Each kiln is fitted with finned hot water heating coils, reversible fans, modulating stub vents on the kiln roof, and a computerised moisture monitoring and control system to optimise drying conditions and product quality. Timber to be dried is loaded onto carts, which are wheeled on rails into the kiln. Timber is filleted with timber slats to allow hot air to circulate within the stack. The timber stack is held down by concrete restraining weights to prevent twisting and warping during drying.

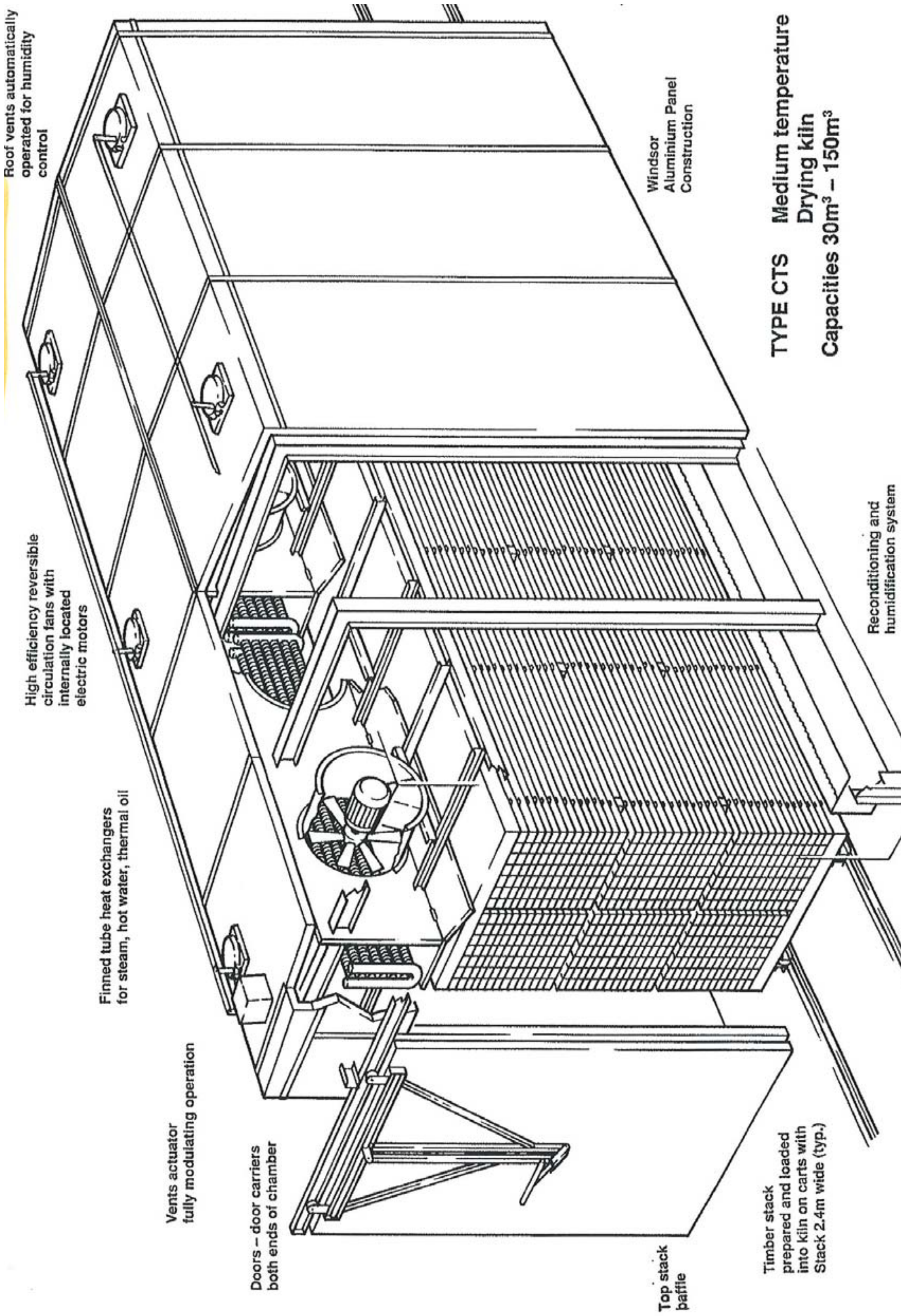
Kilns may be pre-heated for around two hours or more depending on the capacity of the kiln with vents closed (pre-steaming stage) although we understand that this procedure is not necessary for freshly mill green timber. However, some operator's always pre-steam appearance grade timber to ensure the charge has even moisture content before the drying stage. At the end of pre-heating, the stacked timber is generally heated, for conventional temperature drying, for example, to 90°C dry bulb temperature with the wet bulb temperature being maintained at 60°C by modulating the kiln vent dampers to release moisture driven out of the wood.

The kiln vents are discharging for most of the drying cycle but towards the end the drying cycle vent dampers are nearly closed. To maximise thermal efficiency a high degree of air recycle is employed thus the volume of drying air discharged through the vents with water vapour (steam) is only a relatively small percentage of the total air flow within the kiln. Make-up air is drawn into the kiln alternately from 1 of each pair of vents and moisture-laden drying air is discharged from the other.

At the end of the drying cycle, timber is cooled for an hour or so, vents are closed, and the wood is conditioned at 100% humidity for about 3 hours. Conditioning steam is generated from water in troughs heated by heating coils (steam generators). Conditioning, which does not discharge contaminants into the air, is carried out to relieve timber stresses, to even out the moisture content, and to elevate moisture content to that close to atmospheric equilibrium moisture content for the market locality. Little kiln condensate is generated during conditioning. Following conditioning, the timber stacks are removed, placed under cover, then packaged and despatched from the processing site.

A diagram of a typical Windsor kiln is presented as Figure 7.1, and a photograph of Kilns 2 and 3 is presented as Figure 7.2. This photograph also shows the oil-fired boilerhouse and the boiler stack.

- **Figure 7.1: Typical Windsor Engineering Group Kiln**



- **Figure 7.2: Photograph of Windsor Kilns 2 and 3 and Oil-fired Boiler Stack**

7.3.3 Kiln Parameters and Emissions

Base parameters, emission factors, and rates of contaminant discharges into air from the kilns are summarised in Tables 7.1 and 7.2.

- **Table: 7.1: Base Parameters of Kilns**

Nominal volume of each kiln (K1 – K5)	70 m^3 each
Height of each kiln	~ 6.4 m high
Number of discharge vents	5 pairs (5 discharge vents at a time) = 25 discharge vents
Vent height, diameter, & efflux velocity	6.5 m, 0.37 m, and around 2 m/s on average
Vent gas temperature (maximum dry bulb)	Assume all are operating on a $90^oC/60$ schedule
Water vapour discharged	Around 50% of weight of timber charge per drying cycle (say 35 tonnes per kiln)
Drying time with vents open	Around 65 hours or more
Volatile Wood Organic Compounds discharged	See below
'Blue Haze' and odour	See below

Available Forest Research data indicates that the emission of all wood VOC’s increases as drying temperature increases. The emission of wood VOC’s from high temperature drying (for example at a 140/90^{o}C schedule – not carried out by the Company) is significantly higher per m^3 of wood dried that at 100/70^{o}C. Table 7.2 compares drying at 100/70^{o}C schedule with high temperature drying.

- **Table 7.2: Comparison of VOC's Emitted from Testing by FRI of Commercial & Semi-Commercial Timber Kilns Drying Radiata Pine (From McDonald et al 1998[6])**

Contaminant	**100/70^{o}C Commercial Kiln (g/m^3 wood dried) [Max. Rate of Emission Also Reported]**	**140/90^{o}C Semi-Commercial Kiln (g/m^3 wood dried) [Max. Rate of Emission Also Reported]**
Formaldehyde	1.05 [max. 0.1g/m^3/hr at hour 6]	13.2 [max. 2.2g/m^3/hr at hour 10]
Acetaldehyde	8.66 [max. 1.2g/m^3/hr at hour 6]	14.9
Hexanal	1	1.3
Total Aldehydes (Note 2)	17.9 [max. 2.2g/m^3/hr at hour 6]	70.2 [max. 9g/m^3/hr at hour 2.5]
Limonene	[max. 2.1g/m^3/hr at hour 6]	
$_{\alpha}$terpineol	6.7 [max. 1.5g/m^3/hr at hour 6]	141
$_{\alpha}$Pinene	119 [max. 16g/m^3/hr at hour 6]	743
$_{\beta}$Pinene	251 [max. 35g/m^3/hr at hour 6]	1379 [max. 360g/m^3/hr at hour 2.5]
Total Semi-VOC's	405 [max. 60g/m^3/hr at hour 6]	2433 [max. 590g/m^3/hr at hour 2.5]
Acetic acid	13.1 [assume double average rate]	180 [max. 32g/m^3/hr at hour 10]
Formic acid	7.7 [assume double average rate]	64 [max. assume 11g/m^3/hour - Note 4]
Methanol	28.6 [max. 4g/m^3/hr at hour 6]	159 [max. 20g/m^3/hr at hour 10]
Ethanol	74.9	281

No specific information is available for drying at a 90/60^{o}C schedule or at 70/40^{o}C (the schedules that are used by the Company) but the rate of discharge of VOC's at the lower temperature schedules will be less than when drying at 100/70^{o}C, especially when drying at a 70/40^{o}C schedule.

The data presented in the 2nd column (100/70^{o}C) was obtained by Forest Research from testing of a Windsor kiln operated by Carter-Holt-Harvey at Rotorua when drying 40.9m^3 of green *pinus radiata* timber over a 33 hour drying cycle at a temperature schedule of 100/70°C. This testing was carried out by extracting samples from inside the kiln and by indirectly determining air flow from the vents calculated from the wood stack drying rate by accurate measurement of wet and dry bulb temperature differentials and air velocity through the filleted wood stack. While several assumptions had to be made with the testing protocol, the problems with sampling multiple modulating vents were avoided.

Rates of emission of VOC’s used for dispersion modelling and other assessments are summarised in Table 7.3.

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[6] McDonald et al. Air and Condensate Emissions from Timber Drying. Part IV. Multi-Client Drying Research Project Report No. 2 June 1998

- **Table 7.3: Rates of Contaminant Emission for Dispersion Modelling Assessment - Green Timber –Five Kilns at 70 m^3/Kiln = 350 m^3 & 65 Hours Drying at 90/60°C Operating Schedule**

Contaminant	Rate g/m^3 of Wood Dried	Rate kg/hour/Vent (25 vents)	Rate kg/Hour	Rate/Drying Cycle (350m^3)
Formaldehyde	1.05	0.000226	0.00565	0.3675 kg
Acetaldehyde	8.66	0.001865	0.0466	3.03 kg
Terpineol	6.7	0.00144	0.036	2.345 kg
α-Pinene	119	0.0256	0.64	41.65 kg
ß-Pinene	251	0.054	1.35	87.85 kg
Acetic Acid	13.1	0.00282	0.0705	4.585 kg
Formic Acid	7.7	0.00166	0.041	2.695 kg
Methanol	28.6	0.00616	0.154	10.01 kg
Ethanol	74.9	0.016	0.403	26.22 kg

Note: Since the emission factors are based on drying green radiata pine on a 100/70 schedule, the rates of emission of contaminants are higher than will occur in practice.

7.3.4 'Blue Haze' and Odour

From our experience, 'blue haze' is not apparent when operating wood drying kilns at temperatures less than about 150°C and would be expected to occur as temperatures exceeded about 160°C. 'Blue haze' is solid and liquid particulate matter having particle sizes similar to the wavelengths of blue light. It may comprise a significant proportion of partial pyrolysis compounds, which give it an acrid odour and causes eye and nasal irritation. The eye and nasal irritation effects of wood drying discharges when blue haze is not present is relatively low and lessens as drying temperatures decrease. We have never found the odour from wood drying kilns operating at less than about 110°C irritating nor have we observed the characteristic odour of formaldehyde or acetaldehyde downwind of these (nor high temperature) kilns.

At normal operating temperatures the odour from wood extractives has a 'pine-like odour' similar to that from mills processing *pinus radiata* but having overtones of resin acids and alcohols. Generally, the odour from timber drying kilns is not discernible from background pine odour from sawmilling activities at or much beyond the boundary of most wood processing premises.

7.3.5 Abnormal Operation

The temperatures of the kilns that are operated at accelerated conventional temperatures are regulated to a maximum of 100°C by limitation on the heat exchanger surface area, and by electronic control procedures. Over-heating will not occur, and in any case over-heating will adversely affect product quality. The most appropriate drying schedule for the Company's product is 90°C dry bulb and lower.

7.3.6 Alternative Methods of Discharge

There is currently no practicable alternative to discharging kiln drying air and contaminants generated during the drying process into the atmosphere.

Although it is technically practicable to equip kiln vents with a condensing system that substantially removes water vapour and condensable volatile organic compounds, this is compromised by the difficulty of removing the low grade heat then treating the condensed water before discharge from the site.

The Company's kiln discharges contain most of the heat used to dry the timber charge – heat that is generated by the boiler. However, to condense kiln discharges the temperature of the gases from each vent has to be reduced to below dew point and this generates a substantial quantity of low grade heat which is difficult to commercially utilise. The only practicable methods are to waste this heat to atmosphere through evaporative cooling towers or to utilise it in a low temperature timber drying system. Cooling towers of sufficient capacity have a reasonably small footprint, but are expensive and have an appreciable operating cost. Low temperature drying would involve large purpose-designed drying buildings which will be expensive and difficult to locate within the Company’s site.

The condensate then must be further cooled then treated before discharge from the site. Effective cooling of condensate could be carried out by utilising the waste heat in a low temperature timber drying system and/or by using cooling towers (see comment above). While treatment of condensate can be carried out using traditional oxidation lagoons there is no possibility of installing the capacity required within the Company's premises. For each tonne of green timber dried around 0.5 tonnes of condensate is recovered plus water soluble and condensable organic contaminants. Fogarty Industries, who recently developed practicable kiln vent condensers, has a contract with Canterbury University's School of Engineering to come up with a practicable method of treating kiln condensate. We understand that a 'chemical' treatment method has been developed at laboratory scale but application to field use has not been demonstrated as yet. We also understand that development is stalled though lack of finance.

Consequently, these condensing kilns are only practicable if there is a cost-effective method to cool condensate and then to treat condensate to a level acceptable to discharge to the sewer. Currently there is no economically practicable way to cool then treat kiln vent condenser condensate that would be generated.

7.3.7 Emission Monitoring

Determining the rate of discharge of contaminants from kilns is, at best, problematic. Most modern wood drying kilns are fitted with multiple stub vents, which, not only alternate as air intakes and exhausts, also modulate depending on the relative humidity of the discharging gases. While it is relatively simple to determine the emission concentration of discrete contaminants such as aldehydes (providing sampling ceases when kiln air flow is reversed, the sampling programme recognises the change in contaminant concentration as the drying cycle proceeds, and subject to analytical issues), it is very difficult to accurately determine vent volumetric flow and thus rate of contaminant emission.

These problems with testing emissions from normal timber drying kilns is the reason why the Forest Research Institute used a research-oriented approach by sampling from within the test kilns and mass balance determination of airflows and water loss. This approach is not practicable for routine testing, and is not as accurate as normal testing methods for standard discharge vents.

The 'normal' kiln testing results for formaldehyde we have reviewed (sampling for one or two hours from one or two vents) have been very low - much lower than the FRI emission factors, and we suspect the reasons for this are those indicated above.

7.4 Dedicated Oil-Fired Boiler

A diesel oil-fired boiler is located at the end of No.3 kiln adjacent to the north-east facing wall. This boiler provides high pressure steam to kilns when the wood-fired boiler is shut down (up to 10 times per year for $1^{1/2}$ days each).

The boiler is rated at 5MW (gross) which corresponds to a fuel consumption of about 390 kg/hour or 470 litres of automotive diesel oil per hour. The chimney height is 12 m above ground (about 6 m above the highest point of the adjacent kiln), and has a diameter of 0.63 m. The chimney exit is not fitted with a rain shield.

Products of combustion from well maintained and well operated oil-fired boilers include carbon dioxide, water vapour, sulphur dioxide, oxides of nitrogen (primarily nitric oxide with up to about 5% nitrogen dioxide), and low concentrations of carbon monoxide, partially burnt and other hydrocarbons, and other organic compounds.

7.4.1 Normal Operation

The discharge of contaminants to atmosphere from this boiler has not been quantified by testing. The calculated combustion gas discharge is based on 80% thermal efficiency and a fuel specific energy of 45.9 MJ/kg gross. Quantification of contaminants emitted is derived from combustion calculations and from USEPA AP-42 emission factors[7] except carbon dioxide and sulphur dioxide. The sulphur content of automotive diesel oil as at January 2006 is 50 ppm by weight maximum.

All rates of emission assume the boiler is operating at maximum continuous rating (MCR) which, at 5 MW gross, assumes the combustion of 390 kg/hour of fuel at 80% thermal efficiency. Rates of contaminant emission are presented in Table 7.4

The stack height is 12 m with an internal diameter of 0.63 m.

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[7] USEPA. Compilation of Air Pollution Emission Factors. Stationary Point and Area Sources. AP-42, ‘AirChief’ 2005

- **Table 7.4: Rates of Emission of Contaminants from the Diesel-Fuelled boiler**

Parameter	Carbon monoxide	Oxides of nitrogen expressed as NO_2	Total particulate	Sulphur dioxide at 50 ppmw sulphur in fuel	Total non-methane organic compounds
Frequency of discharge	Continuous for around 2 weeks/year				
Mass emission	0.30 kg/hour	1.1 kg/hour	0.11 kg/hour	0.04 kg/hour	0.02 kg/hour
Flow rate	4955 Sm^3/hour at 4.4% oxygen dry (9895 Am^3/hour at 220°C)				
Efflux velocity	~ 10 m/s				
Particle size distribution	-	-	Assume 100% PM_{10}	-	-

The rate of emission of carbon dioxide is calculated to be around 1230 kg/hour

7.4.2 Monitoring of Discharges

It is not necessary to monitor discharges from the oil-fired appliances. Routine tuning of the boilers as a part of servicing is all that is necessary. The boiler maintenance programme includes at least annual routine servicing.

7.4.3 Abnormal Operation

Operating oil-fired boilers with excessive or insufficient excess air will generate high concentrations of carbon monoxide and partially burnt hydrocarbons, unpleasant odours, and smoke. The possibility of abnormal operation is minimised appropriate setting of the ratio of combustion air/fuel, and by regular maintenance and tuning.

7.4.4 Emission Monitoring

No emission monitoring ports are provided in the boiler stack although access is available for combustion gas testing carried out during servicing.

7.4.5 Alternative Method of Discharge

There is no alternative method of discharge of combustion gases from the diesel oil-fired boiler stack.

7.5 Laminated Lumber

7.5.1 Process Description

Solid timber sent to the laminating plant is cut to size in breakdown saws in a similar manner to a conventional saw mill. High quality clear sawn lumber is produced for export.

To manufacture laminated lumber, lumber free of defects is milled, coated with CMP Bond glue, assembled into slabs, and cold pressed. After gluing and pressing, slabs may be sawn, and may be lightly dressed in a planer.

The CMP Bond adhesive (an aqueous paste of vinyl urethane emulsion containing isocyanate cross-linking agents) currently used is No. 790-783 containing polyisocyanate resin hardener (791-784) manufactured by Protec Creative Coatings Ltd. The MSDS indicates that the hardener contains >80% w/w of polyisocyanate resin (probably polymethylene polyphenyl polyisocyanate [a polymer of MDI] or similar) with free methyl m-phenylene diisocyanate being <0.1% w/w. PVA glue is a cross-linking vinyl acetate emulsion containing less than 0.5% by weight vinyl acetate monomer.

7.5.2 Discharges to Air

Laminated lumber processes have minimal air emission impact. Gluing and pressing operations generate minimal emissions to air. Woodworking machinery generates sawdust and planer residues which are pneumatically conveyed to fabric filtration equipment as described in Section 8.

8. Woodworking Machinery Ventilation and Dust Conveying

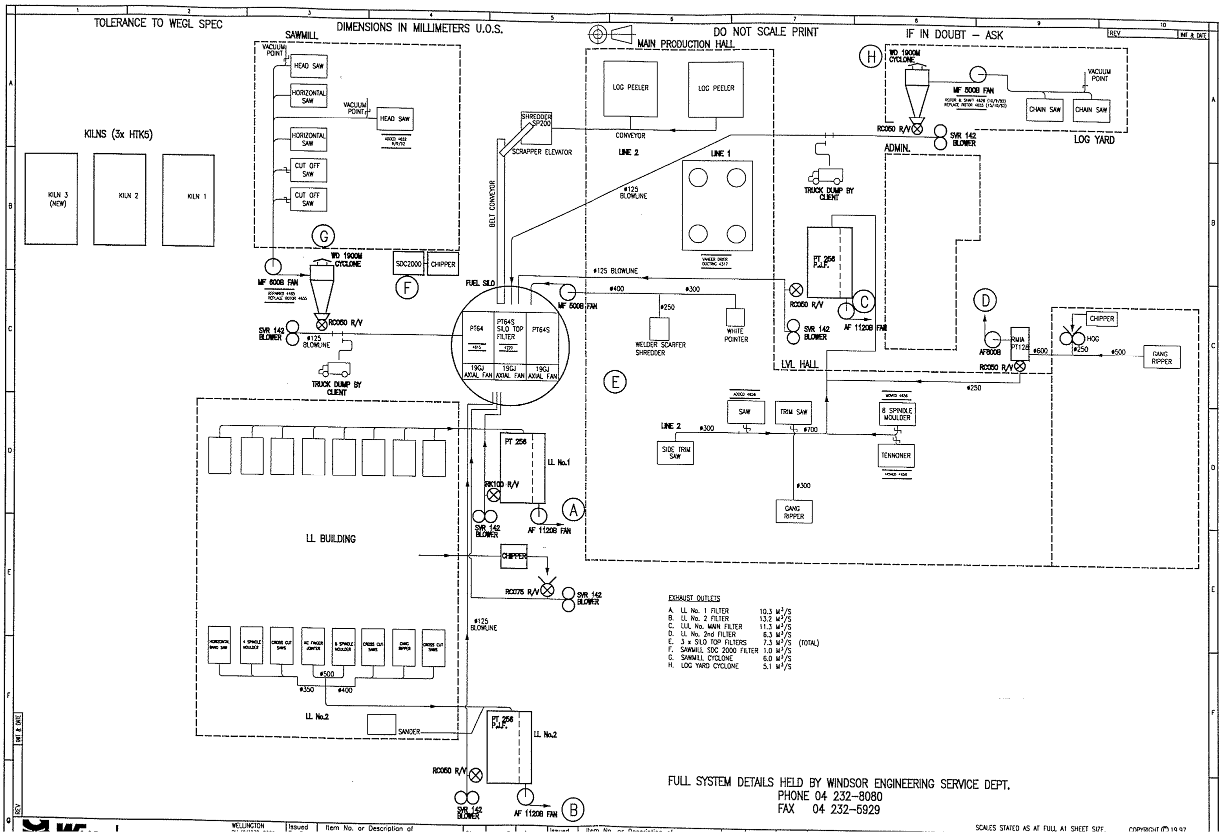
8.1 Introduction

Green wood residues such as sawdust and shredded and chipped off-cuts are generally separated from pneumatic conveying air by cyclones. Dry wood residues, because of higher dust potential, are always pneumatically conveyed to fabric filtration equipment.

The wood-fired boiler fuel silo is fitted with fabric filtration equipment on its discharge air irrespective of the dryness and particle size of wastes received.

The general layout of word-working ventilation and dust conveying systems is attached as Figure 8.1.

- **Figure 8.1: General Layout of Wood-working Ventilation and Dust Conveying Systems**



8.2 Log Yard System

Bark is mechanically recovered from the ring barker, stored on the ground, and then despatched off-site.

Sawdust from the cut saws (chainsaws) is pneumatically conveyed to cyclone WD1900M (designated ‘H' in Figure 8.1) which has a design air flow of about 5.1m3/second (18,400 Am^3/hour). Air is discharged to atmosphere from the top of the cyclone. Collected material is transported by auger into a 3-sided bin then belt fed to the fuel silo.

A photograph of the log yard cyclone is presented in Figure 8.2.

The wet steam emissions are from the log conditioners located in the background.

- **Figure 8.2: Photograph of Log Yard Cyclone**

8.3 Laminated Veneer Lumber Processes

Green chip from the log lathe is routed to the chipper to a shaker screen. Correct size chip is conveyed to storage and sold. Over-size is re-cycled to the chipper. Fines are transported by auger into the 3-sided bin then belt fed to the fuel silo (see Section 8.2).

Wood residues from the shredder, the tennoner, the moulder, the cross-cut saw, the gang rippers, and the side trim saws, etc, are pneumatically conveyed to a Windsor Engineering PT256Mx3000 pulse jet bag filter (designated ‘C' in Figure 8.1, and called LVL 1) designed to accept around 11.3 Am^3/second (40,700 Am^3/hour) of transporting air. Air is discharged direct to atmosphere from a short duct. Collected material is transported by a high pressure blower direct to the wood-fired boiler fuel silo.

A photograph of LVL 1 is presented as Figure 8.3 to illustrate the discharge vent in relation to the adjacent building and the rain shield system employed on all of the bag filters.

- **Figure 8.3: Photograph of LVL 1 Bag Filter**

Flter PT128 (designated 'D' in Figure 8.1 and called LVL 2) was installed to receive ventilation air from a chipper and gang ripper. Design air flow is around 6.3m^3/second (22,700m^3/hour). Air is discharged direct to atmosphere from a short duct. Collected material is transported by a high pressure blower to the line from filter 'C' to the thermal plant fuel silo. This bag filter is a smaller version of LVL 1 illustrated.

8.4 Sawmill

Wood residues from the various saws is pneumatically conveyed to a cyclone WD1900M (designated 'G' in Figure 8.1) which has a design air flow of about 6 Am^3/second (21,600 Am^3/hour). Air is discharged to atmosphere from the top of the cyclone. Collected material is transported by a high pressure blower direct to the thermal plant fuel silo.

A photograph of this cyclone is presented in Figure 8.4. The stack in the background is that for the wood-fired boiler.

- **Figure 8.4: Photograph of Sawmill Cyclone**

Ventilation of the chipper is to bag filter SDC2000 (designated ‘F’ in Fig. 8.1) having a design air flow of around 1Am/s (3600 Am^3/hour). Collected material is pneumatically conveyed to the fuel silo.

8.5 Laminated Lumber Processes

Wood residues from Line 1 cross-cut saw, the gang ripper, the spindles moulders, and the horizontal band saw, are pneumatically conveyed to a Windsor Engineering PT256 pulse jet bag filter (designated ‘A’ in Figure 8.1 and called SW 1) designed to accept around 10.3 Am^3/second (37,000 Am^3/hour) of transporting air. Air is discharged direct to atmosphere from a short duct. Collected material is transported by a high pressure blower direct to the fuel bin. A photograph of SW 1 is presented in Figure 8.5.

Wood residues from Line 2 are pneumatically conveyed to a second PT256 filter (designated ‘B’ in Figure 7.1 and called SW 2) of a similar size to SW 1. Air is discharged direct to atmosphere from a short duct, with collected material is transported to the fuel bin as for Line 1.

A third bag filter also services the Solid Wood facility – SW 3.

A photograph of SW 2 with SW 3 in the background is presented as Figure 8.6

- **Figure 8.5: Photograph of SW 1 Bag Filter**

- **Figure 8.6: Photograph of SW 2 Bag Filter with SW 3 in Background**

The location of the pneumatic conveying bag filters is presented in Figure 5.1 of Section 5.

8.6 Wood-Fired Boiler Fuel Silo

The fuel silo bin, which receives green and dry wastes, is fitted with three Windsor Engineering PT64S pulse jet bag filter units (designated 'E' in Figure 8.1). The three filters are designed to accept 7.3 m^3/second (26,300 Am^3/hour) of transporting air in total . Filtered air is discharged direct to atmosphere from the bag filter vents located on the top of the fuel silo but these are directed outward and slightly downward to prevent rain entry.

A photograph of the fuel silo bag filters is presented as Figure 8.8.

- **Figure 8.8: Photograph of Boiler Fuel Silo and Bag Filter Units**

8.7 Discharges of Contaminants to Air

8.7.1 Green Wood Waste Ventilation Air Cyclones

These green wood cyclones comprise the log yard cyclone, and the sawmill cyclone.

The nature of material recovered by these cyclones is such that particles are either individually large, or small particles agglomerate. These cyclones will operate better than a dust emission concentration of 250 mg/Sm^3 (actual discharge conditions) in discharge air, and will probably be less than half of this. A discharge of 125 mg/Sm^3 corresponds collectively to a mass emission of around 5 kg/hour based on a discharge of 43,600 Am^3/hour or around 40, 600 Sm^3/hour. Various emissions information is presented in Table 8.1.

- **Table 8.1: Green Wood Residues Cyclone Discharges – Air Flow & Total Particulate**

Parameter	Log Yard Cyclone	LVL Log Lathe Cyclone	Sawmill Cyclone
Flow Rate	~ 18,400 Am^3/hour at ambient temperature	~ 3,600 Am^3/hour at indoor temperature	~ 21,600 Am^3/hour at indoor temperature
Efflux Velocity	Not determined	Not determined	Not determined
TSP Concentration	~ 125 mg/Sm^3 or less	~ 125 mg/Sm^3 or less	~ 125 mg/Sm^3 or less
TSP Mass Emission	~ 2.1 kg/hour	~ 0.42 kg/hour	~ 2.5 kg/hour
Particle Size	Mainly + 30 microns	Mainly + 30 microns	Mainly + 30 microns
Frequency of Discharge	Intermittent but frequent	Continuous	Frequent

From SKM's experience with a variety of cyclones handing green sawdust, the coarse dust from the cyclones will primarily settle within the Company's premises and have no adverse effects on the environment.

8.7.2 Dry Wood Waste Ventilation Air Bag Filters

Particulate discharges to atmosphere will be less than 10 mg/Sm^3 on a long-term average, and from experience with testing the Windsor Engineering bag filters at Nelson Pine Industries, the emission of particulate should be less than 5 mg/Sm^3 when averaged over tests of 3 to 4 hours duration each.

At a TSP emission concentration of 5 mg/Sm^3 the mass emission from the bag filters collectively will be around 0.88 kg/hour based on a volumetric discharge rate of 190,500 Am^3/hour (assumed temperature is 20^{o}C except for the fuel silo filters which is assumed to be 15^{o}C). The discharge of TSP from these bag filters has been assessed by dispersion modelling.

- **Table 8.2A: Pneumatic Conveying System Bag Filters – Air Flow & Total Particulate**

Parameter	LVL 1	LVL 2	Sawmill Chipper
Flow Rate	~ 40,000 Am^3/hour at indoor temperature	~ 22,700 Am^3/hour at indoor temperature	~ 3,600 Am^3/hour at indoor temperature
Efflux Velocity	Estimated at 14 m/s	Estimated at 16 m/s	Not determined
TSP Concentration	Less than 10 mg/Sm^3 (5 assumed for modelling)	Less than 10 mg/Sm^3 (5 assumed for modelling)	Less than 10 mg/Sm^3 (5 assumed)
TSP Mass Emission	~ 0.185 kg/hour at 5 mg/Sm^3	~ 0.11 kg/hour at 5 mg/Sm^3	~ 0.017 kg/hour at 5 mg/Sm^3
Particle Size	95% PM_{10}	95% PM_{10}	95% PM_{10}
Frequency of Discharge	Intermittent but frequent	Intermittent but frequent	Intermittent

- **Table 8.2B: Pneumatic Conveying System Bag Filters – Air Flow & Total Particulate (Continued)**

Parameter	SW 1	SW 2	SW 3	Fuel Silo Filters
Flow Rate	~ 37,600 Am^3/hour at indoor temperature	~ 37,500 Am^3/hour at indoor temperature	22, 800 Am^3/hour at indoor temperature	26,300 Am^3/hour at ambient temperature in total
Efflux Velocity	Estimated as 11 m/s	Estimated as 11 m/s	Estimated as 16 m/s	See comment below
TSP Concentration	Less than 10 mg/Sm^3 (5 assumed for modelling)	Less than 10 mg/Sm^3 (5 assumed for modelling)	Less than 10 mg/Sm^3 (5 assumed for modelling)	Less than 10 mg/Sm^3 (5 assumed for modelling)
TSP Mass Emission	0.175 kg/hour at 5 mg/Sm^3	0.175 kg/hour at 5 mg/Sm^3	0.106 kg/hour at 5 mg/Sm^3	0.125 kg/hour total at 5 mg/Sm^3
Particle Size	95% PM$_{10}$	95% PM$_{10}$	95% PM$_{10}$	95% PM$_{10}$
Frequency of Discharge	Intermittent but frequent – day-time	Intermittent but frequent – day-time	Intermittent but frequent – day-time	Continuous

8.7.3 Wood Waste Fuel Silo Filters

These three bag filters should perform better than 10 mg/Sm^3. Since the fuel silo bag filter vents extend sideways, we have calculated for each unit a duct exit diameter (2.4 m) that equates to a low efflux velocity (0.5 m/s) to enable the discharge to be modelled as three point sources. Since the sideways discharge generates turbulence, an upward velocity of 0.5 m/s is realistic. This approach is more appropriate than assigning these vents as volume sources.

8.7.4 Abnormal Discharges

Emissions from Pneumatic Conveying Cyclones

If cyclones block, dust in discharge air will emit to atmosphere. Particulate of the size of material derived from green wood operations will have limited impact and will tend to remain in the immediate vicinity of the cyclone. Cyclone blockages are prevented by regular maintenance and by supervision of operations.

Dust from Defective Pneumatic Conveying Fabric Filters

At a certain point as filter bags age, fine particulate retention decreases and particulate emissions increase. Filter bags can also split or detach with much of the pneumatic conveying air dust load emitted to atmosphere. This material will generally be very fine and if deficiencies are not quickly rectified then excessive dust may cause adverse impact beyond the boundary of the Company’s premises. Bag filter operation can be monitored by simple pressure gauges and, in any case, discharging air should not have any apparent visual emission.

8.8 Emission Monitoring of Particulate Control Equipment

No permanent emission monitoring ports are provided in the ducts from particulate monitoring equipment. These could be installed in bag filter ducts if required but there has been no practical reason in the past to do so. In addition, the geometry of the bag filter vents is far from ideal for particulate emission sampling under isokinetic conditions.

It is not practicable to carry out quantitative particulate emission sampling of the green wood residue cyclones as these are currently set-up.

No ambient monitoring is carried out or proposed.

8.9 Alternative Methods of Discharge

There is no alternative than to discharge wood working machinery ventilation air to atmosphere from the green sawdust cyclones and from the dry wood dust bag filters. The only alternative available is to increase the height of bag filter discharge stacks of ground-located units to, in theory at least, improve the dispersion of the low rate of fine particulate discharged into air. Increasing the stack heights of the ground-located units has significant practical difficulties although is not impossible.

The sideways discharge of filtered air from the three fuel silo vents is designed to prevent rain entry. These could be directed upwards and each vent fitted with a ‘flap-cap’ that open due to pressure of the air flow and close when the units are not operating (c.f. flaps on the vertical exhausts of some diesel powered trucks). While these, unless spring-loaded, tend to lift somewhat when closed during gusty wind conditions, they would provide reasonable rain protection when the pneumatic conveying systems are not operating.

Green wood residue cyclones are equipped with conical rain excluders which direct discharges downwards. While such rain excluders inhibits dispersion of emissions, this is an advantage for such cyclones because discharge of the relatively coarse particulate involved will impact within the Company’s premises.

9. Wood Residues-Fired Boiler

9.1 Introduction

The Company operates a 42 tonne steam/hour at 24 Bar (g) wood-fired high pressure boiler. This has a maximum heat release of around 38 MW gross at maximum continuous rating. The principal fuel is wood residues from all on-site activities (excluding more than minimal quantities of bark) and occasionally screened solids from the wastewater treatment plant. Sub-bituminous coal is occasionally burnt as a supplementary fuel. Products of combustion are discharged to atmosphere through a 30 m high chimney.

9.2 Description of Wood-Fired Boiler and Auxiliary Services

9.2.1 Heat Release and Fuel Consumption

The wood-fired boiler has a maximum continuous rating (MCR) of about 38 MW gross. The thermal efficiency at MCR is about 70%. A rate of heat release of 38 MW (gross) corresponds to the combustion of about 9.6 tonnes/hour of mixed wood residues having a specific energy of 14.25 MJ/kg gross. At maximum operating capacity up to 55,000 tonnes/annum of wood fuels can be burnt.

On the few occasions that coal is used as an emergency fuel, up to 2500 kg/hour is burnt until wood fuel supply is resumed. The use of coal is rare except that to keep the coal feed system functional around 5 tonnes of coal is burnt per month. Coal burnt is Waikato sub-bituminous having a gross specific energy of around 23 MJ/kg. At a rate of 2500 kg/hour, about 16 MW gross of heat is generated (42% of maximum continuous rating).

9.2.2 Fuel Storage

Wood fuel is stored in a single 300 m^3 silo fitted with three Windsor Engineering pulse jet bag filter to substantially remove particulates from pneumatic conveying air (see Section 8).

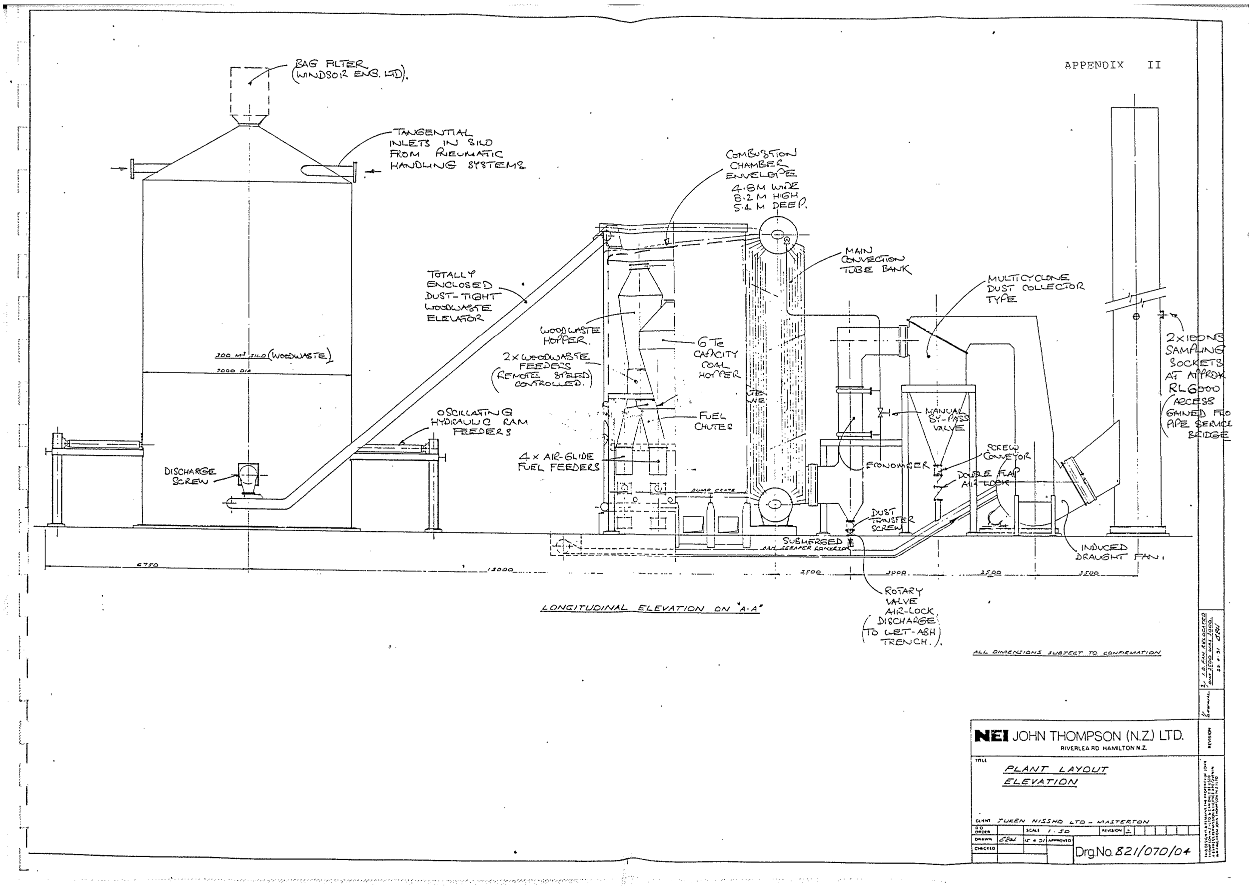
When coal was used as a routine supplementary fuel, it was received in 20 tonne bins and transferred as needed to the boiler fuel bin. Bulk coal is no longer held on the premises because it is no longer used as a supplementary fuel. If needed as an emergency fuel because of failure of wood fuel feed systems, and periodic use to ensure coal feed systems remain operative, a supply is trucked in from Masterton and off-loaded into the boiler fuel bin of 5-6 tonnes capacity.

9.2.3 Description of Wood-Fired Boiler

A diagram illustrating the boiler is attached as Figures 9.1.

The NEI-John Thompson boiler is a vertical water tube unit with a 4-section dumping grate. Wood fuel is transferred in an enclosed elevator from the base of the wood fuel silo into an elevated hopper located above 4 air-glide fuel feeders. Coal is introduced by a bucket elevator from the coal bin to the wood conveyor to the fuel feeders. Fuel is blown down towards the grate with some burning in suspension and the remainder burning-out on the grate. Furnace temperature is up to 900-950°C at MCR. Primary combustion air is added below the grate and in the fire box, and secondary air added with the fuel from the air-glide feeders and above the fuel feed system. Hot gas from the combustion chamber gives up heat to water in the convection section followed by the economiser (secondary convention section) to maximise thermal efficiency.

- **Figure 9.1: Diagram of the John Thompson Boiler**



The boiler is started-up from cold using dry wood kindling.

To reduce deposits on the heat transfer surfaces (water tubes) steam is used to clean these surfaces once each 24 hours. Much of the material dislodged by 'soot blowing' is retained by the multicyclone dust arrestment system but very fine material will not be retained and this discharges from the chimney to disperse down wind. Soot blowing is carried out on modern high efficiency water tube boilers to remove deposits from the gas-side of heat transfer surfaces. Special steam jets are installed for this purpose. There is no alternative to regular steam-cleaning of heat transfer surfaces. To neglect this would soon result in poor heat transfer, lowering steam production, and over-firing the boiler (with resulting poor combustion conditions) as an attempt to maintain steam output. Such cleaning cannot be done mechanically for such boilers without taking them off-line. Grit is the most troublesome deposit in high temperature sections - if allowed to remain it may clinker to form deposits which are very difficult to remove.

Ash from burnt-out fuel is dumped into an ash scrapper conveyer, while under-grate ash is periodically manually removed. Some of the ash transported by flue gas through the primary convention section deposits in the ducting below the economiser and discharges to the ash scrapper conveyor. This conveyor discharges into a pug mill which wets and compacts the ash to an easily transportable consistency. Combustion gases leaving the economiser have most of the remaining ash removed by a multicyclone dust collector prior to flue gases discharging through the induced draught fan into the chimney. Ash collected is transferred to a bin for utilisation off-site.

9.2.4 Wood-Fired Boiler Control

The boiler is fully automated for unattended operation, but is under the control of a responsible person. The control system (Citec System, provided by Automation & Electronics, Tauranga) is based on furnace oxygen; steam pressure and flow; and drum water level. Inputs are processed by a programmable logic controller (PLC) and outputs regulate the rate of fuel feed, and combustion air (variable speed forced draught fan and variable speed induced draught fan). The boiler is equipped with normal instrumentation, alarms, and safety interlocks. In addition, a smoke opacity meter (light extinction meter) is fitted with the optical unit located in the duct downstream of the dust arrestor. Essential parameters are electronically recorded and displayed on a VDU in the Control Room: these include steam flow, combustion gas oxygen concentration, smoke opacity, combustion air pressure, and wood silo % volume. Parameters are available as a graphical print-out.

The boiler management system also continuously determines and records steam flow to each veneer drier, total steam flow to the timber drying kilns, boiler water usage.

When a suitably experienced operator is not on site, the boiler management system routes alarms though an auto-dialler to the on-call responsible person.

9.2.5 Particulate Control Equipment

The multicyclone dust arrestment plant is a Western Precipitation model 9VGR10T multicyclone. It contains cast iron collecting tubes which are reinforced at wear points. The multicyclone is designed to ensure that particulate emissions to atmosphere from the boiler when discharged from the 30m high chimney will comply with reasonable ground level criteria beyond the boundary of the applicant's premises. No performance guarantee was provided by the vendor for collecting wood ash because no inlet loading and ash particle size analyses were available. However, the vendor indicated that for fly-ash particle size range and specific gravity expected when burning coal (fly-ash with a S.G of 2.25 and assuming 20% of particles less than 10 microns) and at design volumetric flow rate, a collection efficiency of 95% was expected. Generally, the emission of total particulate equals or is a bit less than 250 mg/Sm^3 adjusted to 8.5% oxygen by volume dry basis when the boiler is operating at normal steaming rates.

9.2.6 Chimney

The 30 m high chimney has an exit diameter of 1.5 m to ensure that the design efflux velocity of flue gas exceeds 15 m/second at MCR to achieve, with an estimated efflux temperature of about 200°C, good plume rise. The chimney is constructed of mild steel but is not thermally insulated as it is unlikely with the absence of significant concentrations of oxides of sulphur in the flue gas that temperature will drop below dew point (about 65-80°C when burning wood fuel, and when burning coal having a sulphur content of less than about 1.0% by weight). The chimney is fitted with two test sockets to enable isokinetic particulate sampling to be undertaken.

9.2.7 Disposal of Ash

Ash generated from the combustion of mixed bark and clean wood is up to about 1.8% by weight on average, and clean stem wood has an ash content of around 0.25%. In addition, the ash also contains some un-combusted and charred polymerised resins from glues in the waste (and from the disposal of waste glues - see below). Ash may be disposed of at the Council landfill, but it is now mainly collected by a contractor and used as a soil conditioner for its potassium content.

9.2.8 Boiler Water Feed

Water feed to the boiler is a mix of condensate returned from the processes and treated boiler make-up water. The make-up water is softened by passing through an ion exchange unit which replaces magnesium and calcium ions with sodium ions. Regeneration of the ion exchange resin is done on a regular basis by flushing the softener with sodium chloride (common salt) solution. This boiler feed water treatment increases it corrosiveness which is countered by pH adjustment and adding normal corrosion inhibiting chemicals.

9.3 Disposal of Laminated Wood Wastes and Waste Glues in the Boiler

9.3.1 Amino, Phenolic, CMP Bond, and PVA Glues Used By Company

A variety of resins are used by the Company as adhesives (glues) to manufacture laminated veneer lumber, and laminated solid lumber. They are the amino resin melamine urea-formaldehyde (MUF); the phenolic resin phenol melamine-formaldehyde (PMF); aqueous vinyl urethane emulsion containing isocyanate cross-linking agents (CMP Bond); and polyvinyl acetate emulsion (PVA). Currently little PMF resin is used but its use may increase in future at the expense of MUF resin. While economics dictates the maximum efficient use of glues, there is some wastage mainly through wood off-cuts and sawdust containing polymerised glues, and through spillage of glue and glue remaining at the end of run. Washing out equipment also generates water containing low concentrations of glues ('pink water').

MUF glues contain about 42-46% by weight resin mix; PMF glues about 46% by weight resin mix; CMP Bond probably contains around 20-30% copolymer and 13-15% by weight of hardener; and PVA emulsion 43-50% PVA by weight.

Un-polymerised glues used by the Company have relatively low to moderate toxicity. Providing common-sense handling precautions are adopted, and reasonable ventilation is provided, there make-up and use pose no risk to employees and will not affect the public. Glues contain low concentrations of free formaldehyde, phenols, MDI, etc.

Polymerised amino and phenolic resins are very inert and non-toxic. Amino resins are also used to fabricate articles such as dinner-ware and decorative plastic items; and phenolic resins are used to fabricate articles such as telephones, grinding wheels, and external surgical prosthetic devices. Vinyl resins are also used to manufacture floor tiles, packaging film, toys, anatomical films, etc. Urethane resins are also used to manufacture artificial rubber, rigid and flexible foams, and artificial fibres. PVA also has wide domestic usage.

9.3.2 Disposal of Waste Amino and Phenolic Resin-Containing Glues

Waste glues that cannot be returned to the supplier or utilised for other purposes, and wash-water containing glues that cannot be disposed off in the wastewater treatment plant, must be disposed of by landfilling, by incineration in the boiler, or by disposal into the Company’s wastewater treatment plant. While polymerised glues, and wood wastes containing polymerised glues, (because of their inertness), can be safely disposed to landfills, the Company's policy now is to minimise the generation of waste, and to return wastes to the supplier or to dispose through a licensed chemical waste company, and to dispose of the balance as far as practicable within the Company's premises. While wash-water containing glues (except that containing PMF) is disposed of in the wastewater treatment plant, there is no provision to landfill solids on site. Therefore, glue waste unable to be re-utilised is disposed of by incineration in the wood-fired boiler furnace.

The Company introduces waste glues into the wood fuel stream on a daily basis as necessary. This is in additional to those glues incorporated into the Company's wood residues which are currently incinerated. From our experience with the JNL Gisborne plant and the JNL Masterton plant, any discharges from the combustion of waste glues is indistinguishable from the normal boiler discharges to air resulting from the incineration of normal wood residues and wood residues containing polymerised glues.

9.3.3 Disposal of Waste CMP Bond and PVA Glue

Waste CMP Bond and PVA glue from the laminated solid lumber lines not able to be returned to the supplier of collected by a chemical waste operator are disposed of in the wood-fired boiler furnace. These waste glues are introduced into the wood fuel stream as necessary. This is in addition to glues in the fuel which are already incinerated. CMP Bond and PVA glue wastes can also be mopped up and set by sawdust.

9.3.4 Volume of Amino, Phenolic, CMP Bond, and PVA Waste Glues

The following quantities of waste glue solids (resins plus filler) may require disposal at full production as an integral part of wood fuel in the boiler:

▪ MUF and/or PMF:Resin incorporated in wood residues (normal fuel):	25,200kg/month
Additional wastes for disposal:	2000kg/month

▪ CMP glue incorporated in wood residues (normal fuel):	150kg/month
Additional wastes for disposal (see note):	< 300kg/month
▪ PVA glue incorporated in wood residues:	100kg/month
Additional wastes for disposal:	minimal

Note: isocyanate is polymerised to polyureas. Un-reacted isocyanates are not burnt.

The quantity of additional glue wastes to be burnt is about 8% of the glue wastes for incineration at maximum production.

9.3.5 Thermal Breakdown of Amino, Phenolic, CMP, and PVA Glues

Polymerised and un-polymerised amino and phenolic resins decompose at high temperature in the presence of adequate oxygen to mainly form carbon dioxide, carbon monoxide, oxides of nitrogen, and water. Polymerised resins char at lower temperatures. The amino resins, in particular melamine formaldehyde resin, can also generate carbon monoxide and hydrogen cyanide under extreme heating. CMP and PVA, when burnt at elevated temperature with excess oxygen, oxidise to carbon dioxide and water (and, for CMP, also oxides of nitrogen). Polymerised isocyanates oxidise to carbon dioxide, oxides of nitrogen, and water. Carbon monoxide will form under reduced oxygen conditions, and hydrogen cyanide may also be generated. Because glue wastes contain carbon and hydrogen, they, like wood residues and any other hydrocarbon fuel, are also subject to complicated combustion chemistry and will produce a variety of organic compounds in varying concentrations depending on combustion conditions.

The generation of carbon monoxide and hydrogen cyanide within a boiler firebox or other reasonably well designed and operated fuel burning equipment is of no concern because both compounds are flammable and will be substantially destroyed in the presence of adequate oxygen in the boiler firebox. In any case carbon monoxide is a common combustion contaminant and is generated in high concentrations under starved oxygen conditions in most fuel burning equipment including gas fired appliances and in motor vehicles. Hydrogen cyanide is not a common combustion contaminant but it is generated in many electroplating operations and is used as a foodstuffs fumigant. Its toxicity to humans is similar to hydrogen sulphide.

9.4 Discharge of Antisapstain Contaminants

We expect that most of the antisapstain compound within the surface layer of logs and green sawn timber to be degrade in the log conditioners and in the kilns. Any remaining residues in wood residues destined as fuel will be destroyed in the wood-fired boiler firebox. Elemental composition and decomposition temperatures of the antisapstain actives are specified in Section 7.2.1. Products of combustion of any residues will be oxides of carbon, oxides of nitrogen, hydrogen iodide, hydrogen chloride, sulphur dioxide, and water. Various evaluations carried out by SKM, including for the Blue Mountain Lumber application for resource consent referenced in Section 7.2.4, have been carried out by SKM. When assuming as the worst case that all antisapstain treatment used remains in the wood residues to be burnt, then the concentration of combustion contaminants is very low and, with the possible exception of hydrogen iodide, essentially not distinguishable from the usual contaminants generated from combustion of untreated wood fuels. Hydrogen iodide may be detected as a new contaminant because wood fuel when bark is excluded appears to have a low natural iodine content.

9.5 Discharges of Contaminants to Atmosphere

Emissions of potentially significant contaminants to atmosphere from the boiler chimney are aldehydes, ash (particulate), oxides of carbon, oxides of nitrogen, organic compounds, ‘smoke’, oxides of sulphur especially when burning coal, and odours. In addition, discharges include a variety of trace elements and halogens but all in low concentrations. Discharges have been quantified by direct measurement (particulate and aldehydes); by calculation from first principles; and estimated from recognised emission factors.

A summary of actual and estimated discharges from the boiler chimney are presented in Tables 9.1A and 9.1B. Calculated contaminant discharges are based on burning 9600 kg/hour of mixed wood residues (specific energy 14.25 MJ/kg gross). In respect to the discharge of sulphur dioxide, the emissions listed relates to burning 2,500 kg/hour of sub-bituminous coal containing up to 0.25% by weight sulphur. Letters in parenthesis ( ) refers to notes following this Table.

Visible smoke may be emitted from the boiler stack from time to time. This occurs when lighting up the boiler from cold (for up to around 30 minutes) but this is infrequent operation, to a limited degree when lighting up from warm (for a few minutes), when rapid load changes occur (for a few minutes), and when operating a low loads for extended periods.

Because wood ash is very fine and has a whitish-grey ‘colour’, a light white/grey haze is often apparent against the blue sky. This is not ‘smoke’ as normally defined because the concentration of carbon and products of incomplete combustion are low. This haze may at times be more apparent at night under strong moon light because of reflection of light from moisture droplets condensing on fine particulate.

Under most operating circumstances, the opacity of smoke will be low – being no more than equivalent to Ringelmann Shade No.1.

The Company’s discharges rarely include observable emissions of deposited particulate such as grit.

- **Table 9.1: Summary of Estimated and Calculated Rates of Contaminant Emissions at MCR**

Discharge in Combustion Gas	**Calculated from First Principles, and from Emission Factors**		**Measured Discharges January 2007 to February 2008 – Range of Results as the Mean of each Test Series**
	MCR w/w at 9600kg/hour	**Coal only at 2500kg/hour**	**Wood Fuel - at ~ 65 to 85% of MCR**
Volumetric discharge <u>8.5% O_2</u>	31.1 Am^3/s at 200°C	13.2 m^3/s at 150°C & 11% O_2	20.1 Am^3/s at 200°C & 8.5% O_2 19.2 Am^3/s at 191°C & 8.5% O_2 23.8 Am/s at 191°C & 7.9% O_2 21.8 Am^3/s at 188°C & 7.7% O_2

Stack height/diameter	30 m and 1.50 m ID		
Efflux velocity	17 – 18 m/s	7.5 m/s	11.4 m/s 10.9 m/s 13.5 m/s 12.3 m/s
Volumetric discharge 0°C dry 8.5% O_2	15.5 Sm^3/s	6.4 Sm^3/s	9.96 Sm^3/s at 8.5% O_2 11.4 Sm^3/s at 8.5% O_2 12.5 Sm^3/s at 8.5% O_2 10.8 Sm^3/s at 7.7% O_2
Total particulate at 400 mg/Sm^3 dry & 8.5% O_2	22.3 kg/hour	-	263 mg/Sm^3 8.5% O_2 = 9.5 kg/hour 217 mg/Sm^3 at 8.5% O_2 = 8.9 kg/hour 200 mg/Sm^3 at 8.5% O_2 = 9.0 kg/hour 200 mg/Sm^3 at 8.5% O_2 = 8.25 kg/hour
Total particulate at 250mg/Sm^3 & 8.5% O_2	14 kg/hour (prob. 90% PM_{10})	5.8kg/hour	
Carbon dioxide (a)	13,300 kg/hour	-	
Carbon monoxide (b)	35.5 kg/hour	6.25 kg/hour	381 ppmv = 476 $mg/Sm^{3.}$ = 17.1 kg/hour 483 ppmv = 603 mg/Sm^3 = 21.3 kg/hour 295 ppmv = 369 mg/Sm^3 = 15.9 kg/hour 485 ppmv = 606 mg/Sm3 = 23.5 kg/hour
Dioxins (c)	8.64 E^{-08} kg I-TEQ/hour	-	Not tested
Formaldehyde (b)	0.26 kg/hour	Very low	Total C1-C3 aldehydes expressed as formaldehyde 10 & 11 December 2007: Mean: 7.4 mg/Sm^3 and 0.277 kg/hour Maximum: 11.6 mg/Sm^3 & 0.49 kg/hour
Oxides of nitrogen as NO_2 (b) (d)	13 kg/hour	11 kg/hour	251 ppmv = 515 mg/m3 = 18.5 kg/hour 233 ppmv = 478 mg/Sm^3 = 16.7 kg/hour 222 ppmv = 456 mg/Sm^3 = 19.7 kg/hour 235 ppmv = 482 mg/Am3 = 18.7 kg/hour
PAH's 16/16 (b)	7.3 E-03 kg/hour	-	
Benzo(a)pyrene (b)	1.53 E^{-04}		
Sulphur dioxide generated (b – for wood)	< 1.5 kg/hour	12.5kg/hour (at 0.25% S)	
Sulphur dioxide emitted	< 1.5 kg/hour	11.25 kg/hour (assuming 10% removal in furnace ash)	
TOC's (b)	2.3 kg/hour	1.6 kg/hour as TNMOC's	

(a) Emission factor for wood fuels from N.Z. Energy Information Handbook, J.T. Baines (Editor), Taylor Baines and Associates, Christchurch (1993).

(b) From USEPA AP-42 emission factors as presented in AirChief, Version 12, June 2005.

(c) UK emission factors, July 1995. Good combustion conditions = emission factor 9 µg I-TEQ /tonne of fuel.

(d) NO_x is specified as NO reported as NO_2 plus NO_2 as NO_2 = NO_x reported as NO_2.

The calculate rate of emission of total particulate at around 70% MCR is around 8.95 kg/hour which equates to an emission concentration of 200 to 220 mg/Sm^3 at 8.5% oxygen dry basis – see grey highlighted bands in Table 9.1.

9.6 Abnormal Operation

Poor operation of the boiler may generate dense smoke emissions from the stack. The plant PLC control system is designed to ensure that under most circumstances that boiler operation is optimised.

Very occasionally fuel may "hang-up" in the fuel feed system to the furnace section and then release into the furnace at an excessive rate. This can cause smoke emissions for a few minutes until excess fuel burns off.

Excessive particulate discharge can result if mechanical particulate arrestment equipment becomes partially blocked and will no longer remove particulate from the flue gas. This potential problem is minimised by effective multicyclone maintenance and reasonable supervision of operations.

9.7 Boiler Emission Monitoring

An opacity monitor is installed in the duct to the boiler stack and continuous monitoring and recording of data is carried out.

Two 100 mm BSP sampling sockets are fitted to the stack for periodic emission sampling, and safe access is provided.

No ambient monitoring is carried out or proposed.

9.8 Best Practicable Option for Boiler Particulate Emission Control

The boiler primarily burns a mix of dry wood residues and green sawdust. As a contingency coal is available if the wood fuel feed breaks down. The burning of fuel grade wood residues is not only a wise use of renewable resources, burning wood residues substantially avoids burning coal as a fuel (the only financially viable option to wood in the Wairarapa) and avoids landfilling of wood residues or the cost of transporting wood residues out of the district. Finally, burning wood residues substantially assists the Company to be economically viable and competitive.

While the boiler is original equipment, it has been substantially upgraded over time in respect to combustion equipment and automatic combustion management. It is now possible to reasonably consistently operate with the emission of total particulate matter not exceeding around 250 mg/Sm^3 adjusted to 8.5% oxygen by volume dry basis. To consistently meet this limit requires very good management of the combustion process, which is the Company's policy.

If an emission limit of, for example, 125 mg/Sm^3 was adopted, it would effectively halve the rate of particulate emission and halve the predicted ground level concentrations of particulate down-wind for a given stack height. However, it would require the fitting of sophisticated emission control technology to the boiler such as a high efficiency water scrubber or bag filtration, the use of which also has issues including financial.

9.9 Alternative Methods of Discharge

There is no alternative to discharging combustion gases from the boilers to atmosphere.

There are technically feasible options available, including replacement of the heat plant, to reduce the emission of particulate matter from the Company's activities. However, these options also come with a significant cost and, in some cases, other penalties.

9.9.1 Improving the Management/Operation of the Boiler

Significant improvements to the boiler carried out since the current air discharge permit was issued are listed below:

- Secondary furnace air supply upgraded (to improve combustion and decrease carbon content of ash and to reduce carbon-containing particulate emissions);
- Improved furnace oxygen, and carbon monoxide monitoring instigated (to improve carbon containing particulate emissions);
- Steam pressure raised from 22.5 Bar to 23.5 bar (to improve boiler thermal efficiency);
- New main steam and bypass valves (to provide smoother cold starts);
- Boiler control system upgraded (to improve consistency of boiler control);
- Installed boiler water total dissolved solids monitoring (to provide accurate automatic blow-down to replace constant blow-down to minimise boiler water loss and improve thermal efficiency of boiler and to reduce cost of water treatment);
- Boiler water treatment dosing pumps installed (to provide accurate dosing of boiler water to improve boiler thermal efficiency);
- Operate boiler fuel shredder on a continuous basis (to provide a quicker turnover of fuel pile and to minimise wet fuel that causes combustion issues); and
- Ultrasonic testing of steam traps (to improve steam system efficiency thus improve boiler efficiency).

The Company's boiler is equipped with a boiler management system to regulate combustion and to control the flash drier based on set end point data and process sensors with a programmable logic controller (PLC). This automatic control system has been upgraded at various times and has now been optimised.

Solid fuel-fired boilers always operate best if their load is relatively consistent, when changes in load are applied slowly, and when operating towards the higher end of their maximum output rather than towards the lower end. To achieve smooth operation, the Company aims to even out the heat demand from the log conditioners, from veneer driers, and from the kilns as far as practicable by staggering load start-ups and ensuring that the veneer driers operate as consistently as possible. This aim has largely been achieved.

9.9.2 Water Scrubbing

Low and medium efficiency water scrubbing will only have a limited effect on PM_{10} emissions.

High efficiency water scrubbing is an effective method to reduce the emission of fine particulate from boilers. However, the particulate removal efficiency of high efficiency water scrubbers is good but is not as good as fabric filtration unless a very high energy venturi scrubber is used (high energy equates to high operating cost). An effective high efficiency water scrubber will reduce the emission of particulate to around 100 mg/Sm^3, and very high efficiency units to around 50 mg/Sm^3 or a bit less.

Water scrubber discharges are highly visible and cool. Water scrubbing generates wastewater that requires clean-up before recycling and before discharge to the sewer. However, it is difficult to catch a scrubber on fire!

9.9.3 Bag Filtration

Bag filtration is a technically feasible option for the boiler stack given appropriate design and that safeguards are provided to avoid the carry-over of hot particles and sparks which can damage filter bags and cause fires.

The boiler discharge gases also include volatile organic compounds, some of which will condense out within the bag filter especially when the boiler is operating at less than medium firing rates and significantly add to the risk of burning filters and possibly causing fires. Ideally, solid fuel-fired boilers equipped with bag filters should not only be equipped with effective spark and hot particle suppression equipment and fire extinguishing equipment but also operated at constant load with only limited low firing time.

The cost of a suitable bag filter will exceed NZD 1 million plus the cost of protection and fitting.

A suitable bag filter will reduce the emission of particulate matter from solid fuel-fired boilers to less than 50 mg/Sm^3.

The cost and risks associated with bag filtration is acceptable in sensitive areas (for example, within the Masterton urban area) but not, in our opinion, a plant located at Waingawa even though it is with the local airshed.

9.9.4 Electrostatic Precipitation

Electrostatic precipitation has a high capital cost – a cost significantly exceeding that for a bag filter. ESP’s suitable for combustion plant particulate arrestment tend to be used for large plant such as coal-fired power stations and for cement kilns, rather than on medium-sized boilers, although there may be suitable sized ESP’s on the market for boilers of the Company’s capacity. The properties of the ash must also be suitable for effective operation.

A suitable ESP will reduce the emission of particulate matter from solid fuel-fired boilers to less than 50 mg/Sm^3.

Electrostatic precipitation requires sophisticated electrical systems s to successfully operate and these tend to be high maintenance items.

9.9.5 Replacement of the Boiler

Replacement of the boiler with the latest technology is feasible but a very expensive option and is no guarantee that a new boiler (or a series of smaller units) will operate relatively faultlessly.

There are large modern boilers on the market that can continuously burn wood residues containing a wide range of moisture after start-up on dry fuel without needing a sawdust drier. However, these require high performance particulate arrestment equipment such as bag filtration or high efficiency water scrubbing to achieve substantially better particulate emission performance than the current boiler.

There is also one boiler on the N.Z. market that is guaranteed by the vendor to achieve a total particulate emission not exceeding 100 mg/Sm^3 adjusted to 12% carbon dioxide by volume (8.5 % oxygen) when fitted with a single Stairmand high efficiency cyclone. No bag filters or high efficiency water scrubbers are required, but if a concentration of 50 mg/Sm^3 is required then at least partial bag filtration of the combustion gases would, most likely, be needed. This boiler achieves excellent particulate emission performance by using large volume cyclonic two-chamber combustion which maximises the burnout of fuel and retains much of the ash. The capital cost of these boilers of the size needed by JNL Masterton would probably exceed NZD 10 million. In addition, we understand that two recent examples of these boilers are causing problems with turndown when burning high moisture-containing fuel such as green sawdust, and that their heat recovery systems do not appear to be of sufficient capacity to provide the expected thermal efficiency. These issues would be a liability for JNL.

The Company’s boiler has been substantially upgraded over the past few years and is now optimised in respect to providing cost effective and trouble-free high pressure steam. It is not a financially practicable option to replace it.

9.9.6 Improved Dispersion of Boiler Discharge Plume

The Company’s boiler is equipped with a 30 m high stack. The discharge plume is still influenced by downwash effects from adjacent buildings. Increasing the stack height by a few metres will reduce predicted ground level concentrations in the vicinity, but will have little effect on predicted concentrations further afield, nor will this measure reduce the emission of contaminants into the airshed.

10. Wastewater Treatment Plant

10.1 Introduction

The wastewater treatment plant came on line in January 1996 and operates in a semi-automatic mode.

The plant has the following resource consents: No. WAR 950003 01 (discharge of sludge to land); 950003 02 (discharge of treated wastewater by soakage); and 950003 03 (discharge of 'clean' stormwater to the Waingawa River).

10.2 Plant Description

A diagrammatic lay out of the plant is presented as Figure 10.1.

The Primary Clarifier removes solids from the pressate influent. Settled solids are pumped out of the clarifier and dispersed into wood residues that are then burnt as fuel in the boiler.

The Extended Aeration Tank receives glue wastes, boiler blow-down, other process effluent (except raw pressate liquor), and Primary Clarifier effluent. This treatment system enables microorganisms in the anoxic zone to biologically reduce the organic content of the waste stream. Aerobic conditions surrounding the anoxic zone are maintained by a forced draught blower with a submerged sparge pipe with the blower regulated by a variable speed drive.

The Secondary Clarifier separates solids from treated effluent. The retention time of solids is minimised to prevent sludge turning anaerobic (retention time averages 11 hours).

The Sludge Thickening Tank permits the removal of solids at a rate which balances production to maintain a constant mixed liquor suspended solids concentration. The tank is fitted with an aerator to maintain aerobic conditions. Sludge is removed from the site by tanker for disposal onto land in the Company's forests.

Sedimentation pond 1 (capacity of 250 m^3) collects and screens stormwater from the log yard, run-off from the kiln pads, and liquor from the Sludge Thickening Tank. Sedimentation Pond 2 (capacity of 1000m^3) collects overflow from SP 1 and effluent from the Secondary Clarifier. Treated screened effluent is disposed to ground via a soakage pit adjacent to the Waingawa River or to the Masterton District Council trade waste sewer.

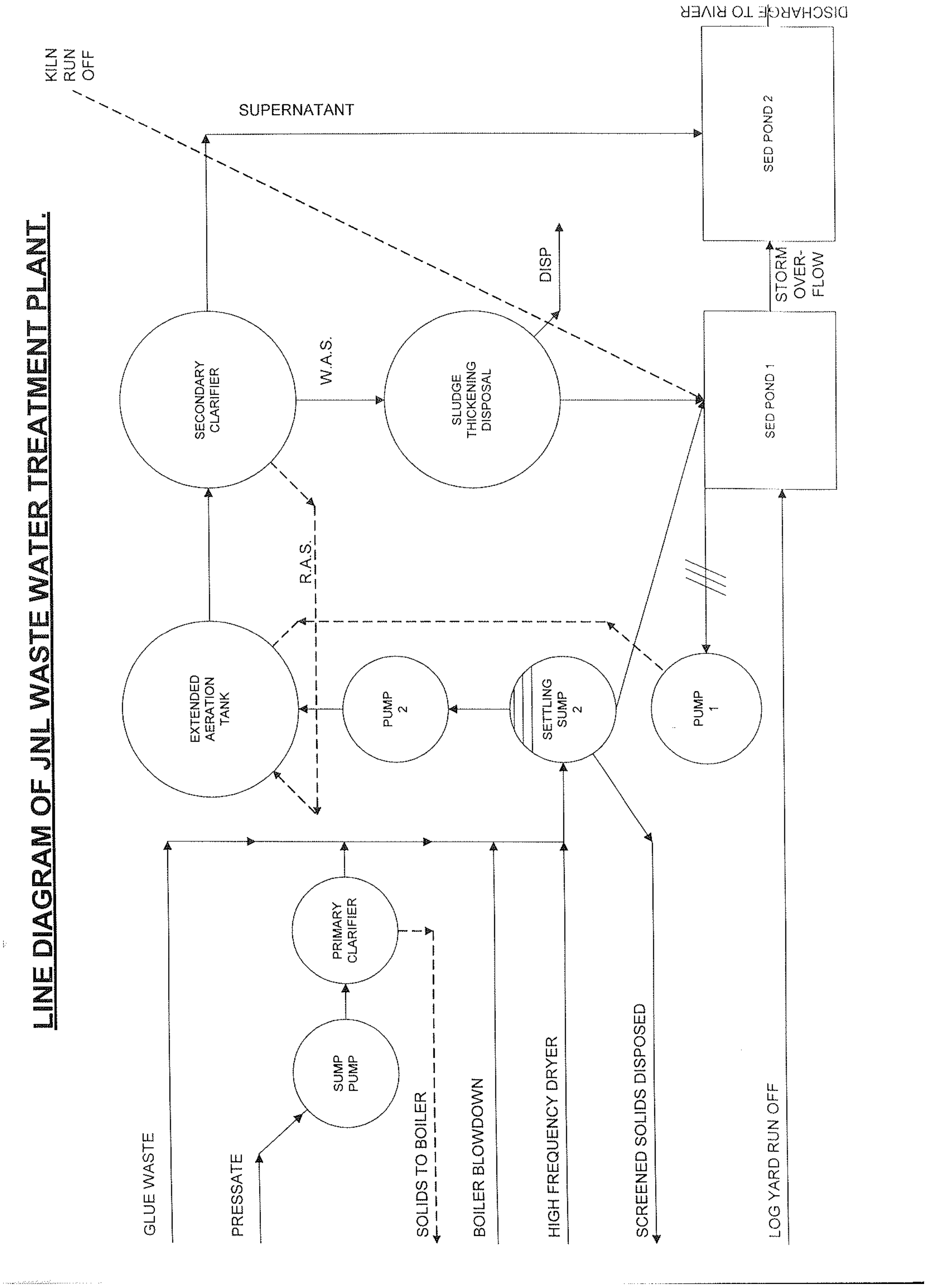
Modification to the log yard stormwater ponds was recommended by consultants as a result of odour issues during late 2007. The Company had already fitted a 'V' culvert to control rainwater run-off from the log yard.

Clean roof and paving rainwater run-off discharges to a clean water pond then to the river.

10.3 Process Monitoring

The plant is monitored as appropriate for effluent flow, pH, dissolved oxygen, BOD_5/COD, suspended solids, temperature, and sludge volume index.

- **Figure 10.1: Diagram of Wastewater Treatment Plant**



10.4 Discharges to Air

10.4.1 General Comment

Discharges of contaminants during normal operation are primarily carbon dioxide, minimal methane, and low odour.

During upset conditions, the starches, sugars, and resins in wood solids and liquor may be subject to excessive anaerobic conditions with resulting malodour. While some reduced sulphur compounds such as mercaptans will be generated, significant concentrations of hydrogen sulphide are unlikely due to the low concentration of sulphur compounds in wood and that no sulphur-containing treatment chemicals are used during wood processing (cf Kraft Process).

Abnormal operation is prevented by appropriate control of the plant. Problems have been caused by power interruptions tripping the plant aerators. If trips are not detected within about 24 hours then developing anaerobic conditions could cause objectionable odour beyond the Company's premises. Automatic monitoring of aerators is now installed with auto-dialling to on-call staff.

In addition, all personnel are encouraged to report as soon as possible any odour from the plant or any other abnormal condition.

The discharge of contaminants from the wastewater treatment plant has not been quantified.

10.4.2 Issues with Odour Late 2007

As a consequence of objectionable odour emissions from the Company’s stormwater treatment plant, an abatement notice was issued on 31 October 2007 by the GWRC to:

- Remove inappropriate waste from settling ponds and dispose of appropriately;
- Implement an odour management system to avoid offensive odour beyond the boundary. The odour management plan was required to set out at least pond maintenance, pond system design and function, discharge monitoring, and odour treatment.

Compliance with the abatement notice was required by 18 January 2008.

In a letter dated 20 December 2007, Better Technical Options Limited (BTO) advised GWRC on behalf of the Company that the requirements of the abatement notice had been fulfilled. BTO advised that the build-up of sludge in the stormwater ponds, that was the major contributor to odours, had been removed, and an odour management plan had been developed which also detailed a number of on-site improvements had been prepared (and was copied to the Council).

The stormwater treatment process had been periodically overloaded and had retained sludge in the ponds for extended periods resulting in anaerobic conditions that encouraged odour generation. The Odour Management Plan detailed steps to avoid large amount of solids reaching the stormwater ponds by installing a solids retaining weirs in the collection channel. Aerators are to be installed in the two stormwater ponds and monitoring for dissolved oxygen and pH carried out to enable good control of the aerators. The third step is for the Company to remove sludge that does build up in the ponds as quickly and effectively as possible. Since solids build up in stormwater pond 1, this pond is to be modified to incorporate a sludge sump to allow effective removal of sludge from time to time. In addition, a long-term disposal route for treated effluent from the wastewater treatment plant is being investigated including negotiations with the Masterton District Council for a Trade Wastes Consent and other disposal routes. We understand that BTO is working on the viability of spray irrigating treated water onto the Company's 10 ha farmland to the north-west of the railway line. Since this approach looks viable, an application to GWRC for a discharge to land permit is expected to be made in the not too distant future.

11. Assessment of Effects on the Environment – Particulate Emissions

11.1 Introduction

The actual and potential effects on the environment of operating the Company’s particulate emitting processes has been assessed from Sinclair Knight Merz experience from the Company’s activities and from similar activities elsewhere, and supplemented by atmospheric dispersion modelling of emissions from the boiler stack.

Wood processing mills (or various components) that SKM is familiar with similar to the Company's include the following: Juken New Zealand, Kaitaia (Triboard Mill and the Northland Mill); Juken New Zealand, Gisborne; Pan Pac Forest Products, Napier; Nelson Pine Limited, Richmond; Dongwha Patinna Limited, Southland; and a large number of sawmills operating a variety of particulate emitting processes.

11.2 Dispersion Modelling

11.2.1 Introduction

Atmospheric dispersion modelling was undertaken to predict the likely impact of the emissions from the wood-fired boiler on air quality and to help with assessing the potential effects on the surrounding environment.

Atmospheric dispersion modelling is a mathematical method of predicting the concentration of contaminants downwind from a discharge source. The model takes into account a number of factors including the emission rate of the contaminant, the height of the discharge, building downwash effects, local topography, and meteorology. The main meteorological aspects considered in modelling are wind speed and direction, ambient temperature, atmospheric mixing height and atmospheric stability.

Computer dispersion modelling is internationally accepted for predicting effects of discharges of pollutants to atmosphere. Many dispersion models are approved by regulatory agencies for specific applications.

The accuracy of predictions depends on a number of aspects. They include the quality of the input data and assumptions; the inherent limitations in the model in respect to predicting plume rise at any point downwind; ability to predict plume dispersion coefficients (plume spread); the assumption that meteorological conditions remain constant between the source and receptor; that varying terrain can be accounted for; and the assumed averaging times, etc. Accuracy is also strongly affected by the sophistication of predictions required and how real-time meteorological data is used. It is common to see statements to the effect that a difference of a factor of two between predicted concentrations and actual concentrations is the best that can be expected - that is predictions could be between ½ and twice actual concentrations. This, however, is a simplification, and if such accuracy or better is assumed then special assumptions and conditions apply.

If modelling is used to estimate (over flat terrain) the highest 1 hour and 24 hour concentration that could occur during a year (to compare with ambient air quality standards) but is not asked to predict when and where these would occur, then, according to Turner (1992)8, EPA studies indicate that predicted concentrations are typically within 10 to 40% of observed concentrations. If modelling is used to predict theoretical concentrations down wind at specified distances over flat terrain for a specified rate and temperature of contaminant discharge using screening meteorological data the predicted concentrations should be within 50% of reality for those stability classes and wind speeds nominated.

11.2.2 Dispersion Models Used

AUSPLUME

AUSPLUME Version 6 was used for the assessment of particulate emissions from pneumatic conveying bag filters and also for the emission of particulate from the wood-fired boiler stack and the fuel silo bag filters in association with the pneumatic conveying bag filters. Since the extent of dispersion of the plumes from the bag filters (including from the fuel silo filters) are within a km or two from the site AUSPLUME is appropriate and convenient. The terrain is un-complicated and the PRIME algorithms are the same as incorporated into CALPUFF. The model is also much less complicated and less time-consuming to operate than CALPUFF, especially with the large number of vents. The PRIME algorithms were used to account for building wake effects caused by winds blowing over and around the Mill buildings.

The model was run with a 3 x 3 km (9 km^2) grid based with 50 m grid spacing. Downwash potential in the lee of structures was included using the Building Profile Input Programme (BPIP). Actual building heights have been included (maximum height of 15 m). Averaging times were 1 and 24-hour.

The Pasquill-Gifford plume dispersion coefficients were used. These are the most common dispersion coefficients and are recommended for this type of application.

Modelling meteorological data was derived from East Taratahi 1999.

CALPUFF

The use of the dispersion model CALPUFF is reasonably appropriate to the Company's boiler emissions. The CALPUFF dispersion model Version 5.714 was used for this assessment. The model contains the PRIME algorithms, which are considered more reliable for assessing building wake effects caused by winds blowing over and around those buildings located near the stacks.

The model is used because of its ability to handle both complex terrain and variable meteorological effects. CALPUFF has been adopted by the US Environmental Protection Agency (US EPA) in its

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[8] Turner, D. Bruce. Fundamentals and Principles of Dispersion Modeling. TAPPI 1992 Environmental Conference, Richmond, Virginia. 1992.

Guideline on Air Quality Models as the preferred model for assessing long range transport (>50km downwind), and shorter downwind distances for applications involving complex wind regimes[9]. CALPUFF is becoming increasingly used in New Zealand, and it is recommended for a range of situations by the Ministry for the Environment Good Practice Guide for Atmospheric Dispersion Modelling[10].

The Greater Wellington Regional Council provided a CALMET meteorological data set developed by the National Institute of Water and Atmospheric Research. This gives a three-dimensional pattern of winds, temperature and atmospheric stability over the Wairarapa with a 1-kilometre grid resolution. While this is the most comprehensive data freely available for modelling purposes, it lacks the CALMET input files thus the meteorological data cannot be interrogated to assist interpreting the predicted concentrations. The CALMET data was adapted for use with CALPUFF version 5.714.

The CALPUFF model was run with a 12 x 12 km (144 km^2) digital terrain file with 100 m grid spacing and a 4 x 4 km digital terrain file with 100 m grid spacing. The model was run to predict one-hour, 24-hour, and annual averages for particulate matter. Other contaminants were calculated on a proportional basis.

Downwash potential in the lee of structures was included using the Building Profile Input Programme (BPIP). The maximum building height has been included at up to 15 m. The ground level in the location of the combustion appliances is 125 m Above Ordinance Datum (AOD). Building wake effects were included in the model using the PRIME building downwash algorithms.

The default model settings for CALPUFF were used except as otherwise specified.

The key settings for CALPUFF were as follows:

Plumes were modelled as a series of ‘puffs’ averaged over a series of 1-hour periods.

Dispersion rates were calculated using the Pasquill-Gifford dispersion coefficients, which are the most common and recommended for this type of application.

Transitional plume rise was switched on.

No chemical transformation was included.

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[9] Federal Register. Part II Environmental Protection Agency. 40 CFR Part 51. Requirements for Preparation, Adoption and Submittal of State Implementation Plans (Guideline on Air Quality Models); Proposed Rule. April 2000.

[10] Ministry for the Environment “Good Practice Guide for Atmospheric Dispersion Modelling”. Air Quality Technical Report No. 27. June 2004.

11.3 Assessing Effects of Discharges to Air from Particulate Emissions

The potential effect of the discharge into air of particulate matter from the pneumatic conveying bag filters and from the wood-fired boiler stack and from the three fuel silo bag filters and other contaminants of potential interest discharged from the boiler have been assessed using air dispersion modelling, and results interpreted based on SKM consultants experience.

The emission of total particulate from all sources is assumed to be 100% PM_{10}.

Tables 8.2A, 8.2B, and 9.1 set out rates of contaminant discharge used for this assessment.

To assist the assessment process we have also used dispersion modelling assessment criteria as presented in Tables 11.1A and 11.1B. The assessment criteria are based on:

- For contaminants specified in the Ministry for the Environment's May 2002 Ambient Air Quality Guidelines: predicted maximum ground level concentrations at or beyond boundary of the site in areas where the guidelines apply preferably not to exceed 50% of the guideline level; and
- The National Environmental Standards for applicable contaminants

Table 11.1A: Modelling Assessment Guidelines for Particulate

Contaminant	Assessment guideline and source
Fine particulate (PM_{10})	10 µg/m^3 – annual average (50% of the MfE Guideline for PM_{10})

Table 11.1B: 2004 National Environmental Standards for Air Quality (Cumulative Emissions)

Contaminant	Threshold concentration (µg/m^3)	Permissible excess
Particulate matter (PM_{10})	50 as a 24-hour mean	One 24-hour period in a 12-month period

11.4 Particulate Matter

11.4.1 Properties of Particulate Matter

General Comment

Suspended fine particulate (PM_{10}) in sufficient concentration can cause respiratory distress, cause soiling of surfaces, and will accelerate corrosion of surfaces by retaining moisture and acidic materials. Overseas health surveys have shown a correlation between the concentration of fine particulate in the atmosphere and increased frequency of respiratory and cardiovascular illness, and increased mortality, especially in those who are suffering from significant illness. These studies have also shown a correlation with increased prevalence of asthma symptoms. To date, the increase in adverse health effects with increasing concentration of fine particulate in the air has not been related to particle composition but only to particle size, concentration, and exposure time. Particles having a diameter of 10 microns or less (PM_{10}), and more probably the very fine component of this ($PM_{2.5}$), being respirable, are of principal concern. In response to these overseas health studies, many jurisdictions (including New Zealand) have lowered the air quality guideline for PM_{10} to 50 $\mu g/m_3$ as a 24-hour average.

'Smoke' is particulate having diameters less than about 5 microns (PM_5) and is comprised of ash, carbon, and carbon-containing adsorbed organic contaminants. The primary impact of smoke as a component of PM10 is aesthetic, being visually objectionable in more than moderate concentrations.

Deposited particulate is particulate material having significant settling velocity in still air, and generally has a particle diameter greater than 10-20 microns. The primary impact of deposited particulate is nuisance (mainly soiling). Deposited particulate will not be an issue from the combustion appliances stacks given adequate control of particulate emissions.

Health Impacts of Wood Dust

Many epidemiological studies have been carried out relating exposure of workers to wood dusts. These have been used to set occupational exposure limits such as those recommended by the American Conference of Governmental Hygienists which are adopted by the New Zealand Department of Labour. The principal physical health effects reported from exposure to wood dusts are dermatitis, respiratory disease, and cancer. Studies reviewed in the Documentation of the Threshold Limit Values (1986)[11] indicates that risk to the physical health of workers relates to exposure to high concentrations of dust from working in the furniture industry with hard woods such as red cedar, oak, teak, beech, mahogany, and birch. It was noted that wood workers in the building industry did not appear to be at risk but it is not clear if this is because soft woods rather than hard woods are commonly used, or if dust particle size is a factor. There is no firm evidence that conditions which gave rise to nasal cancer in the furniture industry still exist now that exposure to very high dust levels have been substantially prevented. In response to these studies, the ACGIH in 1986 reaffirmed the 1981 limits - that the 8-hour occupational exposure to soft wood dust be 5 mg/m^3 (the level for "nuisance dusts") and for hard wood dust 1 mg/m^3. These are the occupational dust levels set in the N.Z. 1994 Workplace Exposure Standards[12].

However, the International Agency for Research on Cancer (IARC), in October 1994, has designated wood dust as a human carcinogen. This is in response to review of literature in industries where primarily hardwood dust exposures were important. In response to the IARC decision, the American Conference of Governmental Hygienists proposed the addition of ‘hardwood’ as an A1 Confirmed Human Carcinogen to its Notice of Intended Changes for 1995/96 ACGIH TLV document to seek submissions from interested parties. In the interim, the occupational limit for ‘hardwood’ remains at 1mg/m^3 - 8 hour day

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[11] ACGIH. Documentation of the Threshold Limit Values and Biological Exposure Indices. Fifth Edition. American Conference of Governmental Industrial Hygienists Inc., Cincinnati, Ohio, USA. 1986.

[12] Department of Labour. Workplace Exposure Standards Effective from 1994. Dept. of Labour, Wellington, New Zealand. 1994

exposure. No change is proposed for 'softwoods' - their occupational limit remains at 5 mg/m^3 - 8 hour day exposure[13]. The State of Texas has effects screening levels for wood dusts: hardwood 10 µg/m^3, and softwood 50 µg/m^3 – both as 1-hour averages.

In view that the Company only processes soft wood; and that the likely concentration of wood dust outside of its premises will be substantially lower the occupational hygiene limit for softwood; it is very unlikely that the concentrations of wood dust as normally experienced will have any adverse physical health effects on neighbours. Particulate matter smaller than 10 microns (PM_{10}) is the key contaminant of potential concern in this application for resource consent.

11.4.2 Dispersion Modelling Predictions

Juken N.Z. Activities

The modelling summary (highest predicted maximum ground level concentrations) for the PM_{10} emissions from the Company's boiler and the various bag filters is presented in Appendix A. The results of modelling PM_{10} using AUSPLUME of ground level concentrations outside of both company's premises are presented in Table 11.2.

- **Table 11.2: AUSPLUME - Highest Predicted Maximum Ground Level Concentrations of Particulate as PM_{10} from Bag Filters and Wood-Fired Boiler (JNLW-PM4A)**

Bag Filters LVL1 +LVL 2 + SW 1 + SW 2 + SW3 – Rates of Emission – see Table 8.2 A & B	Fuel Silo Bag Filters at 5 mg/Sm^3 – Emission of 0.041 kg/hour each	Wood-Fired Boiler at 70% of MCR – Emission of 8.95 kg/hour	Combined Boiler + Bag Filters
26.5 µg/m^3 as a 24-hour average.Location – on Site. (Off-site max = 12µg/m^3)	16.2 µg/m^3 as a 24-hour average. Location - on Site. (Off-site max = < 8 µg/m^3)	25.6 µg/m^3 as a 24-hour average. Location – within Site. (Off-site max = < 8 µg/m^3)	35.3 µg/m^3 – Location - around southern site boundary

Isopleth diagrams over a 3 x 3 km modelling domain illustrating the highest predicted maximum 24-hour average downwind concentrations for particulate as PM_{10} for the ground-located bag filters, the fuel silo bag filters, the boiler stack, and the bag filters and boiler stack combined, are presented as Figures 11.1 to 11.4 inclusive. The black square on the diagrams is the Company's site boundary but this excludes the Company's 10 ha farming block.

The highest ground level concentrations are predicted to occur within the Company's premises as a consequence of downwash from adjacent buildings. Figure 11.4 illustrates the location of highest concentrations at and exceeding 25 µg/m^3 as 24-hour averages from the combined effect of discharges of particulate from the pneumatic dust conveying bag filters plus the wood-fired boiler stack. 25 µg/m^3 is

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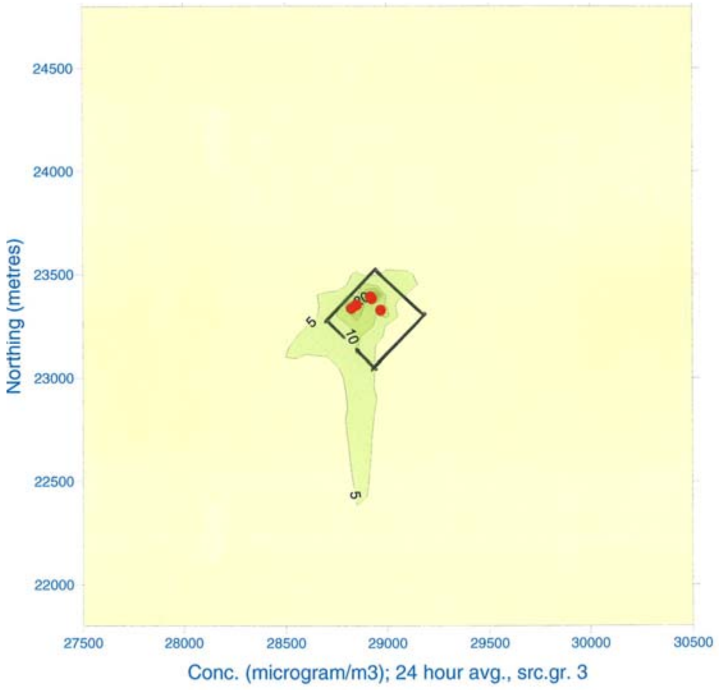
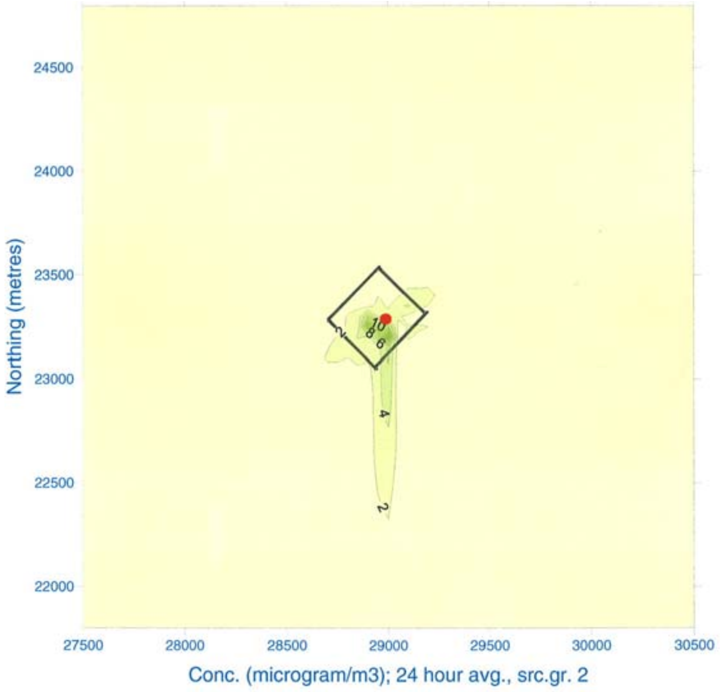
[13] Fisher, R.P. The IARC Decision on Wood Dust. NCASI [Publication & date to be included]

50% of the Ministry for the Environment's ambient air guideline for fine particulate (PM_{10}), which is also ½ of the AirNES PM_{10} standard.

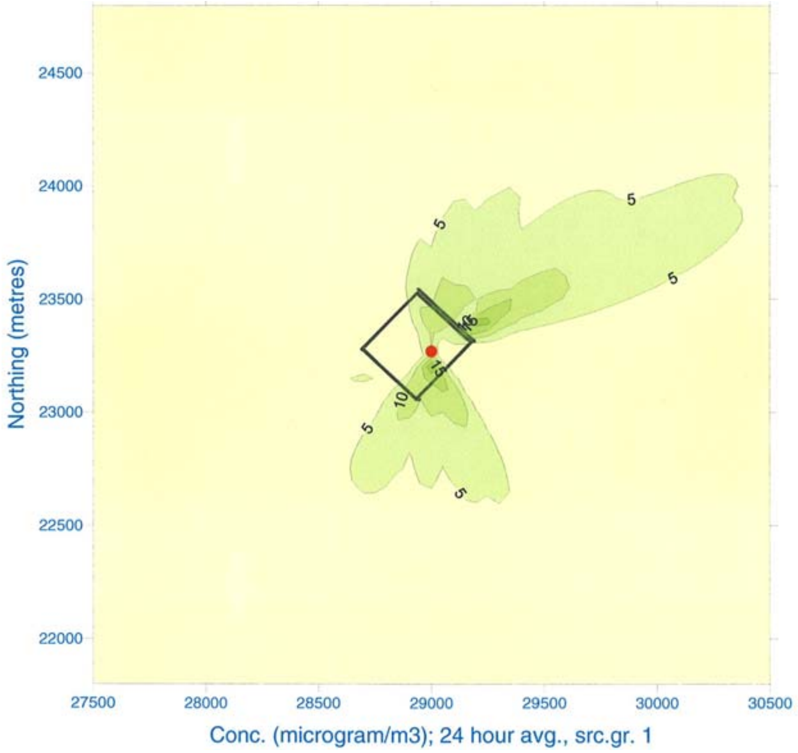
- **Figure 11.1: Maximum Predicted Ground Level Concentrations of PM_{10} (24-hour average) – LVL 1, LVL 2, SW 1, SW 2, and SW 3**



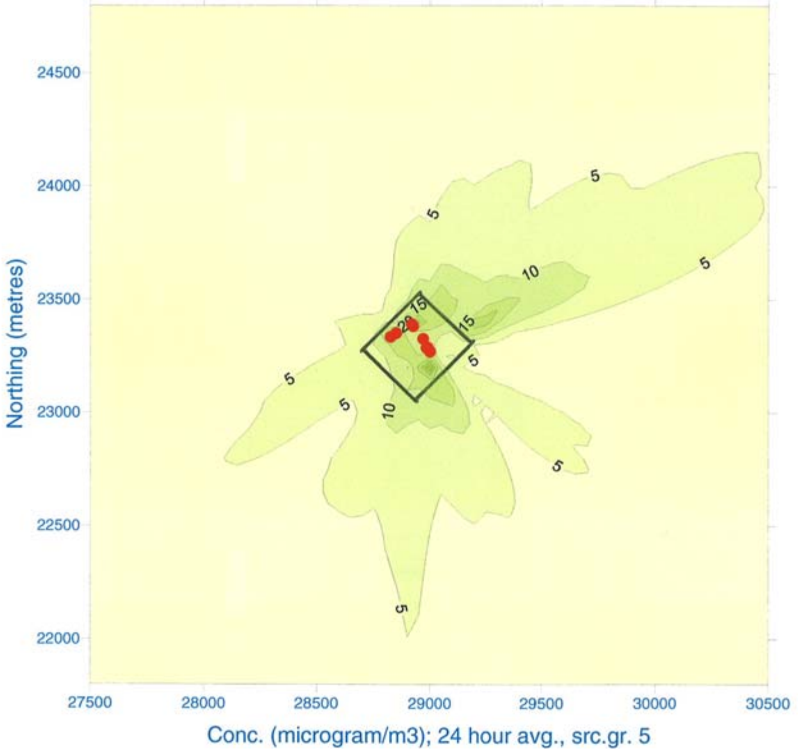
- **Figure 11.2: Maximum Predicted Ground Level Concentrations of PM_{10} (24-hour average) – Fuel Silo Bag Filters**



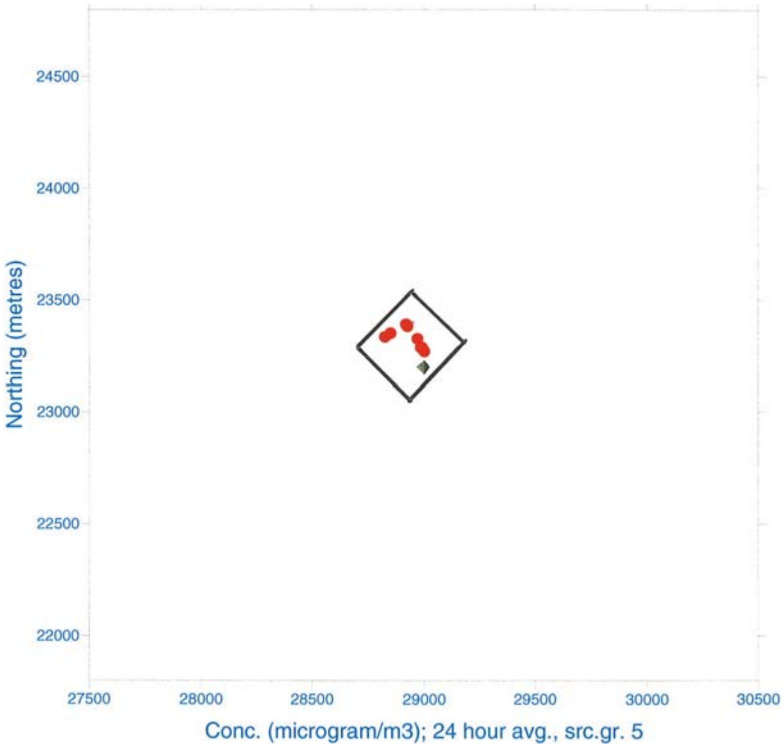
- **Figure 11.3: Maximum Predicted Ground Level Concentrations of PM_{10} (24-hour average) – Wood-Fired Boiler Stack at 70% of MCR**



- **Figure 11.4: Maximum Predicted Ground Level Concentrations of PM_{10} (24-hour average) – Bag Filters plus Wood-fired Boiler Stack**



- **Figure 11.5: Location of Highest Predicted Maximum Ground Level Concentrations of PM_{10} (24-hour average) exceeding 25 µg/m^3 – Bag Filters plus Wood-fired Boiler Stack**



The location is just south of the boiler stack and within the Company's site.

Table 11.5 presents the highest predicted maximum ground level concentrations for the emissions from the fuel silo bag filter plus the wood-fired boiler stack using CALPUFF with a 12 x 12 km modelling domain. This grid encompasses a large section of the Masterton urban area.

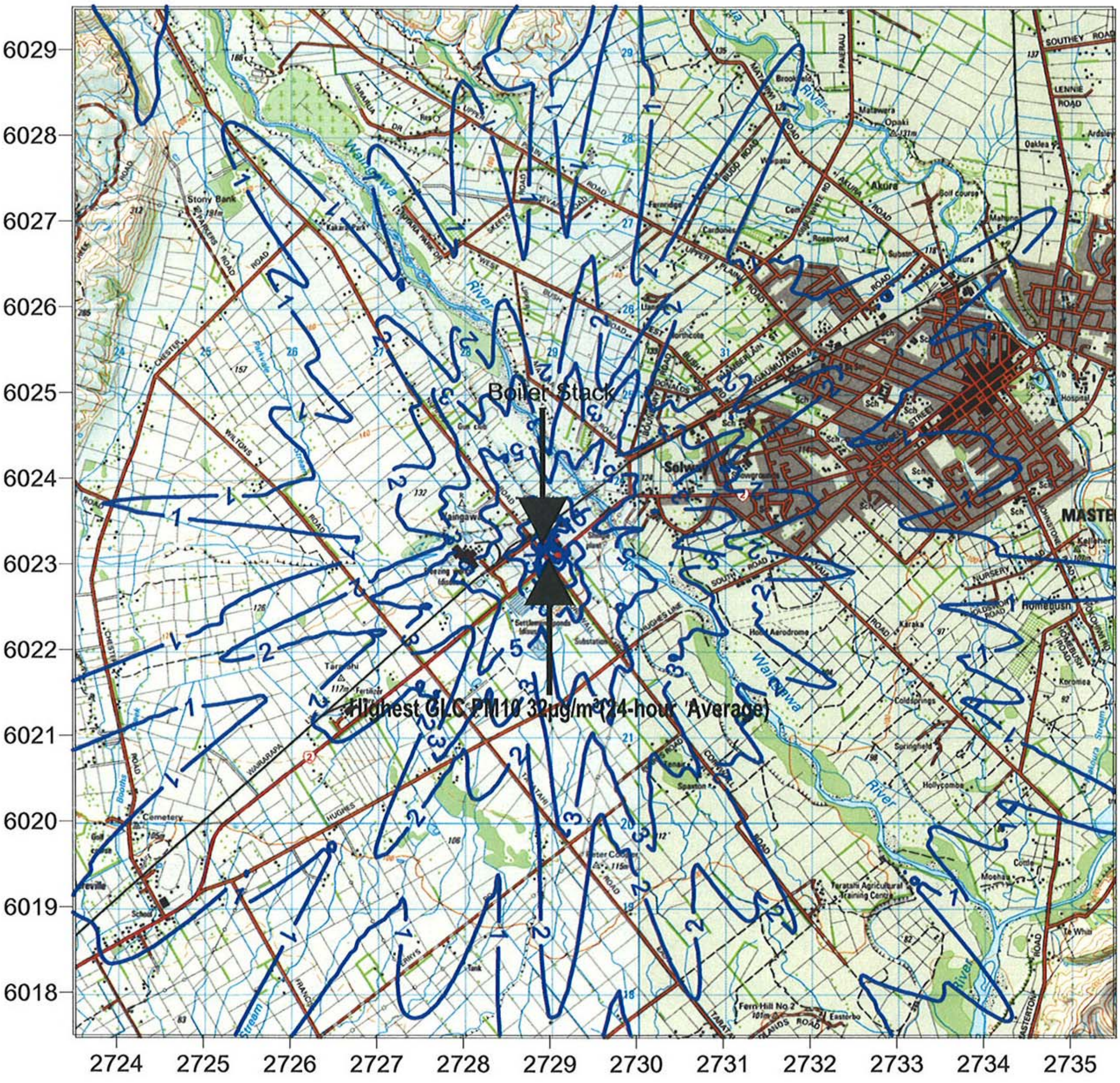
- **Table 11.5: CALPUFF - Highest Predicted Maximum Ground Level Concentrations of Particulate as PM_{10} from Wood-Fired Boiler at 70% of MCR and Fuel Silo Bag Filters (JNLPT03A, B, & C)**

Averaging Time	Wood-Fired Boiler at 70% of MCR – Emission of 8.95 Kg/hour	Fuel Silo Bag Filters at 5 mg/Sm^3 – Emission of 0.041 kg/hour each	Combined Boiler + Silo Bag Filters
1-Hour Average at the 99.9 percentile	61 µg/m^3 – around southern site boundary	20.5 µg/m^3 -	63 µg/m^3 - around southern site boundary
24-Hour Average (highest)	31 µg/m^3 – just south-west of site	4.5 µg/m^3 – close to boiler location	32 µg/m^3 - just south-west of site
Annual Average	2.2 µg/m^3	0.60 µg/m^3	2.5 µg/m^3

The highest predicted ground level concentration of particulate as PM_{10} from the combined fuel silo and boiler discharge is 32 µg/m^3 as a 24-hour average (which is identical to that predicted by AUSPLUME but the location of the highest prediction is slightly different – either on or slightly over the south-south-west site boundary in the vicinity of State Highway 2). The boiler emissions dominate, especially more than a km or so from the plant.

An isopleth diagram over a 12 x 12 km modelling domain illustrating the highest predicted maximum 24-hour average downwind concentrations for particulate as PM_{10} is presented as Figure 11.6.

- **Figure 11.6: Maximum Predicted Ground Level Concentrations of PM_{10} (24-hour average) – Combined Wood-Fired Boiler at 70% MCR plus Fuel Silo bag Filters**



The highest predicted concentrations at Solway are around 2 - 4 µg/m^3, and over the remainder of the Masterton urban area less than around 2 µg/m^3. These concentrations are predicted to occur during south-westerly and westerly wind directions.

The issue in Masterton is, at times, high concentrations of PM$_{10}$ during radiation temperature inversions during the cooler months. During moderately stable meteorological conditions cool air within the ground inversion drains slowly down the slope of the valley (katabatic drainage). In this respect the valley floor contours more or less follow the bed of the Waingawa River which flows from north-west to south-east before turning towards the south just west of Masterton Road. We expect, therefore, that katabatic flow in the Masterton urban area will be towards the Waingawa River then follow the river bed towards the south-east. We also expect that katabatic flow in the Waingawa area will be towards the south-east, and not towards the Masterton urban area which is located north-east of the Waingawa River. The issue of katabatic flow and JNL's emissions is only relevant if the particulate discharges are within the radiation temperature inversion and are not discharging above the inversion ceiling. The dominating JNL emission source is the wood-fired boiler stack.

Following a request by GWRC for SKM to assess the predicted concentrations of particulate over the Masterton urban area in respect to meteorological conditions, we found that this katabatic flow is not demonstrated as a predominant flow when the year 2000 CALMET file is examined. The exception was for the lowest air layer during moderately stable conditions (Stability F) and that air flow on the days that generated the highest predicted 1-hour average concentrations during the cooler months. Generally, air flow 20 to 40 m above ground during stable conditions was from the south-west. It is likely, or course, that the plume will at times discharge above the radiation inversion ceiling, and in this case will follow the direction of the synoptic breeze and have little interaction within the underlying inversion.

The evaluation of predicted particulate ground level concentrations and meteorological conditions is available on request. In summary, we found that our analysis does not indicate, except possibly for 15 August 2000 in north-east Solway, that the contribution by JNL of particulate matter into the Masterton urban area during the cooler months of year 2000 was appreciably adding to PM$_{10}$ discharges into the airshed from domestic solid space heaters and other low-level particulate emitters to cumulatively cause the AirNES to be breached. The reasons for this are:

- The contribution from JNL's significant particulate emission sources (the wood-fired boiler stack and the fuel silo bag filters) would only be potentially significant at night-time during slightly stable and neutral conditions when there is sufficient atmospheric mixing to cause more than minimal impingement of the plumes at ground level.
- During typical Stability F conditions (moderately stable) which are characterised by light winds (up to 3 m/s but typically around 2 m/s) the plumes from elevated discharges fan. Fanning is the result of limited dispersion in the vertical due to lack of atmospheric turbulence and moderate dispersion in the horizontal due to meandering of the plume under typical light wind conditions. Under Stability F conditions, plumes from suitably elevated sources have limited impact on the ground unless the

plume impacts on elevated ground or on high buildings, or if significant fumigation occurs as the ground inversion breaks up during the morning. Significant fumigation is not expected during the cooler months because insolation is relatively weak.

- The year 2000 CALMET dataset is characterised, at least during the cooler months, by slightly stable conditions (Stability E) that have high to very high mixing heights and moderate to high wind speeds some of which are more characteristic of neutral conditions (Stability D). Some Stability E wind speeds exceed the 5 m/s cut-off. Likewise, many Stability F hours also have high mixing heights and higher than expected wind speeds, with some exceeding the 3 m/s cut-off. The higher the wind speed, the better is the mixing within the inversion, and the higher the mixing height (inversion ceiling) the greater is the atmospheric depth for this mixing to occur and to dilute contaminants discharged into the inversion layer. It is likely that the CALMET 2000 dataset is over-predicting wind speeds (we have found this to occur when developing CALMET datasets using TAPM when there is not sufficiently reliable surface meteorological data to assimilate into TAPM).
- On a limited number of occasions, ambient temperatures associated with inverted conditions are relatively mild and unlikely to stimulate widespread use of domestic heating appliances. On other occasions ambient temperatures were sufficiently cool to result in widespread use of domestic heaters. It is difficult to estimate in some cases the ambient air temperatures that will cause widespread use of solid fuel domestic heating appliances. Unfortunately, there is no ambient air PM_{10} monitoring data to enable comparison of predicted conditions with actual conditions.

In any case, the highest predicted particulate concentrations from JNL's activities over the Masterton urban area are generally less than 3 $\mu g/m^3$ as 24-hour averages[14] and such concentrations, even if they occur during radiation temperature inversion conditions, could not be regarded as "significant" (see Section 3.7 in respect to the Chen & Palmer legal opinion of the meaning of the word significantly in respect to regulation 17 of the AirNES [**"**Significant" connotes important or major, not just a few percent.]).

Cumulative Particulate Stack Emissions

As an attempt to assess cumulative particulate emissions, the discharges from the Kiwi Lumber wood-fired boiler, which is located around 850 m to the east of the JNL boiler, and the Oldfield's drum-mix asphalt plant, which is located around 350 m to the east-north-east of JNL's boiler, were included in the modelling. For this modelling AUSPLUME was used with a 3 km x 3 km grid with receptors located

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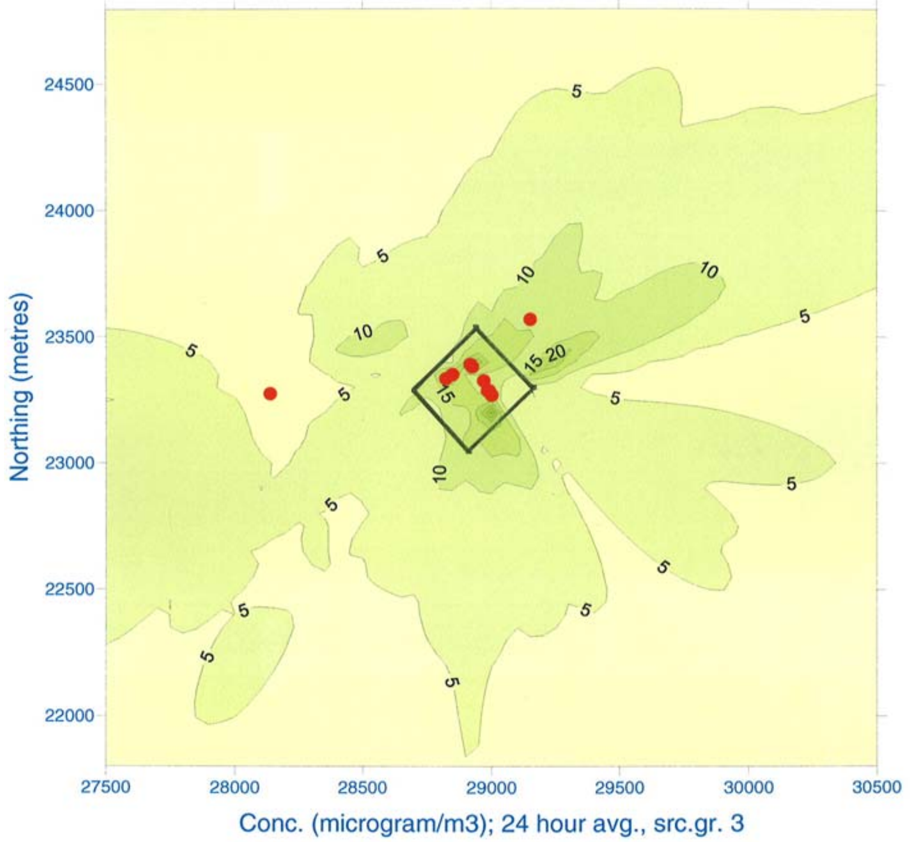
[14] The highest predicted 24-hour average of particulate from JNL's boiler stack was 3.9 $\mu g/m^3$ (2nd highest was 2.4 $\mu g/m^3$). The highest concentration was predicted to occur in June 2000 within south-west Solway. Meteorological conditions were 15 hours of slightly stable conditions with moderate to high wind speeds for this stability (E) category. Although ambient conditions were sufficiently cool to cause widespread use of domestic solid fuel space heaters, the (relatively) high wind speeds and high mixing heights would limit the build-up of fine particulate in the urban air.

every 50 m. The modelling reference is JNLW-PM5. The isopleth diagram illustrating the highest predicted maximum 24-hour average downwind concentrations for the cumulative sources is presented as Figure 11.7.

- **Figure 11.7: Maximum Predicted Ground Level Concentrations of PM_{10} (24-hour average) – Combined Wood-Fired Boiler at 70% MCR plus Bag Filters plus Kiwi Lumber and Oldfield**



Input data for the Kiwi and Oldfield discharge sources is as follows:

- <u>Kiwi Lumber:</u> Wood-fired integrated drier and boiler operating at MCR on a 24-hour/day basis. Stack height and diameter 15 m and 0.80 m, efflux velocity and temperature 16 m/s at 150°C. Rate of particulate discharge at 400 mg/Sm^3 = 4.8 kg/hour. In reality, this boiler will seldom operate at more than around 70% of MCR with a proportionate reduction in particulate emissions.
- <u>Oldfield Construction:</u> Drum-mix asphalt plant operating at around ½ of its 60 tonnes/hour design rate for, on occasions, generally 3 hours per day. We have assumed the plant operates at 60 tph/hour for the following hours every day of the week – 7 to 8 am, 10 to 11 am, and 1 to 2 pm. Stack height and diameter 7 m and 0.60 m, efflux velocity and temperature 15.5 m/s at 70°C. Rate of particulate discharge at 250 mg/Sm^3 = 2.23 kg/hour.

The highest predicted ground level concentration of particulate as PM_{10} when accounting for the emissions from the JNL bag filters and wood-fired boiler plus the Kiwi Lumber and Oldfield emissions is

36 µg/m^3 as a 24-hour average. This is essentially no different from the predicted effects from JNL sources only. The highest concentration is still predicted to occur within JNL's premises, and the JNL wood-fired boiler particulate emissions dominate. The highest concentrations at and exceeding 25 µg/m^3 continue to occur within JNL's premises with a pattern essentially identical to that demonstrated in Figure 11.5 with a few more concentration isopleths occurring in the northern area of the Company's site. Consequently, the effect of the combined JNL and Kiwi Lumber and Oldfield emissions on the down-wind airshed will be minimal.

Other sources of fine particulate in the Waingawa area include fine dust from roads and yards during dry conditions, emissions from vehicles using State Highway 2 and adjacent roads, marine-derived salt, and possibly particulate in ambient air in the Masterton urban area drifting into the Waingawa area during radiation temperature inversion (katabatic drainage). These sources of particulate cannot be easily accounted by the JNL modelling programme.

It should also be taken into account that although the Waingawa area is located in the Wairarapa Airshed, the area where JNL and its industrial and commercial neighbours are located is zoned Rural Industrial.

Note: The emission of particulate from the diesel oil-fired boiler is low and is not accounted for in this assessment. In any case, this boiler only operates when the wood-fired boiler is not operating.

12. Assessment of Effects on the Environment – Combustion Contaminants other than Particulate

12.1 Introduction

Downwind concentrations of contaminants from the wood-fired boiler other than fine particulate, and sulphur dioxide when burning coal as an emergency fuel, have been calculated from the total particulate predictions on a proportional basis relative to the rate of emission of total particulate from the boiler and the highest predicted ground level concentration of total particulate using the following formula:

$$\frac{\text{Rate of emission of contaminant}}{\text{Rate of emission of modelled PM}} \quad \text{x} \quad \text{Predicted concentration of modelled PM}$$

Table 9.1 sets out rates of contaminant discharge from the wood-fired boiler used for this assessment.

To assist the assessment process we have also used dispersion modelling assessment criteria as presented in Tables 12.1A and 12.1B. These assessment criteria are based on:

- For contaminants specified in the Ministry for the Environment's May 2002 Ambient Air Quality Guidelines: predicted maximum ground level concentrations at or beyond boundary of the site in areas where the guidelines apply preferably not to exceed 50% of the guideline level; and
- The National Environmental Standards for applicable contaminants; and
- For contaminants not specified in the MfE's May 2002 Guidelines: 100% of an appropriate guideline from an overseas jurisdiction (for example, the State of Texas effects screening levels).

Table 12.1A: Modelling Assessment Guidelines

Contaminant	Assessment guideline and source
Carbon monoxide	15,000 µg/m^3 – 1 hour average (50% of MfE Guideline)
Dioxin/Furans	3^{-08} µg/m^3 (30 fg/m^3) – annual average (Texas ESL)
Oxides of nitrogen as NO_2 & NO_2 as NO_2	100 µg/m^3 – 1 hour average (50% of the NES standard for NO_2) 50 µg/m^3 – 24 hour average (50% of the MfE Guideline for NO_2) 30 µg/m^3 – annual average (MfE - critical level for protecting ecosystems)
Nitric oxide	300 µg/m^3 – 1 hour average (Texas ESL)
Fine particulate (PM_{10})	10 µg/m^3 – annual average (50% of the MfE Guideline for PM_{10})
Polycyclic aromatic hydrocarbons (PAH's)	Collectively 0.5 µg/m^3 1- hour average (Texas ESL); and BaP 0.00015 µg/m^3 annual average (50% of the MfE Guideline for BAP).
Sulphur dioxide	175 µg/m^3 – 1 hour average (50% of the NES standard for NO_2) 60 µg/m^3 - 24 hour average ((50% of the MfE Guideline for NO_2)

- **Table 12.1B: 2004 National Environmental Standards for Air Quality**

Contaminant	Threshold concentration ($\mu g/m^3$)	Permissible excess
Carbon monoxide	10,000 as an 8-hour running mean	One 8-hour period in a 12-month period
Nitrogen dioxide	200 as a 1-hour mean	9 hours in a 12-month period
Sulphur dioxide	350 as a 1-hour mean 570 as a 1-hour mean not to be exceeded at any time	9 hours in a 12-month period

Texas Commission on Environmental Quality (TCEQ) publishes effects screening levels (ESL's) as 1-hour and annual averages for a large range of substances. They are similar to design ground level concentrations for dispersion modelling – down wind ground level concentrations which, if not exceeded, are believed to be acceptable. If the ESL's are exceeded then additional studies may be warranted to assess the effects on the environment.

12.2 Indicative Highest Maximum Ground Level Concentrations

The indicative modelling results summary for contaminants calculated proportionally from the combined discharge of fine particulate emitted from the combustion appliances operated by the Company are presented in Table 12.2.

- **Table 12.2: Indicative Modelling Results Summary for Contaminants Calculated Proportionally to Total Particulate**

Contaminant	Maximum 1 hr average (99.9%ile) ($\mu g/m^3$)	Maximum 24 hr average ($\mu g/m^3$)	Annual average ($\mu g/m^3$)
PM_{10} Boiler Only from Table 11.5 – 8.95 kg/hour)	*61*	*31*	*2.2*
Carbon monoxide (35.5 kg/hour)	245	-	-
Dioxins/Furans (8.64 x 10^{-08} kg I-TEQ/hour)	-	-	2.1 x 10^{-08} (21 fg/m^3)
Oxides of nitrogen as NO_2 (13.0 kg/hour)	89	45	3.2
Oxides of nitrogen as NO (8.5 kg/hour)	58	-	-
PAH's (16 USEPA Priority) (7.3 x 10^{-03} kg/hour)	0.05	-	-
PAH – Benzo(a)pyrene (1.53 x 10^{-04} kg/hour)	-	-	0.00004

12.2.1 Carbon Dioxide

Carbon dioxide is colourless and odourless, but is a mammalian asphyxiant in high concentrations. CO_2 is present at around 300 ppm (540 mg/m^3) in the atmosphere. While having no direct local or regional impact it is implicated in global climate change.

The forests from which the logs are obtained, and new plantings, provide a sink for CO_2 generated from burning of wood residues.

12.2.2 Carbon Monoxide

Properties of Carbon Monoxide

Carbon monoxide is colourless and odourless, but has high mammalian toxicity in relatively high concentrations. It is slowly oxidised in the atmosphere to carbon dioxide. Its most significant environmental effect, in 'high' concentrations, is human physical health effects.

Dispersion Modelling Predictions

The highest predicted maximum ground level concentration of carbon monoxide from the Company's wood-fired boiler is 245 µg/m^3 as one-hour average at the 99.9 percentile. This concentration is significantly lower that the assessment criterion of 15,000 µg/m^3 expressed as a 1-hour average.

12.2.3 Dioxins & Furans

Properties of Dioxins & Furans

Dioxins (PCDD's) and furans (PCDF's) are compounds consisting of two benzene rings joined by two oxygen atoms (dioxins) or one oxygen atom (furans). From one to eight chlorine atoms can attach to the benzene rings in a variety of positions (each positional relationship is called a congener). Of the 75 possible dioxin congeners, and the 135 furan congeners, only those that have chlorine (or bromine) substitution in the 2,3,7,8 positions are believed to have dioxin-like toxicity. The most toxic dioxin (from laboratory studies) is 2,3,7,8-TCDD and this is assigned a Toxicity Equivalency Factor (TEF) of 1.0. The remaining dioxins and furans have TEF's less than 1.0 and range down to zero. The method for rating toxicity adopted internationally is that of NATO/CCMS (1988) – and the toxic equivalent factors are known as International Toxic Equivalent Factors or I-TEF's. Multiplying the concentration of various dioxins and furans in a sample by the respective I-TEF's gives the toxic equivalents (I-TEQ) of the mix. WHO also have TEQ's and these are similar to the International TEQ's.

These compounds range in toxicity from potentially highly toxic to moderate to low toxicity. They have very low water solubility, are soluble in fats, have low vapour pressure, and tend to bioaccumulate. Most congeners appear to be highly stable under most environmental conditions and show little tendency to leach or volatilise once adsorbed on to particulate matter.

Dioxins and furans are discharged in low concentrations from combustion appliances burning uncontaminated wood, and in moderate concentrations when burning certain 'contaminated' wood.

Of the three mechanisms for generating dioxin emissions (presence of dioxin & furans in fuel, presence of precursor (dioxin-like) compounds in fuel, and *de novo* synthesis), *de novo* synthesis is the most likely cause of dioxin & furan emissions from combustion plant such as boilers. With *de novo* synthesis, dioxins and furans are formed from chemical compounds having little resemblance to the dioxin/furan molecules (non-precursor substances). Non-precursors include chemically unrelated carbon sources such as petroleum products, chlorinated plastics such as PVC, non-chlorinated plastics such as polystyrene, cellulose and lignin (basic constituents of wood), coke, coal, particulate carbon, and hydrogen halides. Like formation from precursor compounds, *de novo* formation is believed to occur in the temperature range of around 450 to 200^{o}C.

The formation mechanisms of dioxins and furans are complicated and not completely understood. A 1999 review on the formation of dioxins by incineration prepared for Environment Australia[15] provides useful information. While formation of dioxins and furans requires organic or inorganic chlorine or bromine, combustion conditions are the most important factor, followed by the presence of contaminants in combustion ash such as carbon, copper and iron (or in boiler construction materials contacted by the combustion gas stream). Dioxin generation is relatively independent of the chlorine concentration of the fuel if combustion conditions are good. If combustion conditions are less than optimum, and ash composition is favourable for dioxin formation, then the rate of dioxin formation appears to be related to the level of chlorine in the fuel.

The Company's fuel is a mix of stem wood residues and residues containing glues and wastewater treatment plant sludge. However, the chlorine content of the fuel mix is unlikely to contain significant amount of sodium chloride and other chlorides since ammonium chloride is no longer used as a MUF hardener. In any case, we selected as an emission factor the lower end of the contaminated wood range (U.K. Emission factors, 1995) since the boiler combustion is good.

Dispersion Modelling Predictions

Dispersion modelling assessed the emission of dioxins & furans from the wood-fired boiler.

The highest predicted maximum ground level concentration is 2.1 x 10^{-08} µg/m^3 (21 fg/m^3) as an annual average. This highest predicted concentration is lower than the assessment criterion of 3 x 10^{-08} µg/m^3 as 2,3,7,8-TCDD Texas Effects Screening Level. The prediction also can be compared with ambient air concentrations in New Zealand urban areas. Ambient air monitoring commissioned by the Ministry for the Environment (MfE 1998[16]) indicated that the concentration of dioxins in air at urban sites evaluated averaged from 28fg/m^3 (Auckland City) to 84fg/m^3 (Greymouth) as long term averages, and for Masterton, about 57fg/m^3. The predicted concentrations downwind of the Company's combustion

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[15] Environment Australia (1999). Incineration and Dioxins - Review of Formation Processes. http://www.ea.gov.au/industry/chemicals/dioxins

[16] Ministry for the Environment. Ambient Concentrations of Selected Organochlorines in Air. December, 1999. ISBN 0 478 09033 1.).

appliances are significantly less than these urban ambient air levels and similar to what has been measured in rural areas (from 1 to 30 fg/m^3).

12.2.4 Oxides of Nitrogen (NO_x)

Properties of Oxides of Nitrogen

Nitric oxide (NO), which is less toxic than nitrogen dioxide, odourless, and colourless, is the primary compound produced during combustion (around 95% of NO_x emitted from most combustion appliances is NO). Up to around 50% of the NO emitted is oxidised to NO_2 over some hours in the presence of atmospheric oxidants (based on Auckland oxidant concentrations).

Nitrogen dioxide is an acidic gas with a characteristic odour. It is substantially more toxic and more reactive than nitric oxide, and is more of concern as an air contaminant if concentrations are excessive. In sufficient concentration, NO_2 irritates the eyes and the respiratory tract and damages vegetation.

Dispersion Modelling Predictions

Dispersion modelling assessed the emission of oxides of nitrogen expressed as NO_2 from the boiler. The highest predicted maximum ground level concentrations are 89 µg/m^3 as a one-hour average, 49 µg/m^3 as a 24-hour average, and 3.2 as an annual average.

The highest predicted NO_x as NO_2 ground level concentrations as a 1- hour, 24-hour, and annual averages are 45% or less of the guideline and AirNES levels, even without calculating the actual nitrogen dioxide concentrations. According to Jansen et al (1998)[17] observations of the ratio NO_2/NO_x in the plume less than a kilometre from the source is generally 10% or less. Therefore, the actual highest predicted off-site concentrations of NO_2 can be assumed to be less 5% of the guideline and AirNES levels.

The highest predicted concentration of nitric oxide as NO is 58 µg/m^3 as a 1-hour average. This concentration is 20% of the assessment criterion used (the Texas ESL).

12.2.5 Odour

Excessive odour emissions from many industrial activities causes nuisance to people living or working in the adjacent areas. Odour as such, is not ‘toxic’, but if objectionable or offensive odour episodes are frequent then sensitive people may demonstrate physical effects.

The rate of odour emission from combustion appliances is difficult to accurately quantify. Combustion appliances like those operated by the Company will not cause odour nuisance under normal operation when appropriately managed.

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[17] Janssen et all, *A classification of NO oxidation Rates in Power Plant Plumes Based on Atmospheric Conditions,* IN Atmospheric Environment Vol. 22. No 1 pp 43 -53, 1998.

12.2.6 Polycyclic Aromatic Hydrocarbons (PAH's)

Properties of PAH's

Many PAH's are suspected of being carcinogenic. The best studied is benzo(a)pyrene which is classified as a suspected human carcinogen. Most PAH's are discharged to atmosphere adsorbed on to particulate and are degraded by sunlight. The AP-42 emission factors for benzo(a)pyrene from the combustion of wood are low and providing the Company's combustion appliances are appropriately maintained and operated, the emission of PAH's will not be significant.

Dispersion Modelling Predictions

Dispersion modelling assessed the emission of total priority PAH's, and benzo(a)pyrene (BAP) from the wood-fired boiler.

The highest predicted maximum ground level concentration of total PAH's in combustion gases discharged from the Company's combustion appliances is 0.05 µg/m^3 as a 1-hour average. This concentration is 10% of the assessment criterion (Texas ESL) of 0.5 µg/m^3 expressed a 1-hour average.

The highest predicted maximum ground level concentration of BAP in combustion gases is 0.00004 µg/m^3 as an annual average. This concentration is less than 15% of the Ministry for the Environment's guideline level.

12.2.7 Water Vapour (Steam)

The emission of water vapour from the boiler stack will only be visually apparent during cool conditions and low wind speeds. However, water vapour does condense onto emitted particulate and increases its visibility during cool and dry conditions because evaporation of water vapour is inhibited. This may be more apparent at night-time under moonlight conditions when the plume may have a 'luminous' appearance.

12.2.8 Emissions under Upset Operation

Under upset conditions, the emission of products of incomplete combustion (smoke and odour) and particulate generally substantially increases but upset operation is infrequent from reasonably well designed and operated wood-fired combustion plant.

12.3 Diesel Oil-fired Boiler

Rates of emission of various contaminants from the oil-fired boiler are presented in Table 7.3 of Section 7.

These emissions have not been formally assessed because this boiler only operates when the wood-fired boiler is being serviced, and since the fuel (automotive diesel oil) is now a low sulphur fuel, the emissions from this appliance will not cause adverse effects (if any) that are more than minor.

12.4 Sulphur Dioxide

12.4.1 Introduction

Coal is used as an emergency fuel if problems with the wood fuel feed systems occurs that cannot be quickly rectified. Such problems are rare. In addition, about 5 tonne of coal is burnt per month to ensure the coal feed system remains functional.

The emission of sulphur dioxide from the wood-fired boiler stack was assessed by assuming 2,500 kg of coal per hour was burnt in the boiler for 24 hours, and for 12 hours commencing at 6 am and for 12 hours commencing at 6 pm. 2,500 kg/hour is equivalent to around 40% of the maximum continuous rating of the boiler. It was assumed that the sulphur content of coal was 0.25% which is the upper limit for Waikato coals currently available to industry, and on this basis, the rate of generation of sulphur dioxide would be 12.5 kg/hour. It was also assumed that 10% of sulphur dioxide generated reacted with the ash in the boiler, giving a rate of discharge of 11.25 kg/hour.

This rate of emission was assessed by atmospheric dispersion modelling using AUSPLUME Version 6 and the meteorological dataset for East Taratahi 1999 (see section 11.2.2). The stack gas efflux temperature and velocity was assumed to be around 150^{o}C and 7.5 m/s respectively based on operating the boiler at 42% of MCR with an oxygen content in stack gases of 11% oxygen by volume dry basis.

It was also assumed that the emission of sulphur dioxide from other industrial and commercial activities in the area, and the contribution from road traffic and the occasional train, is minimal.

12.4.2 Properties of Sulphur Dioxide

Oxides of sulphur are generated by the combustion of sulphur in fuels. Sulphur dioxide is the principal oxide generated. Sulphur trioxide is also generated in minor concentrations by oxidation of sulphur dioxide in down-stream of the combustion chamber.

The background concentrations of sulphur dioxide throughout New Zealand away from specific point sources are generally low.

Sulphur dioxide is a colourless and pungent gas which, in sufficient concentration, irritates the eyes and respiratory tract and may damage vegetation, and promotes corrosion of some materials. Sulphur dioxide is a reactive gas, which is neutralised (in the presence of moisture), in contact with rocks and soil form sulphates.

The odour threshold of sulphur dioxide is reported as 0.33 to 5.0 ppmv (950 to 14,000µg/m^3) so the gas cannot be smelt by most people at the current 1-hour ambient air guideline level.

The current N.Z. guidelines and standards for ambient air sulphur dioxide are presented in Table 12.1B.

WHO Air Quality Guidelines Global Update 2005 - Report on a Working Group Meeting, Bonn, Germany, 18-20 October 2005, updated the guideline values for sulphur dioxide, setting as 24-hour averages an interim (1) guideline of 125 μg/m^3, an interim (2) guideline of 50 μg/m^3 and a final guideline of 20 μg/m^3 as a 24-hour average, which WHO (2005) has recommended as a "prudent precautionary level." The WHO short-term average of 500 μg/m^3 as a 10-minute average, is unchanged.

It is apparent from the WHO (2005) documentation that there is concern about public health effects at low levels of SO_2, This concern was initially based on the results of a Hong Kong study (2002) which reported a substantial reduction in health effects corresponding with a major reduction in sulphur content in fuels over a short space of time. Time series studies on hospital admissions in Hong Kong and in London (2002); and studies in Canadian cities, supported the concern. WHO does state, however, there is considerable uncertainty as to whether SO_2 is the pollutant responsible for the observed effects, or is a surrogate for ultra-fine particles or some other correlated substance. The Working Group considered, however, that there was a need to provide a greater level of protection and thus has reduced the 24-hour average guideline accordingly.

We understand the Ministry for the Environment is currently undertaking work to consider whether the New Zealand standards and guidelines should be formally reviewed in light of the WHO 2005 guidelines and supporting technical information.

12.4.3 Dispersion Modelling Predictions

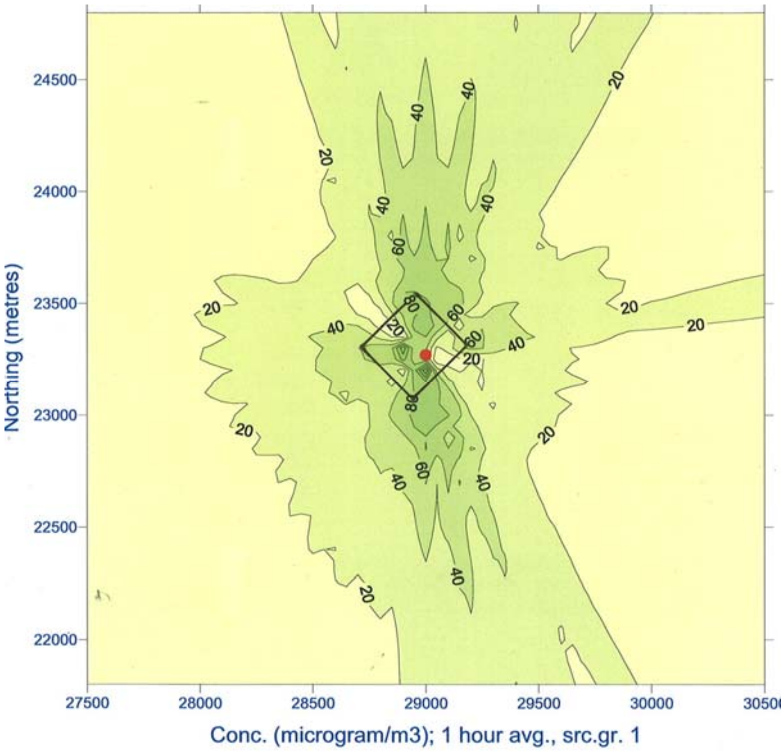
The modelling summary (highest predicted maximum ground level concentrations) for the sulphur dioxide emissions from the Company's boiler when burning coal is presented in Appendix A. The results of modelling using AUSPLUME of ground level concentrations outside of the Company's premises are presented in Table 12.3.

- **Table 12.3: AUSPLUME - Highest Predicted Maximum Ground Level Concentrations of Sulphur Dioxide from the Wood-Fired Boiler Stack when burning 2,500 kg/hour of Coal (JNLW-SO2-01)**

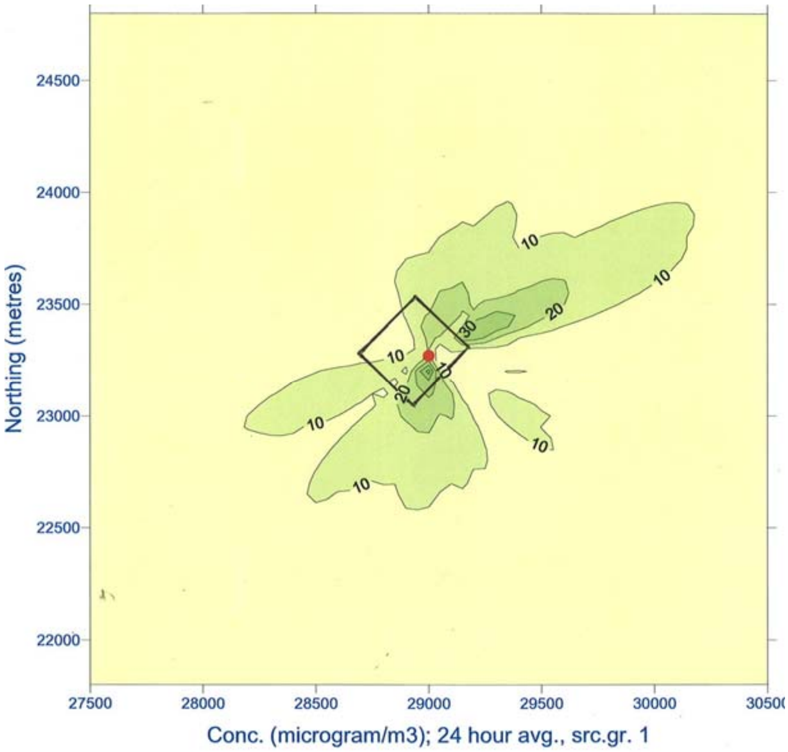
Scenario	**1-Hour Average 100%ile (μg/m^3)**	**24-Hour Average (μg/m^3)**	**Assessment Guideline**
24-hour operation	157 on-site 95 off-site (south of stk)	54.4 on-site 40 off-site (n-east of stk)	175 μg/m^3 – 1 hour average (50% of the NES standard for NO_2) 60 μg/m^3 - 24 hour average ((50% of the MfE Guideline for NO_2)
12 hour operation – 6 am to 6pm	157 on-site 95 off-site (south of stk)	40.7 on-site 25 off-site (north of stk)	
12 hour operation – 6pm to 6 am	147 on-site 95 off-site (south of stk)	23.2 on-site 20 off-site (n-east of stk)	
Scenario	**1-Hour Average 99.9%ile (μg/m^3)**		
24-hour operation	~ 130 on-site < 95 off-site (south of stk)		

Isopleth diagrams covering a 3 x 3 km modelling domain illustrating the highest predicted maximum 1-hour and 24-hour average downwind concentrations for sulphur dioxide based on the emission of 11.25 kg/hour over 24-hours are presented as Figures 12.1 and 12.2. The black square on the diagrams is the Company's factory site boundary.

- **Figure 12.1: Maximum Predicted Ground Level Concentrations of SO_2 (1-hour average 100 percentile) 11.25 kg/hour over 24 hours**



- **Figure 12.2: Maximum Predicted Ground Level Concentrations of SO_2 (24-hour average) 11.25 kg/hour over 24 hours**



An annual average was not computed because of the infrequent use of coal as an emergency fuel and to ensure the coal feed system remains operational.

The highest ground level concentrations are predicted to occur within the Company's premises as a consequence of downwash from adjacent buildings.

In respect to the highest predicted maximum ground level concentrations as 1-hour averages, the highest off-site concentrations are all 95 $\mu g/m^3$ which are predicted to occur south of the boiler stack. These predicted concentrations are 55% of the assessment criterion or around ¼ of the 1-hour AirNES standard.

The highest predicted maximum ground level concentration as 24-hour average off-site is 40 $\mu g/m^3$ for continuous operation. This concentration is predicted to occur north-east of the stack and is 2/3^{rds} of our assessment criterion and 1/3rd of the MfE ambient air guideline level. Reduced operation indicates highest off-site concentrations of SO_2 of around ½ of the continuous operation off-site prediction.

Given that background concentrations of sulphur dioxide will be low, these predicted concentrations of SO_2 are not an issue in respect to current standards and guidelines.

It is possible that under adverse meteorological conditions that the concentration of SO_2 just outside of the Company's site but probably still within the industrial zone could exceed the new 20 $\mu g/m^3$ WHO guideline if coal was burnt for 24-hours or more.

13. Assessment of Effects on the Environment - Organic Compounds from the Veneer Driers and Timber Drying Kilns

13.1 Introduction

The actual and potential effects on the environment of operating the Company's veneer driers and timber drying kilns have been assessed from Sinclair Knight Merz experience from similar activities elsewhere and by computer dispersion modelling.

13.2 Dispersion Modelling

AUSPLUME was used for the veneer drier and kiln assessments because it is appropriate for un-complicated terrain and with effects that are going to be relatively local in extent. The model is also less complicated and less time-consuming to operate than CALPUFF, especially with the large number of vents (6 and 8 discharge vents per kiln). AUSPLUME contains the PRIME algorithms, which were used to account for building wake effects caused by winds blowing over and around the Mill buildings.

The model was run with a 3 km x 3 km grid with receptors every 50 m and flat terrain. Downwash potential in the lee of structures was included using the Building Profile Input Programme (BPIP). Actual building heights have been included (maximum height of 15 m).

13.3 Modelling Assessment Guidelines & Standards

Guidelines used for assessing the effects of kiln discharges on the environment are presented in Table 13.1.

- **Table 13.1: Assessment Guidelines for Kiln Discharge Assessments**

Contaminant	Assessment Guideline and Source
Formaldehyde	50 µg/m^3 – 30-minute average (50% of the WHO/MfE guideline)
Acetaldehyde	90 µg/m^3 – 1 hour average based on odour (Texas ESL)
Acetic acid	250 µg/m^3 – 1 hour average (Texas ESL)
Ethanol	18,800 µg/m^3 – 1 hour average (Texas ESL)
Formic Acid	90 µg/m^3 – 1 hour average (Texas ESL)
Methanol	2620 µg/m^3 – 1 hour average (Texas ESL)
α-Pinene	60 µg/m^3 – 1 hour average based on odour (Texas ESL)
ß-Pinene	None specified

Formaldehyde is used as the key contaminant, especially for emissions from timber drying kilns.

13.4 Rates of Emission of Wood Drying VOC's

These are presented in Tables 6.1 of Section 6 (veneer driers), and Tables 7.1, 7.2, and 7.3 of Section 7. For the kiln component of this assessment, only five conventional temperature kilns operating at 90/60°C drying schedules (and assumed to be operating simultaneously) were used for the assessment. The rates of emission of VOC's are those from Table 7.2 which are rates of emission determined by the FRI from a commercial kiln operating at a 100/70°C schedule. Consequently, rates of emission from kilns operating on a 90/60°C schedule will be less, but probably not significantly so. The other kilns operated by JNL run on much lower temperature schedules and for much longer drying times thus the rate of emission of VOC's from those kilns will be significantly less than reported in Table 7.2. In addition, since not all kilns operate at the same time (operation is staggered) the assessment, which assumes simultaneous operation, is conservative. To make the assessment more conservative, we assumed that drying time was 65 hours where in practice drying time is normally 72 hours. The nominal wood volume for the kilns assessed is 450 m^3.

The three veneer driers were assumed to be operating at full capacity.

13.5 Formaldehyde Modelling

13.5.1 Properties of Formaldehyde

Formaldehyde is emitted from veneer driers and timber drying kilns,in minor concentrations in combustion gases from solid fuel-fired boilers, and in minor to moderate concentrations from sawdust and similar driers.

The World Health Organisation (1987)[18] recommended that to avoid irritation to people formaldehyde concentrations in air should be kept below 0.1mg/m^3 (100µg/m^3) as a 30 minute average. WHO confirmed this guideline in 1999[19]. The N.Z. Ministry for the Environment has now adopted the WHO guideline as the New Zealand ambient air guideline[20].

The odour detection threshold is reported as ranging from 60 to 1200µg/m^3.

Formaldehyde is also listed by IARC as a suspected human carcinogen. However, various agencies have identified measures of cytotoxicity in the nasal mucosa after exposure to formaldehyde do not occur at concentrations less than 2,400 µg/m^3. Since the reliable threshold for sensory irritation occurs at concentrations (500 – 1200 µg/m^3) substantially less than those required for cytotoxicity, nasal cancer can be prevented by controlling for sensory irritation. (Drew 2001)

There is little published information about the effects of formaldehyde on vegetation. N.Z. studies in the mid-1970's suggested that 1ppm (1.2mg/m^3) of formaldehyde was safely below the limit for vegetation damage. High doses adversely affects soil metabolism and impairs pollen germination. In ruminant

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[18] World Health Organisation. Air Quality Guidelines for Europe, 1987. WHO Regional Publications, European Series No.23. ISBN 92-890-1114-9.

[19] World Health Organisation (2000). Air Quality Guidelines (In Press). Available at http://who.int/peh/air/airqualitygd.html

[20] Ministry for the Environment, Wellington. Ambient Air Quality Guidelines. May, 2002

animals, formaldehyde in feed protects dietary protein in the rumen and increases utilisation of amino acids.

Aldehydes are not environmentally persistent – formaldehyde, for example, has a half life in air of 1 to 3 hours depending on air temperature and sunlight. It is oxidised in air, in soil, and in water to carbon dioxide and water; undergoes biodegradation in natural water; and is degraded by micro-organisms in soils and sludge. Consequently, it does not accumulate in the environment.

Formaldehyde is also widespread in the environment (it is a product of mammalian metabolism, and is present in foods such as cheese, tomatoes, meat, fish, and apples, at concentrations ranging from 3 to 20mg/kg). Tests by Nelson Pine Limited in 1996 indicated that the concentration of formaldehyde in an apple orchard near their Mill (with, presumably, a significant quantity of fallen fruit on the ground) was up to 54µg/m^3 during light wind conditions when mill discharges were not impacting on the orchard[21].

13.5.2 Dispersion Modelling Predictions

The highest predicted maximum ground level concentrations of formaldehyde are presented in Table 13.2. The modelling output summary (JNLW-Form1B) is included in Appendix A.

Modelling outputs are 1-hour averages at the 100 percentile. The 30-minute averages are calculated using the Power Law with a factor of 0.20.

- **Table 13.2: Predicted Highest Maximum Ground Level Concentrations of Formaldehyde (JNLW-Form1B)**

Boiler (at 70% MCR – Highest Test Result)	Veneer Driers (Highest test Result)	Kilns (Based on 350 m^3 at 100/70^{o}C	All Sources
Formaldehyde – 1 Hour Average			
4.7 µg/m^3 on-site. Highest off-site 3 µg/m^3 south of boiler.	15.5 (with Taihei drier 11.7) µg/m^3 on-site. Highest outside JNL land 6 µg/m^3 south-west.	1.9 µg/m^3 on-site. Highest off-site 1.2 µg/m^3 south of kilns.	15.5 µg/m^3 on-site. Highest outside JNL land 6 µg/m^3 south-west.
Formaldehyde – Calculated 30 Minute Average (1-Hour Average x 1.15)			
5.4 µg/m^3	18 µg/m^3	2.1 µg/m^3	18 µg/m^3

An isopleth diagram of all sources combined is presented as Figure 13.1.

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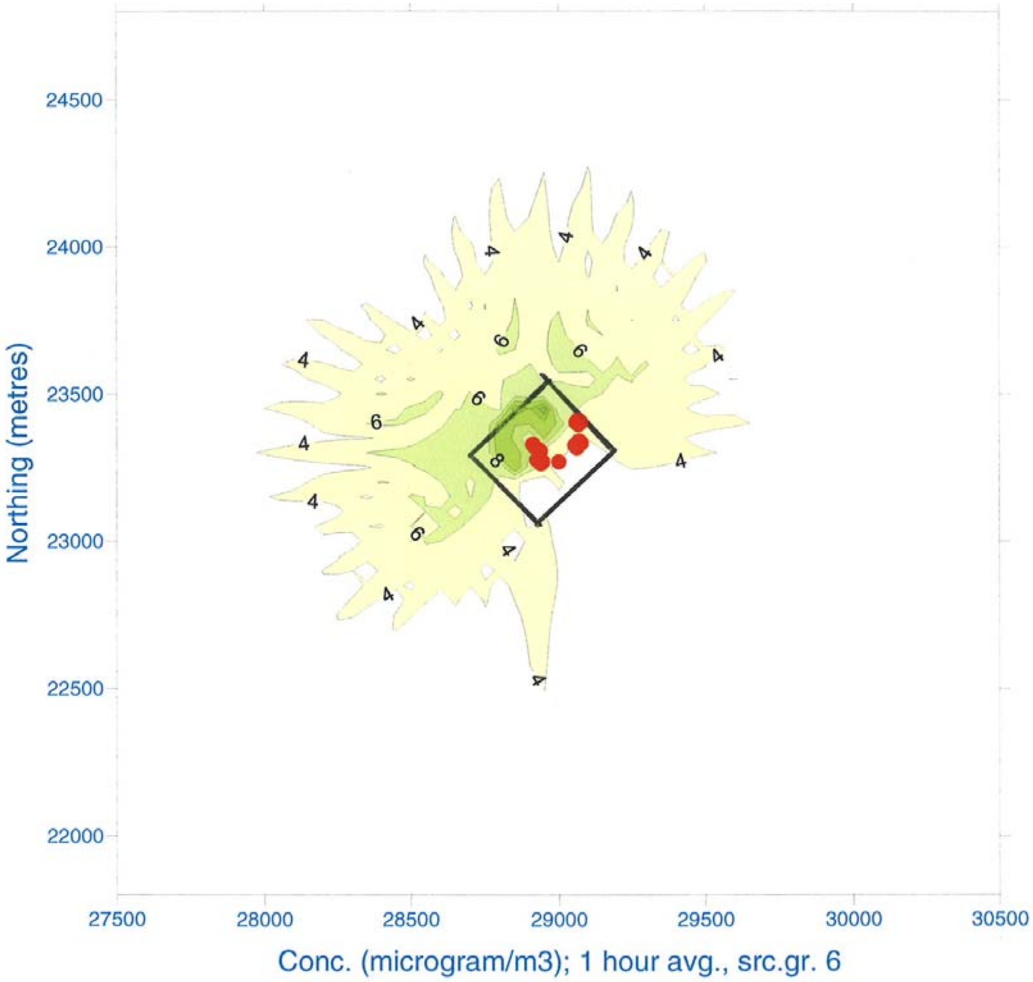
[21] Evidence of Philip Wilson to Tasman District Council, 22 July 1996. Formaldehyde testing by USEPA Method TO 11 and 1 hour averages, with analyses by ESR Environmental.

- **Figure 13.1: Predicted Highest MGLC's Formaldehyde when Operating Boiler, 3 Veneer Driers, and 450 m^3 of CT Kilns (100 percentiles)**



The highest maximum ground level concentrations of formaldehyde are all predicted to occur within the Company's site. The highest concentration predicted to occur outside of land owned by JNL is 6 µg/m^3 – on Oldfield's site to the north-east, and on Norfolk Road and land further south-west. Note: The land to the north-west of the Company's site is owned by JNL.

On this basis, the emission of formaldehyde from the Company's activities will not cause adverse effects in the community, nor cause adverse effects on vegetation.

13.6 Emission of other Volatile Organic Compounds from Kilns

13.6.1 Properties of other VOC's

A variety of volatile organic compounds are emitted from timber drying kilns and from generally from similar processes such as drying of wood veneer and wood fibre. The principal volatile compounds emitted from timber drying kilns are indicated below. Some of these VOC's are also emitted in low concentrations from combustion of wood in thermal plant, and when drying sawdust.

Acetaldehyde

Acetaldehyde is emitted from timber drying kilns, from veneer driers, from veneer hot presses, and in minor concentrations in combustion gases from solid fuel-fired boilers.

Acetaldehyde is generated from partial decomposition of wood at elevated temperatures. This compound is less significant as an air contaminant than formaldehyde. The toxicity of acetaldehyde, based on relative occupational threshold limit values for example, is some two orders of magnitude less than for formaldehyde. The WHO ambient air guideline for acetaldehyde is 2,000µg/m^3 as a 24-hour average (WHO 1995 & 1996) based on irritation. The Victorian EPA design ground level concentration is 82µg/m^3 as a 3-minute average based on odour (which is equivalent to about 50µg/m^3 as a 30 minute average). The Texas Effects Screening Level for acetaldehyde is 90 µg/m^3 as a 1-hour average based on odour effects.

The odour detection threshold is reported[22] (range of all referenced values) ranging from 0.0028 to 1000 ppm by volume.

Acetaldehyde is listed by IARC as a suspected human carcinogen. Although the data base and research for acetaldehyde is relatively poor compared to formaldehyde, there is enough similarity between the two aldehydes for the assumption of a threshold for acetaldehyde-induced tumours in rat nasal epithelium, and that the mode of action is very likely to be dependent upon cytotoxicity at the tumour induction sites. There is also a large dose mass differences between the 24 hour guideline recommendation of WHO (2000) of 2,000µg/m^3, the no observed effects level (NOEL) for human irritancy of 45,000µg/m^3, and the NOEL for nasal tissue damage in the rat of 275,000 µg/m^3. (Drew 2001).[23]

Acetic and Formic Acids

Acetic acid (an organic acid) in gaseous form has a pungent odour and a smell of vinegar. Its odour threshold is reported as 75 to 375µg/m^3 air. While acetic acid is moderately toxic in high concentrations, it is an approved as a food additive and for preservation of some foods. Gaseous acetic acid has a Workplace Exposure Standard of 10 mg/m^3 as a 8-hour time weighted average and a short term exposure limit of 25 mg/m^3. The Texas Effects Screening Level is 250 µg/m^3 as a 1-hour average.

Formic acid (an organic acid) in gaseous form has a pungent penetrating odour and has similar toxicity to acetic acid. Its odour threshold is reported as 3 to 640 mg/m^3 (range of all referenced values). Gaseous formic acid has a Workplace Exposure Standard of 9.4 mg/m^3 as an 8-hour time weighted average and a short term exposure limit of 19 mg/m^3. The Texas Effects Screening Level is 90 µg/m^3 as a 1-hour average.

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[22] ACGIH. Odor Thresholds for Chemicals with Established Occupational Health Standards. 1989.

[23] Drew, R. Comments on Proposed Air Quality Guidelines for Formaldehyde and Acetaldehyde for New Zealand. Toxicos Pty. Ltd., Victoria, Australia, March, 2001.

Ethanol (Ethyl Alcohol)

This alcohol has low toxicity and is not an issue as a contaminant in air. Its odour threshold is reported as 5.5 to 7800mg/m^3. During kiln drying the alcohol is emitted as a wood extractive. The Texas Effects Screening Level is 18,800 µg/m^3 as a 1-hour average.

Methanol

Methanol is generated by the breakdown (pyrolysis) of wood material at elevated temperature. It has an alcohol-like odour, with an odour threshold reported as 5.5 to 7800mg/m^3. It has low to moderate toxicity, with a Workplace Exposure Standard of 262 mg/m^3 as an 8-hour time weighted average and a short term exposure limit of 328 mg/m^3. The Texas Effects Screening Level is 2,620 µg/m^3 as a 1-hour average.

Pinene & Terpineol

Pinenes are terpenes which are a group of unsaturated hydrocarbons occurring in most essential oils and oleoresins of plants and some plant fruits such as citrus fruits. Terpenes derived from *Pinus* species have a pine-like odour, a relatively high vapour pressure thus are volatile at moderate temperatures, and have low mammalian toxicity. The Texas Effects Screening Level for α-pinene is 60 µg/m^3 as a 1-hour average based on odour. There is no Texas ESL for ß-pinene.

Terpineol is a terpene derivative (such as is camphor and menthol). This compound also has low mammalian toxicity (it is used as a flavouring agent, in medicine, and in perfumes and soaps). The Texas Effects Screening Level is 1,000 µg/m^3 as a 1-hour average.

13.6.2 Indicative Highest Predicted Ground Level Concentrations

We have calculated the predicted maximum ground level concentrations of principal VOC's emitted from timber drying kilns on a proportionate basis to the highest mglc of formaldehyde. These are presented in Table 13.3.

The rates of emission are calculated from Table 7.2 (FRI emission factors) on the following basis: grams of contaminant per m^3 of wood x m^3 of wood processed per drying cycle for each kiln ÷ the drying time for each kiln = rate of contaminant discharge (g/hour) for each operating kiln.

All of the highest predicted VOC concentrations occur within the Company’s site.

- **Table 13.3: Predicted Highest MGLC's for Principal VOC's - Green Timber 350 m3 of Kilns - Average Rate of Emission (100 percentile)**

	Maximum Ground Level Concentrations of Kiln VOC's (all µg/m^3 – 1 Hour Averages)						
Contaminant	Formald.	Acetald.	α-pinene	ß-pinene	Acetic Acid	Formic	Methanol
(and Rate)	5.65 g/hour	46.6 g/hr	641 g/hr	1352 g/hr	70.5 g/hour	41.5 g/hour	154 g/hour
Multiplier	1.00	8.25	113.5	239.3	12.5	7.35	27.25
Highest mglc at/ beyond boundary	1.9 µg/m^3	16 µg/m^3	215 µg/m^3	455 µg/m^3	24 µg/m^3	14g/m^3	52 µg/m^3

All indicative highest maximum ground level concentrations of the above organic compounds are less than the environmental guidelines selected (Texas ESL's) except for α-pinene.

The indicative highest maximum ground level concentration of α-pinene (455 $\mu g/m^3$ as a 1-hour average) is around $3^{1/2}$ times higher than the Texas ESL of 60 $\mu g/m^3$, which is set for odour. On this basis, a pine-like odour will be noticed at times outside of the Company's site. It is unlikely that pine-like odours cause odour annoyance in the industrial, commercial, and rural areas.

There are no ambient air guidelines for ß-pinene thus the indicative highest maximum ground level concentration of 455 $\mu g/m^3$ as a 1-hour average cannot be usefully assessed. However, this wood organic compound (which has a pine odour) has low toxicity but will add to the pine-like odour of kiln and other discharges.

The emission of wood organic compounds from kilns is not uniform over the drying cycle. Generally the maximum rate of emission only occurs for a few hours. The stage in the drying cycle and the time over which higher than average rates of emission occurs also varies with the contaminant species. As a necessity, operation of the kilns is staggered to even out heat demand and to better utilise manpower which also smoothes out VOC emissions. This procedure also smooth's out the emission of kiln VOC's.

13.6.3 Discharge of Antisapstain Actives during Kiln Drying

In view of the generally low volatility of the antisapstain formulation biocides used, emissions into air with kiln drying gases will be low. This is supported by evaluation of the properties of the actives and by anecdotal information from kiln and yard workers at various mills who are often exposed to relatively 'high' concentrations of kiln drying gases.

13.7 Emission of Volatile Organic Compounds from Veneer driers and from Presses

The estimated discharge of VOC's from the veneer driers and the presses are presented in Table 6.2 of Section 6. We have not attempted to model these discharges except the C1 to C3 aldehydes because it is a complicated procedure.

Evaluation of the VOC emissions indicates that the contaminants most likely to be emitted at the highest rates are:

- From the Veneer Driers: α-pinene, β-pinene, limonene, 3-Carene, methanol, and p-mentha-1,5-diene, and acrolein ; and
- From the Presses: methanol and pinene.

Of these, the pinenes and methanol are discussed above as kiln contaminants. Pinenes have low toxicity but are odorous (pine-smell), and methanol has relatively low toxicity as an air contaminant. The remaining contaminants are discussed below.

13.7.1 Properties of other VOC's

3-Carene

This compound is a terpene and is commercially derived from wood turpentine. It has a pine-like odour, and low toxicity.

Limonene

Limonene is also a terpene extracted from oils in lemons and other citrus fruits, and used as flavouring and in perfume materials. It has low toxicity.

p-mentha-1,5-diene

This compound, which has an alternative name Phellandrene, is a terpene of the same class as limonene, that is used in the perfume industry. Toxicity is apparently low.

Acrolein

Acrolein is an aldehyde with a disagreeable and pungent odour and is irritating to the eyes and nose. It is assigned a Texas ESL of 3 $\mu g/m^3$ as a 1-hour average.

13.7.2 Assessment of Effects on the Environment

The emission of aldehydes, except for acrolein, have been assessed as formaldehyde equivalents. Since the concentration of aldehydes reported as formaldehyde appear to be at a relatively low concentration beyond the boundary of the Company's site (about 6 $\mu g/m^3$ as a 1-hour average), it is unlikely that the emission of acrolein from the veneer driers and the presses will cause adverse effects on the environment providing the emission of 'blue haze' is minimised.

The emission of the other VOC's are unlikely to cause adverse effects in the area even through the emission of pinenes and other terpenes will add to the pine-like odour.

14. Assessment of Effects on the Environment - Wastewater Treatment Plant

As discussed in Section 10, odour issues resulting from the Company's stormwater ponds caused, in late 2007, objectionable odour issues resulting in an abatement notice being served by GWRC.

These issues were evaluated by Better Technical Options Limited (BTO) who recommended remedial action which included de-sludging the ponds and modifications to operating procedures and the fitting of weirs to minimise carryover of solids into the ponds, a sludge sump for Pond 1, and aeration of the ponds.

BTO is confident that these measures will ensure that the condition of the stormwater ponds in future should not cause objectionable odour.

In addition, a long-term disposal route for treated effluent from the wastewater treatment plant is being investigated including negotiations with the Masterton District Council for a Trade Wastes Consent and other disposal routes. We understand that BTO is working on the viability of spray irrigating treated water onto the Company's 10 ha farmland to the north-west of the railway line. Since this approach looks viable, an application to GWRC for a discharge to land permit is expected to be made in the not too distant future.

15. Cumulative Effects

Contaminants discharged from the Company's combustion appliances and wood processing plant will combine with other contaminants in the air resulting from other local land use activities. The following summarises the potential of emissions from sawmill activities to accumulate in the environment.

15.1 Carbon Dioxide and Carbon Monoxide

These gases are generated when burning wood fuels. Carbon monoxide is slowly oxidised in the atmosphere to carbon dioxide. Carbon dioxide is strongly implicated in climate change. However, rate of emission of carbon oxides is relatively low and more than compensated by photosynthesis within the plantations from which logs are derived, and new plantings.

15.2 Dioxins and Furans

These compounds, while they degrade to some degree in sunlight in the presence of oils and waxes such as on the surface of vegetation, when washed into the soil they have very long half-lives. They also tend to bioaccumulate. The rate of emission of dioxins and furans from burning wood residues in well-managed boilers is low, and rate of discharge is minimised by efficient operation of combustion appliances.

15.3 Formaldehyde from Veneer Driers and Kilns

Formaldehyde is widespread in the environment. It forms naturally in the atmosphere by the oxidation of methane. It is a product of mammalian metabolism; is present in fruit such as apples and cheese; in smoke from food fried in oil; and in tobacco smoke. Formaldehyde is also discharged from motor vehicle engine exhausts. Formaldehyde is a reactive contaminant, which has a half-life in air of some 1-3 hours depending on air temperature, oxidant concentrations, and sunlight intensity. It is oxidised in air, in soil, and in water, to carbon dioxide and water. Consequently, it does not accumulate in the environment. In view of formaldehyde's high reactivity and expected low ambient air concentrations from contributions from other sources, the potential for cumulative effects of formaldehyde is essentially nil in the proposed environment.

Background concentrations of formaldehyde will be low.

15.4 Other Wood Organic Compounds from the Veneer Driers and Kilns

The discharge of wood organic compounds generally from the drying of wood are degraded in the atmosphere, in water, and in soil, by chemical and microbial activity and will not accumulate. Many of these compounds, especially the wood extractives, are also emitted from vegetation including from pine during normal tree metabolism, and when lumber is being milled and air dried, albeit at a much slower rate than during kiln drying and drying of veneer.

15.5 Oxides of Nitrogen

The principle oxide of nitrogen generated by combustion equipment is nitric oxide (NO). Possibly up to 50% of the NO emitted may oxidise to nitrogen dioxide over periods of hours in polluted atmospheres but a much lower rate of oxidation is expected in areas such as the Wairarapa. NO_2 is a reactive gas and oxidises in air to nitrous and nitric acids. These acids react with soils to form nitrates and some nitrites. Consequently, NO and NO_2 do not, as gases, accumulate in the environment. The emission of oxides of nitrogen from the Company's combustion appliances will not cause adverse effects on the environment.

15.6 PAH's

These compounds are emitted from all industrial, commercial, domestic, and transportation combustion equipment. They have low vapour pressure and are discharged into air adsorbed on particulate. PAH's dissolved in surface water and adsorbed onto surface particulate are degraded by ultraviolet light. Some soil micro-organisms degrade PAH's. We expect that PAH's discharged from combustion processes will not accumulate in the environment. PAH combustion emissions are minimised by efficient boiler operation.

15.7 Particulate Matter

There will be cumulative effects from the discharge of particulate matter from the Company's activities and from other activities in the area, and from natural sources. Although the level of PM_{10} in the Wairarapa Airshed in the Masterton urban area exceeds the AirNES at times during cooler weather conditions, the contribution of the Company's activities to this will be minimal.

Deposited particulate discharged from the combustion appliances is relatively non-reactive and will persist in the environment until incorporated into the soil.

15.8 Total Organic Compounds

The discharge of PAH's and phenols from well designed and operated coal and wood-fired combustion appliances is low. These compounds are degraded in the atmosphere, and in water and in soil, and will not accumulate.

15.9 Sulphur Dioxide

Sulphur dioxide is emitted from combustion of all fuel containing combustible sulphur, including wood fuel but wood contains minimal sulphur as a trace element. There are two wood-fired boilers in the Waingawa area – Kiwi Lumber and JNL. The Masterton hospital and Webstar boilers are coal-fired but these are located in the Masterton urban area. The mission of SO_2 from diesel-fuelled motor vehicles is now low because automotive diesel oil now contains a maximum of 50 ppm of sulphur. Railway engines are diesel oil-fired.

Sulphur dioxide is a reactive gas, which is neutralised (in the presence of moisture) in contact with rocks and soil form sulphates. Consequently, sulphur dioxide does not accumulate in the environment if local or regional overloading does not occur.

16. Process and Discharge Monitoring

16.1 Process Monitoring

Process monitoring is covered in the various sections discussing process operation and control. While appropriate process (including emission control equipment) operation for all activities is essential to minimise discharges to air and to maximise product quality, it is particularly important for operation of the veneer drier. Poor drier operation will produce sub-standard veneer and will (if excessive over-drying occurs) cause excessive discharge of contaminants from the drier vents. This is because the drier is not fitted with discharge emission control equipment.

16.2 Discharge Monitoring

The following evaluations are carried out on a routine basis.

16.2.1 Wet Wood Cyclones

Visual assessment to gauge approximate particulate emissions by shift supervisors on a daily basis. In addition, employees are encouraged to report unusual situations as soon as they notice them. Unusual discharges are recorded in the log sheets. (Note: Isokinetic dust determinations [quantitative sampling] on cyclones is difficult and often gives misleading results unless the units are fitted with long discharge extensions, which is normally impracticable and may upset cyclone efficiency). ‘Sticky tape’ evaluations can be carried out if discharge problems occur.

16.2.2 Bag Filters

Visual assessment to gauge effectiveness by shift supervisors on a daily basis. All employees are encouraged to report unusual situations as soon as they notice them. Bag filters can be fitted with appropriate sampling sockets although quantitative emission sampling is rarely necessary but is useful if discharge problems occur. They are fitted with pressure drop indication to assist, with visual assessment, monitoring filter bag condition.

16.2.3 Veneer Drier Vents (excluding the cooler vents)

Volumetric flows and aldehydes emission assessment was carried out as a routine assessment before the expiry of the air discharge permit.

16.2.4 Boiler Chimney

Emission monitoring for particulate and for combustion gases is carried out three times each year. Smoke opacity is continuously monitored and recorded. Combustion gas oxygen concentrations are continuously determined and recorded (part of the combustion control procedures).

16.3 Ambient Air Monitoring

No ambient air monitoring is carried out.

17. Hazardous Substances and Installations

The company has no operations which are "hazardous" in the normal sense. The boiler, while large, is common technology and its operation is not regarded as a risk to people living or working in the area. Various process chemicals are stored and handled in accordance with the Toxic Substances Regulations, with the appropriate Dangerous Goods Regulations, and with OSH requirements.

18. Community Consultation

People who may be affected by or interested in the discharge of contaminants from the Company's activities are neighbours and other who live or work in the area, including people in Solway.

Community consultation specific to this application for resource consent has not been carried out. This will be done during the period following submitting this detailed Technical Report.

The Company will meet with interested people and discuss with then any concerns they have.

The Company has regularly offered to meet with neighbours during the currency of the existing air discharge permit.

Neighbours of JNL are:

- Oldfield Contractors, State Highway 2;
- Burlings Transport, Norfolk Road;
- Vending Services, Norfolk Road;
- Intimber, Norfolk Road;
- Kiwi Wood Processing, Waingawa;
- Dave & Andrew Tullock, Crofton farm, Cornwall Road;
- Mr Keith McEwan, Waingawa, RD7;
- Balance Fertiliser, State Highway 2;
- Kiwi Lumber, Waingawa; and
- OnTrack (Railway) and Transit N.Z. (S.H. 2).

In addition, the Board of Trustees of Solway Primary School has always maintained an interest in the activities of the Company.

Ron Pilgrim

CALPUFF modelling carried out by Dr Mira Chakraborty

12 September 2008

Appendix A Dispersion Modelling Summaries

Provided as a separate attachment.