SEPP 33 - RISK ASSESSMENT EVALUATION

No. 1 Demolition and Excavation (NSW) Pty Ltd

Lot 8 DP 1039882, No. 191 Miller Rd, Chester Hill, NSW
Report No: 2008 / 387 R1.0

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EXECUTIVE SUMMARY

This report documents the findings of a Risk Assessment Evaluation (RAE) for No.1 Demolition and Excavation (NSW) Pty LTD (hereafter known as DAE) for a S96 addition to their existing waste facility located at 191 Miller Road, Chester Hill.

The proposed S96 covers the addition of building materials recycling operations at the existing Recycling Facility at Chester Hill. The building materials recycling operations will comprise mainly:

- Site storage and sorting areas for building waste comprising timber, concrete and scrap metal; and
- Provision of mobile crushing machinery.

The existing recycling centre was approved in 2007 and comprises:

- Site storage for ferrous and non-ferrous metals;
- Concreting and sealing of surfaces;
- Provision of one mobile & one fixed metal shearing and baling machines;
- Installation of a new substation; and
- Upgrading of existing storm water systems to include a first flush water quality system.

As required under SEPP33 any Development Application in the Bankstown Industrial area for potential hazardous development must be accompanied by a risk report commenting on whether the proposed use will adversely affect surrounding land uses, or expose the general public to unacceptable risk levels.

The land use safety implications imposed by the NSW Dept of Planning (NSW DoP) required that risk levels are below 50 per million per year (50×10^{-6} pa) at the boundary.

The findings of the RAE demonstrate that the proposed S96 additional operations by DAE are acceptable, subject to:

- Fire protection systems to be compliant with the BCA and are to cover the additional building recycling operations;
- Transport routes recommended by the RTA to be followed where practicable; and
- The site Emergency Response Plan (ERP) be reviewed against AS 3745-2002 requirements and extended to cover the S96 building recycling activities proposed.

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1 INTRODUCTION

This report documents the findings of a Risk Assessment Evaluation (RAE) for No.1 Demolition and Excavation (NSW) Pty LTD (hereafter known as DAE) located at 191 Miller Road, Chester Hill.

Works included in the S96 proposal are:

- Site storage and sorting areas for building waste comprising timber, concrete and scrap metal; and
- Provision of mobile crushing machinery.

Details and site features abovementioned are shown in Appendix 1 – Site Layout Plan.

2 PURPOSE OF STUDY

The impetus for this study comes from Bankstown Council DCP requirements and the NSW Dept of Planning Guidelines, SEPP 33 for potentially hazardous industries. The requirements include the need for a risk assessment of the proposal.

The risk assessment is an integral part of the planning & approvals process for potentially hazardous development in NSW under SEPP 33. As such any new proposal must demonstrate that:

i) The resultant risk levels are well below the suggested criteria adopted by the planning authorities in NSW, for land use safety planning purposes, namely, the Risk levels at 50 per million per year (50×10^{-6} pa) be contained wholly within plant boundaries.

3 SCOPE OF RAE STUDY AND LIMITATIONS

3.1 SCOPE

The scope of this Risk Assessment Evaluation (RAE) study covers the:

- Movement, storage and handling of dangerous goods (if any);
- Truck movements involving dangerous goods (if any); and
- Land use safety issues, primarily the emergency planning principles and safety management systems to be addressed as an industrial neighbour.

The format of the RAE study and context is generally defined within the guidelines provided by the NSW Dept of Planning's Hazardous Industry Planning series, including:

i) Advisory Paper No:6 - Guidelines for Hazard Assessment ; and
ii) SEPP33 & Multilevel Risk Assessment

Note: For Completeness this study should be read in conjunction with the Development Application and all supporting documentation.

3.2 LIMITATIONS

The following limitations apply to the assessment:

- Generally the assessment does not incorporate the detailed requirements of the Building Code of Australia (BCA 2007);
- Life safety objectives are limited to those identified in SEPP 33.

3.3 ASSUMPTIONS

The site will be used in accordance with the site plan shown in Appendix 1 – Site Layout Plan.

4 RISK ASSESSMENT EVALUATION (RAE) APPROACH

Essentially four major steps are involved in the assessment, namely incident identification, consequence Assessment, probability and frequency estimations, leading to a quantitative risk assessment result. In practice however, as shown in **Figure 1,** there are many other factors to be considered.

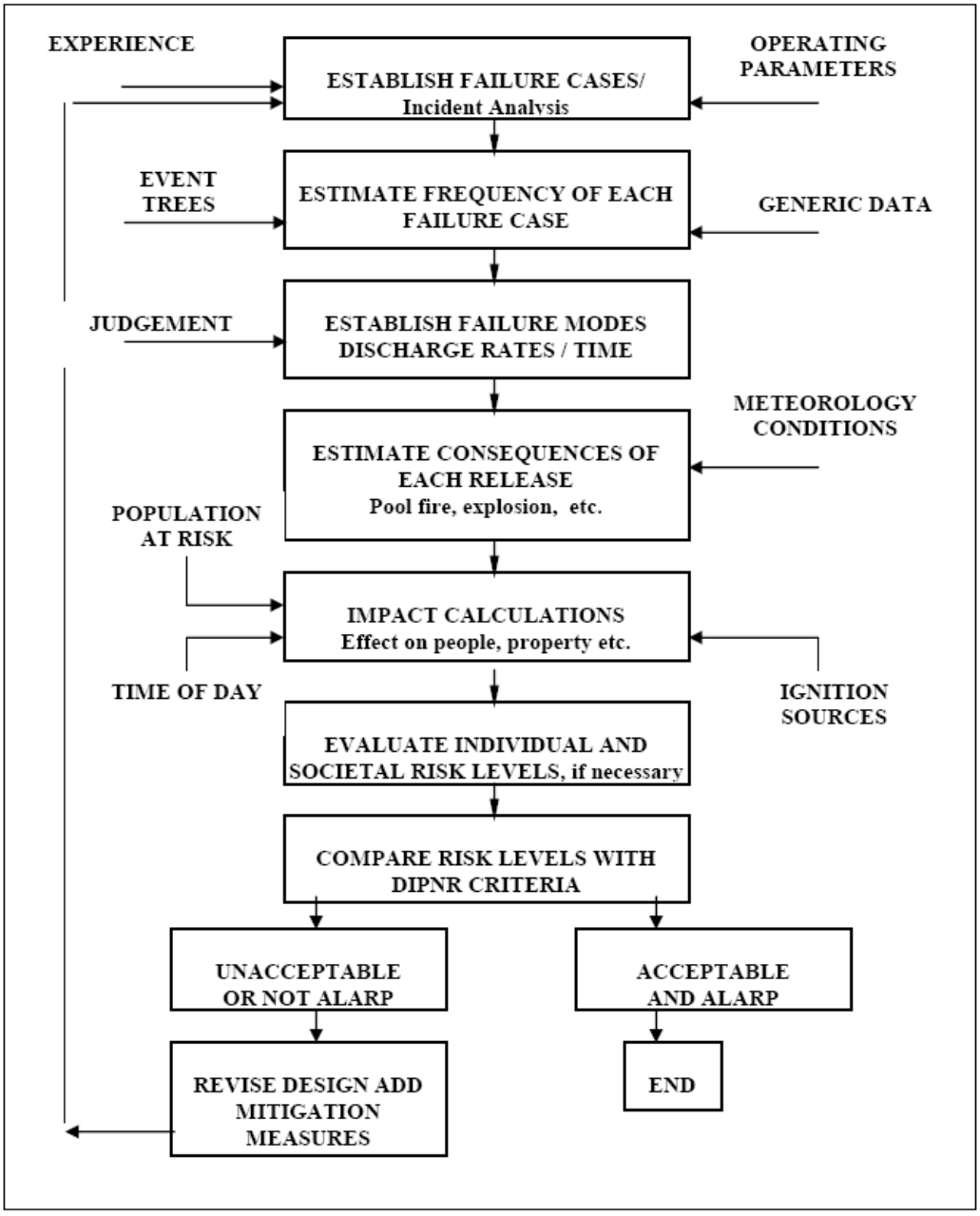


FIGURE 1 – Overview of RAE Process

5 SITE DESCRIPTION AND SURROUNDING LAND USE

5.1 BRIEF SITE DESCRIPTION & OPERATIONS

The property is located at 191 Miller Rd, Chester Hill on a site currently zoned 4(a) General Industrial. The site has a total area 6.5 hectares.

Appendix 1 – Site Layout Plan – provides details of the proposal. The plan depicts the existing offices and parking layout, weighbridge and workshop and the location of the existing metal recycling works, shown in green shading.

The S96 proposal includes:

- Site storage and sorting areas for building waste comprising timber, concrete and scrap metal; and
- Provision of mobile crushing machinery.

Site operations remain unchanged and will operate from 7.30am – 5pm, Mon – Friday, and 8 am – 12pm Saturdays with 4 staff.

5.2 SURROUNDING LAND USE

The site is adjacent to CityRail's main southern line; this forms the common northern boundary. Miller Road is located immediately to the west.

Surrounding industry includes;

- Aperio Packaging and AquaCool refrigeration to the south; and
- Mainway Intermodal Terminals to the west (across Miller Road).

The nearest residential areas are located approximately 100 metres to the north of the CMA site (along Waldron Rd).

6 PRELIMINARY HAZARD ASSESSMENT

The following basic assessment data has been drawn from:

- Discussions with Mr Peter Fryer, of Moody & Doyle Town Planners; and
- Documentation listed in the references and appendices.

6.1 NATURE AND QUANTITY OF MATERIALS STORED OR PROCESSED

The nature of the materials stored or processed on site is an important part of the RAE because it establishes whether fire, explosion or toxic releases are possible and to what degree. For example the gaseous combustion products produced by fire, and if so, what risks are imposed on adjacent land users.

The building recycling operations proposed by DAE include crushing and sorting operations, as such additional fire scenarios may include stockpile fires.

Any oils, or fuels present in the vehicles processed are captured during the shearing/baling process within the charge box of the Lefort Crushing unit. The charge box drains to a collection drum. When full the contents of the collection drum are transferred to a mini tanker and removed from site for approved waste disposal.

Oxy/acetylene equipment and small amounts of oils and other lubricants are also to be stored within the workshop. The hazardous nature and physical properties of Diesel fuel/oils and motor spirit that may be collected during the shearing / baling process are covered in Table 1 – Nature and Quantity of Materials stored. In that regard DAE advise that they do not propose to store bulk quantities of dangerous goods or hazardous chemicals on-site. However, if future storages are proposed, these storages will be subject to a further assessment.

TABLE 1 - NATURE AND QUANTITY OF MATERIALS STORED

MATERIAL STORED	HEALTH HAZARD AND PHYSICAL PROPERTIES	ENVIRONMENTAL HAZARDS	SAFEGUARDS PROPOSED
Distillate / Oils or residual fuel	Class 3 Combustible Liquids, usually C1 or C2 Flash Point (various) ; above 60 deg. C Flammable limits in air: 0.5 %- 5 %. TLV, IDLH and STEL data not available. SG 0.8 - 0.85 (typical)	Pale yellow liquid. Immiscible in water (i.e., floats on water). Aquatic Toxicity: Exact details are not known, however, according to the NFPA Hazard Classification, the health and environmental hazard potential is regarded as low.	The Lefort shearing and baling machine captures any fuel or oil in a charge box. This is later emptied into a dedicated mini-tanker for waste disposal. The area around the Lefort shearing/ baling units are to be graded for containment purposes. Captured fuels / oils are generally immiscible with water, and spill kits are provided for clean up in case of spills. Batteries will be removed from all cars to reduce ignition sources Hydrants/hosereels and foam extinguishers will be provided as required.
ULP / Motor Spirit	Class 3 PG II - Flammable Liquids. Flash Point (various) ; above 23 deg. C Flammable limits in air 1 %- 8 %. TLV, IDLH and STEL data not available. SG 0.73 - 0.78 (typical)	Immiscible in water (i.e., floats on water).	

TABLE 2 – GENERALISED HAZARD IDENTIFICATION TABLE

FACILITY/EVENT	CAUSE/COMMENTS PHYSICAL PROPERTIES	POSSIBLE RESULTS CONSEQUENCES	SAFEGUARDS EMPLOYED
1. Flammable liquids pool or bund fire	• Leakage / transfer hose failure and ignition	• Fire may destroy entire Lefort shearing and baling installation	◆ Suppliers instructed to remove batteries, oil/petrol and all fluids from cars ◆ Lefort machines drain and collect any residual fluids which drain to a holding tank ◆ Fire prevention/protection systems to AS 1940
2. Office Building fire	• Electrical/Computer or peripheral fault	• Fire may destroy office	◆ Site area generous / Buildings well spaced ◆ Hose reels and extinguishers provided to BCA requirements
3. Workshop fire	• Hot work or welding	• Fire may destroy workshop	◆ Site area generous / Buildings well spaced ◆ Hose reels and extinguishers provided to BCA requirements
4. Stockpile fire	• Ignition of paper, cardboard or timber	• Fire contained within stockpile area.	◆ Strict non-smoking policy applies. ◆ Fire protection services to be provided in accordance with BCA requirements

6.2 HAZARD IDENTIFICATION

The proponent was consulted in relation to the potential hazards that could occur on site.

Relevant potential incidents that could occur due to mechanical, electrical or other failures for general warehouse development in NSW are described in **Table 2**. The table describes each potential incident and how it may be initiated, the consequences of the event occurring, and the safeguards employed to mitigate against such incidents.

Additional operations at the site will involve the handling, sorting and storage of building waste. Such waste would generally comprise, cement, bricks, timber, plaster and other material. DAE advise that asbestos waste will not be accepted.

Table 2 - The Generalised Hazard Identification Table lists those incidents that have the potential to result in a major hazardous event at the site. From this table the following incidents have been listed for detailed review:

1. Flammable liquids pool or bund fire
2. Office Building or Workshop Fire
3. Stockpile Fire

Having identified these events, a brief quantitative assessment of their potential consequences is warranted, to determine their effects.

The table describes each potential incident and how it may be initiated, the consequences of the event occurring, and the safeguards employed to mitigate against such incidents.

6.3 CONSEQUENCE ASSESSMENT

6.3.1 Flammable Liquids Pool or Bund Fire

As a result of on-board tank failure (1000 litres) or transfer fill hose failure and leakage of fuel followed by immediate ignition, a pool fire or bund fire could result in or around the Lefort machine. The effect distances are shown in Appendix 2 – Lefort Shearing/baling machine bund fire, based on a pool area of approximately 20 m^2.

The distance to 5kw/m^2 is deemed to be the minimum distance between the location of the Lefort machine and the boundary i.e. approximately 20 meters minimum, should be maintained at all times.

6.3.2 Workshop / Office Building Fire

A developing fire could commence in the offices or workshop. Fires could start in computer equipment, mobile phone battery chargers, electric clocks, refrigerators, hot water heaters (tea making and domestic units), etc. within the office areas. As this is the most substantial

building on-site a fire scenario will be developed for this building.

In the workshop, welding and other hot work activities may also cause fires. However the workshop and maintenance facilities are small single story, steel frame metal clad buildings. Given their separation distance from other buildings and structures these fire incidents have not been carried forward to the risk assessment.

Combustibles stored within the open yard could possibly include building materials including timber, paper, paint tins, pallets etc.

Such solid fires would exhibit flame surface heat flux levels range between 80-140 kW/m^2, and temperatures exceeding 1000 degrees Celsius, dependant on combustion efficiency.

It should be noted that the Chester Hill Fire Brigade services are located within 300 metres of the facility.

6.3.3 Stockpile Fire

Sorting of building materials, including combustibles may result in a solids fire within the sorting area. For the purpose of this study, the figures quoted for fire starts will be sourced from the Fire Engineering Guidelines (Reference 18) and reduced by a factor of 10 to account for the fact that sorting operations are undertaken in the open yard.

6.4 FREQUENCY ASSESSMENT

In relation to the office/ factory area and the sorting areas the frequency of fire starts are derived from data collected by the Australia Bureau of Statistics (ABS) between 1979/1988, the NSW DoP and the National Building Fire Safety Systems Code & the Interim Fire Engineering Guidelines (Reference 18).

The failure rate data for process equipment, such as fuel tanks is derived from the COVO study. (Reference 19)

6.4.1 Fuel Tank Failure and Fire

The failure rate data for the failure of the Lefort shear unit fuel tank or the Crushing unit fuel tank is taken from the COVO study for similar vessels in the chemical industry and shown in Table 3.

System	ITEM	FAILURE POSSIBILITY	REFERENCE
Lefort Unit / Crushing Unit	Fuel Tank	1 x 10^{-6} pa	Covo Study (19)

TABLE 3 - GENERALISED PROBABILITY DATA

6.4.2 Office Fire

Using the National Building Fire Safety Systems Code & the Interim Fire Engineering Guidelines the figures quoted for fire starts in factory offices are 8.9 x 10-6 / m^2 / annum. For a 30 m^2 office, as is the case here, we estimate a fire frequency of **2.7×10^{-4}** per year for the DAE offices.

Hence, a conservative figure of **3.0×10^{-4} pa** fires per factory office per year has been adopted for this study for the worst case scenario (which is a fully developed fire in the office). The event outcome tree for such a scenario is given in **Figure 2 – Office – Major Fire.**

The potential for the failures is dealt with for each of the system components:

1. Whether the fire occurs during operating hours (8/24 hrs)?
2. Whether staff detect fire out of hours?
3. Whether security detects fire out of hours?
4. The success of the response of the brigade

The total frequency and resultant risk of a major fire can now be computed and related to the NSW Department of Planning (NSW DoP) criteria for hazard/risk to industrial neighbours. In this case the risk must be no greater than 50 x 10^{-6} pa (for industrial land uses) at the boundary of the site.

6.4.2.1 Fire During Operating Hours

If the fire occurs during working hours there would be a number of employees on the site to immediately detect and possibly extinguish the fire or summon the fire brigade.

However, the office maybe unattended after normal working hours, therefore, the probability that the fire occurs during the period when the office is closed also forms a part of the event tree. The office area operating times will be from 7.00 am to 6.00 pm, 6 days per week. This equates to about 66 hours occupancy per week. Based on 7 x 24 = 168 hours in a week the probability that a fire will occur when no one is in attendance would be 168-66/168= 0.6. Hence, the probability that a fire would occur during operating hours is 0.4.

6.4.2.2 Staff Fail to Detect

Once a fire starts in the office, in order for action to be taken it must be detected. For the purpose of the study the failure of a sprinkler or detection system (fail to activate) or a person sounding the alarm was estimated to be 0.1 per year (Tweeddale, 1993), this is considered to be conservative as other data sources indicate lower failure frequencies (e.g. 0.05 - RMC, 1988).

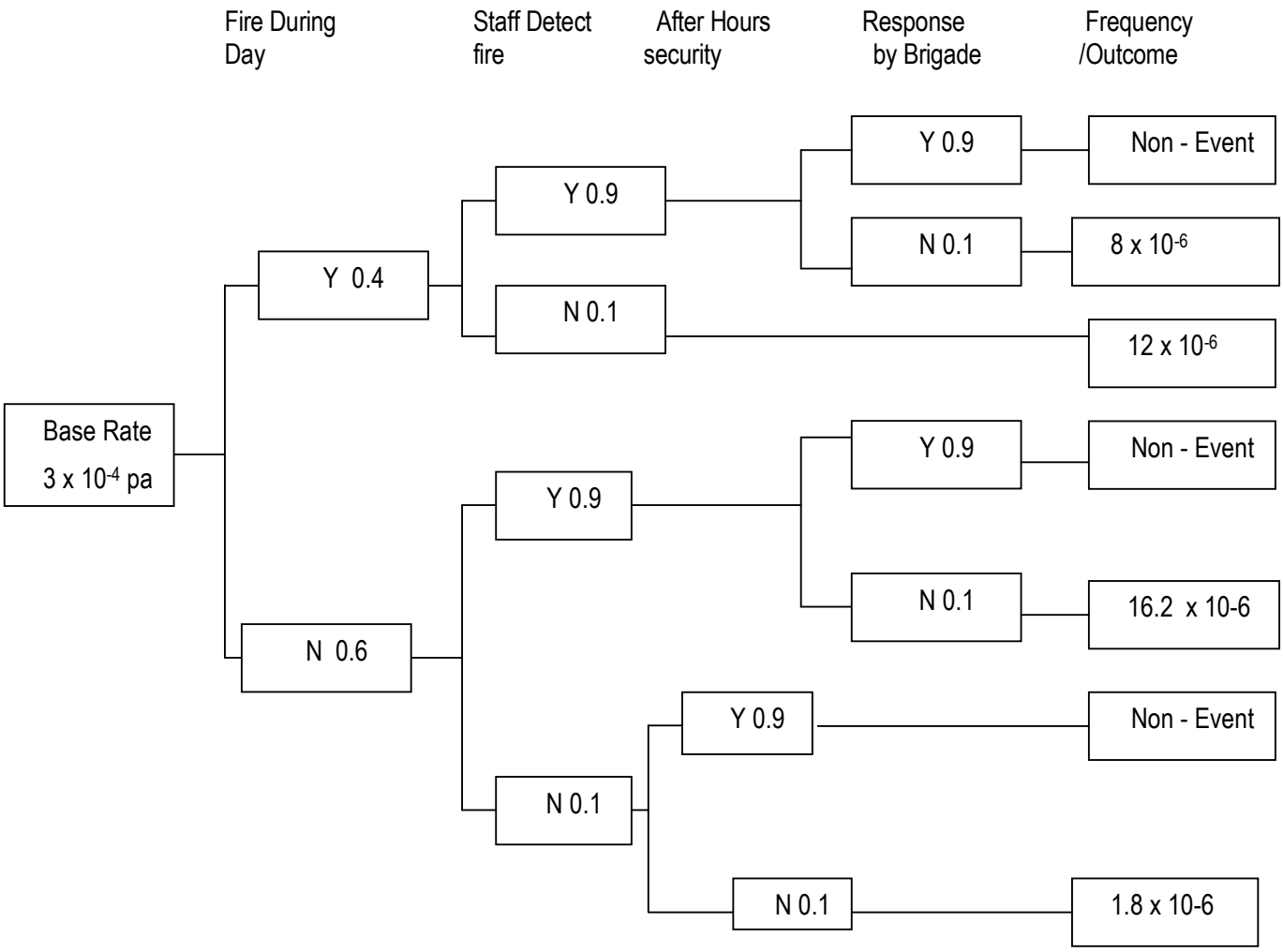
6.4.2.3 Security Services & After Hours Access

A security company will be retained to visit the site on a regular basis between the hours of 6pm and 7 am if the site is unattended. The probability that the fire is detected will be 0.9 and the probability that the fire will go undetected is 0.1 for the unattended hours.

6.4.2.4 Response and Extinguishment by Brigade

The probability that the fire brigade responds in time is a major component of the response to and suppression of the fire. The Health and Safety Executive (HSE) in the UK and the United Kingdom Atomic Energy Authority (UKAEA) conducted research into warehouse fires in the UK and noted that the probability of a fire not being controlled was about 10% (Hymes and Flynn, 1993). *This was representative of all warehouse fires including those warehouses without fire detection and with limited fire protection systems, and hence this figure is believed to be conservative. Hence a success rate of 90% or 0.9 is adopted*.

Figure 2 – Office – Major Fire – Event Tree



Hence the TOTAL frequency of an Office / factory Major Fire = 38.2 x 10^{-6} pa.

6.4.3 Sorting Area Fire

Referring to a NSW DoP publication for warehouse fires (NSW DoP, 1987): From 1974 to 1978 (a period of 5 years) there have been 543 warehouse fires in NSW, among a total number of warehouses estimated at 23 470. This gave a fire frequency for general warehousing of 4.6×10^{-3} per year.

Using data from the Australian Bureau of Statistics & the Fire Engineering Guidelines (Reference 18), the figures quoted for fire starts in factory warehouses are 345 fires in 10 years (1964 - 1973), this gives a fire frequency of around (345 / 10 x 23470) = 1.47×10^{-3} per year. These figures from different sources are for statistical purposes similar in magnitude.

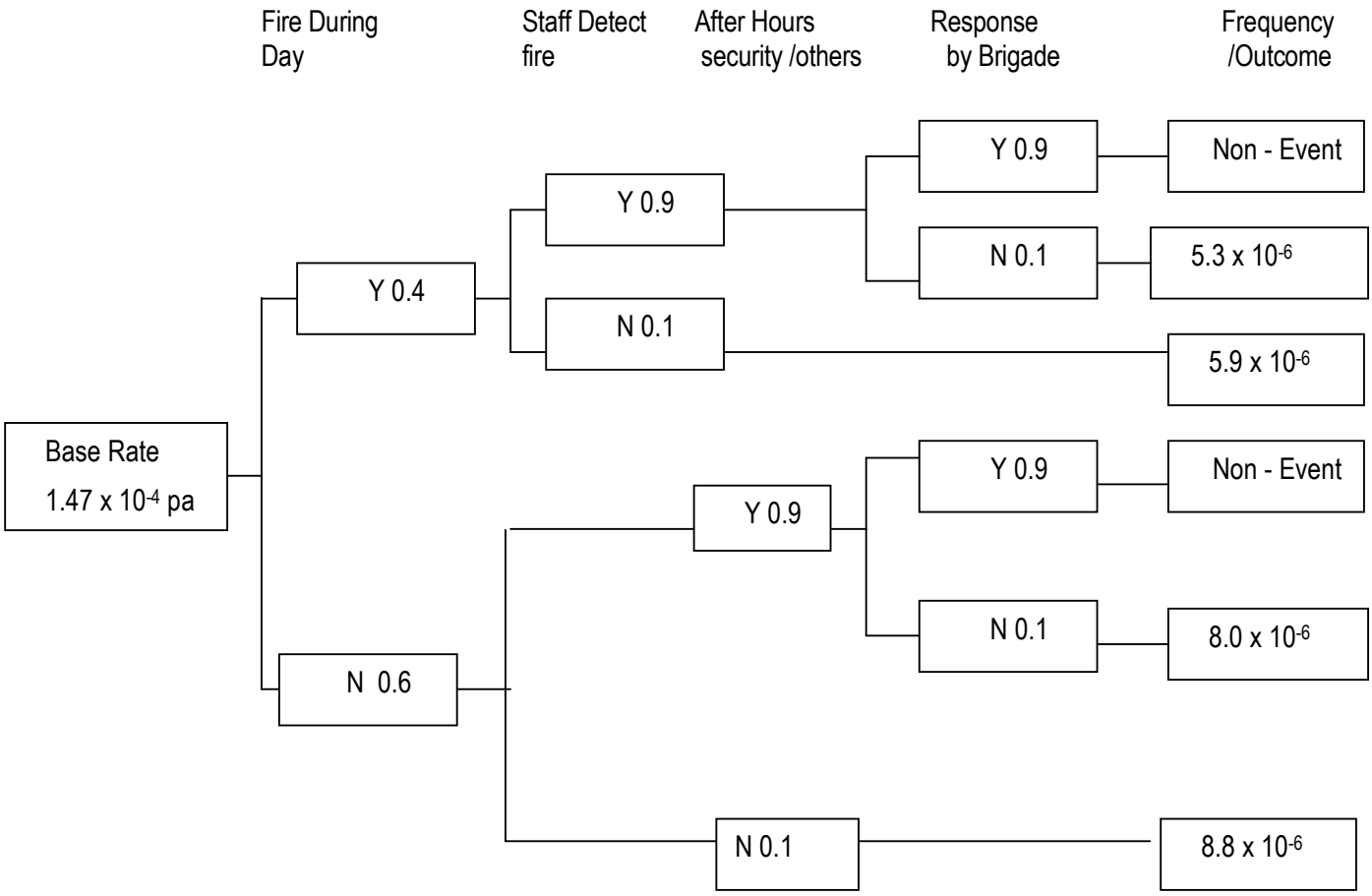
For the purpose of this study, the figures quoted for fire starts will be sourced from the Fire Engineering Guidelines (Reference 18) and reduced by a factor of 10 to account for the fact that sorting operations are undertaken in the open yard. The event outcome tree for such a scenario is given in **Figure 3 –Sorting Area Fire.**

As in the previous case the potential for the failures is dealt with for each of the system components, namely;

1. Whether the fire occurs during operating hours (8/24 hrs)?
2. Whether staff detect fire out of hours?
3. Whether security detects fire out of hours?
4. The success of the response of the brigade

The total frequency and resultant risk of a major fire can now be computed and related to the NSW DoP criteria for hazard/risk to industrial neighbours. In this case the risk must be no greater than 50×10^{-6} pa (for industrial land uses) at the boundary of the site.

Figure 3 – Sorting Area Fire – Event Tree



Hence the TOTAL frequency of a Major Fire = 28 x 10^{-6} pa.

6.5 CUMULATIVE RISK RESULTS

The land use safety implications for the proposed development are summarised in Table 4 – Overall Risk Evaluation. The table summarises the events, event probability and risk. The parameters as provided in the table are defined as follows:

1. Event – the event is taken from the risk identification table, and is comprised of a stockpile fire
2. Base Frequency x 10^{-6} – is the failure frequency of the event
3. PF (E) – is the probability of fatality to a person outside (or on the boundary) from a fire. For the purpose of this study PF = 0.1
4. Risk x 10^{-6} – is the product of the frequency x probability of injury and is defined as the risk of exposure from the event
5. CF-Risk – is the cumulative addition of the individual risk results.

EVENT	BASE FREQ X 10^{-6}	PF(E)	RISK X 10^{-6} (E)	CF-RISK (E)
1. Office fire event	38	0.1	3.8	3.8
2. Lefort Unit / Crushing Unit – pool fire	1	0.1	0.1	3.9
3. Stockpile Fire	28	0.1	2.8	6.7

Table 4 - Overall Risk Evaluation

Therefore the cumulative risk levels at the boundary of the site are around 6.7 x 10^{-6} pa. Such risk levels are deemed acceptable (Ref: NSW DEPT. of Planning Risk Criteria at Boundary of site = 50 x 10^{-6} pa) under the NSW Dept. of Planning guidelines (Reference 11.)

This risk of fatality is comparable to the risk of fatality for all fires of 8 deaths per million population. This fatality rate is derived from CSIRO statistics for all building fires in NSW (Reference 17).

7 TRASPORT OPERATIONS - SAFEGUARDS

Heavy vehicle truck routes recommended by the RTA to be followed as shown in Figure 4 RTA preferred heavy vehicle routes – South Western Sydney

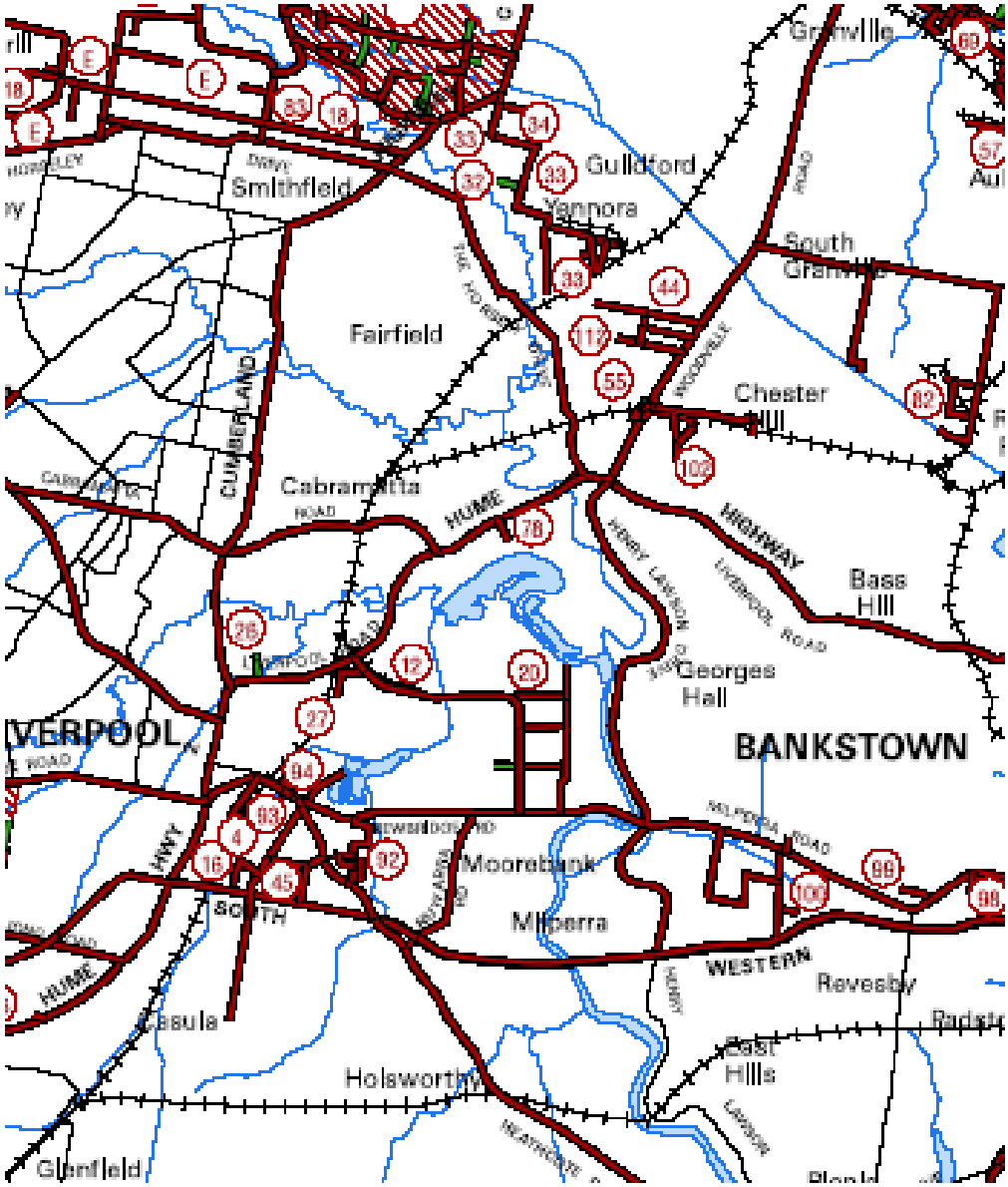


Figure 4 – RTA preferred heavy vehicle routes – South Western Sydney

8 FIXED FIRE PROTECTION SYSTEMS

Fire protection services are to be provided for the new works in accordance with BCA, including, hydrants, hose reels and fire extinguishers.

9.1 Portable Fire Extinguishers

The number of fire extinguishers in each area to be provided shall be as per the requirement of the local authority and AS 2444.

9.2 Fire Hydrants & Hose Reels

The site will be provided with small bore 20 mm hose reels to AS 2441 " Installation of Fire Hose Reels ". (Note: There are existing hydrants & hose reels on-site)

9.3 Access for Fire & Emergency Vehicles

Emergency vehicles are able to access the site easily via Miller Rd.

9 ORGANISATIONAL SAFETY & ENVIRONMENTAL MANAGEMENT SYSTEMS

9.1 EMERGENCY PLANNING PRINCIPLES

A basic Emergency Plan exists and should be reviewed against AS 3745-2002 requirements and incorporate the additional S 96 activities. In general the emergency plans should cover as a minimum:

- Alarm initiation and Response
- Lines of communication and emergency operations flowchart
- Roles and responsibilities of all staff
- Emergency resources and procedures
- Emergency Training, evaluation and debriefing

All DAE employees should be familiar with the emergency procedures, and ideally these should form part of the induction for new employees. It is also recommended that the plan be vetted and regularly updated. Training exercises should also be carried out regularly, at least annually.

10 CONCLUSIONS

The preliminary risk assessment evaluation results for the proposed S96 activities and the existing development are summarised as follows:

- Computed risk levels of 6.7 per million per year computed at the boundary are lower than the risk levels at 50 per million per year (50 x 10^{-6} pa) allowed under the NSW DoP guidelines.

It is concluded the S96 proposal, comprising additional building recycling activities, is considered acceptable on risk grounds when compared against the NSW Dept. of Planning land use safety criteria for industrial proposals.

11 RECOMMENDATIONS

The findings of the RAE demonstrate that the proposed S94 building recycling activities generally complies with the NSW DoP risk criteria subject to:

- Fire protection systems to be compliant with the BCA and are to cover the additional building recycling operations;
- Transport routes recommended by the RTA to be followed where practicable; and
- The site Emergency Response Plan (ERP) be reviewed against AS 3745-2002 requirements and extended to cover the S96 building recycling activities proposed.

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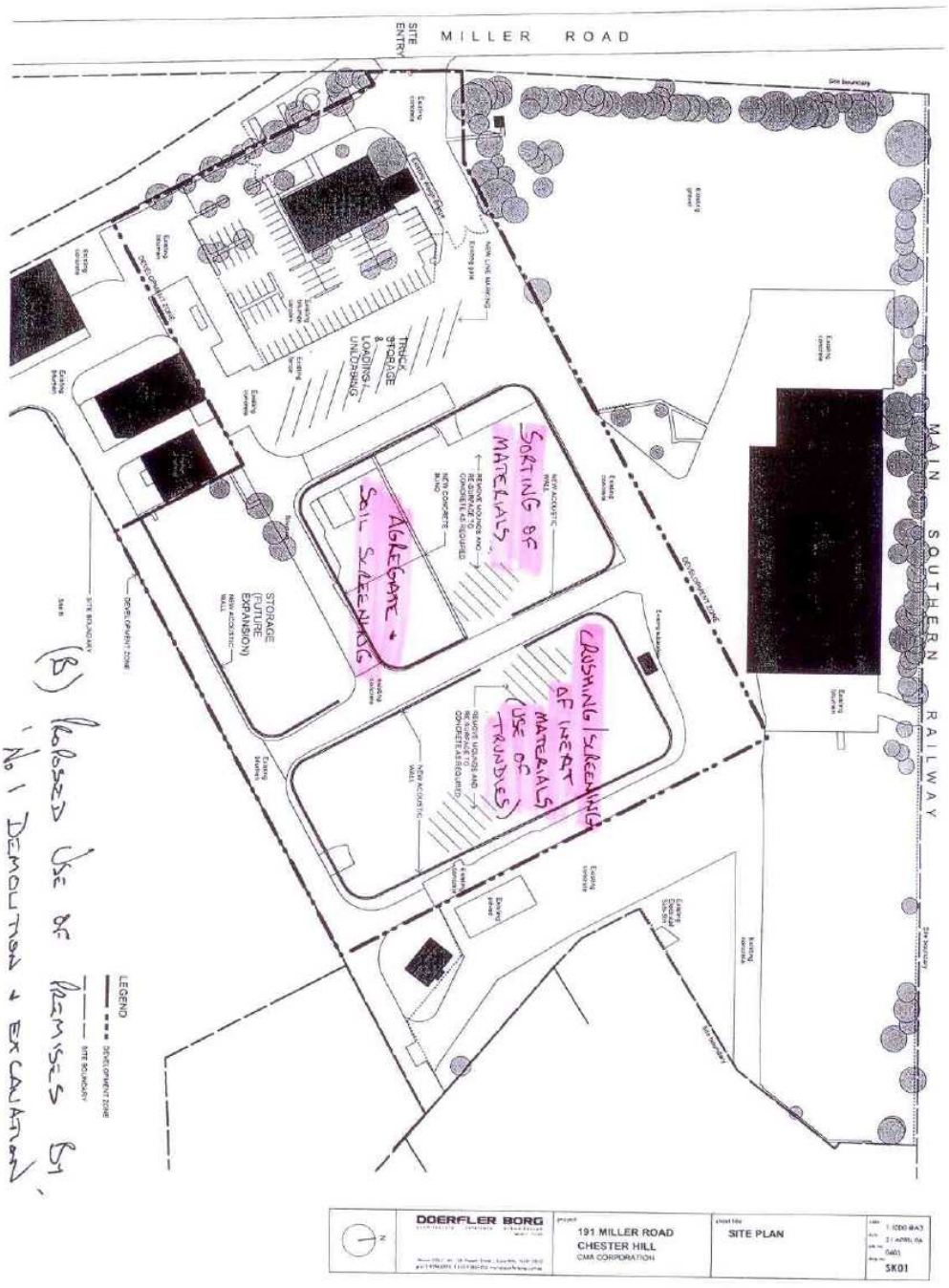
13 APPENDIX 1 - SITE LAYOUT PLAN



14 APPENDIX 2 – LEFORT SHEARING/BALING MACHINE BUND FIRE

POOL FIRE CALCULATIONS

Program Functions

1. For a given set of heat fluxes received, calculates the distance from the flame to the receiver.
2. Calculates the heat flux received at a given distance from the flame.

Calculation Methods

1. Inverse Square and API methods
 - They can be used to calculate the direct distance from the flame centre to the receiver r2 (m)
 - They do not allow for attentuation effects
2. View Factor ICI method
 - This can be used to calculate the horizontal distance from the flame centre to receiver R (m)
 - Includes correlations for effect of attentuation** (in the form of transmissivity T) of the base of the pool and the re
 - If R < 30m, then attentuation is negligible & T = 1 (This gives a conservative estimate of the heat radiated)
 - If 30m <= R <= 200m, then the Lihou & Maund correlation (depends only on R) is used
 - If R > 200m, go to inputs of % relative humidity & the ambient temperature to account for the effect of water vapc

**NOTE: If attentuation is significant, the distance R can be recalculated in the spreadsheet by replacing the initial of T (cells I42-I45) by those of T(cells G42-G45)

Assumption

Flame height = 2 times the pool diameter

Calculations

Calculation of the surface flux q1 from the pool fire (kW/m^2)

Pool diameter (D)	5	m
Burning rate of fuel (r)	4	mm/min
Fuel density (p)	850	kg/m^3
Proportion of heat radiated to surrounds (n)	0.3	
Heat of combustion of fuel (Hc)	40	MJ/kg
Heat radiated per unit area of flame (q1)	**85**	**kW/m^2**

Calculation of water vapour partial pressure Pw

% relative humidity	70	
Ambient temperature	30	deg C
Water vapour partial pressure Pw	**2959.22**	

DISTANCE FROM THE FLAME TO HEAT FLUX q2 AT THE RECEIVER

Flux q2 (kW/m^2)	Direct distance to q2		Horizontal distance to q2		Initial T values	View Factor f	R/x1	Slope a	Y-intercept b
	API	Inverse Square	ICI View Factor	Calculated Attenuation					
40	5.15	3.64	3.29	1.00	1	0.4706	1.3165	-1.23	-0.1805
35	5.51	3.90	3.67	1.00	1	0.4118	1.4675	-1.23	-0.1805
30	5.95	4.21	4.16	1.00	1	0.3529	1.6635	-1.23	-0.1805
25	6.52	4.61	4.82	1.00	1	0.2941	1.9294	-1.23	-0.1805
20	7.29	5.15	5.78	1.00	1	0.2353	2.3133	-1.23	-0.1805
12.6	9.18	6.49	8.42	1.00	1	0.1482	3.3682	-1.23	-0.1805
4.7	15.04	10.63	16.23	1.00	1	0.0553	6.4912	-1.601	0.0428

15 APPENDIX 3 – STOCKPILE FIRE

Calculations

Calculation of the surface flux q1 from the fire (kW/m^2)

Area (D)	4	m
Burning rate of fuel (r)	4	mm/min
Fuel density (p)	800	kg/m^3
Proportion of heat radiated to surrounds (n)	0.3	
Heat of combustion of fuel (Hc)	40	MJ/kg
Heat radiated per unit area of flame (q1)	**80**	**kW/m^2**

Calculation of water vapour partial pressure Pw

% relative humidity	70	
Ambient temperature	30	deg C
Water vapour partial pressure Pw	**2959.22**	

DISTANCE FROM THE FLAME TO HEAT FLUX q2 AT THE RECEIVER

Flux q2 (kW/m^2)	Direct distance to q2		Horizontal distance to q2		Initial T values	View Factor f	R/x1	Slope a	Y-intercept b	Mean Dist
	API	Inverse Square	ICI View Factor	Calculated Attenuation						
40	4.00	2.83	2.51	1.00	1	0.5000	1.2532	-1.23	-0.1805	3.111600166
35	4.28	3.02	2.79	1.00	1	0.4375	1.3969	-1.23	-0.1805	3.364586409
30	4.62	3.27	3.17	1.00	1	0.3750	1.5835	-1.23	-0.1805	3.683926319
25	5.06	3.58	3.67	1.00	1	0.3125	1.8366	-1.23	-0.1805	4.103497611
20	5.66	4.00	4.40	1.00	1	0.2500	2.2020	-1.23	-0.1805	4.686944653
12.6	7.13	5.04	6.41	1.00	1	0.1575	3.2062	-1.23	-0.1805	6.192975415
4.7	11.67	8.25	12.50	1.00	1	0.0587	6.2499	-1.601	0.0428	10.80677348

HEAT FLUX AT VARIOUS DISTANCES FROM THE FLAME SOURCE

Method 1: ICI View Factor

Distance to receiver from the centre of the base of the fire (ie. horizontal distance) (R)	15	m
Attentuation: Transmissivity (T)	1.00	
NB. If R>200m, then input values of temp (deg C) and % relative humidity		
Hence R/x1 (x1 = fire radius)	7.50	
Slope (a)	-2.12	
Y-intercept (b)	0.48	
View factor (f)	0.04	
Heat flux received (q2)	**3.39**	**kW/m^2**