ANNEXURE 4

Preliminary Hazard Analysis

prepared by

Pinnacle Risk Management

ANNEXURE 4

Pinnacle
Risk Management Pty Ltd

PRELIMINARY HAZARD ANALYSIS, MODIFICATIONS TO BOILERS 2, 4 AND 6, SHOALHAVEN STARCHES, BOMADERRY, NSW

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Preliminary Hazard Analysis, Shoalhaven Starches, Modifications to Boilers 2, 4 and 6

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Rev	Date	Description	Reviewed By
A	23/1/17	Draft for Comment	Shoalhaven Starches
B	22/4/17	Modifications to Boilers 2 and 6 Added	Shoalhaven Starches
C	26/4/17	Final Issue	Shoalhaven Starches

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EXECUTIVE SUMMARY

The Shoalhaven Starches factory located on Bolong Road, Bomaderry, produces a range of products for the food, beverage, confectionary, paper and motor transport industries including starch, gluten, glucose and ethanol.

Shoalhaven Starches plan to:

- Revert Boilers 2 and 4 to their original design, i.e. coal fired;
- Add a new baghouse filter to Boiler No. 6; and
- Increase the boiler stack heights.

As part of the project requirements, a Preliminary Hazard Analysis (PHA) is required. This report details the results from the analysis.

The risks associated with the proposed modifications to Boilers 2, 4 and 6 at the Shoalhaven Starches Bomaderry site have been assessed and compared against the DoP risk criteria.

The results are as follows and show compliance with all risk criteria.

Description	**Risk Criteria**	**Risk Acceptable?**
Fatality risk to sensitive uses, including hospitals, schools, aged care	0.5×10^{-6} per year	Yes
Fatality risk to residential and hotels	1×10^{-6} per year	Yes
Fatality risk to commercial areas, including offices, retail centres, warehouses	5×10^{-6} per year	Yes
Fatality risk to sporting complexes and active open spaces	10×10^{-6} per year	Yes
Fatality risk to be contained within the boundary of an industrial site	50×10^{-6} per year	Yes
Injury risk – incident heat flux radiation at residential areas should not exceed 4.7 kW/m^2 at frequencies of more than 50 chances in a million per year or incident explosion overpressure at residential areas should not exceed 7 kPa at frequencies of more than 50 chances in a million per year	50×10^{-6} per year	Yes
Toxic exposure - Toxic concentrations in residential areas which would be seriously injurious to sensitive members of the community following a relatively short period of exposure	10×10^{-6} per year	Yes

Description	Risk Criteria	Risk Acceptable?
Toxic exposure - Toxic concentrations in residential areas which should cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community	50 x 10^{-6} per year	Yes
Propagation due to Fire and Explosion – exceed radiant heat levels of 23 kW/m^2 or explosion overpressures of 14 kPa in adjacent industrial facilities	50 x 10^{-6} per year	Yes

Societal risk, area cumulative risk and environmental risk is also concluded to be acceptable.

The primary reasons for the low risk levels from the modifications are that significant levels of impact from potential hazardous events are contained on-site.

The following recommendation is made from this review.

1. All existing coal handling equipment for the boilers is to be functionally tested to ensure it is fit-for-purpose prior to reuse. This includes the safety instrumented controls, e.g. alarms, trips and interlocks, as well as any mechanical protective systems.

GLOSSARY

AS	Australian Standard
DoP	NSW Department of Planning
EPA	Environmental Protection Authority
HIPAP	Hazardous Industry Planning Advisory Paper
PHA	Preliminary Hazard Analysis

REPORT

1 INTRODUCTION

1.1 BACKGROUND

From Ref 1, Shoalhaven Starches is a member of the Manildra Group of companies. The Manildra Group is a wholly Australian owned business and the largest processor of wheat in Australia. It manufactures a wide range of wheat based products for food and industrial markets both locally and internationally.

The Shoalhaven Starches factory located on Bolong Road, Bomaderry, produces a range of products for the food, beverage, confectionary, paper and motor transport industries including starch, gluten, glucose and ethanol.

Shoalhaven Starches are planning the following changes to their existing boilers:

1. Boiler No. 2. This boiler was originally a coal fired boiler but was converted to enable the use of woodchips instead of coal and presently generates approximately 7 tonnes of steam per hour. It is now proposed to convert this boiler back to coal fired, i.e. return it to the original design intent. This will require the construction of a new baghouse adjacent to the Boiler No. 2 building and the construction of a new emissions stack which will have a height above ground level of 40 metres. These modifications will increase production of steam from this boiler back to 14 tonnes per hour (consistent with what it originally produced before it was converted to burn woodchips).
2. Boiler No. 4: This boiler was also originally designed, constructed and operated using coal. Approximately 6 to 7 years ago, it was converted to a gas fired boiler. Due to economic reasons, it is advantageous to convert the boiler back to its original design, i.e. coal fired. The coal handling and feed system as well as the bottom ash handling system will be identical to the existing system, i.e. there is no new equipment for these areas. All reused existing equipment is to be refurbished. The changes involve the construction of a new baghouse filter on top of the existing boiler building, and an extension of the existing boilers' stack. The stack height will be increased by 9 m to 40 m.
3. Boiler No. 6: This boiler is already a coal fired boiler. It is proposed, however, to construct a new baghouse filter and associated ducting adjacent to this boiler. These works will have a maximum height above ground level of 15 metres. The purpose of this work will be to increase steam production from this boiler by 7 tonnes per hour.

Converting the boilers 2 and 4 to coal fired will require an additional 60 trucks per week (approximately) based on 38 te capacity to deliver coal to the site. The increase in coal trucks is partially offset by the reduction in trucks supplying the woodchips to Boiler 2.

As part of the project requirements, a Preliminary Hazard Analysis (PHA) is required. Shoalhaven Starches requested that Pinnacle Risk Management prepare the PHA for the proposed boilers' modifications. This PHA has been prepared in accordance with the guidelines published by the Department of Planning (DoP) Hazardous Industry Planning Advisory Paper (HIPAP) No 6 (Ref 2).

1.2 OBJECTIVES

The main aims of this PHA study are to:

- Identify the credible, potential hazardous events associated with the proposed boilers' modifications;
- Evaluate the level of risk associated with the identified potential hazardous events to surrounding land users and compare the calculated risk levels with the risk criteria published by the DoP in HIPAP No 4 (Ref 3);
- Review the adequacy of the proposed safeguards to prevent and mitigate the potential hazardous events; and
- Where necessary, submit recommendations to Shoalhaven Starches to ensure that the proposed modifications are operated and maintained at acceptable levels of safety and effective safety management systems are used.

1.3 SCOPE

This PHA assesses the credible, potential hazardous events and corresponding risks associated with the Shoalhaven Starches proposed modifications to Boilers 2, 4 and 6 with the potential for off-site impacts only.

As coal is not a Dangerous Good then off-site transport risk assessment for acute hazardous events are not warranted to be assessed.

1.4 METHODOLOGY

In accordance with the approach recommended by the DoP in HIPAP 6 (Ref 2) the underlying methodology of the PHA is risk-based, that is, the risk of a particular potentially hazardous event is assessed as the outcome of its consequences and likelihood.

The PHA has been conducted as follows:

- Initially, the proposed boilers' modifications and their location were reviewed to identify credible, potential hazardous events, their causes and consequences. Proposed safeguards were also included in this review;
- As the potential hazardous events are located at a significant distance from other sensitive land users, the consequences of each potential hazardous event were estimated to determine if there are any possible unacceptable off-site impacts;
- Included in the analysis is the risk of propagation between the proposed equipment and the adjacent processes; and

- If adverse off-site impacts could occur, assess the risk levels to check if they are within the criteria in HIPAP 4 (Ref 3).

2 SITE DESCRIPTION

From Ref 1, the Shoalhaven Starches factory site is situated on various allotments of land on Bolong Road, Bomaderry, within the City of Shoalhaven (see Figure 1). The factory site, which is located on the south side of Bolong Road on the northern bank of the Shoalhaven River, has an area of approximately 12.5 hectares.

The town of Bomaderry is located approximately 0.5 km to the west of the factory site and the Nowra urban area is situated 2.0 km to the south west of the site. The "Riverview Road" area of the Nowra Township is situated approximately 600 metres immediately opposite the factory site across the Shoalhaven River.

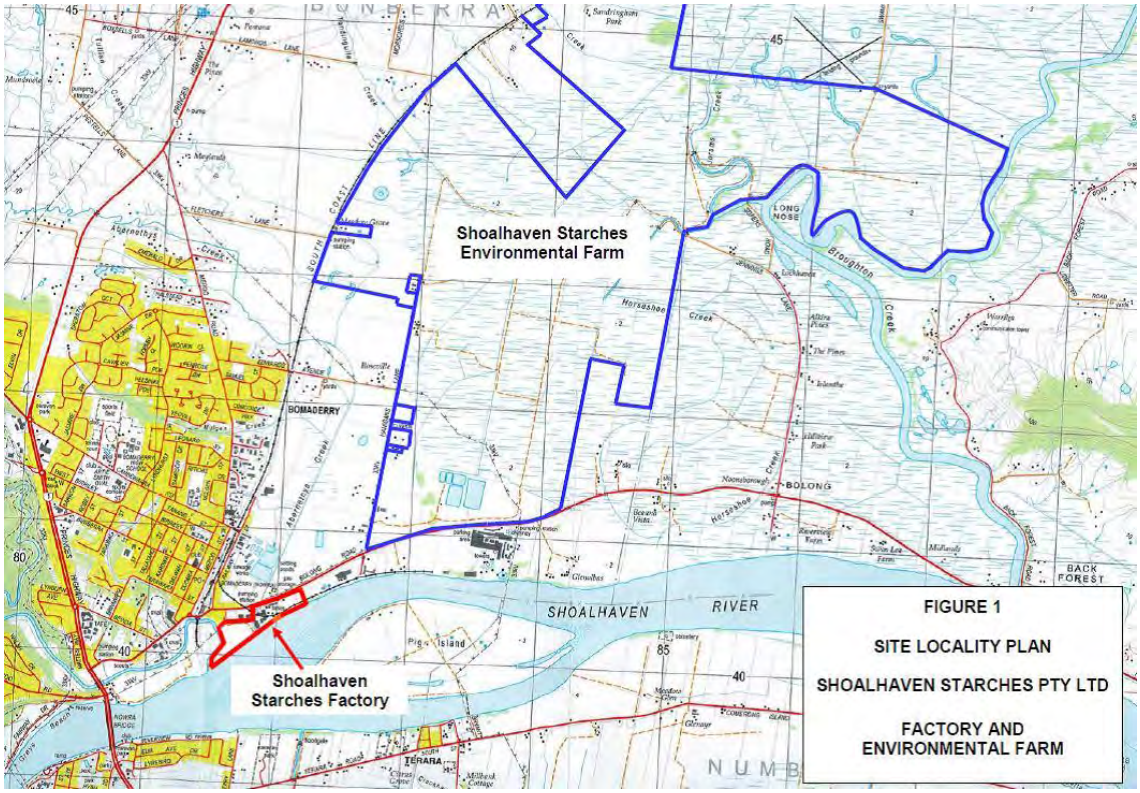
The village of Terara is situated approximately 1.5 kilometres to the south east of the site, across the Shoalhaven River. Pig Island is situated between the factory site and the village of Terara and is currently used for cattle grazing.

There are a number of industrial land uses, which have developed on the strip of land between Bolong Road and the Shoalhaven River. Industrial activities include a metal fabrication factory, the Shoalhaven Starches site, Shoalhaven Dairy Co-op (formerly Australian Co-operative Foods Ltd – now owned by the Manildra Group) and the Shoalhaven Paper Mill (also now owned by the Manildra Group). The industrial area is serviced by a privately-owned railway spur line that runs from just north of the Nowra-Bomaderry station via the starch plant and the former Dairy Co-op site to the Paper Mill.

The Company also has an Environmental Farm of approximately 1,000 hectares located on the northern side of Bolong Road. This area is cleared grazing land and contains spray irrigation lines and wet weather storage ponds (total capacity 925 Mega litres). There are at present six wet weather storage ponds on the farm that form part of the waste water management system for the factory. A seventh pond approved in 2002 was converted into the biological section of the new wastewater treatment plant has now been commissioned.

The Environmental Farm covers a broad area of the northern floodplain of the Shoalhaven River, stretching from Bolong Road in the south towards Jaspers Brush in the north. Apart from its use as the Environmental Farm, this broad floodplain area is mainly used for grazing (cattle). The area comprises mainly large rural properties with isolated dwellings although there is a clustering of rural residential development along Jennings Lane (approximately 1 kilometre from the site), Back Forest Road (approximately 500 metres to 1.2 kilometres to the west) and Jaspers Brush Road (approximately 1.2 kilometres to the north).

Figure 1 - Site Locality Plan



Source: Ref 1.

Security of the site is achieved by a number of means. This includes site personnel and security patrols by an external security company (this includes weekends and night patrols). The site operates 7 days per week (24 hours per day). Also, the site is fully fenced and non-operating gates are locked. Security cameras are installed for staff to view visitors and site activities.

There are approximately 126 people on site during Monday to Fridays 8 am to 5 pm and 88 people on site at other times.

The main natural hazard for the site is flooding. No other significant external events are considered high risk for this site.

Layout drawings showing the proposed location of the boilers are shown in Figures 2 and 3.

Figure 2 – Site Layout – Shoalhaven Starches

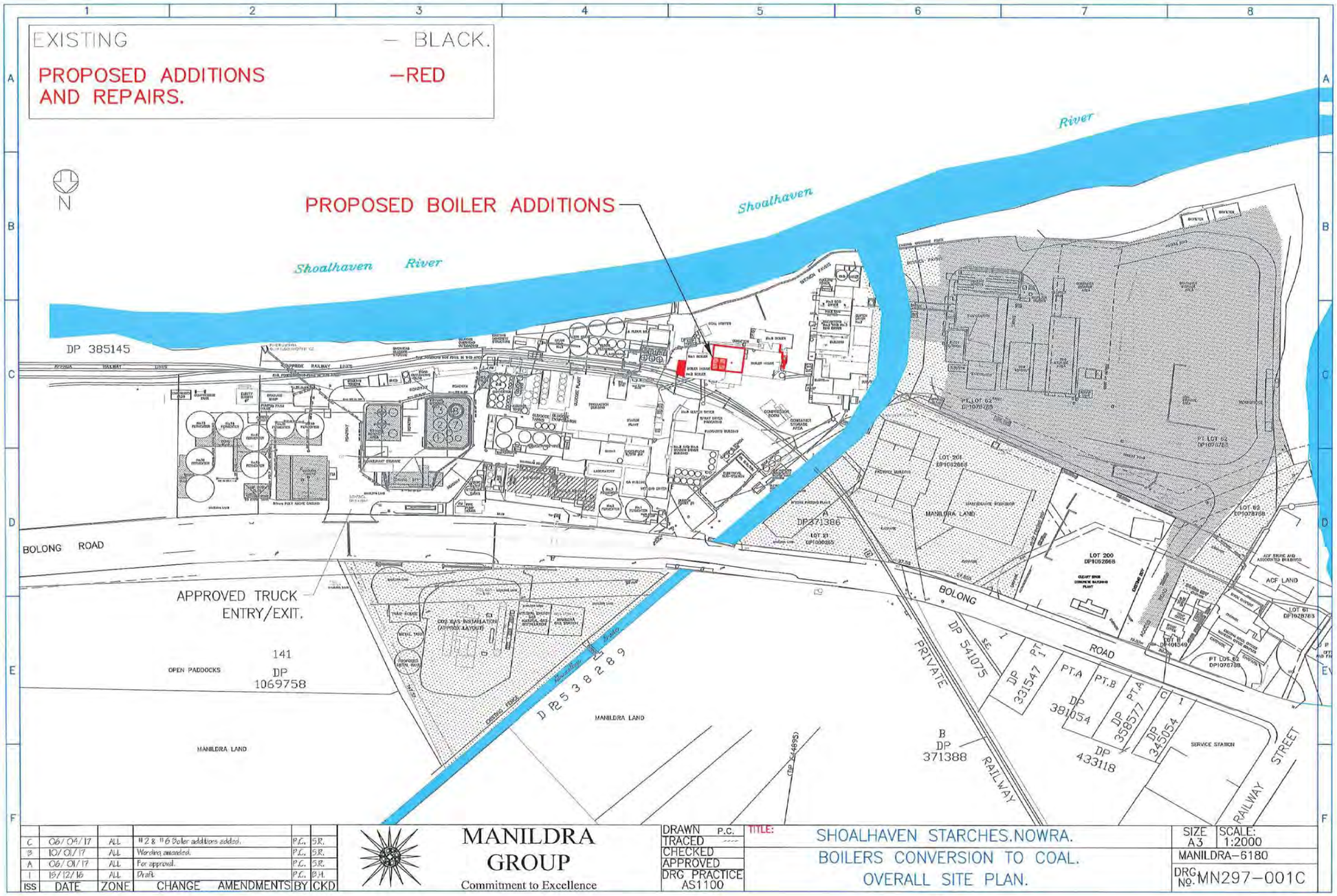
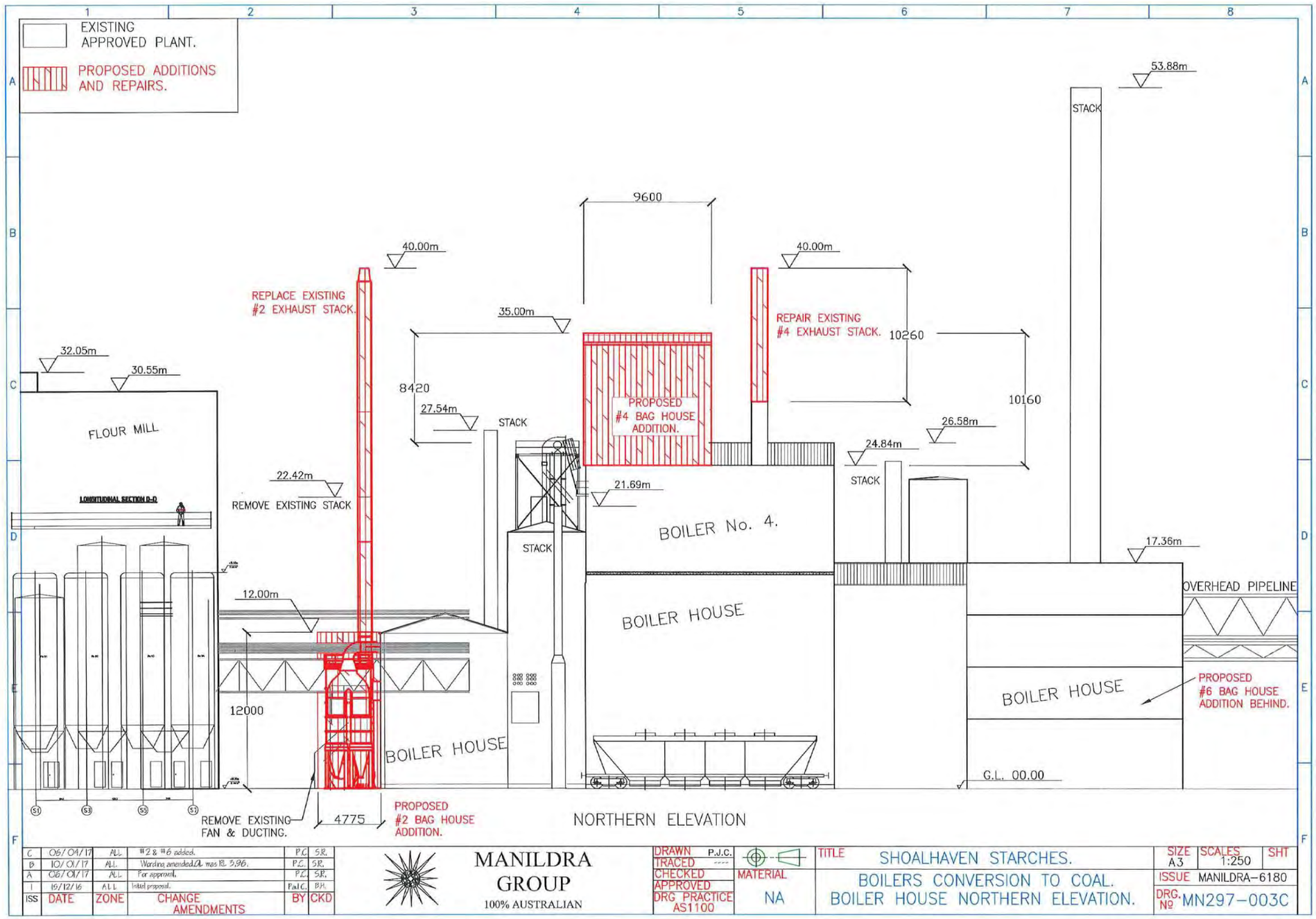


Figure 3 – Elevation Drawing



ISS	DATE	ZONE	CHANGE AMENDMENTS	BY	CKD
C	06/01/17	ALL	#2 & #6 added.	P.C.	S.R.
B	10/01/17	ALL	Wording amended A. was R. 3.96.	P.C.	S.R.
A	06/01/17	ALL	For approval.	P.C.	S.R.
1	16/12/16	ALL	Initial proposal.	Paul C.	B.H.

MANILDRA GROUP
100% AUSTRALIAN

DRAWN	P.J.C.
TRACED	
CHECKED	
APPROVED	
DRG PRACTICE	AS1100
MATERIAL	NA
TITLE	SHOALHAVEN STARCHES. BOILERS CONVERSION TO COAL. BOILER HOUSE NORTHERN ELEVATION.
SIZE	A3
SCALES	1:250
SHT	
ISSUE	MANILDRA–6180
DRG. Nº	MN297–003C

3 PROCESS DESCRIPTION

Trucks deliver the coal to the existing coal stockpile on the Shoalhaven Site. The coal is currently used in Boilers 5 and 6 whereas previously it was also used in Boiler Nos. 2 and 4. For this project, coal will be reused in Boilers 2 and 4. Therefore, all of the existing coal handling equipment is to be reused.

All the coal-fired boilers are designed for limited attended operation in compliance with the requirements of AS2593, however, are operated as attended boilers.

Black coal is used at the Shoalhaven Starches site. The coal size is 10 to 25 mm and contains approximately 15% ash. It is reclaimed from the coal stockpile using a frontend loader. The frontend loader feeds the coal into an existing hopper and denseveyor (pneumatic transfer machine). Compressed air is used to transfer the coal to the boiler. The flowrate of coal to Boiler No. 2 will be approximately 4 tonnes per hour (the original design basis).

Each of the four boilers (2, 4, 5 and 6) has an existing feed hopper which is level controlled. The coal is gravity fed onto a grate for delivery into each boiler. A door at the coal inlet to each boiler can be closed (manually) to stop the coal and hence the source of heat, e.g. in the event of an emergency.

The coal passes through a guillotine door that maintains the desired bed depth. After about 1 m of travel, the coal is ignited by the heat from the existing coal that is burning. The heat from the burning coal raises the required steam. There are no changes to the water and steam equipment, controls and protection.

The boiler will be ignited during start-up by two gas burners.

The fly ash from Boiler No. 2 will pass through a **new** multi-cyclone, economiser and air heater before passing through two new baghouse filters via a balanced flow arrangement. These are to be constructed adjacent to the boilers. They will contain 5 m long socks that will collect the fly ash. The socks will be pulsed with air to remove the fly ash (which falls to the bottom of the baghouse). This fly ash, along with the fly ash collected by the multi-cyclones, economiser and air heater, will be conveyed pneumatically to a receiving hopper located above the No. 4 Boiler pug mill (produces a paste by forcibly combining fly ash with water) and then combined with the bottom ash from the boilers on the existing ash conveyor and conveyed to the existing ash bin to be removed from site by truck.

Combustion gas waste heat is used by the economiser to preheat feed water to the steam drum while the air heater uses the waste heat to preheat the combustion air thus improving the energy efficiency of the boiler.

Combustion gas will exit the new baghouse filter and vent to atmosphere via a new 40 m high exhaust stack.

The existing coal bin is fitted with a baghouse to aspirate the bin from the pneumatic conveying and to prevent the build-up of coal dust and hence the risk of a dust explosion. The baghouse vents directly to atmosphere.

A simplified process flow diagram is shown in Appendix 1.

The modifications to Boiler No. 4 are very similar to Boiler No. 2. The differences are shown below.

The flowrate of coal to Boiler No. 4 will be approximately 9.6 tonnes per hour (the original design basis).

The fly ash from Boiler No. 4 will pass through the **existing** multi-cyclone, economiser and air heater before passing through two new baghouse filters via a balanced flow arrangement. These are to be constructed above the boilers. They will contain 5 m long socks that will collect the fly ash. The socks will be pulsed with air to remove the fly ash (which falls to the bottom of the baghouse). This fly ash, along with the fly ash collected by the multi-cyclones, economiser and air heater, will be conveyed by screw conveyors to a new pug mill (produces a paste by forcibly combining fly ash with water) and then combined with the bottom ash from the boilers on the existing ash conveyor and conveyed to the existing ash bin to be removed from site by truck.

Combustion gas will exit the new baghouse filter and vent to atmosphere via the modified stack, i.e. the height will be increased by 9 m to 40 m.

For Boiler No. 6, it is only proposed to construct a new baghouse filter and associated ducting adjacent to this boiler. These works will have a maximum height above ground level of 15 metres. The purpose of this work will be to increase steam production from this boiler by 7 tonnes per hour.

4 HAZARD IDENTIFICATION

4.1 HAZARDOUS MATERIALS

Coal:

The main hazardous material is anthracitic black coal. Anthracite is a hard, compact variety of coal that has a submetallic lustre. It has the highest carbon content, the fewest impurities and the highest calorific content of all types of coal except for graphite.

Coal is not a Dangerous Good but is classified as hazardous according to Safe Work Australia criteria. It is a combustible solid and may form explosive dust mixtures with air. When involved in a fire it may evolve toxic gases, e.g. carbon monoxide, nitrogen and sulphur oxides, and hydrocarbons.

Spontaneous combustion may occur under storage conditions of elevated temperatures and a continuous supply of oxygen. Smouldering combustion of coal can also lead to flammable gases such as methane and carbon monoxide. These can cause explosions when confined and ignited, e.g. in silos.

Coal may also evolve toxic coal ash decomposition products such as mercury, arsenic, selenium, cadmium and lead when burnt.

Coal Ash:

Coal ash is the waste that is left after coal is combusted (burned). It includes fly ash (fine powdery particles in the combustion gas stream and captured by pollution control devices such as cyclones and baghouse filters) as well as coarser materials that fall to the bottom of the furnace.

Depending on where the coal was mined, coal ash typically contains heavy metals including arsenic, lead, mercury, cadmium, chromium and selenium, as well as aluminium, antimony, barium, beryllium, boron, chlorine, cobalt, manganese, molybdenum, nickel, thallium, vanadium, and zinc.

The US Environmental Protection Agency has found that living next to a coal ash disposal site can increase the risk of cancer or other diseases. If eaten, drunk or inhaled, these toxic materials can cause cancer and nervous system impacts such as cognitive deficits, developmental delays and behavioural problems.

Note: The boiler feedwater dosing chemicals will not change as a result of this project.

4.2 POTENTIAL HAZARDOUS INCIDENTS REVIEW

In accordance with the requirements of **Guidelines for Hazard Analysis**, (Ref 2), it is necessary to identify hazardous events associated with the facility's operations. As recommended in HIPAP 6, the PHA focuses on "atypical and abnormal events and conditions. It is not intended to apply to continuous or normal operating emissions to air or water".

In keeping with the principles of risk assessments, credible, hazardous events with the potential for off-site effects have been identified. That is, "slips, trips

and falls" type events are not included nor are non-credible situations such as an aircraft crash occurring at the same time as an earthquake.

For this PHA, Boilers No. 2 and 4 have previously been operated using coal. This project involves returning these boilers back to the original operation. The new equipment includes the multicyclone, economiser, combustion air preheater and baghouse filters on the flue gas stream and a new stack for Boiler No. 2. Boiler No. 4 will have a new pug mill, baghouse filter and modified stack.

The increase in stack height has no negative impact on process safety with respect to fires, explosions and toxic releases. There may be a slightly higher backpressure on the induced draught fan in the flue gas stream, however, this is a design issue for the project. Therefore, no further analysis of the modified stack is required.

Fly ash in its pure state is inert and not a dust explosion hazard. In the power generation industry, fly ash can be mixed with pulverised fuel (coal) and form an explosive dust. In these cases, the coal pulveriser crushes the coal lumps into dust particles; hence the explosion hazard. However, with the three coal boilers at Shoalhaven Starches, the coal lumps are not crushed but combusted whilst on a grate. The organic content of the fly ash is low and not expected to be a dust explosion hazard during normal operation.

The main hazards associated with the baghouse filters are impact to health, e.g. people breathing the fly ash dust which can contain heavy metals, and impact to the environment if the fly ash is released. These are hazards the existing Boilers 5 and 6 pose at the site as well as Boilers 2 and 4 when they were previously in operation with coal.

There are existing hazards for the coal fired boilers, e.g. boiler overpressure (pressure safety valves installed) and low boiler water level (instrumented controls in-place). These hazards exist for the current boiler design and there are existing controls approved for these hazards. Therefore, these hazards are not reproduced in this study.

Hence, the limited identified credible, significant incidents (in particular, with the potential for off-site impacts) for the proposed modifications are summarised in the Hazard Identification Word Diagram following (Table 1).

This diagram presents the causes and consequences of the events, together with major preventative and protective features that are to be included as part of the design.

Table 1 – Hazard Identification Word Diagram

Event Number	Hazardous Event	Causes	Consequences	Existing Safeguards - Prevention Detection Mitigation
1	Release of fly ash	Failed sock within a baghouse filter, e.g. due to sock blockage and high differential pressure, and wear and tear of socks	Potential impact to people due to inhaled dust, e.g. silicosis, as well as exposure to heavy, toxic metals, e.g. may cause cancer or nervous system damage for long term exposure. Potential to impact the environment, i.e. increase in background dust levels	Maintenance (e.g. regular sock replacement and filter inspections at major shutdowns). Replacement socks to meet the original equipment manufacturers specifications. Air pulsing used to reduce high differential pressure across the socks. Visual detection of a fail sock and hence maintenance. Reporting from observations. Pressure differential measured across the baghouse filters and hence operator inspections. Obscuration meter and impact detectors on top of the stacks. Regular operator check to confirm warm screw conveyor temperature

Event Number	Hazardous Event	Causes	Consequences	Existing Safeguards - Prevention Detection Mitigation
2	Release of fly ash when it is deposited on the roads at the Shoalhaven Starches farm	Fly ash drying and moved by the wind or vehicles	Potential impact to people due to inhaled dust, e.g. silicosis, as well as exposure to heavy, toxic metals, e.g. may cause cancer or nervous system damage for long term exposure. Potential to impact the environment, i.e. increase in background dust levels	Water, syrup and calcium chloride are used to manage road dust levels associated with the ash (fly and bottom). The farm roads are also sealed with coal wash
3	Fire in a baghouse	Ignition of carryover fly ash and socks smouldering	Damage to equipment, environmental impact, loss of production	Obscuration meter in the stacks. Alarm on high temperature in the baghouses. Hydrant system and hoses for fire attack response. Emergency Response Team on site
4	Coal dust explosion (this is an existing hazard for Boilers 5 and 6 and also for Boilers 2 and 4 when they were previously operated on coal)	Attrition of coal particles and ignition of the fine particulates e.g. static in the denseveyor, hopper, hot work adjacent to the denseveyor seals where losses of containment of particles can occur	Equipment damage, injury (engulfment) from dust fire / explosion	Unlikely event given the limited quantities of coal dust expected as per the history of operation for Boilers 2, 4, 5 and 6 and hence operating below the lower explosion limit. Earthing of equipment. Sprinklers are installed over the denseveyor so product is moist (not dusty). Control of ignition sources (hot work permit).

Event Number	Hazardous Event	Causes	Consequences	Existing Safeguards - Prevention Detection Mitigation
5	Coal stockpile fire (this is an existing hazard for Boilers 5 and 6 and also for Boilers 2 and 4 when they were previously operated on coal)	Source of ignition such as hot work, lightning strike and self-heating	Local coal fire resulting in equipment damage and products of combustion (i.e. environmental impact) which could include methane and carbon monoxide	Control of ignition sources (hot work permit). Direct water injection to the coal bunkers and isolations on the chutes. Hydrant system and hoses for fire attack response. Emergency Response Team on site. Operator response to the initial combustion, i.e. by smell and/or sight. Water sprinklers on coal stockpile (adjacent to the boilerhouse)
6	Fugitive coal dust emissions	Dust build-up on pipes and structures within the coal fired boiler houses	Destruction of boiler house due to a coal dust explosion and significant injury to workers	Regular housekeeping / cleaning of coal dust build-up
7	Fire propagation back through the coal feed system	Fire from grate burns upward to the coal bunker, in particular, when the feed system is shutdown	Equipment damage, injury coal fire	Steam sparge system that will extinguish a fire, controlled automatically via thermocouples. Guillotine door closes when feed system stops

5 RISK ANALYSIS

5.1 HIPAP 4 CRITERIA ANALYSIS

The assessment of risks to both the public as well as to operating personnel around the proposed modifications requires the application of the basic steps outlined in Section 1. As per HIPAP 6 (Ref 2), the chosen analysis technique should be commensurate with the nature of the risks involved. Risk analysis could be qualitative, semi-quantitative or quantitative.

The typical risk analysis methodology attempts to take account of all credible hazardous situations that may arise from the operation of processing plants etc.

Having identified all credible, significant incidents, risk analysis requires the following general approach for individual incidents:

Risk = Likelihood x Consequence

The risks from all individual potential events are then summated to get cumulative risk.

The risk criteria applying to developments in NSW are summarised in Table 2 on the following page (from Ref 3).

Table 2 - Risk Criteria, New Plants

Description	Risk Criteria
Fatality risk to sensitive uses, including hospitals, schools, aged care	0.5 x 10^{-6} per year
Fatality risk to residential and hotels	1 x 10^{-6} per year
Fatality risk to commercial areas, including offices, retail centres, warehouses	5 x 10^{-6} per year
Fatality risk to sporting complexes and active open spaces	10 x 10^{-6} per year
Fatality risk to be contained within the boundary of an industrial site	50 x 10^{-6} per year
Injury risk – incident heat flux radiation at residential areas should not exceed 4.7 kW/m^2 at frequencies of more than 50 chances in a million per year or incident explosion overpressure at residential areas should not exceed 7 kPa at frequencies of more than 50 chances in a million per year	50 x 10^{-6} per year
Toxic exposure - Toxic concentrations in residential areas which would be seriously injurious to sensitive members of the community following a relatively short period of exposure	10 x 10^{-6} per year
Toxic exposure - Toxic concentrations in residential areas which should cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community	50 x 10^{-6} per year
Propagation due to Fire and Explosion – exceed radiant heat levels of 23 kW/m^2 or explosion overpressures of 14 kPa in adjacent industrial facilities	50 x 10^{-6} per year

The consequences of the potential hazardous events in Table 1 are initially assessed to determine if any events have the potential to contribute to the above-listed criteria and hence worthy of further analysis.

The distance from the boiler house and coal handling equipment to the nearest site boundary (Bolong Road) is approximately 120 m.

Fires:

As the coal remains in solid lump form, potential fires are expected to be local impact only from radiant heat. The following photographs show typical coal fires, i.e. limited flames and hence limited radiant heat emitted at distance.

Figure 4 – Small Coal Fire

Figure 5 – Large Coal Stockpile Fire

Given the large distance to the nearest off-site receptors (i.e. approximately 120) then it is not credible that significant levels of radiant heat will affect these receptors. Therefore, the risk criteria in Table 2 with respect to radiant heat from potential coal fires are satisfied.

Explosions:

Whilst Table 1 includes potential coal dust explosions, these are historically low likelihood for facilities handling relatively small quantities of coal (in lump form). If coal dust were to be formed and ignited, e.g. within the boiler house, again the significant impacts are not expected at distances of 120 m or more.

The primary means to prevent this event is to design for containment, i.e. do not make and release combustible dust into the building. This is the basis for the design of the coal handling equipment. This includes the existing identical operational equipment for Boilers 5 and 6.

Should losses of containment of combustible dust occur then controls such as housekeeping, hazardous zoning and permits to work are required. These are in-place for the existing coal handling equipment and are important measures to lower the risk of dust explosions within the existing boiler house. As this hazard exists now on-site and the Boilers 2 and 4 existing equipment are being refurbished to the same standard as the existing equipment then no further safeguarding is recommended for this scenario.

Correspondingly, the low likelihood of these types of events for this type of facility plus the separation distances involved then the risk criteria in Table 2 with respect to overpressures from potential coal dust explosions are deemed to be satisfied.

Toxic Impact:

There are no toxic materials involved with the boiler operation that could cause significant impact to people off-site. Therefore, the risk criteria in Table 2 with respect to toxic impact from potential toxic gas releases are satisfied.

There are potential chronic impacts from long term exposure to boiler ash and these need to be managed as per the existing arrangements for Boilers 5 and 6. This includes the installation of the new baghouse filters for collecting the fly ash.

5.2 CUMULATIVE AND PROPAGATION RISK

Given that significant levels of impacts from potential hazardous events are expected to remain on-site then it is reasonable to conclude that the modified boilers do not make a significant contribution to the existing cumulative risk in the area.

As Boilers 2 and 4 are being returned back to their original design intent and in compliance with the Australian Standards, the risk of propagation is deemed acceptable. This risk is similar to that which exits at the site now, i.e. Boiler 5 propagating to Boiler 6 and vice versa. If event propagation were to occur, mostly likely due to a coal fire propagating, then the outcomes are still expected to be local events only given anecdotal evidence (see Figure 4 and Figure 5).

There are no foreseeable credible hazardous events associated with the new baghouse filters and modified stacks that can lead to event propagation.

5.3 SOCIETAL RISK

The criteria in HIPAP 4 for individual risk do not necessarily reflect the overall risk associated with any proposal. In some cases, for instance, where the 1 pmpy contour approaches closely to residential areas or sensitive land uses, the potential may exist for multiple fatalities as the result of a single accident. One attempt to make comparative assessments of such cases involves the calculation of societal risk.

Societal risk results are usually presented as F-N curves, which show the frequency of events (F) resulting in N or more fatalities. To determine societal risk, it is necessary to quantify the population within each zone of risk surrounding a facility. By combining the results for different risk levels, a societal risk curve can be produced.

In this study of the modified boilers, the risk of off-site fatality is below the HIPAP 4 risk criteria. As the nearest boundary is approximately 120 m away, the concept of societal risk applying to off-site populated areas is therefore not applicable for this project.

5.4 RISK TO THE BIOPHYSICAL ENVIRONMENT

The main concern for risk to the biophysical environment is generally with effects on whole systems or populations. For this site, it is suitably located away from residential areas.

However, there are two areas, i.e. due to the failure of the new baghouse filter socks and ash release from the roads on the Shoalhaven Starches farm, where losses of containment can potentially impact the environment. The releases at the farm can also impact people (predominantly the Shoalhaven Starches farm employees). This risk is similar to that on the site now, e.g. for Boilers 5 and 6. The existing safeguards are listed in Table 1 for these events.

The disposal of ash via the Shoalhaven Starches farm's roads is an EPA approved method of disposal. The health risk to people is to be assessed via an Air Quality Assessment.

Whereas any adverse effect on the environment is obviously undesirable, the results of this study show that the risk of losses of containment is broadly acceptable.

6 CONCLUSION AND RECOMMENDATIONS

The risks associated with the proposed modifications to Boilers 2, 4 and 6 at the Shoalhaven Starches Bomaderry site have been assessed and compared against the DoP risk criteria.

The results are as follows and show compliance with all risk criteria.

Description	Risk Criteria	Risk Acceptable?
Fatality risk to sensitive uses, including hospitals, schools, aged care	0.5 x 10^{-6} per year	Yes
Fatality risk to residential and hotels	1 x 10^{-6} per year	Yes
Fatality risk to commercial areas, including offices, retail centres, warehouses	5 x 10^{-6} per year	Yes
Fatality risk to sporting complexes and active open spaces	10 x 10^{-6} per year	Yes
Fatality risk to be contained within the boundary of an industrial site	50 x 10^{-6} per year	Yes
Injury risk – incident heat flux radiation at residential areas should not exceed 4.7 kW/m^2 at frequencies of more than 50 chances in a million per year or incident explosion overpressure at residential areas should not exceed 7 kPa at frequencies of more than 50 chances in a million per year	50 x 10^{-6} per year	Yes
Toxic exposure - Toxic concentrations in residential areas which would be seriously injurious to sensitive members of the community following a relatively short period of exposure	10 x 10^{-6} per year	Yes
Toxic exposure - Toxic concentrations in residential areas which should cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community	50 x 10^{-6} per year	Yes
Propagation due to Fire and Explosion – exceed radiant heat levels of 23 kW/m^2 or explosion overpressures of 14 kPa in adjacent industrial facilities	50 x 10^{-6} per year	Yes

Societal risk, area cumulative risk and environmental risk is also concluded to be acceptable.

The primary reasons for the low risk levels from the modifications are that significant levels of impact from potential hazardous events are contained on-site.

The following recommendation is made from this review.

1. All existing coal handling equipment for the boilers is to be functionally tested to ensure it is fit-for-purpose prior to reuse. This includes the safety instrumented controls, e.g. alarms, trips and interlocks, as well as any mechanical protective systems.

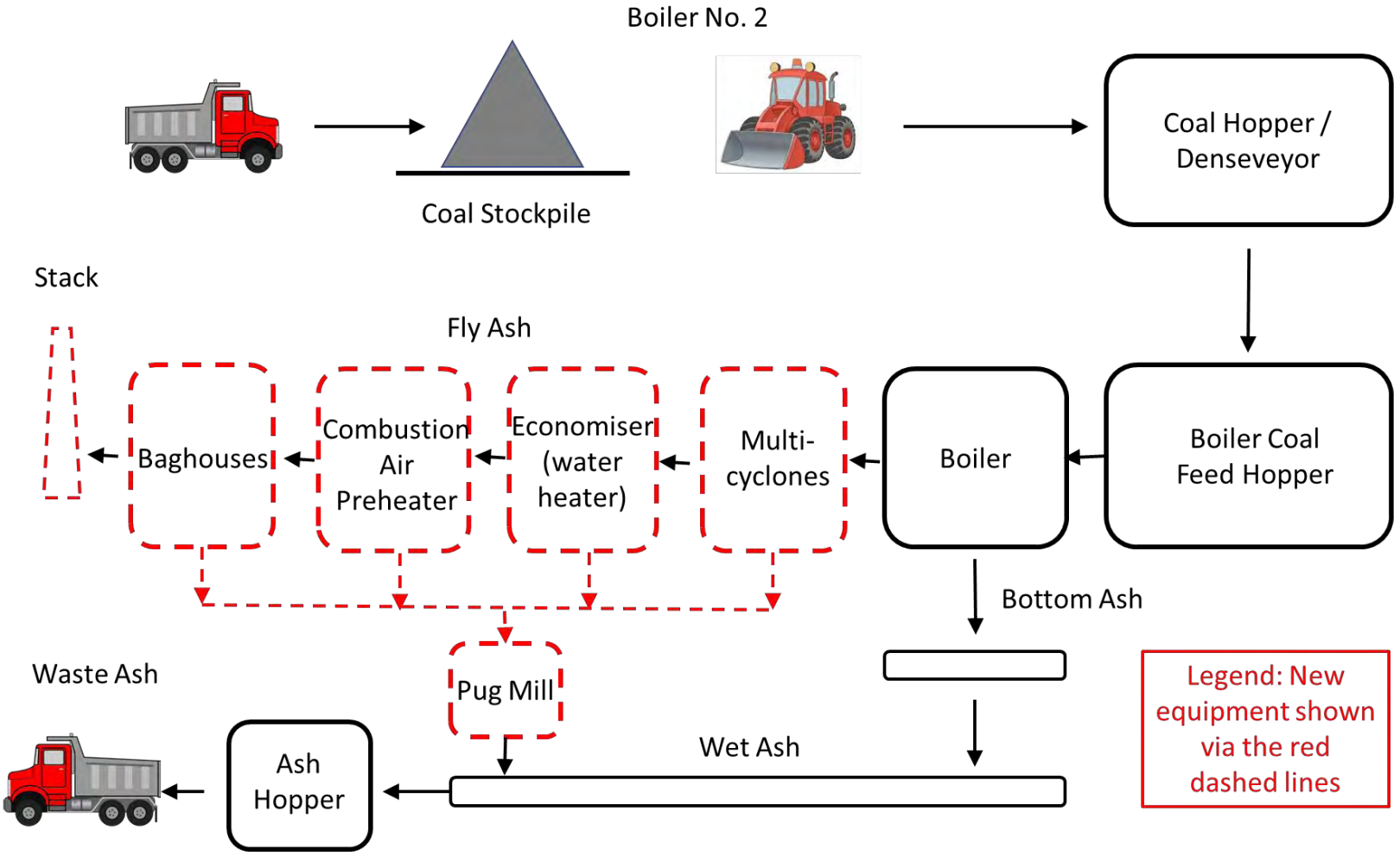
Appendix 1

Simplified Process Flow Diagram

Preliminary Hazard Analysis, Shoalhaven Starches,

Modifications to Boilers 2, 4 and 6

Appendix 1 – Simplified Process Flow Diagram – Boilers 2, 4 and 6.



7 REFERENCES

1 Cowman Stoddart Pty Ltd, **Environmental Assessment, Shoalhaven Starches, Proposed Modificaton in Relation to Location, Design and Footprint of the DDGSSSSS pelletisirg plant, Project Approval MP 06_0228**, February 2014

2 Department of Planning and Infrastructure (NSW) **Hazardous Industry Planning Advisory Paper No 6 – Hazard Analysis,** January, 2011

3 Department of Planning and Infrastructure (NSW) **Hazardous Industry Planning Advisory Paper No 4 – Risk Criteria for Land Use Safety Planning,** January, 2011