ANNEXURE 6

Environmental Noise Impact Assessment

prepared by

Day Design Pty Ltd

ANNEXURE 6

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Environmental Noise Impact Assessment

Proposed Starch Dryer
Shoalhaven Starches, Bolong Road, Bomaderry, NSW

REPORT NUMBER

5788-1.1R

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SGS

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1.0 EXECUTIVE SUMMARY

Shoalhaven Starches Pty Ltd is part of the Manildra Group of companies and their existing Bomaderry complex produces a range of products including starch, gluten, glucose, ethanol and stock feed.

Their existing facility is located on the southern side of Bolong Road, Bomaderry, NSW, on the northern side of the Shoalhaven River. The surrounding area is a mix of commercial, industrial and residential premises. The nearest residences are located in the township of Bomaderry to the north-west and across the Shoalhaven River in Nowra to the south and Terara to the south-east.

It is proposed to relocate Starch Dryer No. 5, originally approved as part of the PRP No. 7 Project Approval (and which was brought into the Shoalhaven Starches Expansion Project Approval (MP06-0228)) onto land at the western side of Abernathy's Creek onto land otherwise known as the 'Moorehouse' site, as shown in Figure 1 and the attached Appendix A.

The starch dryer building will comprise three levels with various plant and equipment on each level as well as on the roof of the building. All plant and equipment will be new, provided from overseas manufacturers and include, for example, sifters, heaters, disintegrators, centrifuges, silos and conveyors.

Shoalhaven Starches has project approval, as part of the Shoalhaven Starches Expansion Project Approval, for a new packing plant to be located opposite the site on Bolong Road, which will ultimately service the new starch dryer. In the interim, product generated via the new starch dryer will be packaged, warehoused and dispatched from either of the existing packing facilities on site. These processes therefore either already occur or are approved. Consequently this assessment addresses noise emission from the proposed starch dryer only, however consideration is given to all existing and proposed noise producing facets of the facility when designing noise goals for this proposal.

Shoalhaven Starches operates under Environment Protection Licence Number 883 which sets noise limits for the overall operation of the complex. Noise goals have been designed for the proposal so as to ensure existing noise levels are not increased by the introduction of the new plant and equipment. The noise goals for any new plant are a minimum 10 dB below the EPL noise limits and range between 28 dBA and 32 dBA depending upon the residential receptor location.

These goals are also in accordance with Shoalhaven Starches Noise Management Plan originally prepared 31 October 2009 and revised 7 September 2010 under the Project Approval conditions for the Shoalhaven Starches Expansion Project.

Noise modelling has been undertaken using a combination of measured noise levels from existing indicative plant and equipment as well as manufacturer's noise data.

Recommendations are made in Section 7 of this report to reduce the level of noise emission from the starch dryer to within the noise goals. These include advice on the construction of the building.

Providing the recommendations are satisfactorily implemented the level of noise emitted by the proposed starch dryer will comply with the Shoalhaven Starches Environment Protection Licence noise limits and Shoalhaven City Council's general noise requirements.

The construction works will consist of the demolition of the Moorehouse building, preliminary earthworks, potential piling work, pouring of the concrete slabs and the erection of the structure.

Calculations show that the level of noise emission from the construction phase will be within noise management levels set by the NSW EPA's *Interim Construction Noise Guideline* at all receptor locations for the majority of the construction phase.

2.0 CONSULTING BRIEF

Day Design Pty Ltd was engaged by Shoalhaven Starches Pty Ltd to assess the potential environmental noise impact of a proposed starch dryer to be located at the site of the Moorehouse Building at their existing complex on Bolong Road, Bomaderry, NSW.

This commission involves the following:

Scope of Work:

- Inspect the site and environs
- Prepare a site plan identifying the proposal and nearby noise sensitive locations
- Establish acceptable noise level criteria and design goals
- Quantify noise emission from the proposal
- Calculate the level of noise emission, taking into account building envelope transmission, distance loss, screen walls, etc
- Consider noise emission from the construction phase of the development
- Provide recommendations for noise control if necessary
- Prepare an Environmental Noise Impact Assessment Report.

3.0 SITE AND DEVELOPMENT DESCRIPTION

3.1 Site Description

The Shoalhaven Starches complex is located on the southern side of Bolong Road across the Shoalhaven River from Nowra.

The area surrounding Shoalhaven Starches is a mix of commercial, industrial and residential premises with vacant land, owned by the Manildra Group, to the north.

The nearest residential locations to the proposal are as follows:-

- Location 1 – Nobblers Lane, Terara approximately 1400 metres to the south east
- Location 2 – Riverview Road, Nowra approximately 975 metres to the south west;
- Location 3 – Meroo Street, Bomaderry approximately 620 metres to the north west;
- Location 4 – Coomea Street, Bomaderry approximately 750 metres to the north west;

Locations are listed in keeping with the order shown in the Environment Protection Licence (see Section 4.1 of this report).

The Shoalhaven Starches site, surrounding area and receptor locations are shown in Figure 1.

3.2 Development Description

It is proposed to relocate an approved starch dryer from the Shoalhaven Starches site to the western side of Abernathy's Creek to the existing Moorehouse Building toward the western end of Shoalhaven Starches complex.

The location of the proposal is shown in the attached Appendix A.

The starch dryer plant and equipment will be located within a three storey building and include, for example, sifters, heaters, disintegrators, centrifuges, silos and conveyors.

Shoalhaven Starches has approval for a new packing plant to be located opposite the site on Bolong Road, which will ultimately service the new starch dryer. In the interim, product generated via the new starch dryer will be packaged, warehoused and dispatched from either of the existing packing facilities on site. These processes therefore either already occur or are approved. Consequently this assessment addresses noise emission from the proposed starch dryer only, however consideration is given to all existing and proposed noise producing facets of the facility when designing noise goals for this proposal.

As such this assessment addresses noise emission arising from the construction and operation of the proposed starch dryer only.

Figure 1. Location Plan – Shoalhaven Starches, Bomaderry *(source: Google Maps Imagery © 2014).*

4.0 ACOUSTICAL CRITERIA

This section presents the noise guidelines applicable to this proposal and establishes the project specific noise criteria.

4.1 Environment Protection Licence 883

Shoalhaven Starches operates under Environment Protection Licence 883 issued by the NSW Environment Protection Authority.

Section L5 'Noise Limits' of the licence states:-

"L5.1 the $L_{A10\ (15min)}$ sound pressure level contribution generated from the premises must not exceed the following levels when measured at or near the boundary of any residential premises:

a) 38 dBA at locations in Terara on the south side of the Shoalhaven River;

b) 38 dBA at locations in Nowra on the south side of the Shoalhaven River;

c) 42 dBA at locations in Meroo Street, Bomaderry;

d) 40 dBA at other locations in Bomaderry."

These noise limits apply to the overall operation of the Shoalhaven Starches complex.

4.2 Shoalhaven Starches Noise Management Plan

Previous approval for the Shoalhaven Starches Expansion Project, required the preparation of a Noise Management Plan for addressing and managing noise emission from the expansion project.

The Shoalhaven Starches Noise Management Plan originally prepared 31 October 2009 and revised 7 September 2010 addresses, among other things, acoustic criteria relating to the Shoalhaven Starches complex and any new developments. Section 3 of the plan lists noise limits from the Environmental Protection Licence as shown in Section 4.1 above and states:-

"Compliance testing conducted on a regular basis on behalf of the Mill [Shoalhaven Starches complex] *has found noise emission from the premises satisfies the EPA criteria as a result of works on the Shoalhaven Starches site. In order to ensure that there is no increase in noise emission from the subject premises, with respect to the noise criteria nominated by the EPA in License Condition 6.3* [now 5.1], *the design goal for such additional plant should be at least 10 dB below the criteria nominated by the EPA."*

4.3 EPA Construction Noise Guideline

The NSW EPA published the *Interim Construction Noise Guideline* in July 2009. While some noise from construction sites is inevitable, the aim of the Guideline is to protect the majority of residences and other sensitive land uses from noise pollution most of the time.

The Guideline presents two ways of assessing construction noise impacts; the quantitative method and the qualitative method.

The quantitative method is generally suited to longer term construction projects and involves predicting noise levels from the construction phase and comparing them with noise management levels given in the guideline.

The qualitative method for assessing construction noise is a simplified way to identify the cause of potential noise impacts and may be used for short-term works, such as repair and maintenance projects of short duration.

In this instance the entire construction phase may take several months although significant noise producing aspects, such as piling, if required, will last a total of approximately two weeks. Consideration is given to the potential for noise impact from construction activities on residential receptors in Section 6 of this report.

Table 2 in Section 4 of the Guideline sets out noise management levels at affected residences and how they are to be applied during normal construction hours. The noise management level is derived from the rating background level (RBL) plus 10 dB in accordance with the Guideline. This level is considered to be the 'noise affected level' which represents the point above which there may be some community reaction to noise.

Day Design has carried out numerous noise surveys in Nowra, Bomaderry and Terara and has found daytime background noise levels range between 33 and 40 dBA depending on the location, as shown in Table 1 below.

Table 1 Rating Background Levels

Noise Measurement Location	Time Period	Rating Background Level
135 Terara Road, Terara March 2012	Day (7 am to 6 pm)	**33 dBA**
250 Bolong Road, Bomaderry March 2014	Day (7 am to 6 pm)	**38 dBA**
Shoalhaven Village Caravan Park, Nowra - March 2012	Day (7 am to 6 pm)	**40 dBA**

For the purpose of determining the potential for community reaction to noise emission from construction activities, previously measured background noise levels in the vicinity of each receptor location have been used to determine the noise management levels as shown in Table 2 below.

Table 2 L_{eq} Noise Management Levels from Construction Activities

Receptor Location	Noise Management Level	How to Apply
Location 1 (Terara) Location 2 (Nowra) Locations 3 & 4 (Bomaderry)	**43 dBA** (33 + 10) **50 dBA** (40 + 10) **48 dBA** (38 + 10)	The noise affected level represents the point above which there may be some community reaction to noise. ▪ Where the predicted or measured $L_{Aeq\ (15\ min)}$ noise level is greater than the noise affected level, the proponent should apply all feasible and reasonable* work practices to meet the noise affected level. ▪ The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. ▪ Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences) 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

* Section 6, "work practices" of The *Interim Construction Noise Guideline*, states:- *"there are no prescribed noise controls for construction works. Instead, all feasible and reasonable work practices should be implemented to minimise noise impacts.*

This approach gives construction site managers and construction workers the greatest flexibility to manage noise".

Definitions of the terms feasible and reasonable are given in Section 1.4 of the Guideline.

The 'highly noise affected' level of 75 dBA represents the point above which there may be strong community reaction to noise. This level is provided in the Guideline and is not based on the RBL.

4.4 Project Specific Noise Criteria

When all the above factors are considered, we find that the most stringent noise criteria for the proposed starch dryer facility are as follows:-

Operational Phase (Environment Protection Licence noise limits less 10 dB) -

- *28 dBA ($L_{10,\ 15\,minute}$) at locations in Terara on the south side of the Shoalhaven River;*
- *28 dBA ($L_{10,\ 15\,minute}$) at locations in Nowra on the south side of the Shoalhaven River;*
- *32 dBA ($L_{10,\ 15\,minute}$) at locations in Meroo Street, Bomaderry;*
- *30 dBA ($L_{10,\ 15\,minute}$) at other locations in Bomaderry.*

Construction Phase Noise Management Levels

- *43 dBA ($L_{eq,\ 15\,minute}$) at locations in Terara;*
- *48 dBA ($L_{eq,\ 15\,minute}$) at locations in Bomaderry; and*
- *50 BA ($L_{eq,\ 15\,minute}$) at locations in Nowra.*

The residential criteria apply at the most-affected point on or within the residential property boundary or, if that is more than 30 metres from the residence, at the most-affected point within 30 metres of the residence. For upper floors, the noise is assessed outside the nearest window.

5.0 PRODUCT DRYER OPERATIONAL NOISE EMISSION

5.1 Starch Dryer Noise Levels

The main sources of noise associated with the operation of the starch dryer will be the plant and equipment located within the new building.

Day Design Pty Ltd has conducted several noise surveys at Shoalhaven Starches' complex including noise measurements of similar plant and equipment to that proposed for the starch dryer. In addition, the manufacturers of some plant and equipment have supplied sound data for various items of plant to be installed at the site.

Table 3 below provides a schedule of the octave band and overall 'A' frequency weighted sound power levels, in decibels re: 1 pW, of noise sources associated with the starch dryer.

Table 3 L_{10} Sound Power Levels – Grain Silos

Mechanical Plant	dBA	Sound Power Levels (dB) at Octave Band Centre Frequencies (Hz)							
		63	125	250	500	1k	2k	4k	8k
Sifters [1]	**93**	94	94	94	93	87	83	80	78
Gas and Steam Heaters [1]	**99**	93	91	91	93	91	91	95	87
Small motors / screw feeds [1]	**87**	85	91	91	82	81	77	75	69
Silo motors (roof top) [1]	**82**	89	77	78	81	78	74	68	57
Dryer ID Fan [2]	**83**	71	75	81	79	79	74	73	59
Cooler ID Fan [2]	**83**	71	75	81	79	79	74	73	59
Disintegrators [2]	**88**	73	88	85	84	83	79	79	67
Centrifuges [2]	**88**	86	83	85	87	83	80	75	71

1. Derived from Day Design's noise measurements of similar existing plant and equipment;
2. Derived from Day Design's noise measurements of similar existing plant and equipment adjusted to manufacturer's specifications for new plant.

5.2 Predicted Noise Levels

Knowing the sound power level of a noise source (see Table 3), the sound pressure level (as measured with a sound level meter) can be calculated at a remote location using suitable formulae to account for building envelope transmission, distance losses, etc.

Table 4 below shows the predicted noise level at each of the receptor locations from the ongoing operation of the starch dryer.

Table 4 Predicted Noise Levels at Receptor Locations – Starch dryer

Description	Predicted Noise Level $L_{10,\ 15\ minute}$ (dBA) at Receptor Location			
	Location 1	**Location 2**	**Location 3**	**Location 4**
Starch dryer Operating	21	27	32	30
Acceptable Noise Limit ($L_{10,\ 15\ minute}$)	28	28	32	30
Complies	**Yes**	**Yes**	**Yes**	**Yes**

The above calculations and predictions consider distance loss to each receptor and depend on the following:-

- Starch dryer building is constructed as outlined in Section 7;
- Manufacturer's stated noise levels for all items of plant and equipment are achieved.

6.0 CONSTRUCTION NOISE EMISSION

The construction process will involve demolition of the existing Moorehouse Building, preliminary earthworks, pouring of concrete slabs, erection and fit out of the buildings and installation of the starch dryer plant within the building.

It is likely also that piling will be required to establish the footing of the new structures.

As the Department of Planning and Environment is aware, a separate application is being submitted for the demolition of the Moorehouse Building site. Day Design Pty Ltd is preparing a separate Construction Noise and Vibration Management Plan for the demolition of the Moorehouse Building to support a separate application. This assessment therefore considers the construction processes following the demolition of the Moorehouse Building.

Table 5 below shows a schedule of sound power levels for typical construction equipment.

Table 5 Construction Equipment – L_{eq} Sound Power Levels

Description	L_{eq} Sound Power Level (dBA)
Piling Rig	118
Mobile Crane (Diesel)	110
Excavator – 30 T	110
Concrete Truck / Pump	105
Grinder	105
Power Saw	101

Table 6 below shows the predicted level of noise emission from construction activities at each of the receptor locations.

Table 6 Predicted Noise Levels at Receptor Locations – Construction Phase

Description	Predicted Noise Level $L_{eq,\,15\,minute}$ (dBA) at Receptor Location			
	Location 1	Location 2	Location 3	Location 4
Construction Activity*	35 – 41	43 – 49	41 – 46	39 - 45
Acceptable Noise Limit ($L_{eq,\,15\,minute}$)	43	50	48	48
Complies	✓	✓	✓	✓

* The range provided is with and without piling activity.

7.0 NOISE CONTROL RECOMMENDATIONS

7.1 Construction of the Starch Dryer Building

Walls

The external walls of the starch dryer building should have a minimum weighted sound reduction index (R_w) 23. In this instance calculations are based on *'Kingspan'* architectural wall paneling system *'AWP/80'*.

Alternative products may be suitable providing the minimum rating of R_w 23 is achieved or exceeded.

Roof / Ceiling

The roof and ceiling of the building should have a minimum weighted sound reduction index (R_w) 23. In this instance calculations are based on *'Kingspan'* architectural roof paneling system *'K-Dek (KS 1000 KD)'*.

Roller Doors

Roller doors should have a minimum weighted sound reduction index (R_w) 14, be located in the eastern and southern facades of the building only and not exceed a total area of 40 m² (i.e. 2 doors 5 m x 4 m). Roller doors should remain closed at all times the starch dryer is in operation and opened only for maintenance and installation / removal of plant and equipment.

Ventilation Penetrations

There should be no acoustically untreated penetrations in the walls or roof other than the roller doors outlined above. Any doors to the starch dryer building must remain closed at all times the plant is in operation.

If natural ventilation is required, sections of the walls may be fitted with acoustic louvres.

The required insertion loss of acoustic louvres will depend on the maximum surface area of louvred sections required to facilitate adequate ventilation.

As an example, based on a maximum 20 m² of louvred sections in each of the four walls, acoustic louvres should have minimum insertion losses shown in Table 7 below:-

Table 7 Acoustic Louvre Insertion Loss

Description	Minimum Insertion Loss (dB) at Octave Band Centre Frequencies (Hz)							
	63	125	250	500	1k	2k	4k	8k
Acoustic Louvre *	3	7	9	13	15	16	15	14

*Based on the Sound Attenuators Australia Acoustic Louvre, type AL1H (300 mm depth)

A larger area may result in a higher required insertion loss and consequently a deeper blade depth. A final assessment should be made prior to the issue of a Construction Certificate once the location and size of any openings for ventilation are finalised.

7.2 Additional Mechanical Plant and Equipment

At the time of writing this report it is not known what, if any significant noise producing mechanical plant or equipment may be located externally to the starch dryer building other than that considered in this assessment.

A final assessment should be carried out prior to the issue of a Construction Certificate once details of any external plant, if any, are known.

We are confident that the level of noise emission from the proposal will, or can easily be controlled to, meet the acceptable noise limits at all receptor locations.

7.3 Construction Noise

It can be seen from Table 6 that the construction noise management levels are likely to be met at each receptor location.

8.0 NOISE IMPACT STATEMENT

An assessment of the potential noise impact from the proposed construction and operation of a new starch dryer at Shoalhaven Starches on Bolong Road, Bomaderry, NSW has been undertaken.

Calculations show that the level of noise emission from the operation of the dryer will be within the noise design goals derived from Environment Protection Licence 883 noise limits at each receptor location. This is providing noise control recommendations made in Section 7 of this report are implemented and adhered to.

Matthew Harwood, MAAS
Senior Acoustical Consultant

for and on behalf of Day Design Pty Ltd

AAAC MEMBERSHIP

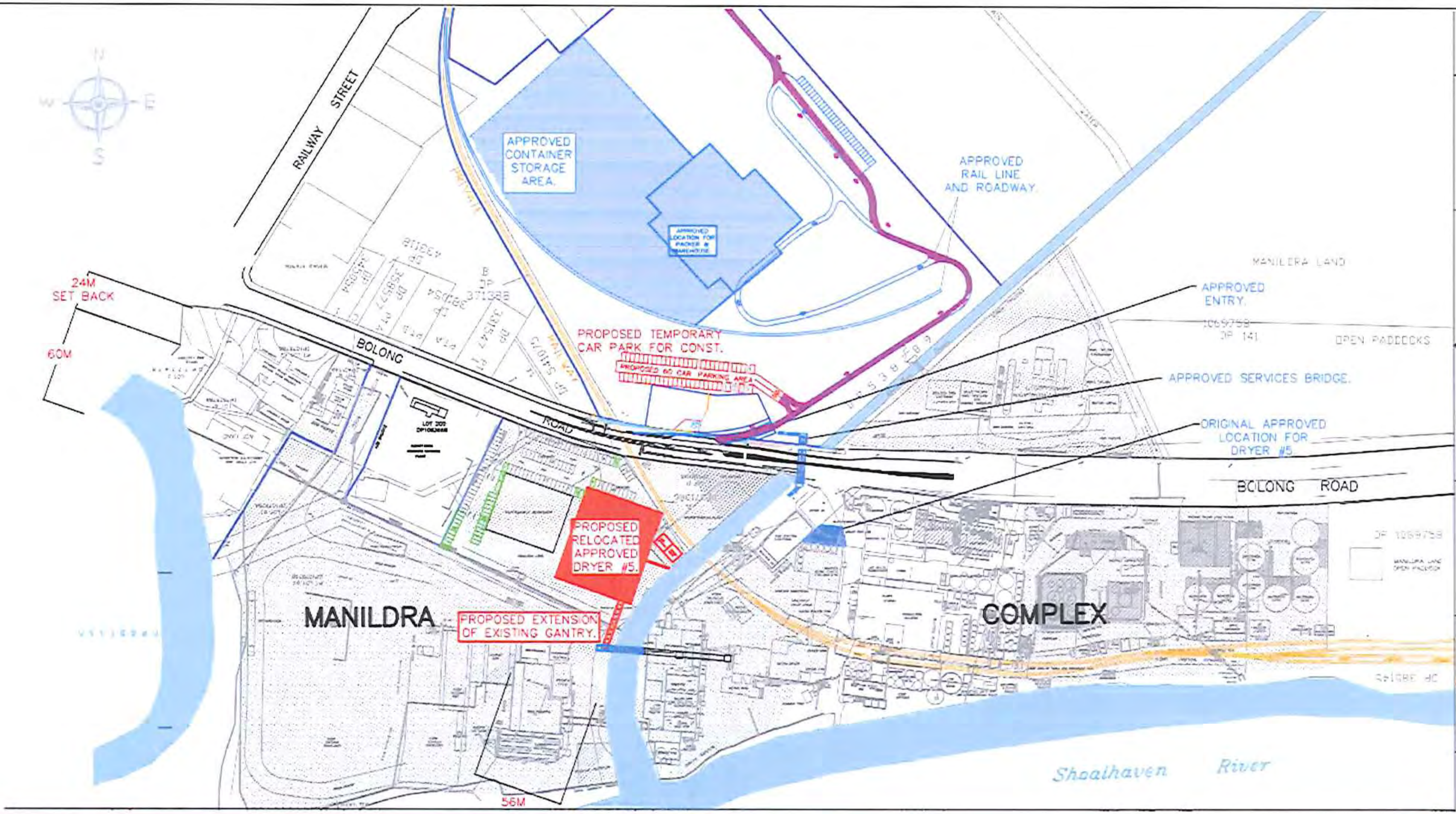
Day Design Pty Ltd is a member company of the Association of Australian Acoustical Consultants, and the work herein reported has been performed in accordance with the terms of membership.

Attachments:

Appendix A – Proposed Starch Dryer layout

Proposed Product Dryer Location – Shoalhaven Starches, Bomaderry

5788-1
Appendix A



ANNEXURE 7

ANNEXURE 7

Traffic and Car Parking Assessment

prepared by

ARC Traffic & Transport

Shoalhaven Starches, Bomaderry

Proposed Starch Dryer No. 5 Relocation

Traffic Impact Assessment

October 2015

prepared for

Manildra Shoalhaven Starches

prepared by

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Introduction

Manildra Shoalhaven Starches (Manildra) proposes a Modification to Project Approval MP06_0228 (the Shoalhaven Starches Expansion Project – SSEP Approval) to allow for the relocation of Starch Dryer No. 5 (the Dryer), originally approved as part of the PRP No. 7 project, from its previously approved location within the existing Shoalhaven Starches Site (SS Site), Bolong Road Bomaderry, to land comprising Lot 201 DP 1062668, 24 Bolong Road, otherwise known as the 'Moorehouse Site'

At present the area situated adjacent to the buildings on the Moorehouse Site is used for SS Site staff parking. During Stage 1 construction (external works, estimated at 10 months) 30 of the 118 parking spaces in this area will be required to provide an appropriate construction works area, and for the storage of construction materials and plant; as such, it is proposed that during the Stage 1 construction a commensurate level of staff parking would be temporarily relocated to the approved Shoalhaven Starches Packing Plant Site (PP Site) which lies directly opposite the SS Site on the northern side of Bolong Road. During Stage 2 construction (internal works, estimated at 2 months) SS Site staff parking would be fully reinstated at the Moorehouse Site.

Importantly from an access, traffic and parking perspective, once operational the Dryer would not result in any increase in production from the broader SS Site over that which has been the subject of past approvals, nor therefore any increase in either vehicle traffic or rail movements/duration of train crossings at the Bolong Road rail crossing. The only potential for short term traffic impacts would be during the Dryer construction stages.

ARC Traffic + Transport (ARC) has been commissioned to examine the access, traffic and parking issues associated with the Modification. This Traffic Impact Assessment references recent reports prepared by ARC in regard to vehicle access modifications to/from Bolong Road further to Shoalhaven Starches and other local approvals; specifically, ARC has referenced the following past reports: -

- Shoalhaven Starches Demolition Modification Traffic Impact Assessment October 2015 (Demolition TIA)
- Dairy Farmers Site Reuse Proposal - Meat Processing Plant Traffic Impact Assessment March 2014 (DF Meat TIA)
- Shoalhaven Starches Access Review March 2014 (Access Review)
- Shoalhaven Starches Ethanol Upgrade & Packaging Plant Traffic Impact Assessment May 2008 (SS Upgrade TIA)

This assessment also responds to the assessment requirements provided in regard to the Modification by the Department of Planning & Environment (DP&E, 19th November 2015), which state a requirement for a 'detailed assessment' of traffic issues. While no further (specific traffic) requirements have been provided by the DP&E, this assessment nonetheless considers all key issues as required by the DP&E for previous SS Site Modification proposals.

Details relating to the Modification – including confirmation of construction staff and heavy vehicle numbers - have been provided to ARC by Manildra.

1 Background

1.1 Manildra Shoalhaven Starches

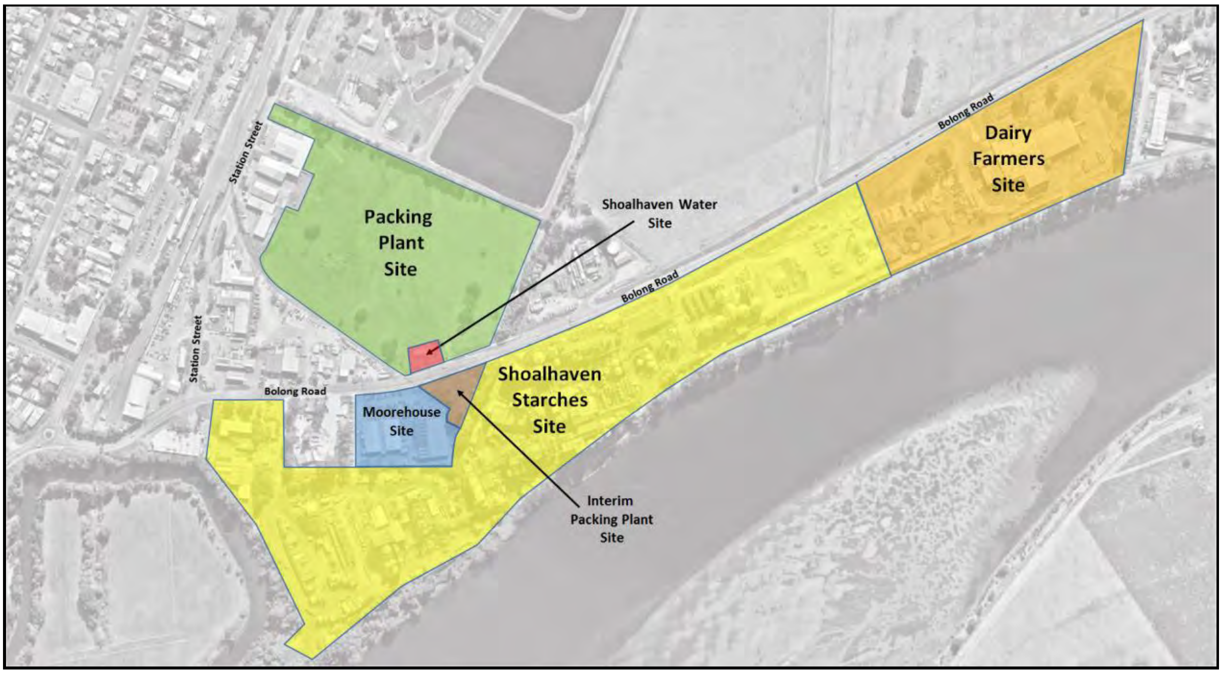
Manildra's Shoalhaven Starches operations occupy a number of distinct 'sites' in Bomaderry; while operations are integrated across all sites, they are differentiated in this assessment for ease of reference.

The primary SS Site and immediately adjacent Dairy Farmers Site (DF Site) are located south of Bolong Road, Bomaderry, while the approved PP Site is located directly opposite the SS Site on the northern side of Bolong Road. Within the broader SS Site, the Moorehouse Site lies south of Bolong Road, immediately west of the railway line, while the Interim Packing Plant Site (IPP Site) lies south of Bolong Road immediately east of the railway line.

A final site warranting mention is the small Shoalhaven Water Site (SW Site) which fronts Bolong Road directly opposite the IPP Site.

These sites are shown in their local context in Figure 1.1.

Figure 1.1 Manildra Shoalhaven Starches, Bolong Road Bomaderry



1.2 Previous Site Approvals

1.2.1 Shoalhaven Starches Expansion Project Approval MP06-0228

The SSEP Approval was granted by the Minister for Planning on the 28th January 2009. This approval also encapsulated previous approvals into one overall approval. The SSEP is a 'transitional Part 3A Project' for the purposes of Schedule 6A of the Environmental Planning & Assessment Act.

The SSEP provides for an increase in ethanol production at Shoalhaven Starches in a staged manner from 126 million litres per year to 300 million litres per year. To accomplish the increase in ethanol production, the SSEP required a series of plant upgrades and increases in throughput of raw materials, principally flour and grain. The SSEP included the following alterations and additions: -

- The provision of an additional product dryer;
- Additional equipment and storage vessels for the ethanol plant including additional fermenters, additional cooling towers and molecular sieves;
- Upgrades to the Stillage Recovery Plant, including additional DDGS Dryers, Decanters, chemical storage and evaporators. This proposal also included the installation of a DDGS Pellet Plant; and
- The establishment of a new Packing Plant, container loading area and rail spur line on the northern side of Bolong road.

As stated, the SSEP Approval also consolidated all previous approvals (up to that time) into a single approval; this included the consolidation of the PRP 7 Project (DA No. 223-7-2002), which itself included the installation of the No. 5 Starch Dryer. It is this Dryer that is proposed to be relocated as part of this Modification.

Following the SSEP Approval, Manildra acquired the DF Site, and commenced investigations into relocating the Packing Plant from the approved PP Site north of Bolong Road to the DF Site; as an interim measure during these investigations, approval was provided in 2012 for interim Packing Plant operations at the IPP Site. At this time (October 2015) the PP Site remains broadly unused, though a Bolong Road driveway crossover per the SSEP Approval has been constructed (adjacent to and east of the SW Site) connecting to a short access road servicing a small number of informal parking spaces immediately north of Bolong Road (see also Section 1.3.4).

In addition, a condition of the SSEP Approval required the provision of additional staff parking (across the broader SS Site). The DF Site was identified as an appropriate location for this parking, and subsequently a new staff car park on the DF Site – accompanied by significant additional infrastructure at the intersection of Bolong Road and the DF Site access road (DF 1) – was approved. It is noted that while much of this intersection and internal infrastructure is now in place at the DF Site, the car park itself has not been constructed.

With regard to key access, traffic and parking issues, this generally summarises all Shoalhaven Starches proposals/approvals relating to the SS Site, DF Site, PP Site and IPP Site to date.

1.2.2 DF Site Meat Processing Plant & SS Site Access Review

In 2014, a Meat Processing Plant (the Meat Plant) at the DF Site, which utilises the existing on-site buildings generally occupying the eastern portion of the DF Site, was approved by Council. It is noted that the background traffic analysis of the Meat Plant identified a number of access issues relating to the broader SSEP Approval at the DF Site, and specifically the fact that a number of the required infrastructure upgrades (under the SSEP Approval) had not been completed.

This was largely as a result of the fact that the approved staff car park had not be built, and as such the infrastructure required to support the additional movements to/from the staff car park at the intersection of Bolong Road & DF 1 were not [at that time] warranted.

Notwithstanding – and further also to a review of general access at the adjacent SS Site Eastern Access Point (SS AP 1) in consultation with Council – ARC prepared an Access Review as a general supplement to the DF Meat TIA, detailing the infrastructure and management measures required to provide compliance with the SSEP Approval, and subsequently to appropriately accommodate the traffic demands of the Meat Plant proposal at the intersection of Bolong Road & DF1, and DF Site internal movements. As stated above, the infrastructure works recommended in the Access Review and the DF Meat TIA – and moreover conditioned upgrades required under the earlier DF Site approvals - have either been completed, or have been approved by Council [based on final engineering/design plans] to construction.

ARC notes that the Meat Plant has been approved, and is currently operational.

1.3 Access

The Modification will generate additional construction trips, and redistribute existing trips, at a number of Shoalhaven Starches access points through the Dryer construction stages. ARC notes that the 'Access Point' reference numbers provided below are based on past assessments, and have been retained for ease of reference.

1.3.1 Bolong Road & SS Site Western Access Point (AP 3)

The intersection of Bolong Road & AP 3 currently provides two-way access for light and heavy vehicle traffic generated in the western and southern parts of the SS Site. This intersection will provide access for all construction heavy vehicles, which would then use the internal SS Site access road network to enter and depart the Moorehouse Site from the south.

1.3.2 Bolong Road & Moorehouse Site Access Point (AP 4)

The intersection of Bolong Road & AP 4 currently provides two-way access to a designated staff car park for some 118 vehicles. As discussed, 30 SS Site staff parking spaces would be relocated from the Moorehouse Site during the Stage 1 external construction works, but would then be fully reinstated during Stage 2 internal construction works.

1.3.3 Bolong Road & Interim Packing Plant Access Point (IPP 1)

The intersection of Bolong Road & IPP 1 provides separate entry and departure driveways (joined by a small internal access road). This intersection is located directly opposite the approved PP Site access point (PP 1), such that the use of PP 1 during the Stage 1 construction for access to the temporary car park would effectively create an off-set four-way intersection (see also below).

1.3.4 PP Site Access Points

The SSEP Approval provides for two access points to the PP Site.

At Bolong Road, an approval has been provided for a left in only access point (PP 1) accessed via a short deceleration lane; as discussed, this deceleration lane and a driveway crossing for this intersection of Bolong Road & PP 1 have been constructed, but currently connect to a short access road running perpendicular to Bolong Road and providing two-way access, rather than angled access road from Bolong Road, providing left in arrival access only, as per the SSEP Approval.

As detailed in the Demolition TIA, the Demolition Modification provides for the retention of this crossover and existing access road to provide access to a temporary car park, to be constructed as part of the Demolition Modification to accommodate SS Site staff parking relocated from the Moorehouse Site during the demolition of an existing building (to facilitate the Dryer construction), and for demolition staff.

This Modification requires almost identical SS Site staff parking relocation (for the Stage 1 external construction works) and construction staff parking provisions, and as such it is proposed that these same access arrangements and temporary car park would remain in place as part of this Modification.

It is again acknowledged that the SSEP Approval provides for an angled access road from Bolong Road at PP 1 facilitating only heavy vehicle arrival trips; this design was proposed (and approved) to appropriately accommodate heavy vehicles entering PP 1 from Bolong Road. Following the construction and use of the existing access road and temporary car park for the construction works associated with the Modification, the construction of the PP 1 access road as per the SSEP Approval would be undertaken as part of the Packing Plant construction (a separate Modification application for which is currently being finalised for the DP&E).

In Railway Street, an approval has been provided for an all movement priority access point (PP 2). This access point would also be constructed as part of the future Packing Plant construction.

1.3.6 Other SS Site Access Points

Three other SS Site access points are provided to Bolong Road, including the Central Access Point (AP 2); Eastern Access Point (AP 1); and the Dairy Farmers Access Point (DF 1). However, the Modification proposal would not generate any additional movements to these intersections.

1.4 Assessment Traffic Flows

1.4.1 Existing Traffic Flows

Further to the commission of traffic surveys over many years, and in consultation with Council, ARC has over time developed base peak period traffic flows for the key intersections along Bolong Road that reflect 120th Highest Hour (or 'recreational peak') conditions. 2014 recreational peak flows were most recently reported in the Meat Plant TIA, and have been adapted for this assessment, and include: -

- 2016 recreational peak through flows in Bolong Road
- All approved/proposed access and intersection infrastructure to September 2015
- All approved/proposed flows to the SS Site and DF Site to September 2015 (i.e. including the DF Car Park and Meat Plan)
- A minor trip assignment to reflect the occasional parking accessed via PP 1

1.4.2 Princes Highway Upgrade

The upgrade of the Princes Highway between Gerringong and Bomaderry has developed as three consecutive RMS projects – the Gerringong Bypass Project; the Foxground & Berry Bypass Project; and the Berry to Bomaderry Upgrade Project. As these projects have developed, the RMS estimate of the number of trips that will transfer from the "Sandtrack" (currently approximately 45% of through trips between Bomaderry and Gerringong and vice versa) to the Princes Highway (currently approximately 55% of through trips between Bomaderry and Gerringong and vice versa) has also developed.

The most recent RMS modelling concludes that the transfer from the Sandtrack to the upgraded Princes Highway will be very significant. Further to our discussions with the RMS (Mr Nick Boyd, Senior Project Manager), ARC has confirmed that further to the completion of the (currently under construction) Foxground & Berry Bypass, that with or without the construction of the Berry to Bomaderry Upgrade (in planning by the RMS) the RMS estimates the Princes Highway attracting some 80% of through trips, and the Sandtrack only 20% of through trips.

Taking into account other factors (such as general background traffic growth) the future traffic flows to the Princes Highway and to the Sandtrack (and indeed specifically to Bolong Road at Meroo Road, i.e. immediately west of the SS Site) are provided in Table 1.4.2 below.

Table 1.4.2 Princes Highway Upgrade Future Flow Estimates

Ref.	Route | Direction	Location	AADT											
			2013			2019			2029			2039		
			Base Year			Construction | Opening			Opening +10			Design - Do Something		
			Light	Heavy	Total	Light	Heavy	Total	Light	Heavy	Total	Light	Heavy	Total
Princes Highway														
A	south of Berry	southbound	5,139	1,019	6,158	8,187	1,212	9,399	11,386	1,614	13,000	14,254	2,020	16,274
B		northbound	5,449	950	6,399	9,039	1,130	10,168	12,571	1,504	14,075	15,737	1,883	17,620
-		two-way	10,588	1,970	12,557	17,225	2,342	19,568	23,958	3,118	27,076	29,990	3,903	33,893
C	north of Meroo Rd	southbound	5,378	1,052	6,430	8,904	1,248	10,152	12,629	1,649	14,278	15,778	2,054	17,832
D		northbound	5,686	961	6,647	9,772	1,140	10,912	13,871	1,506	15,377	17,334	1,876	19,210
-		two-way	11,065	2,013	13,077	18,676	2,388	21,064	26,501	3,155	29,655	33,112	3,930	37,042
E	south of Abernethys Lane	southbound	4,897	926	5,823	8,345	1,102	9,447	11,941	1,469	13,410	14,960	1,841	16,801
F		northbound	5,207	840	6,047	9,215	1,000	10,215	13,185	1,333	14,518	16,519	1,669	18,189
-		two-way	10,104	1,766	11,870	17,560	2,102	19,662	25,126	2,802	27,928	31,479	3,510	34,990
S10	Meroo Road Interchange	southbound off ramp	599	155	754	695	180	876	857	222	1,079	1,018	264	1,282
N10		northbound on ramp	598	151	749	694	176	870	855	216	1,072	1,016	257	1,273
S11		southbound on ramp	117	30	147	136	34	171	168	42	210	199	50	250
N11		northbound off ramp	119	30	148	138	35	172	170	43	212	201	51	252
Local Roads														
G	Meroo Road - south of Princes Highway	southbound	718	186	903	834	216	1,049	1,027	266	1,293	1,220	316	1,536
H		northbound	715	181	896	831	210	1,041	1,023	259	1,282	1,216	307	1,523
-		two-way	1,433	367	1,799	1,664	426	2,090	2,050	525	2,575	2,436	623	3,059
I	Sandtrack - north of Meroo Road	southbound	4,544	467	5,011	2,304	551	2,855	2,688	724	3,412	3,339	899	4,238
J		northbound	4,404	386	4,790	2,432	455	2,887	2,837	599	3,435	3,524	744	4,267
-		two-way	8,948	853	9,801	4,736	1,006	5,742	5,525	1,323	6,848	6,862	1,643	8,505

Source: Princes Highway Upgrade – Berry to Bomaderry Technical paper: Traffic and Transport 2013 AECOM Australia

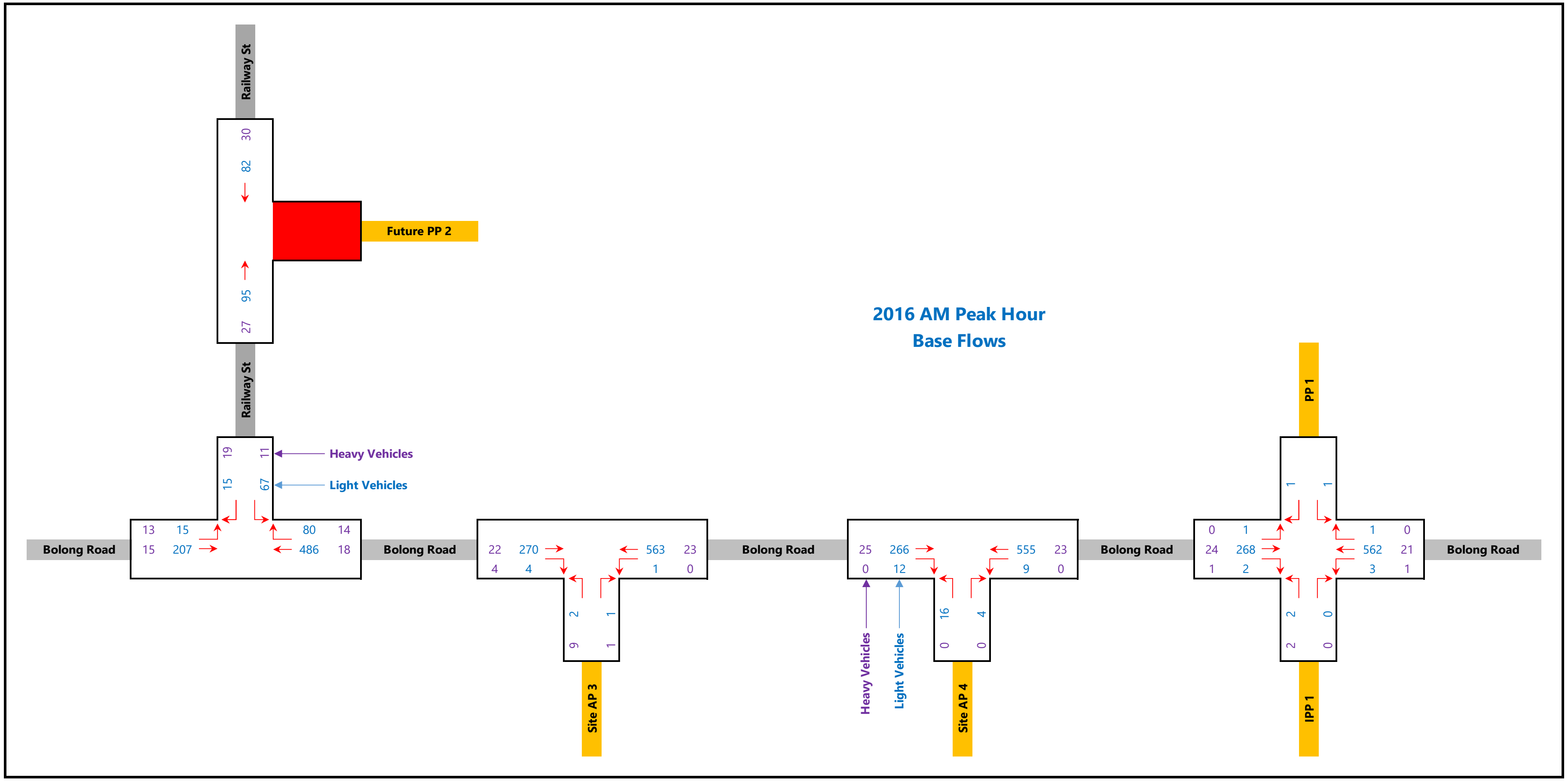
In real terms, these figures indicate that following the completion of the Princes Highway bypass projects, the 2019 AADT in Bolong Road (immediately west of the SS Site) will represent less than 60% of the 2013 AADT, reducing from a 2013 AADT of some 9,800 vehicle trips per day (vtpd) to a 2019 AADT of only 5,742 vtpd. Even with background growth continuing after 2019, the 2029 AADT is estimated to represent only 70% of the 2013 AADT; and the 2039 AADT some 87% of 2013 AADT.

The opening of the Gerringong Bypass in August 2015 will see this transfer from the Sandtrack to Princes Highway commence, but with construction of the additional stages still ongoing or in planning, the Sandtrack is still expected to attract moderate flows in the short term (to 2018), i.e. the significant reduction would not be achieved until the opening of the Foxground and Berry Bypass. It is estimated that in this period (2015 – 2018) Bolong Road flows would be reduced by approximately 15% - 20% (from pre-opening levels). Importantly, this means that the 2016 base flows provided below represent essentially ‘worst case’ flows for the foreseeable future, and certainly through the Dryer construction.

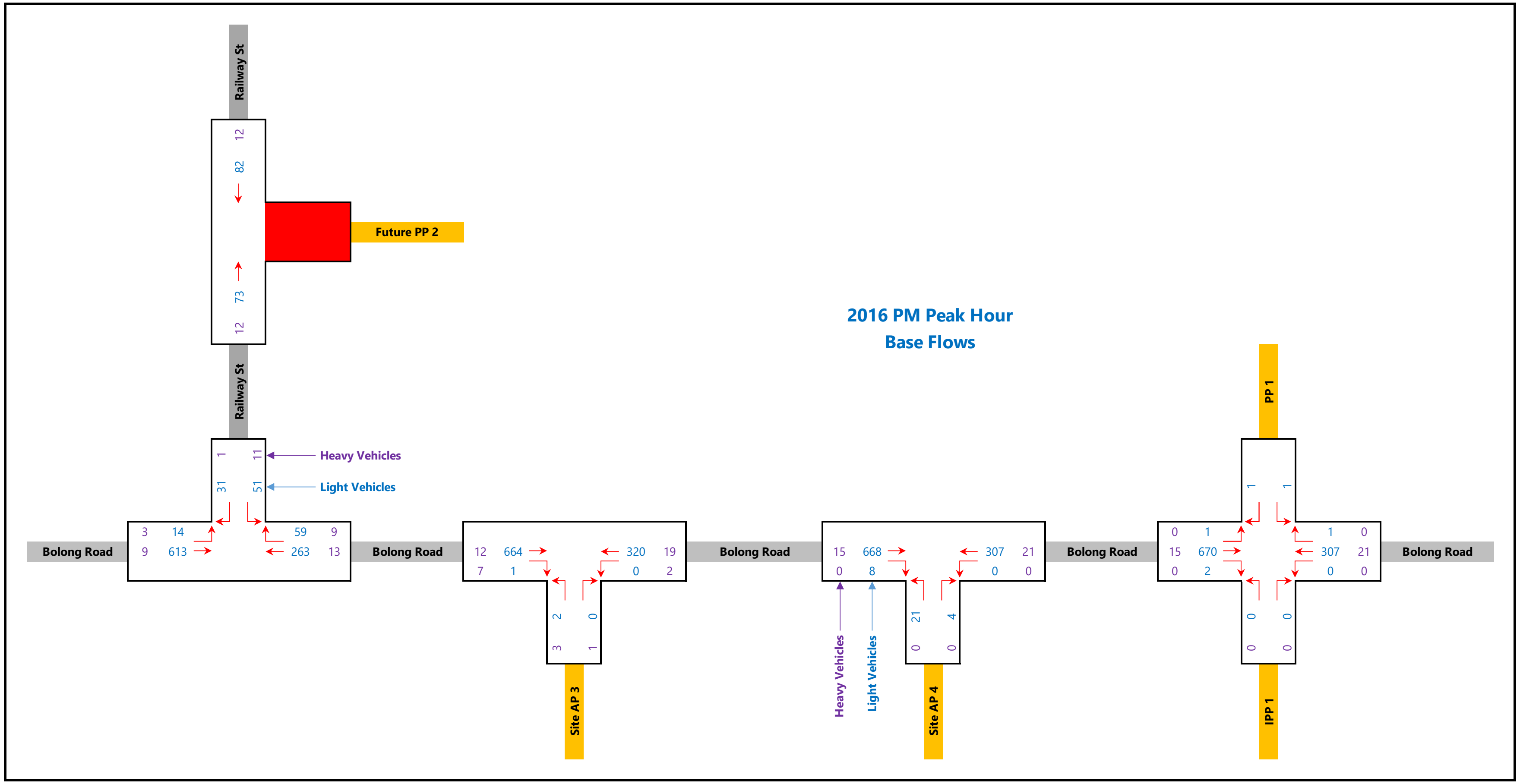
1.4.3 Assessment Base 2016 Traffic Flows

With reference to sections above, base 2016 peak hour traffic flows for the assessment are provided in the figures below.

1.4.3.1 2016 AM Peak Hour Base Traffic Flows



1.4.3.2 2016 PM Peak Hour Base Traffic Flows



1.4.4 Intersection Performance Assessment

In order to determine the performance of the key intersections as detailed in Section 1.3, as well as the local intersection Bolong Road & Railway Street, the RMS approved SIDRA (Version 6.1) intersection model been utilised to determine current intersection operations. The SIDRA inputs includes peak hour traffic flows and speed profiles, intersection geometry and operational controls, and in turn SIDRA reports the following key performance measures: -

- Level of Service

  Level of Service (LoS) is a basic performance indicator assigned to an intersection based on average delay. For signalised and roundabout intersections, LoS is based on the average delay to all vehicles, while at priority controlled intersections LoS is based on the worst approach delay. The RMS LoS criteria, which have been used in the assessment, are provided below: -

Level of Service (RMS)	Control delay per vehicle in seconds (d) (including geometric delay)		
	Signals and Roundabouts	Rating	Stop and Give Way / Yield Signs
A	d < 14.5	Good	d < 14.5
B	14.5 < d < 28.5	Good with acceptable delay	14.5 < d < 28.5
C	28.5 < d < 42.5	Satisfactory	28.5 < d < 42.5
D	42.5 < d < 56.5	Near capacity	42.5 < d < 56.5
E	56.5 < d < 70.5	At capacity	56.5 < d < 70.5
F	70.5 < d	Over capacity	70.5 < d

- Delay

  Delay represents the difference between interrupted and uninterrupted travel times through an intersection, and is measured in seconds per vehicle in this assessment. Delays include queued vehicles accelerating and decelerating from/to the intersection stop, as well as general delays to all vehicles travelling through the intersection. With reference to the LoS criteria above, the average intersection delay for signals and roundabouts represents an average of delays to all vehicles on all approaches, while for priority intersections the average delay for the worst approach is used.

- Degree of Saturation

  Degree of Saturation (DoS) is defined as the ratio of demand (arrival) flow to capacity. DoS above 1.0 represent over-saturated conditions (demand flows exceed capacity) and degrees of saturation below 1.0 represent under-saturated conditions (demand flows are below capacity). The capacity of the movement with the highest DoS is reported.

The performance of key intersections in the forecast year 2016 is reported in Table 1.4.4 below.

Table 1.4.4 Existing Intersection Performance

2016 Base Traffic Flows Intersection Performance	Level of Service		Average Delay (s)		Degree of Saturation		Queue Length (m)	
	AM	PM	AM	PM	AM	PM	AM	PM
Bolong Road & Railway Street	B	A	1.9	1.9	0.343	0.332	7.4	7.7
Bolong Road & Access Point 3	B	B	0.4	0.3	0.309	0.303	1.5	1.4
Bolong Road & Access Point 4	A	B	0.4	0.2	0.309	0.301	1.1	0.8
Bolong Road & IPP 1 & SW 1	A	B	0.1	0.1	0.308	0.357	0.3	0.1

With reference to Table 1.4.4, all site access intersections, and the intersection of Bolong Road & Railway Street, currently operate at a good LoS, with minimal average delays and significant spare capacity.

Finally, it is also noted that further to the opening of upgraded sections of the Princes Highway, a large percentage of the arrival and departure trips from/to the east reported at the SS Site access points are expected to be redistributed to the Princes Highway (i.e. to/from the west) in the same way as general sub-regional trips are redistributed. However, this would have little if any impact on the performance of the intersections as reported in Table 1.4.4.

2 The Modification Proposal

2.1 The Proposal

Manildra proposes the relocation of Starch Dryer No. 5, originally approved as part of the PRP No. 7 project, from its previously approved location within the existing SS Site to the Moorehouse Site.

As described in the Introduction, the area situated between the buildings on the Moorehouse Site and Bolong Road is currently used for SS Site staff parking; part of this area would be required during the Stage 1 (external) construction works, resulting in 30 of the 118 existing parking spaces being temporarily relocated to the PP Site on the northern side of Bolong Road. Following the completion of the Stage 1 construction works, Stage 2 (internal) construction works would allow for the reinstatement of these parking spaces at the Moorehouse Site.

Once operational, the Dryer would not result in any increase in production from the broader SS Site over that which has been the subject of past approvals, nor therefore any increase in either vehicle traffic or rail movements/duration of train crossings at the Bolong Road rail crossing over that which has been the subject of past approvals. The only potential for short term traffic impacts would be during the Dryer construction stages.

Detailed plans of the proposed Modification are provided elsewhere within the submission which this TIA accompanies.

2.2 Construction Access

2.2.1 Access Paths

The Stage 1 and Stage 2 construction periods will result in a redistribution of staff trips, and the introduction of construction vehicle trips as detailed in Section 1.3 above. In summary: -

- AP 3 will generate minor additional construction heavy vehicle arrival and departure trips during both Stage 1 and Stage 2 construction, which would be exclusively to/from the west.
- AP 4 will generate a reduced number of SS Site staff vehicle trips during Stage 1 construction commensurate with the relocation of 30 SS Site staff parking spaces to the PP Site; during Stage 2 construction these spaces would be reinstated, and as such AP 4 would have a trip profile essentially identical to the existing trip profile.
- PP 1 will generate the SS Site staff arrival and departure vehicle trips relocated from the Moorehouse Site during the Stage 1 construction, and construction staff vehicle trips during both Stage 1 and Stage 2 construction.

2.2.2 Access Point Design

All access for the construction of the temporary car park on the PP Site will be via the intersection of Bolong Road & PP 1. To facilitate this access, the existing access road will be widened and extended between Bolong Road and the temporary car park with reference to AS 2890.2 as part of the Demolition Modification; further details of these works are provided in the Demolition Modification submission to the DP&E.

As discussed, as part of the future Packing Plant construction, PP 1 would be constructed in accordance with the SSEP Approval, as would PP 2 to Railway Street, and the temporary car park removed.

2.3 Construction Trip Generation

2.3.1 Construction Heavy Vehicle Trips

It is estimated that both the Stage 1 and Stage 2 construction periods could generate up to 10 heavy vehicles (or 20 heavy vehicle trips) per day bringing construction materials and plant; as such, it is estimated that no more than 1 – 2 heavy vehicle trips would be generated during the (commuter) peak hours. It is noted that a crane and other plant required for the construction would remain on-site for the duration of their requirement rather than be transported daily.

2.3.2 Construction Staff Vehicle Trips

It is estimated that both the Stage 1 and Stage 2 construction will employ up to 30 construction staff per day, including an on-site supervisor and occasional specialists. As with previous projects, a core group of construction staff (11) are expected to arrive in group transport (i.e. shuttle buses) from Wollongong, while other construction staff would generate a mix of shared and individual private vehicle trips. Given that shift times are expected to fall outside of (commuter) peak periods, and the expectation of only minor driver only trips, it is estimated that the no more than 1 - 2 construction staff vehicle trips would be generated during the commuter peak hours.

2.3.3 SS Site Staff Trip Redistribution

The relocation of 30 SS Site staff parking spaces from the Moorehouse Site during Stage 1 construction is expected to result in a commensurate redistribution of SS Site staff vehicle trips. With reference to Figure 1.4.3.1 and Figure 1.4.3.2, AP 4 currently generates the following peak period staff vehicle trips: -

- In the AM peak hour, 21 arrival trips and 20 departure trips
- In the PM peak hour, 8 arrival trips and 25 departure trips

As such, the relocation of 30 parking spaces from the Moorehouse Site to the PP Site is expected to result in approximately 25% of staff trips being redistributed to PP 1, or the redistribution of the following trips:-

- In the AM peak hour, 6 arrival trips and 5 departure trips
- In the PM peak hour, 2 arrival trips and 6 departure trips

The trip generation associated with the remaining 88 spaces on the Moorehouse Site would continue to be generated at AP 4 during the Stage 1 construction.

During the Stage 2 construction, all SS Site staff parking spaces would be reinstated at the Moorehouse Site, i.e. SS Site staff trips would return to their existing trip profile at AP 4.

2.4 Construction Traffic Flows

With reference to sections above, total traffic flows through the Dryer construction period are shown in the following figures:-

- Figure 2.4.1 Dryer Construction Stage 1 AM Peak Hour Total Flows
- Figure 2.4.2 Dryer Construction Stage 1 PM Peak Hour Total Flows
- Figure 2.4.3 Dryer Construction Stage 2 AM Peak Hour Total Flows
- Figure 2.4.4 Dryer Construction Stage 2 PM Peak Hour Total Flows

Figure 2.4.1 Dryer Construction Stage 1 AM Peak Hour Total Flows

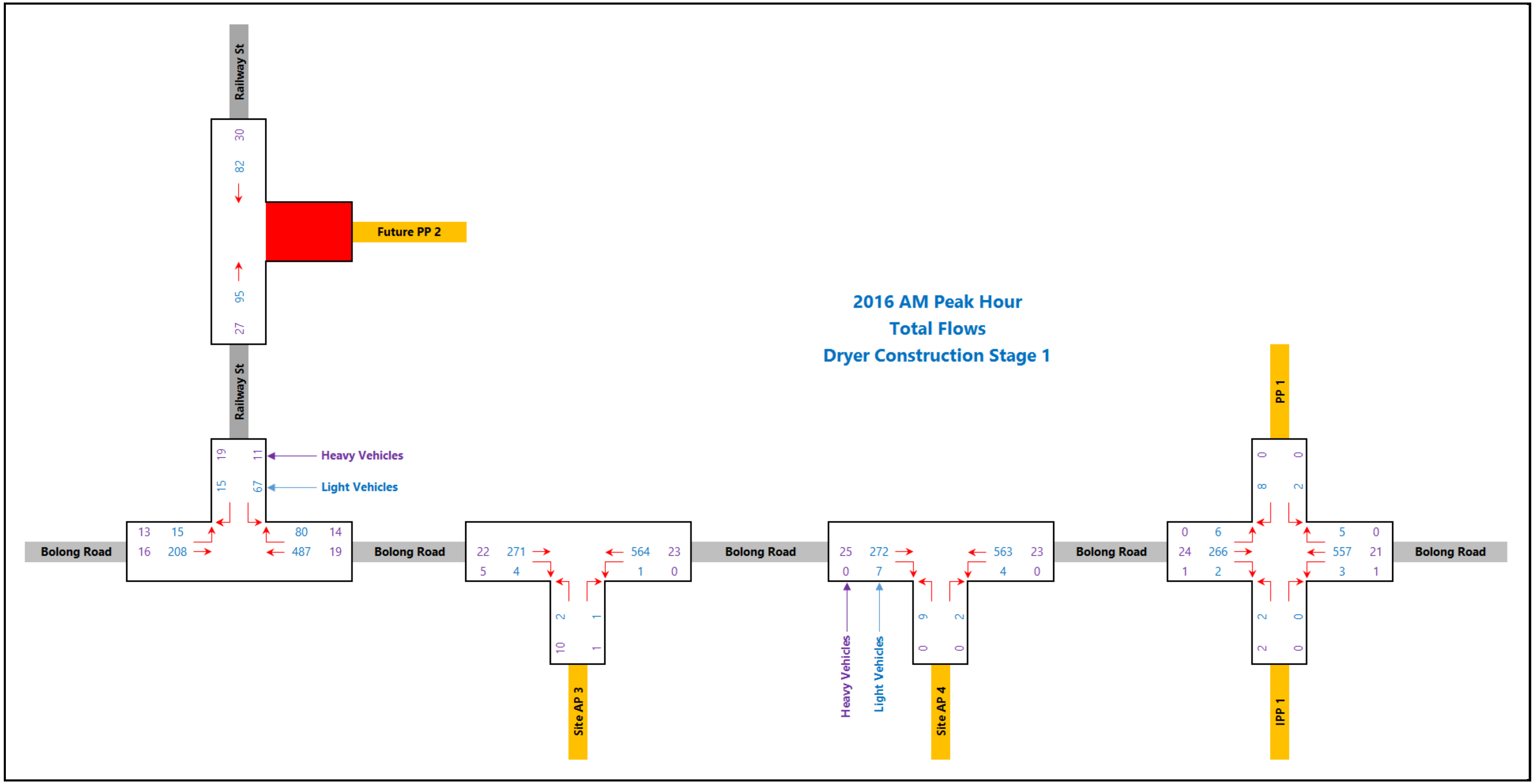


Figure 2.4.2 Dryer Construction Stage 1 PM Peak Hour Total Flows

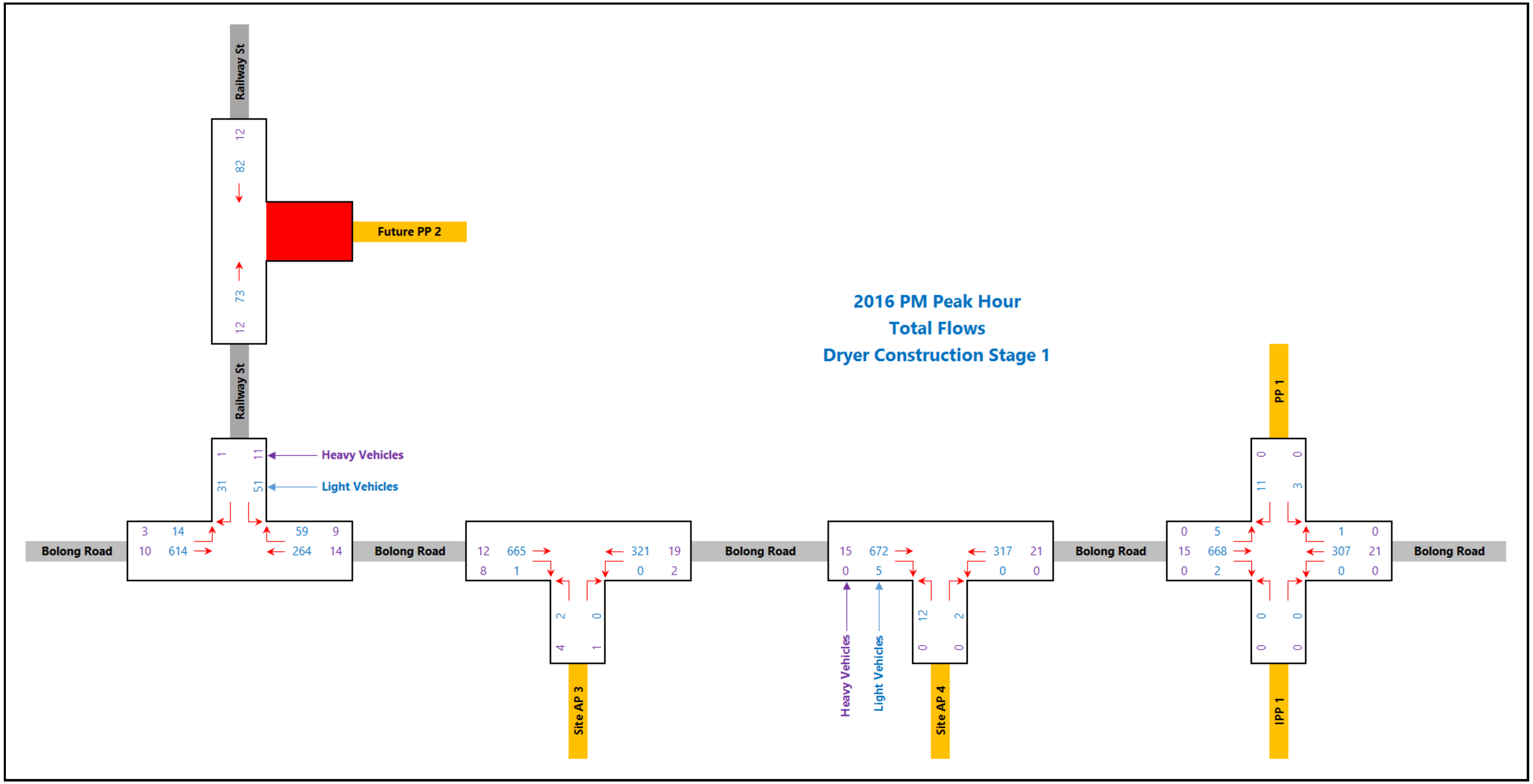


Figure 2.4.3 Dryer Construction Stage 2 AM Peak Hour Total Flows

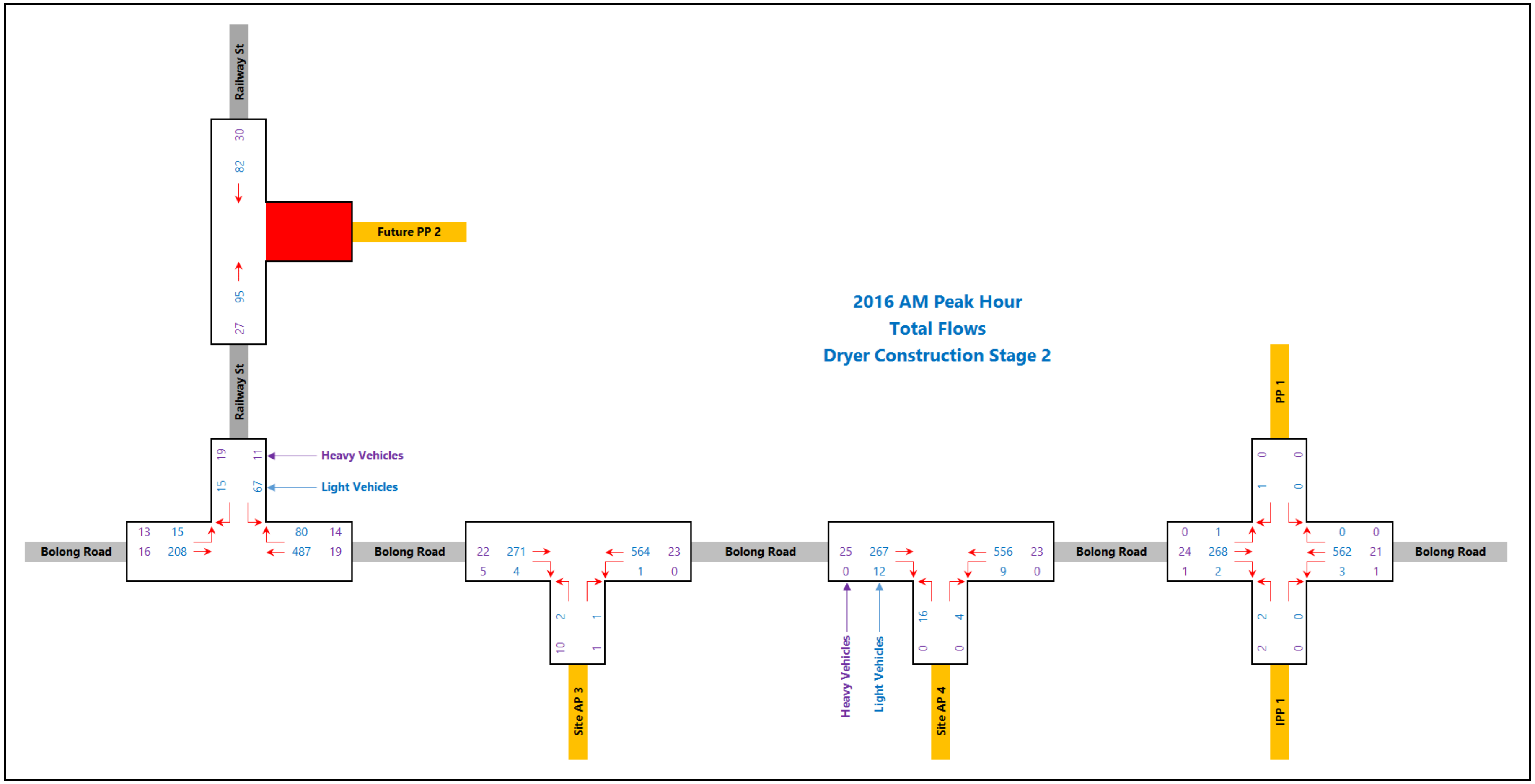
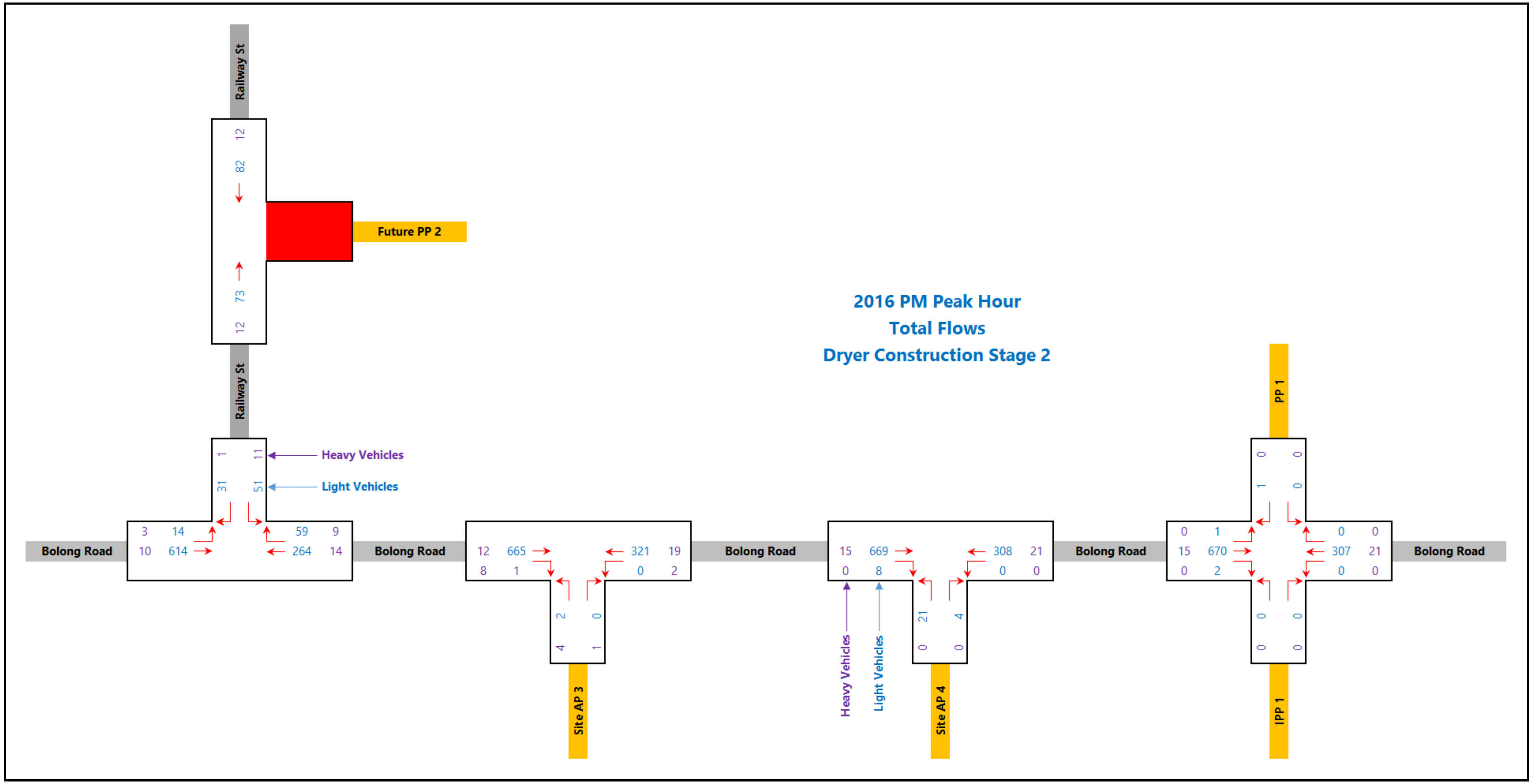


Figure 2.4.4 Dryer Construction Stage 2 PM Peak Hour Total Flows



2.5 Construction Traffic Impacts

The performance of the key intersections identified in Section 1.4 have been assessed using SIDRA based on the total traffic flows through both stages of construction. The results of the assessment are provided below.

Table 2.5.1 Dryer Construction Stage 1 Intersection Performance

Dryer Construction Stage 1 Intersection Performance	Level of Service		Average Delay (s)		Degree of Saturation		Queue Length (m)	
	AM	PM	AM	PM	AM	PM	AM	PM
Bolong Road & Railway Street	B	A	1.9	1.9	0.345	0.334	7.5	7.8
Bolong Road & Access Point 3	A	A	0.4	0.3	0.309	0.304	1.6	1.4
Bolong Road & Access Point 4	A	A	0.2	0.1	0.310	0.301	0.7	0.4
Bolong Road & IPP 1 & PP 1	A	B	0.3	0.3	0.310	0.358	0.9	1.4

Table 2.5.2 Dryer Construction Stage 2 Intersection Performance

Dryer Construction Stage 2 Intersection Performance	Level of Service		Average Delay (s)		Degree of Saturation		Queue Length (m)	
	AM	PM	AM	PM	AM	PM	AM	PM
Bolong Road & Railway Street	B	A	1.9	1.9	0.345	0.334	7.5	7.8
Bolong Road & Access Point 3	A	A	0.4	0.3	0.309	0.304	1.6	1.4
Bolong Road & Access Point 4	A	A	0.4	0.3	0.309	0.302	1.2	0.8
Bolong Road & IPP 1 & PP 1	A	A	0.1	0.1	0.308	0.357	0.3	0.1

Reference to the tables above clearly indicates that the new and redistributed traffic conditions during the construction would have no significant impact on the operation of the local traffic network, with no significant changes in average delay, reductions in capacity, or increases in queue lengths at any of the key intersections.

Finally, it is important to note that while the traffic generation to/from PP 1 will increase further to the Modification, the turn paths to/from Bolong Road at PP 1 would be no different to those currently available, i.e. all movements to and from PP 1. Moreover, the driveway would operate in an almost identical manner to other industrial and commercial driveways in this section of Bolong Road, and only for the Stage 1 construction.

2.6 Parking

As described, during the Stage 1 construction some 30 staff parking spaces will be relocated from the Moorehouse Site to the PP Site. With reference to the Demolition Modification (and Demolition TIA), it is proposed that 60 temporary spaces will be provided in the temporary car park, accommodating not only the relocated SS Site staff parking, but also all construction staff parking. The temporary car park would provide hardstand comprising steel mill slag with a bitumen surface, and be delineated with reference to Australian Standard 2890.1 so as to provide appropriate aisle width and parking space dimensions.

Again, once the Stage 1 construction works are completed, the full complement of SS Site staff parking would be reinstated at the Moorehouse Site, but the temporary car park would continue to be used by Stage 2 construction staff.

2.7 Pedestrian Access

During both stages of construction, SS Site staff and construction staff utilising the temporary car park would be able to cross Bolong Road via the existing pedestrian refuge immediately east of the PP1 access point. This links to the formal pedestrian path on the southern side of Bolong Road, and from there provides access to the broader SS Site internal pedestrian path network.

It is noted that the formal pedestrian footbridge crossing of Bolong Road per the Expansion Project Approval (between the PP Site and southern side of Bolong Road) is expected to be constructed as part of a future Packing Plant construction project.

3 Conclusions

Following a detailed and independent assessment of the access, traffic and parking conditions associated with the Modification, ARC has concluded that the Modification – and specifically the construction works associated with the Modification - would have no significant impacts on the local or on-site traffic environments. In summary: -

- During the Stage 1 construction works, 30 staff parking spaces will be relocated from the Moorehouse Site to the PP Site, with a resulting redistribution of existing trips. However, this redistribution of trips – and the minor additional generation of construction vehicle trips – would have no impact on the operation of the local road network during the Stage 1 construction.

- During the Stage 2 construction, the 30 staff parking spaces relocated from the Moorehouse Site during the Stage 1 construction will be reinstated, but construction vehicle trips will continue to be generated at AP 3 and PP 1. However, these minor additional construction vehicle trips would have no impact on the operation of the local road network during the Stage 2 construction.

- The temporary car park to be provided on the PP Site will be constructed as part of the Demolition Modification, and be designed with reference to AS 2890.1 in regard to aisle width and space dimensions. The temporary car park will be specifically constructed to accommodate the peak demand associated with the relocation of SS Site staff car parking and peak construction staff parking demand.

- Pedestrian access between the PP Site and the broader SS Site south of Bolong Road would be via the existing pedestrian refuge crossing immediate adjacent to the intersection of Bolong Road & PP 1.

ANNEXURE 8

Preliminary Hazard Analysis

prepared by

Pinnacle Risk Management Pty Ltd

ANNEXURE 8

PRELIMINARY HAZARD ANALYSIS, STARCH DRYER, SHOALHAVEN STARCHES, BOMADERRY, NSW

Prepared by: Dean Shewring

28 October 2015

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Preliminary Hazard Analysis, Shoalhaven Starches, Starch Dryer

Disclaimer

This report was prepared by Pinnacle Risk Management Pty Limited (Pinnacle Risk Management) as an account of work for Shoalhaven Starches. The material in it reflects Pinnacle Risk Management's best judgement in the light of the information available to it at the time of preparation. However, as Pinnacle Risk Management cannot control the conditions under which this report may be used, Pinnacle Risk Management will not be responsible for damages of any nature resulting from use of or reliance upon this report. Pinnacle Risk Management's responsibility for advice given is subject to the terms of engagement with Shoalhaven Starches.

Rev	Date	Description	Reviewed By
A	31/8/14	Draft for Comment	Shoalhaven Starches
B	6/1/15	Initial Comments Included	Shoalhaven Starches
C	18/1/15	Drawings Updated and Silos Included	Shoalhaven Starches
D	3/8/15	Layout Modified	Shoalhaven Starches
E	9/9/15	PHA Scope Changed to Dryer Only	Shoalhaven Starches
F	27/10/15	Final Issue	Shoalhaven Starches
G	28/10/15	Minor Process Description Edits	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.

A new starch dryer is proposed to be installed. The new processes include:

- The feed (starch in water) is to be from the existing Starch Plant;
- The liquid feed is to be stored in tanks prior to being dewatered in the centrifuges;
- The starch product from the centrifuges is to be fed to the starch dryer and product grinding area; and
- Chemicals for clean-in-place (CIP) purposes.

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 new starch dryer at the Shoalhaven Starches Bomaderry site have been assessed and compared against the DoPE risk criteria.

In summary:

- The potential hazardous events associated with the new equipment are primarily dust explosions. Given the location of the new equipment then no significant adverse off-site impacts to residential areas or similar are expected. Correspondingly, all risk criteria in HIPAP 4 are expected to be satisfied for this proposal;
- The risk of propagation to neighbouring equipment is low given the proposed facility location; and
- Societal risk, environmental risk and transport risk are all considered to be broadly acceptable.

The following recommendations are made from this review:

1. The existing safety management systems, e.g. maintenance procedures, operating procedures, training and emergency response plans, will need to be updated to reflect the proposed changes; and
2. All explosion vents should be positioned to avoid impact to personnel and sensitive equipment.

GLOSSARY

AS	Australian Standard
ATEX	Explosive Atmospheres (European Directive)
CIP	Clean-in-Place
DoPE	NSW Department of Planning and Environment
DP	Differential Pressure
HAZOP	Hazard and Operability Study
HIPAP	Hazardous Industry Planning Advisory Paper
LEL	Lower Explosion Limit
NFPA	National Fire Protection Association (USA)
PHA	Preliminary Hazard Analysis
QRA	Quantitative Risk Assessment
SEPP	State Environmental Planning Policy
TNO	Dutch Based Research Organisation
TWA	Time Weighted Average

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.

A new starch dryer is proposed to be installed. The new processes include:

- The feed (starch in water) is to be from the existing Starch Plant;
- The liquid feed is to be stored in tanks prior to being dewatered in the centrifuges;
- The starch product from the centrifuges is to be fed to the starch dryer and product grinding area; and
- Chemicals for clean-in-place (CIP) purposes.

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 new starch dryer. This PHA has been prepared in accordance with the guidelines published by the Department of Planning and Environment (DoPE) 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 new starch dryer;
- 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 DoPE 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 starch dryer is 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 new starch dryer with the potential for off-site impacts only. Transport of the starch is not included as it is not a Dangerous Good.

1.4 METHODOLOGY

In accordance with the approach recommended by the DoPE 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 new starch dryer and its 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 is 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.

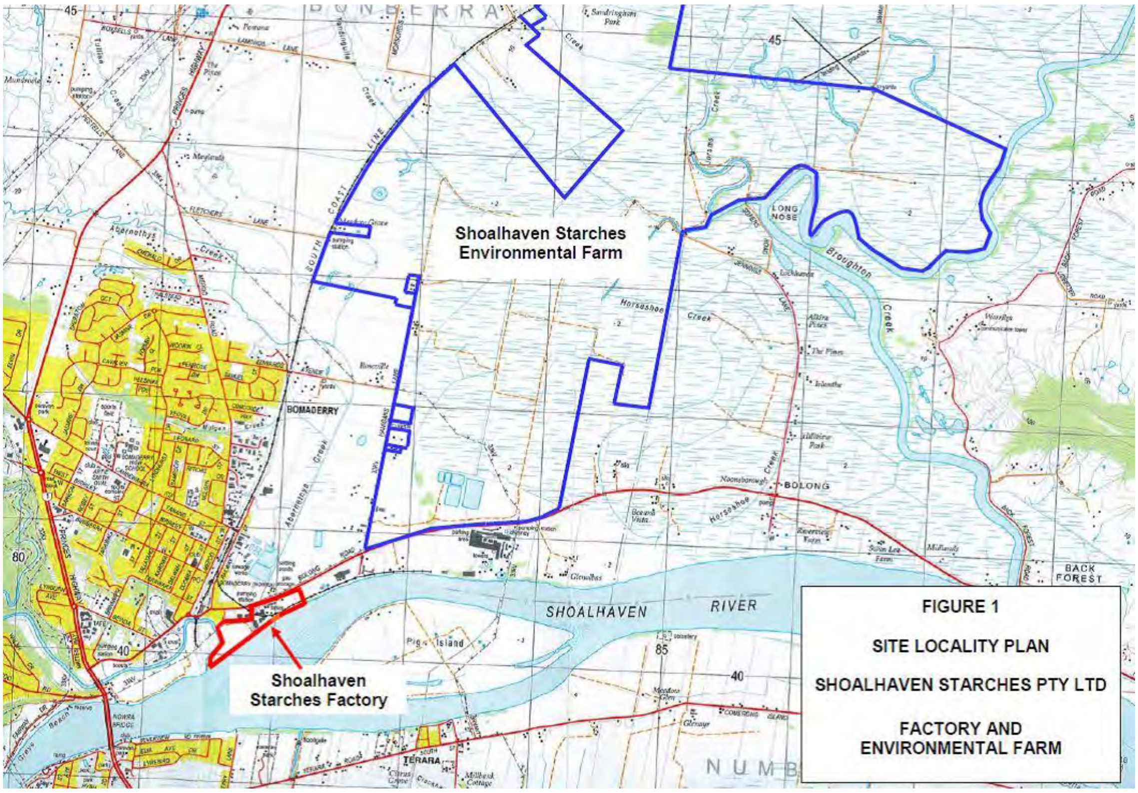
The village of Terara is situated approximately 1.5 kilometres to the south east of the site, across the Shoalhaven River. Pig Island is situated between the factory site and the village of Terara and is currently used for dairy cattle grazing.

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 (Australian Papers). 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 located over 1,000 hectares 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.

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.

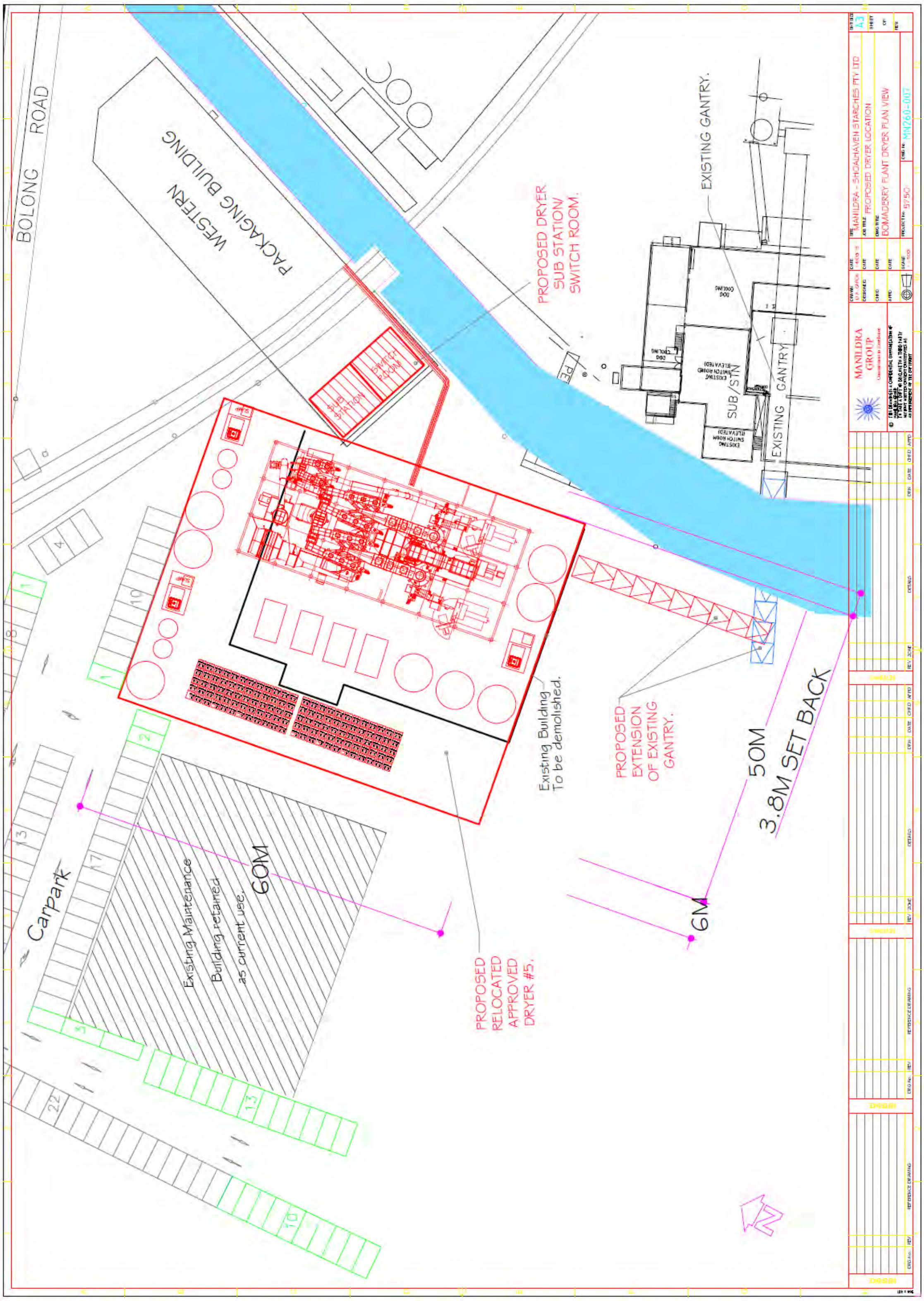
Security of the site is achieved by a number of means. This includes site personnel and security patrols by an external security company (this includes weekends and night patrols). The site operates 7 days per week (24 hours per day). Also, the site is fully fenced and non-operating gates are locked.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

There are approximately 120 people on site during Monday to Fridays 8 am to 5 pm and 30 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.

A layout drawing showing the proposed location of the new starch dryer is shown in Figure 2.

Figure 2 – Site Layout



3 PROCESS DESCRIPTION

A process flow diagram is included in Appendix 1 to assist with the following explanation.

A water and starch mixture is pumped from the existing Starch Plant to the new equipment. This is a low pressure transfer (as is the rest of the process) and the mixture is approximately 30 to 40^{o}C.

The liquid starch can be stored in an atmospheric holding tank (approximately 50 m^3) or pumped direct to the centrifuges feed tanks. If held in the holding tank, the liquid starch is subsequently pumped to the centrifuges feed tanks as per production demands.

From the centrifuges feed tanks, the liquid starch is pumped to the centrifuges. These are driven by approximately 200 kW motors. Centrate flows by gravity from the centrifuges to the effluent tank which is then recycled back to the existing plant. Any overflows or spills from the starch holding tank or the centrifuges feed tanks also flow into the effluent tank.

The wet starch from the centrifuges (approximately 40% solids) passes through an agitated feed vessel to ensure it is homogeneous. It then is combined with dry starch in a paddle mixer and conveyed to a disintegrator or hammer mill where the starch particle size is reduced. At this point, the stream is approximately 65% starch.

The starch is then feed into the dryer which is a vertical pipe with co-current hot air flow to provide the drying. The air is drawn through fabric filters to remove foreign objects, heated by steam (10 barg) and then a gas fired burner to approximately 185^{o}C. The gas fired burner is to have its own dedicated burner management system and is to be built to the Australian Standards. There will be a spark arrestor on the outlet of the gas burner to prevent dust explosions being initiated by the burner or flames being emitted from the air intake due to a dust explosion downstream.

After passing through a hot air box, the air and starch combine and flow up through a pipe. The moisture in the starch is evaporated and this stream enters the primary cyclones where approximately 30% of the product starch is removed. This portion of the product starch is conveyed via screw conveyors to the product cooler (atmospheric air is used for cooling) and then the cooler cyclones.

The air stream from the primary cyclones, still containing starch, flows to the secondary cyclones for further product starch collection. Again, the product starch from these cyclones is conveyed via screw conveyors to the product cooler and then the cooler cyclones.

The combined air stream from the secondary cyclones passes through the induced draught variable speed fan and is discharged via a tall stack. A silencer on the discharge of the air fan will limit the noise emitted from the stack. The product cooler air stream is also vented direct to atmosphere.

The starch from the cooler cyclones passes through a screw conveyor and a metal trap (to remove tramp metal and hence the risk of ignition) before entering the buffer hopper for the final sifting phase. There are three sifters in parallel which sift the final product to a size of 180 micron. The over-sized product is then conveyed to a small hopper prior to being processed through a grinder. This stream then returns to the buffer hopper to be re-sifted

The final product will then be transferred to the proposed Packing Plant on the northern side of Bolong Road (subject to its own assessment).

The plant is designed to make approximately 450 to 480 te per day of product starch with a moisture content of approximately 12% at 45^{o}C.

All equipment in contact with the starch is to be constructed from 304L or equivalent stainless steel.

All equipment handling potentially explosive dust is to be designed to ATEX and/or NFPA standards. This will include rotary valves, explosion vents, spark arrestors, interlocks to prevent only dry feed to the paddle mixers, metal trap to minimise the risk of ignitions in the pin mill, equipment earthing and hazardous area zoning with the electrics and instruments to suit the requirements.

As per the existing processes on site, clean-in-place (CIP) will be performed on a routine basis to ensure the equipment is kept clean and hence to maintain product quality. Typical chemicals used are low strength caustic soda, sodium hypochlorite, hydrochloric acid and sulphuric acid. It is not proposed to store significant quantities of these materials (less than 5 m^3). It is likely that some of these materials may be pumped to the new equipment from the existing tanks on site.

The processes are to be bunded to contain spills. Liquids spills are to be returned to the existing process for reclaiming. As per the existing facilities, housekeeping is to be done on a regular basis to also minimise the risk of a dust explosion.

4 HAZARD IDENTIFICATION

4.1 PROCESS MATERIALS

Starch:

Starch or amylum is a carbohydrate consisting of a large number of glucose units joined together. The chemical formula for starch is $(C_6H_{10}O_5)n$. It is not defined as a hazardous material or a Dangerous Good.

Starch is produced by most green plants as an energy store. It is the most common carbohydrate in human diets and is contained in large amounts in such staple foods as potatoes, wheat, corn, rice, and cassava.

Papermaking is the largest non-food application for starches globally. In a typical sheet of copy paper, the starch content may be as high as 8%.

Starch is a fine, white, odourless powder. The respiratory TWA is 5 mg/m^3. It is insoluble in water. Starch is not defined as a combustible solid (it will not support combustion) but may form explosive mixtures with air. It is a potentially explosive dust when critical parameters exist, e.g. particle size less than 500 micron and moisture content less than 30% (Ref 4).

Potential ignition sources include (Ref 5):

- Smouldering, self-heating or burning dust;
- Open flames, e.g. welding, hot work, cutting and matches;
- Hot surfaces, e.g. hot bearings, dryers, incandescent materials and heaters;
- Lightning;
- Heat from mechanical impact or friction; and
- Electrical discharges and arcs.

K_{st} is a measure of a dust's explosibility classification and is a measure of the maximum rate of pressure rise, i.e. the higher the K_{st} value, the greater the explosive energy. For starch, the K_{st} value is 199 bar.m/s. These are deemed potentially weak explosions although it is noted that previous incidents involving starch dust explosions have led to fatalities (Refs 4 and 5).

Starch is non-toxic to people and has a low environmental impact potential. It is mildly irritating to eyes and lungs.

CIP Chemicals:

Typical chemicals used are low strength caustic soda, sodium hypochlorite, hydrochloric acid and sulphuric acid. These materials are all Class 8 corrosive liquids, i.e. there is the potential for burn injuries to personnel on contact.

There is the potential for adverse reactions if mixed, e.g. caustic with sulphuric acid or hydrochloric acid with give heat whilst sodium hypochlorite with sulphuric acid or hydrochloric acid will yield chlorine gas. These are existing known hazards at the site given these materials are routinely used for equipment cleaning.

From the above review, the quantities of Dangerous Goods associated with the new starch dryer, i.e. the CIP chemicals, is limited. From the State Environmental Planning Policy (SEPP) No.33 (Ref 6), a PHA would not be required for them. However, as dust explosions are possible with the product starch then a PHA is required.

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.

The identified credible, significant incidents with the potential for off-site impacts for the proposed facility are summarised in the Hazard Identification Word Diagram following (Table 1). These potential events are based known incidents and dust process safety (Refs 4 and 5) and were derived via a Hazardous Event Identification workshop conducted at the Manildra site. Only the potential hazardous events that could cause significant consequences are shown in Table 1.

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

Table 1 – Hazard Identification Word Diagram

Event ID No.	Hazardous Event	Causes	Possible Consequences	Proposed Prevention and Mitigation Control Measures
1.	Dust explosions within the new equipment, e.g. the cyclones, grinder, disintegrator, screw conveyer, paddle mixer, rotary seal valves and final hopper	Ignition of combustible dust, e.g. due to smouldering, open flames, hot surfaces, lightning, heat from mechanical impact or friction, and electrical discharges and arcs	Damage to the processing equipment and injury to personnel. Potential propagation to the combustible material processed and stored at the facility. Products of combustion emitted with the potential to impact people and the environment. The explosion can also travel throughout equipment with the potential for pressure piling and hence more significant explosive energy. Projectiles are possible with the risk of injury to people and damage to equipment	All equipment containing dust is to be designed to ATEX standards including explosion vents and airlocks to separate transfer systems. Housekeeping to keep the area dust-free. The building is to be rated for hazardous zones including electrics and instruments are to be suitably rated and all equipment is to be bonded and earthed. Permit to work system requiring adequate cleaning and control of ignition sources. Condition monitoring of equipment and preventative maintenance to limit the probability of hot surfaces from friction occurring. Underspeed detection on the screw conveyors, high level detection on the cyclones. Use of fire hoses and steam to quench smouldering fires. As the minimum ignition temperature for starch is approximately 380 C and higher, maintenance of equipment and possibly detection by operators may prevent hot

Event ID No.	Hazardous Event	Causes	Possible Consequences	Proposed Prevention and Mitigation Control Measures
				surfaces initiating a dust explosion. Spark arrester installed upstream of the hot air box to mitigate flames being emitted from the air intake
2.	Explosion in a dust collector	Propagation of fire event from elsewhere in the process, e.g. burning embers drawn into the dust collector	Explosion with the potential for injury and equipment damage	Inducted draft which keeps the concentration below the LEL (lower explosive limit). All filters are to be pulsed with air for cleaning. All filters are to be checked routinely by maintenance for high differential pressure (DP). If issues arise then the socks are changed
3.	Explosion in the dryer	Build-up of solids within the dryer piping	The deposits can self-heat and autoignite resulting in a fire / explosion	Routine cleaning of equipment to prevent material build-up
4.	Fire in the grinder	Blocked dust collector on the grinder	Material heating due it being trapped in the grinder and therefore continuous grinding	High dust collector DP trip on the grinder. High level probe on hopper below the grinder. Grinder amps monitored
5.	Dust explosion	Loss of containment of dust within the dryer building, e.g. failure of product lift pipe	Dust explosion within the building, loss of life, equipment damage, production downtime, potential for both a primary and secondary explosion	Sealed system lowering the likelihood of leaks, aspirated system, instruments and electrics to hazardous zones, housekeeping. No purlins on the inside of the building where dust can accumulate
6.	Fire / explosion in the disintegrators	Foreign objects in the disintegrator causing ignition which can propagate to other equipment	Injury to workers, production downtime due to equipment damage and product loss. Secondary explosion possible. Foreign objects can also block the disintegrator feed chute	Temperature sensor, vibration transmitter on the disintegrator. Magnetic separator prior to the grinder. Equipment designed to ATEX standards

Event ID No.	Hazardous Event	Causes	Possible Consequences	Proposed Prevention and Mitigation Control Measures
7.	Loss of the dust collectors fans	Potential for the combustible dust concentration to increase and enter the explosive range	The plant will be tripped on loss of the dust collectors fans	Hoerbiger valves installed for explosion protection of the grinder, the equipment is to be rated for hazardous zones including electrics and instruments are to be suitably rated and all equipment is to be bonded and earthed
8.	Natural gas explosion within the dryer	Natural gas flow when the burners are offline	Buildup of natural gas in the ducting. If ignited, there is the potential for an internal explosion	Burner management system will be certified to Australian Standards which will include the need for adequate natural gas isolation and air purging prior to startup. The explosion vents for dust explosions will also limit the developed overpressures for an internal gas explosion
9.	Overheating of the starch in the dryer	Loss of temperature control	Potential for autoignition of the starch	High temperature trip on the dryer outlet (hard wired to the burner). Starch has a relatively high autoignition temperature of 380^{o}C. Spark arrestor on the discharge of the air heater.

Event ID No.	Hazardous Event	Causes	Possible Consequences	Proposed Prevention and Mitigation Control Measures
10.	Loss of containment of natural gas from the supply pipe	Pipe failure, e.g. corrosion or weld defect, gasket failure, valve leak, impact	If ignited, potential for a jet fire, flash fire or explosion which can impact personnel and equipment	The natural gas supply pipe is to be tied into the existing natural gas supply pipe system that runs through the site at present. This is an existing site risk. The pipe is to be protected from impact by locating it in a piperack. Minimum flanges used. Pipe to be included in the hazardous zone study. Remote isolation of the natural gas is possible at the gas metering station. The natural gas supply pipe is to be pressure tested following construction and protected against corrosion by painting
11.	Catastrophic failure of a centrifuge	Imbalance, e.g. starch distribution problem	Excessive vibration leading to projectiles and hence injury to personnel and damage to equipment	Casing to contain the bowl, vibration switches, balancing switch, structural integrity study including harmonics frequencies to avoid structural components failure, emergency brake, high current trips, overspeed protection
12.	Release of starch	Failed sock in a dust collector	Starch release and environmental impact	Visual detection of an emission and response, reporting from outside sources, LEL levels not reached, i.e. not considered to be an ignition risk. Maintenance of the socks to check the integrity

Event ID No.	Hazardous Event	Causes	Possible Consequences	Proposed Prevention and Mitigation Control Measures
13.	Release of starch via the dryer air exhaust stack	Blocked outlet on one or more cyclones	Release of starch to atmosphere, i.e. environmental impact	High level switch on each cyclone trips the process, shutdown on visual detection of starch emission. Obscuration meter to be installed
14.	Corrosive burns	Loss of containment of caustic soda, sodium hypochlorite, hydrochloric acid or sulphuric acid, e.g. pipe or road tanker transfer leak	Injury to personnel from corrosive burns	Minimum flanges and joints in the piping, appropriate materials construction to avoid corrosion and erosion, PPE when using chemicals including goggles, apron and gloves, area is bunded to contain spills
15.	Chlorine generation	Mixing sodium hypochlorite with hydrochloric or sulphuric acid	Potential to cause injury to personnel from exposure to toxic chlorine gas	All dosing chemicals to be separately bunded, limited quantities of chemicals stored and used for CIP
16.	Overpressure of a chemical tank	Mixing of incompatible chemicals due to road tanker unloading error	Catastrophic failure of tank and release of contents, e.g. significant reaction if caustic soda is mixed with an acid	If chemical storage tanks are included in the design then dissimilar couplings, signage, layout / separation and possibly colour (i.e. different coloured painted systems) to reduce the risk of transferring the wrong material into a tank are to be used as appropriate
17.	Flooding	Natural event involving significant rain fall	Potential for off-site environmental impact from material being swept away in the flood	The structural characteristics of the new facility will be certified by an engineer as capable of withstanding flooding and will not become unsafe during floods or as a result of moving debris that would potentially threaten the safety of people or the integrity of the structures

5 RISK ANALYSIS

The assessment of risks to both the public as well as to operating personnel around the new starch dryer 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.

For QRA and hazard analysis, the consequences of an incident are calculated using standard correlations and probit-type methods which assess the effect of fire radiation, explosion overpressure and toxicity to an individual, depending on the type of hazard.

In this PHA, however, the approach adopted to assess the risk of the identified hazardous events is scenario based risk assessment. The reasons for this approach are:

1. The distance from the new equipment to residential and other sensitive land users is large and hence it is unlikely that any significant consequential impacts, e.g. due to radiant heat from fires, from the facility will have any significant contribution to off-site risk;

2. The new equipment is to be protected from explosions using explosion vents and hence these will limit the impact distance; and

3. There are a limited number of process safety events and therefore cumulative and societal risk is not required. The main events of interest are dust explosions and fire events. Therefore, these are analysed in the remaining sections of this report.

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	0.5×10^{-6} per year
Fatality risk to residential and hotels	1×10^{-6} per year
Fatality risk to commercial areas, including offices, retail centres, warehouses	5×10^{-6} per year
Fatality risk to sporting complexes and active open spaces	10×10^{-6} per year
Fatality risk to be contained within the boundary of an industrial site	50×10^{-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	50×10^{-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	10×10^{-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	50×10^{-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	50×10^{-6} per year

As discussed above, the consequences of the potential hazardous events are initially analysed to determine if any events have the potential to contribute to the above-listed criteria and hence worthy of further analysis.

5.1 DUST EXPLOSIONS

A summary of historical dust explosions is given in Ref 5. Two of the reported studies detail dust explosions in Germany from 1965 to 1985 and in the USA from 1900 to 1988. The following tables show some of the analysis results. It is noted that analysts suggest that not all dust explosions are reported. One analyst (Ref 5) reports that only 15% of the actual dust explosions that occur are reported, i.e. many more may have occurred.

Table 3 – Grain Dust Explosions in the USA

Loss Category	1900 - 1956		1957 - 1975		1979 - 1988	
	Total	Per Year	Total	Per Year	Total	Per Year
Number of Explosions	490	8.6	192	10.1	202	20.2
Fatalities	381	6.8	68	3.6	54	5.4
Injuries	991	17.4	346	18.2	267	26.7
Estimated Damage to Facility ($US millions), not inflated	70	1.3	55	2.9	169	16.9

Table 4 – Source Locations of Dust Explosions in Germany (1965-1985)

Type of Plant Item	Percentage of Total Dust Explosions in the Food and Feed Industry
Silos and Bunkers	22.9
Dust Collecting Systems	9.5
Milling and Crushing Plants	18.1
Conveying Systems	26.7
Dryers	7.6
Furnaces	2.0
Mixing Plants	2.0
Grinding and Polishing Plants	0
Sieves and Classifiers	2.8
Unknown and Others	8.4
Total	100.0

That is, dust explosions are credible events and can cause significant impacts.

From Ref 7, the damage radius of a dust explosion is usually limited to the building (or equipment item) in which it occurs and to a very short range outside. This is supported by the historical incidents involving dust explosions where the majority of fatalities involve on-site personnel.

The majority of dust explosion incidents detailed in Ref 5 resulted in no fatalities. For the incidents where fatalities occurred, these were to on-site personnel. Ref 5 quotes statistics from the USA where, on average, dust explosions result in approximately 5 deaths per year. Historically, about one in six fatalities occur in the food and grain industry. Again, the greater risk for fatality or injury for dust explosions is to on-site personnel as claimed in Ref 7.

To support the above findings, see the following calculations for maximum explosive overpressures and flame length from a dust explosion through the side vents in the building, i.e. the vents protecting the heat exchangers. The explosion vents on top of the building point vertically up and hence do not pose hazards to people who are off-site or to adjacent equipment via propagation.

The maximum explosion overpressures at a distance D (m) from a vent or point of release is given by (Ref 5):

P_{blast} = (P_{max} x C1 x C2) / D

Where:

P_{blast} is the overpressure (or peak blast pressure) at a distance D from the vent, kPag

P_{max} is the pressure within the vessel when the vent opens or the rupture pressure of the vessel (if no vent installed), kPag

C1 = 10^((-0.26/A) + 0.49)

A = vent area, m^2

C2 = 1 m

D = distance away from the vent, m

The rupture pressure of weak structures such as grain handling equipment is typically less than 90 kPag (Ref 5). This reference quotes one experiment where a 500 m^3 silo ruptured at 60 kPag with a hole size of 50 m^2.

The information available to date for the heat exchangers explosion vents is as follows:

- P_{max} = 0.4 barg; and
- The combined vent size is 2 m^2 (two vents to be provided; each 1 m^2).

The overpressures at various distances away from the building are estimated as shown in Table 5.

Table 5 – Overpressures from Dust Explosions

Distance, m	Overpressure, kPag
	Heat Exchangers
5	18
10	9
20	5
30	3
40	2
50	2
60	2

The effects of explosion overpressures are summarised in the following table (Ref 3).

Table 6 – Effects of Explosion Overpressures

OVERPRESSURE, kPa	PHYSICAL EFFECT
3.5	90% glass breakage No fatality, very low probability of injury
7	Damage to internal partitions & Joinery 10% probability of injury, no fatality
14	Houses uninhabitable and badly cracked
21	Reinforced structures distort, storage tanks fail 20% chance of fatality to person in building
35	Houses uninhabitable, rail wagons & plant items overturned. Threshold of eardrum damage, 50% chance of fatality for a person in a building, 15% in the open
70	Complete demolition of houses Threshold of lung damage, 100% chance of fatality for a person in a building or in the open

Given the estimated impact distances in Table 5 and the distances to off-site areas from the vents (at least 50 m) then no significant off-site impacts, i.e. fatalities, or injuries in residential areas are expected from explosion overpressures.

To estimate the possible maximum horizontal flame length from a vented dust explosion, the following equation is used (Ref 8):

$$\text{Flame Length} = 10 \times V^{1/3} \text{ (m)}$$

Where:

V is the volume of the vessel, m^3

However, no flame length has ever been measured greater than 30 m (even for large volumes) so this should be taken as the upper limit (Ref 9). Other studies in Ref 9 also show that effects of thermal radiation from the fireball is limited to close to the fireball's surface given the short duration. For the new starch dryer, the estimated flame length using the above methodology is approximated as 30 m given the sizing information is yet to be finalised (i.e. consider the worst case flame length).

Typically, the flames from a ruptured or vented vessel travel horizontally and vertically. For the new explosion vents, the flame will travel horizontally given the proposed orientation. For a 30 m flame length, the flames are therefore unlikely to impact people off-site as the new explosion vents are elevated (approximately 25 m high) and point to the east, i.e. across the creek that runs through the site.

Hence, given the above consequence assessment, adverse impact from the vented dust explosions is unlikely for off-site personnel and therefore the risk of fatality, injury or property damage is expected to comply with risk criteria in Table 2.

5.2 BUILDING EXPLOSIONS

It is possible that dust explosions could occur in the new starch dryer building, e.g. deposited dust is not removed due to failure of the housekeeping program.

This hazard exists at the site now for the existing dryer buildings.

The primary means to prevent this event is to design for containment, i.e. do not release combustible dust into the building. This is the basis for the design of the existing dryer buildings and will be similarly for the new starch dryer.

Should losses of containment of combustible dust occur then controls such as housekeeping, hazardous zoning and permits to work are required. These are discussed in more detail in Section 5.4 but are important measures to lower the risk of dust explosions within the existing building. As this hazard exists now on-site and the new equipment is being designed to the same standard as the existing equipment then no further safeguarding is recommended for this scenario.

As supported by historical evidence (Ref 7) where the damage radius of dust explosions is usually limited to the building (or equipment item) in which it occurs and to a very short range outside, significant adverse impact to people off-site is not expected, in particular, given the large distances to residential areas.

5.3 NATURAL GAS PIPELINE FAILURES

Failures associated with the natural gas feed line to the air heater will release the natural gas to atmosphere and, if ignited, it can form a jet fire, a flash fire and/or an explosion.

The natural gas line will be installed aboveground in a piperack from the existing on-site natural gas main. The supply pressure is 2 barg. The gas pipe will be approximately 80 mm nominal diameter (maximum heating is approximately 36 GJ/hr) and it will be approximately 100 m long. The pipe will have welded joints where possible. All flanged joints will have a hazardous atmosphere zone around them.

The analysis of the potential jet fires from the natural gas pipe is shown in Table 7. From above, the natural gas pressure is taken as 2 barg (at ambient temperature).

Table 7 – Natural Gas Jet Fires

Stream	Estimated Release Rate, kg/s	Estimated Length of Jet, m
Full bore failure (80 mm)	0.71	9
50 mm hole	0.55	8
13 mm hole	0.053	3

Notes: Jet flames modelled using methane.

As expected for these size jet fires, no adverse radiant heat levels will be imposed off-site as the natural gas pipe will be at least 59 m from Bolong Road.

Potential vapour cloud explosions and flash fires can occur from the natural gas line failures, i.e. delayed ignition.

The effects from explosion overpressures (Ref 3) were summarised in Table 6.

For flash fires, any person inside the flash fire cloud is assumed to be fatally injured. As flash fires are of limited duration (typically burning velocity is 1 m/s, Ref 10) then those outside the flash fire cloud have a high probability of survival without serious injury.

The analysis of the potential vapour cloud explosions and flash fires from the natural gas pipe failures is shown in Table 8. The mass calculated in the flammable range is assumed to be 100% confined, i.e. all this gas is involved in the explosion calculations. As methane is not a high reactive flammable gas and the quantities involved are relatively small then a weak deflagration is assumed in the explosion calculations (multi-energy method – TNO).

Table 8 - Natural Gas Vapour Cloud Explosions and Flash Fires

Stream	Mass of Natural Gas in the Flammable Range, kg	Radius of Flash Fire, m	Distance (m) to 14 kPa Explosion Overpressure	Distance (m) to 7 kPa Explosion Overpressure
Full bore failure (80 mm)	7.5	36 m	< 10 m	16 m
50 mm hole	5	30 m	< 10 m	14 m

Notes: 1. Pipeline failures assumed to be isolated within 30 minutes.
2. Radius of flash fires calculated to be the distance to LEL at F weather stability and 2 m/s wind speed.
3. 13 mm holes not modelled as they are too small to generate gas clouds of any significant size.

For these releases of natural gas, choked flow exists and rapid jet mixing with air occurs. The result is a relatively small vapour cloud size with limited consequential impacts if ignited. The 30 minute release duration also has no significant impact on the release. Steady state conditions are reached soon after the release occurs (i.e. after approximately 4 minutes, the distance to the LEL does not change at steady state dispersion conditions).

Given these results for the natural gas vapour cloud explosions and flash fires, no adverse consequential impacts will be imposed off-site.

The low likelihoods for natural gas releases and fires/ explosions are supported by the following data. For piping failures, frequencies have been estimated either from data compiled and published by ICI (Ref 11) or from frequency estimates published by the Institution of Chemical Engineers (Ref 12).

Table 9 - Piping Failure Frequencies

Type of Failure	Failure Rate per year
Pipelines	
13 mm hole	3×10^{-6} / m
50 mm hole	0.3×10^{-6} / m
3 mm gasket (13 mm hole equivalent)	5×10^{-6} / joint
Guillotine fracture (full bore):	
< 50 mm	0.6×10^{-6} / m
> 50 mm but < 100 mm	0.3×10^{-6} / m
> 100 mm	0.1×10^{-6} / m

Should a release occur, the following ignition probabilities are used Ref 13).

Table 10 – Natural Gas Ignition Probability

Leak	Probability of Ignition	Probability of Explosion Given Ignition	Probability of Explosion Given Leak
	Gas		
Minor (<1 kg/s)	0.01	0.04	0.0004
Major (1 to 50 kg/s)	0.07	0.12	0.008
Massive (>50 kg/s)	0.3	0.3	0.09

As an estimate of a natural gas release with subsequent ignition, take the following:

1. 80 mm pipe, catastrophic failure frequency is 3×10^{-7} per metre per year
2. For 100 m of pipe, the total catastrophic release frequency is 3×10^{-5} per year
3. For an ignition probability of approximately 0.1 then the release and ignition frequency is 3×10^{-6} per year

This is a low level of risk and not considered intolerable. Given the significant consequential effects are contained on-site then the criteria in Table 2 are expected to be satisfied.

5.4 Dust Explosion Safeguarding

For equipment processing a potentially explosive dust, it is generally not possible to always ensure the concentration of the dust is below the lower explosive limit. Rather, safeguarding is required to prevent and/or control the potential explosions as discussed below.

There are no mandatory standards or regulations that dictate the design criteria and features for equipment where dust explosions can occur. However, the main means for safeguarding against dust explosions are as follows.

A discussion of the proposed safeguards for the new equipment is included at the end of this Section.

5.4.1 Dust Free Process

Inherently safer options include operating with the materials being wet rather than dry, i.e. preventing dust formation. Not all processes are suited to this option though, e.g. wheat grains, as self-heating can occur and degradation of the grain can occur.

5.4.2 Dust Control

Measures to control dust and avoiding the explosive range include:

- Avoid large volumes as much as possible, e.g. to avoid equipment items running empty;
- Avoid dust formation by limiting the free-fall;
- Remove the dust at the point of production rather than convey it along ducts where it can accumulate;
- Buildings which contain plant handling flammable dusts should be designed to minimise the accumulation of dust deposits and to facilitate cleaning; and
- Regular housekeeping to avoid dust build-up.

5.4.3 Control of Ignition Sources

Measures used to control ignition sources which could give rise to dust explosions include:

- Avoid direct fired equipment;
- Bonding and earthing for static dissipation;
- Permits to work, training and auditing;
- Regular housekeeping to avoid dusts overheating, e.g. on hot surfaces;
- Hazardous area determination with compliant electrics and instruments;
- Preventative maintenance on equipment to minimise the probability of fault conditions;

- Use appropriate electrical equipment and wiring methods;
- Control smoking, open flames, and sparks;
- Avoid the possibility of a thermite reaction, e.g. aluminium reacting with iron oxide;
- Use separator devices to remove foreign materials capable of igniting combustibles from process materials; and
- Separate heated surfaces and heating systems from dusts.

5.4.4 Inerting

The suspension of a flammable dust in air may be rendered non-explosive by the addition of an inert gas. The main gases used for inerting of dust handling equipment are nitrogen, carbon dioxide, flue gas and inert gas from a generator, e.g. argon or helium.

Inerting by adding an inert dust is another means to prevent dust explosions. This is mainly done in mining, e.g. coal dust is mixed with ground stone to render the coal dust non-explosive.

5.4.5 Explosion Containment

One option for dealing with a dust explosion is total containment, i.e. design the equipment to withstand the maximum generated pressure. For dust explosions, the maximum generated pressures are quoted as 7 to 12 barg for atmospheric processes or up to 12 times the initial pressure in the equipment item. Hence, if the equipment has a design pressure equal to or exceeding these values then the explosion will be contained with no flames being emitted. Grinding mills are an example of such equipment items which may be made strong enough to withstand a dust explosion.

5.4.6 Explosion Isolation

The two basic methods for explosion isolation are:

- Automatic isolation, e.g. a pressure sensor will send a signal to a fast closing valve to shut and isolation the equipment item or pipe; and
- Material chokes such as rotary valves, screw conveyors with baffle plates and/or part of the helix removed to prevent the conveyor emptying on no feed flow, and self-actuating float valves.

5.4.7 Explosion Suppression

Typically an increase in operating pressure is detected (e.g. pressure rises to 5 kPag) which then results in a suppressant being injected into the equipment item to suppress the flame. By suppressing the flame early, the pressure rise is limited. Suppressants include dry powder and water.

5.4.8 Explosion Venting

Explosion venting is an effective and economic way to provide protection against dust explosions, however, it is only suitable if there is a safe discharge for the material being vented. For equipment within a building, ducting the vent to outside should be done provided it is short, e.g. less than 10 m (detonations can occur in pipes of 10 to 30 m in length).

5.4.9 Equipment Separation

It is possible that an explosion from one equipment item or building could propagate to another. This could be via secondary explosions due to dust lifting and forming a cloud or from projectiles embedding into thin-walled equipment and hence being a point of ignition due to heat. If layout considerations permit, adequately separately higher risk process items or buildings is an inherently safe option.

In practice (Ref 5), the assessment of dust explosion hazards is bound to be subjective because the problem is too complex for quantitative analytical methods to yield an indisputable answer. Therefore, the acceptable safeguards for any given design will vary from company to company. Ref 5 quotes work by Pinkwasser and Haberli who suggest most of the dust explosion hazards in the grain, feed and flour industry can be eliminated by soft means such as training, motivation, improving the organisation, good housekeeping and proper maintenance. All of these safeguards are in-place at Shoalhaven Starches.

When these are combined with the additional measures proposed for the new equipment then further risk reduction is achieved. These additional measures include all equipment handling potentially explosive dust is to be designed to ATEX standards including rotary valves, explosion vents, spark arrestors, interlocks to prevent only dry feed to the paddle mixers, metal trap to minimise the risk of ignitions in the pin mill, equipment bonding and earthing, minimisation of horizontal surfaces in the buildings where dust can collect, screw feeders to contain plugs to prevent flame propagation, steam quenching and hazardous area zoning with the electrics and instruments to suit the requirements.

5.5 AIRCRAFT IMPACT AND OTHER EXTERNAL EVENTS

Previous risk assessments (e.g. Ref 14) have shown that the likelihood of an aircraft crash is acceptably low within Australia. Typical frequencies associated with aircraft crashes are:

- Scheduled aircraft 1×10^{-8}/year; and
- Unscheduled aircraft 4×10^{-7}/year.

The likelihood of this type of event is acceptably low for a site of this size and location.

Other external events that may lead to propagation of incidents on any site include:

Subsidence	Landslide
Burst Dam	Vermin/insect infestation
Storm and high winds	Forest fire
Storm surge	Rising water courses
Earthquake	Storm water runoff

Breach of security Lightning

Tidal waves

These events were reviewed and none of them were found to pose any significant risk to the new facility given the proposed safeguards. Flooding can occur at this site, however, any potential propagation events are unlikely to be significant given that the new equipment is being designed for the expected flood conditions.

5.6 CUMULATIVE RISK

As shown in this PHA, the proposed changes to the Shoalhaven Starches site will have negligible impact on the cumulative risk results for the local area as the significant consequential effects such as explosion overpressures are local to the equipment.

Therefore it is reasonable to conclude that the development does not make a significant contribution to the existing cumulative risk in the area.

A review of the potential propagation risks both from and to the new equipment was conducted. The main potential for propagation is dust explosions including flames being emitted from the new explosion vents. From the information available to date, either the vented explosions discharge vertically up from the top of the building (i.e. to a safe location) or are pointed to the east of the building across the creek that flows through the site. Propagation from the latter is not expected given the low overpressures beyond 10 m from the vents (i.e. less than 9 kPa) and the short duration of the event.

5.7 SOCIETAL RISK

The abovementioned criteria in Table 2 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 new equipment, the risk of fatality does not extend significantly from the equipment and is therefore well away from the residential areas. The concept of societal risk applying to residential population is therefore not applicable for the new equipment.

5.8 RISK TO THE BIOPHYSICAL ENVIRONMENT

The main concern for risk to the biophysical environment is generally with effects on whole systems or populations.

As there are no hazardous materials of significant quantities associated with the new equipment, significant environmental impact is not expected. Importantly, any spilt material will be contained in the area or via the environmental farm.

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

From the analysis in this report, no incident scenarios were identified where the risk of whole systems or populations being affected by a release to the atmosphere, waterways or soil is intolerable.

5.9 TRANSPORT RISK

As starch is not deemed to be a Dangerous Good or hazardous material then the transport risk via road and rail is low. The CIP chemicals (Class 8 Dangerous Goods) are currently transported to site in limited quantities. The CIP operations for the new equipment will not result in a significant increase in these chemicals. The expected usage of these chemicals is only approximately 200 L per week. Therefore, the new facility is not deemed to be potentially hazardous due to materials transport by SEPP 33 (Ref 6) and hence the transport risk is broadly acceptable.

6 CONCLUSION AND RECOMMENDATIONS

The risks associated with the proposed new starch dryer at the Shoalhaven Starches Bomaderry site have been assessed and compared against the DoPE risk criteria.

In summary:

- The potential hazardous events associated with the new equipment are primarily dust explosions. Given the location of the new equipment then no significant adverse off-site impacts to residential areas or similar are expected. Correspondingly, all risk criteria in HIPAP 4 are expected to be satisfied for this proposal;
- The risk of propagation to neighbouring equipment is low given the proposed facility location; and
- Societal risk, environmental risk and transport risk are all considered to be broadly acceptable.

The following recommendations are made from this review:

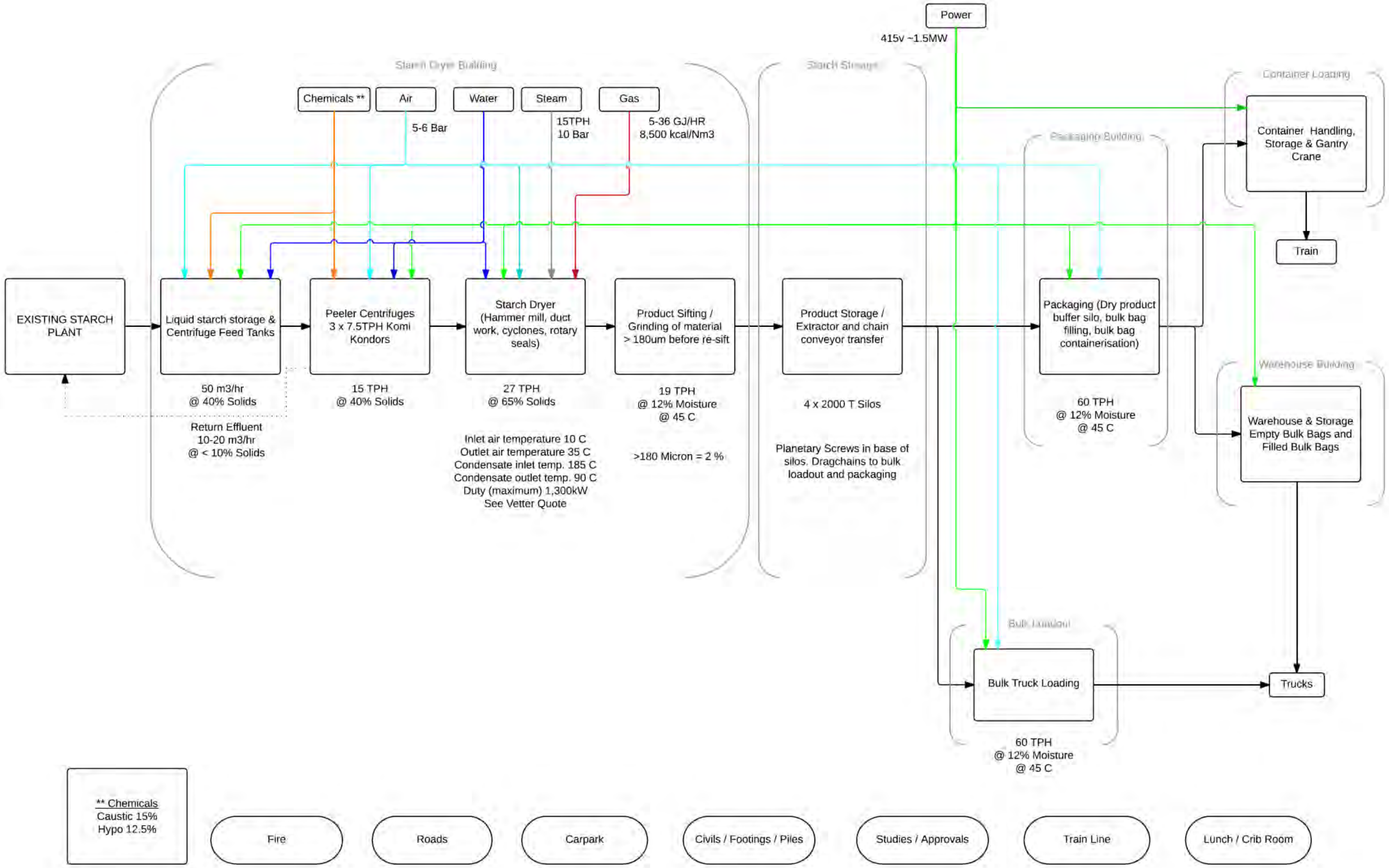
1. The existing safety management systems, e.g. maintenance procedures, operating procedures, training and emergency response plans, will need to be updated to reflect the proposed changes; and
2. All explosion vents should be positioned to avoid impact to personnel and sensitive equipment.

Appendix 1

Process Flow Diagram

Preliminary Hazard Analysis, Shoalhaven Starches, Starch Dryer

Appendix 1 – Process Flow Diagram.



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