Connell Wagner Pty Ltd
ABN 54 005 139 873
116 Military Road
Neutral Bay
New South Wales 2089 Australia

Telephone: +61 2 9465 5599
Facsimile: +61 2 9465 5598
Email: cwsyd@conwag.com
www.conwag.com

Coffs Harbour Highway Planning
Coffs Harbour Section

Dangerous Goods Transport
Comparative Risk Assessment
Working Paper No 8

February 2004
Reference 1093.76.GE

Connell Wagner

Table of Contents

1. Introduction

1.1 Introduction

The RTA is currently investigating options for an upgrade of the Pacific Highway road corridor between Sawtell and Woolgoolga as part of the Coffs Harbour Highway Planning Strategy (CHHPS). In the southern section of the Strategy area, a number of options have been developed, including an upgrade of the existing highway to motorway standard and an Inner Bypass option (including four sub-options). Due to the rugged topography in the Coffs Harbour area, tunnels may be required at various sections along each of these corridors. Further details of these route options are provided in Section 2 and illustrated in Appendix A.

1.2 Purpose of Report

The purpose of this report is to provide a comparative assessment of the risks associated with transporting dangerous goods along the short listed Inner Bypass route options and the Existing Highway upgrade option between Sawtell and Woolgoolga. This risk assessment considers the potential impacts from an incident involving dangerous goods vehicles. The risk assessment is required as part of the ongoing design and evaluation process for the various options to assist in the selection of the preferred option.

1.3 Scope of Work

This report assesses and compares the likelihood and severity of incidents involving the transport of dangerous goods on the various route options for the Existing Highway Upgrade and for the Inner Bypass corridor (including sub-options identified as Inner South 1 and 2 and Inner North 1 and 2).

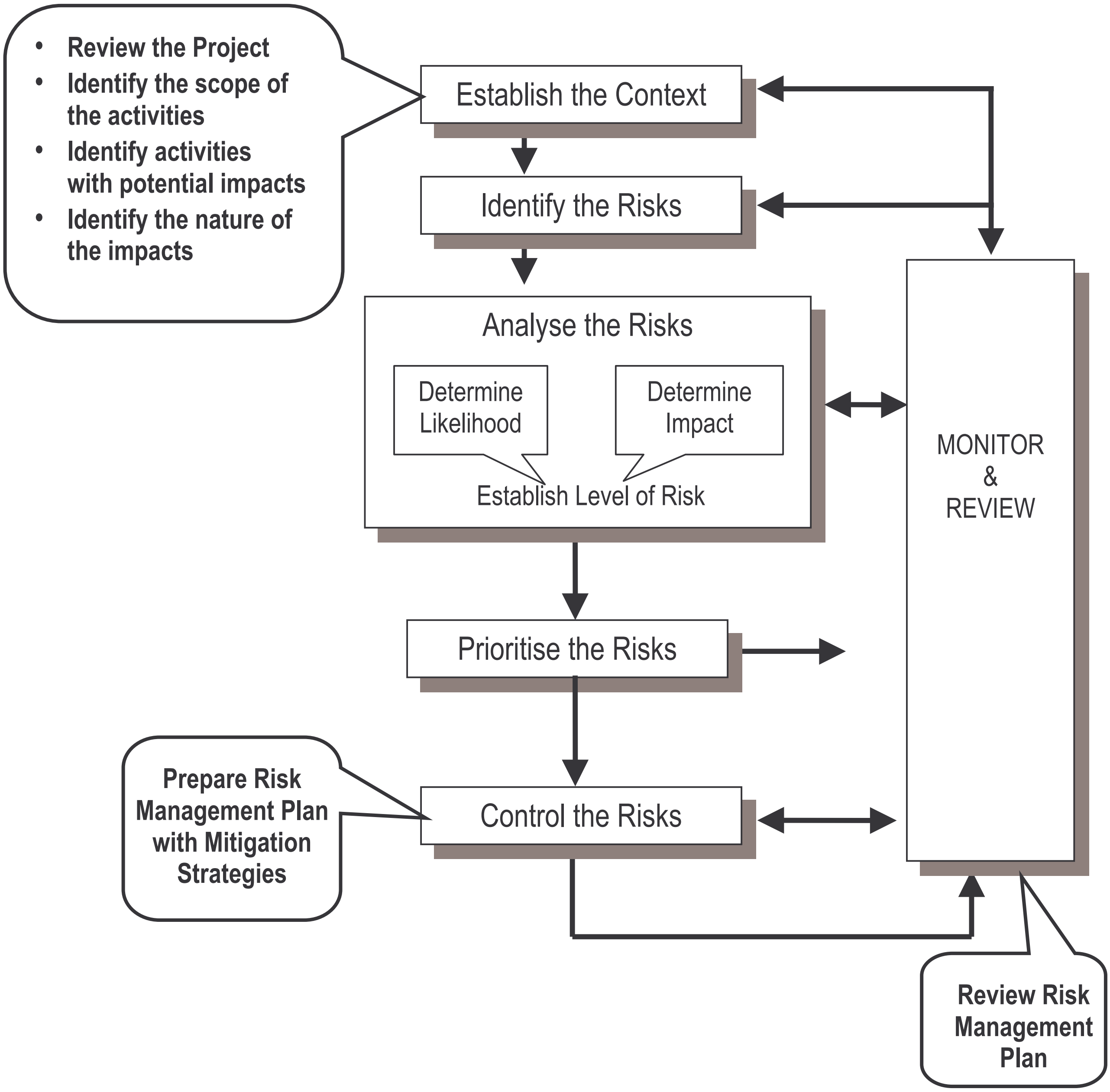
The assessment also necessarily considers risks associated with the existing Pacific Highway through the main urban area of Coffs Harbour as it will remain as an alternative route for transport of dangerous goods.

Traffic surveys were conducted in Coffs Harbour to determine the proportion and types of dangerous goods transported and the number of vehicles involved. From incident statistics and the proportion of dangerous goods vehicles the likelihood of dangerous goods related incidents was determined. Severity of incidents was determined from a literature review of heavy vehicles and dangerous goods incidents on roads and tunnels and consideration of the nature of developments adjacent to the current or proposed road corridor.

1.4 The Risk Assessment Process

This risk assessment was conducted in accordance with AS 4360: Risk Management and Risk Assessment – Hazardous Industry Planning Advisory Paper No 3, Department of Urban Affairs and Planning (1994). The paper assesses the risks associated with the transportation of dangerous goods in accordance with the process outlined in Australian Standard "Risk Management" AS/NZS 4360 – 1999. A summary of the process is shown in Figure 1.

Figure 1 – Risk Management Process



The steps in the process as applied to this project include the following:

Establish the Context

The context can be established by understanding the proposed development, including the various options being considered. The risk assessment relates to a comparison of the risks of a dangerous goods incident on the current highway (base case) against the Inner Bypass Options and the Existing Highway Upgrade option as described in section 2 of this report. Some of the options include tunnels.

Identify the Risks

The risk identification process involves the following issues:

- Assessment of the likelihood of incidents on each of the route options
- Percentage of dangerous goods vehicles on each option
- Types of dangerous goods transported and the impact of an incident
- Identification of stakeholders and receptors impacted by the proposals such as:
    - Areas identified as residential, commercial and industrial or areas supporting community facilities
    - Road users
    - Natural areas, watercourses
    - Agricultural land

Analyse the Risks

Analysis of the risks involves a determination of the likelihood of the event occurring and the consequence or severity of each type of hazard.

Likelihood of incident

Likelihood is dependent on:

- Frequency of incidents for each of the options
- The percentage of dangerous goods vehicles travelling on each option compared to total traffic
- The number of vehicle kilometres travelled on each route option by all vehicles

The likelihood of an incident (or crash) will be compared to a base figure for the current highway of 51incidents per 100 Million Vehicles Kilometres Travelled (MVKT).

For the Inner Bypass corridor and the Upgrade of the Existing Highway, it is assumed that the road safety objective of the Coffs Harbour Highway Planning Strategy of 15 incidents or crashes per 100 MVKT is achieved.

The calculations for the likelihood of an incident occurring are based on a number of traffic surveys undertaken at Coffs Harbour, which are further detailed in Section 4 of this report. Incident frequency rates for the existing highway were obtained from RTA crash data.

Incident Consequence/ Severity of outcomes

The consequence or severity is dependent on:

- The type of dangerous goods carried
- The type and sensitivity of receptors within and adjacent to the road corridor

- The amount of traffic within the impact radius of an incident

Hazards arising from incidents involving dangerous goods include toxicity, infection, fire, explosion, radiation and corrosion.

In order to determine the severity of impact of a dangerous goods vehicle incident it is necessary to determine the following:

- the area impacted by the incident for various types of dangerous goods (affected zone).

- sensitivity of receptors along the route.

A literature review of comparative projects in Australia and overseas was undertaken to provide information on recent road and tunnel incidents involving dangerous goods. This identified that due to the confinement of the dangerous goods in a tunnel different outcomes may result. The incident may be restricted to the inside of the tunnel and nearby traffic but may not affect nearby properties. The structure of the tunnel may be damaged as a result of a fire or explosion from an incident. Details of recent road and tunnel incidents involving dangerous goods are provided in Section 3.

The most severe outcome of a dangerous vehicle incident is considered to be fatalities.

Prioritise the Risks

Risks are prioritised based on the combination of likelihood and consequence / severity. The more likely the event and the more serious the consequence, the higher the risk. In this report in terms of severity, fatalities are considered to be a higher risk than potential environmental damage or damage to agricultural land. Incidents on agricultural land would be considered to be less severe due to the lower population density and thus, the risk of fatalities. However, contamination of land may require clean up and / or remediation.

This report compares the risks associated with the various route upgrade options.

Risk impact criteria are categorised as:

- Critical - could lead to fatalities,

- Major - could lead to injuries, significant delays or significant environmental issues

- Minor – would be an inconvenience

Control the Risks

Control of identified risks requires the implementation of suitable management measures. Management measures may include, in order of preference:

- removal of the risk

- minimisation of the risk (e.g. installing ventilation in a tunnel to reduce fume concentration)

- mitigation of the risk (e.g. provision of emergency response equipment)

The Risk Management Plan

The Risk Management Plan (RMP) incorporates the outcome of the above risk management process and provides a summary of the risks identified, the impact level of each risk, measures to control the risk and the action which has been undertaken to date.

Monitor and Review

The RMP requires monitoring and review to ensure that it continues to be relevant and is updated with details of new developments, infrastructure etc. Monitoring and review should be conducted at suitable intervals. New risks and impacts arising through the design and construction process should be incorporated into the RMP.

2. Future Highway Options

2.1 Introduction

Details of the Existing Highway Upgrade and Inner Bypass options are contained within the 'Strategy Report' (Connell Wagner, 2004). Relevant sections have been extracted from that report.

2.2 Existing Highway Upgrade

The concept for an "ultimate" upgrade of the existing highway through Coffs Harbour is based on contemporary urban motorway schemes and has been developed to provide a dual-carriageway facility with grade-separated interchanges and overpasses at key locations for access to and from the highway and / or for local east-west traffic movements. These would be complemented by the provision of separate local north-south service roads or adjustments to existing local roads for access to properties and businesses along the existing corridor.

The scenario was developed to a form that is sufficient to allow a valid comparison with a possible bypass scenario within the Inner Bypass corridor.

The main features outlined are as follows:

- A total of 9 grade-separated interchanges at:
  - Englands Road / Stadium Drive
  - North Boambee Road / Cook Drive
  - Thompsons Road / Halls Road
  - Combine Street / Albany Street
  - North of Coffs Creek near Beryl Street
  - Bray Street / Orlando Street
  - Arthur Street / Mastrocolas Road
  - Bruxner Park Road / James Small Drive south
  - Old Coast Road / James Small Drive north
- Rationalisation and connection of industrial area access roads on the southern outskirts of town between Englands Road and Thompsons Road.
- Horizontal alignment improvements (larger radii) and widening between Thompsons Road and Albany Street.
- Adjustment of local streets to provide service roads for motel and CBD access north of Combine Street.
- Lowering of the highway (in an open slot arrangement) through the CBD area between Park Avenue and Coffs Street.
- Provision of a service road on the eastern side of the highway over the same length.
- East / west overbridges at Park Avenue / Moonee Street and High Street / Harbour Drive.

- A series of local road connections to provide service roads and property access between Coffs Creek and Orlando Street.

- A 550 metre long tunnel through Macauleys Headland, with local traffic remaining on the existing highway.

2.3 Inner Bypass

Two indicative route options have been identified in both the southern and northern sections of the Inner Bypass corridor. The four component routes are between 4.5km and 6.8km long with a common 'cross-over point' in the vicinity of Coramba Road, near its intersection with Bennetts Road. The northern and southern sections of the options are interchangeable and combine to form a total of four potential route options starting on the existing Pacific Highway just south of Englands Road, passing through the common point, and rejoining the Pacific Highway north of Coffs Harbour at Korora Hill. Each component has been designed so as to minimise negative impacts of the proposed roadway.

The two southern and two northern components are illustrated in the map attached in Appendix A and described below:

- *Inner South 1:* This option deviates from the existing highway just south of the Englands Road roundabout, aligning to the east of the CHCC waste depot and to the west of Isles Industrial Park. It crosses North Boambee Road approximately 300m west of Bishop Druitt College and continues north toward the low saddle in the Roberts Hill ridgeline approximately 100m west of Buchanans Road before proceeding North-West to Coramba Road, crossing near the Bennetts Road intersection.

- *Inner South 2:* This alignment is initially the same as Inner South 1 but deviates from that route south of North Boambee Road and tracks further to the west, to the Roberts Hill ridgeline about 800m west of the other alignment. Due to the higher terrain in this area a cutting theoretically 103m deep, 290m wide and 560m long would be required to achieve a desirable vertical alignment. As it is not feasible to provide a cutting of such magnitude, a 560m long tunnel is proposed for this alignment. This route then proceeds north to Coramba Road, crossing near Bennetts Road intersection.

- *Inner North 1:* From Coramba Road this alignment veers north-east, crossing Spagnolos Road and Shephards Lane before heading east to Mackays Road, following close and parallel to the railway line for about 1.6km. From this point it deviates from the railway line to pass through another main ridgeline near the western end of Gatelys Road. Further north the alignment skirts the West Korora basin crossing Bruxner Park Road before rejoining the existing highway at Korora Hill.

- *Inner North 2:* This alternative alignment features a more westerly sweep of the West Coffs Harbour basin, providing more separation between the alignment and existing residential areas. Beginning at Coramba Road it proceeds to cross Shephards Lane at its western extremity passing over the railway east of the railway tunnel under Shephards Lane. The route passes through and then behind a major ridgeline near the end of Shephards Lane and traverses a relatively isolated valley that is shielded from the residential areas of West Coffs Harbour. It then passes through the same ridgeline as Inner North 1 near the western end of Gatelys Road and from that point the two northern alternatives are the same on the curved approach to the existing highway.

As Roberts Hill Ridge provides a Regional Koala Movement Corridor, provision has been made for a vegetated fauna overpass on the Inner South 1 Option where it crosses the ridge.

With both of the northern options, short tunnels could potentially be used to eliminate the deep cuttings at the Gatelys Road ridge (70m) on Inner North 1 and at both the Shephards Hill ridge (55m) and Gateleys Road ridge (60m) on Inner North 2. It should also be noted that by providing tunnels it would be possible to lower the proposed gradeline of the highway by up to 18m, thus providing better vertical alignment, reducing the quantity of embankment fill required in the adjacent area and making the highway less visible. It would be intended that the required tunnels be in the form of twin bored tunnels each containing two travel lanes and an emergency stopping lane. Each tunnel would be approximately semi circular in shape having an area of about $114m^2$.

The various north/south routes created by combining the separate northern and southern components are summarised in Table 2.1. To define the tunnelling options within the various routes, a notation using the suffix "T" and a number indicating the number of tunnels incorporated within the route has been used.

Table 2.1: Route Option Components and Combined Route Options

North / South Route Combination	Option	Tunnel Proposals / Options	Length of Tunnel	Total Length of Tunnel
IS1 and IN2	A – 0T	–	–	–
IS1 and IN2	A – 2T	Shephards Lane Ridge Gatelys Road Ridge	340 415	755
IS1 and IN1	B – 0T	–	–	–
IS1 and IN1	B – 1T	Gatelys Road Ridge	390	390
IS2 and IN2	C – 1T	Roberts Hill Ridge	560	560
IS2 and IN2	C – 3T	Roberts Hill Ridge Shephards Hill Ridge Gatelys Road Ridge	560 340 415	1315
IS2 and IN1	D – 1T	Roberts Hill Ridge	560	560
IS2 and IN1	D – 2T	Roberts Hill Ridge Gatelys Road Ridge	560 390	950

The proposed road is typically 31m wide with a cross-section based on a dual carriageway, having two dual lane shouldered pavements, separated by a 7m median. The width of formation varies with terrain, with fill batters.

Depending on the route option, up to 11 highway bridges may be required to cross various creeks, roads and the North Coast Railway. Highway bridges would generally be provided as twin one-way bridges each having a pavement width of 10.5m. The proposed bridge over Coffs Creek and Coramba Road would be required to be 14m wide to allow for an interchange at this location.

Where bridges are not provided for waterway crossings, drainage culverts sized to allow passage of design storm events would be provided. Where it is considered necessary to provide fauna underpasses, these culverts may be enlarged to provide for this. Fauna overpasses would be required where the options cross Regional Koala Movement Corridors on ridgelines if tunnels are not provided.

3. Recent Road and Tunnel Incidents

3.1 Introduction

In this section some analysis of dangerous goods related incidents in tunnels and open roads is discussed. Data was obtained from the NSW Department of Environment & Conservation (DEC) and through a literature search. The aim is to determine severity of open road incidents and allow some qualitative comparison of tunnel related incidents. In general terms, the data collated indicates that severe incidents relating to dangerous goods transport can occur on both open road and in tunnels.

3.2 Overseas Tunnel Incidents

The rules and regulations for the transport of dangerous goods in tunnels vary considerably between and even within countries. The definition of local rules and regulations, decision taking, responsibility and enforcement are left to local or provincial authorities and politicians, the tunnel owners or "expert" opinions. For the most part there are no general rules and regulations in Europe that are applicable to all tunnels at the national level.
Generally in Europe, dangerous goods are allowed through main route tunnels with restrictions.

Mont Blanc

The Tunnel was built jointly by France and Italy and opened in 1965. Two operating entities were created, the STMB (Societe de Tunnel du Mont Blanc) which became ATMB in France and SITMB (Societa Itaiana del Traforo di Monte Bianco) in Italy, each Operating half the tunnel.

The tunnel is 11,600m long and carries bi-directional traffic. There are vehicle rest areas every 300m. A safe refuge is provided at every second rest area. Two fire extinguishers and a manual call point are provided every 100m. Hydrants, telephones and manual call points are provided every 150m for use by the fire brigade.

On 24 March 1999 a fire was initiated in a truck with a thermal foam trailer containing margarine and flour. Thirty eight people died in the tunnel and the fire chief died in hospital. Two of the victims were in a refuge in the tunnel. The tunnel was closed for a number of months.

The basic findings of the report highlighted that:

- The speed and magnitude of the fire which developed in the truckthat caused the fire, and its spreading to other vehicles impacted on the outcome;
- The lack of coordination between the two operating companies;
- The inadequacy and poor functioning of certain equipment (including tunnel closure lights, ventilation to safe refuges, location exit lighting, refuge signage, no central control facility, lack of fire water, incompatible equipment, fresh air duct to refuges also served as tunnel exhaust).

In the reduced oxygen levels of the tunnel, the rescue vehicle engines failed. (French Government Minister of the Interior, 1999)

Tauern Tunnel

The Tauern tunnel is 6400m long and is operated bi-directionally. It is fitted with 30 emergency call bays set 212m apart, 61 fire extinguishing bays every 106m and a total of 7 breakdown bays every 750m. At the time of the incident (29 May 1999), there was a construction site in the tunnel with traffic signals regulating the traffic, which was confined to a single lane. A truck drove into the back of stationary vehicles at high speed and pushed four cars under the truck stopped in front. The incident caused 8 deaths and resulted in one truck catching fire. Attempts to extinguish the blaze were unsuccessful and the flames spread to another truck with a mixed cargo including aerosol cans. Altogether 12 died, 49 were injured, 14 trucks and 26 cars were destroyed. The tunnel was closed for 3 months for repairs (Jones, 2000)

St Gotthard

The fire in St Gotthard tunnel on 31 October 1997 was the third fire in the tunnel. This event was caused by a car transporter carrying six vehicles. As in previous incidents, several occupants remained in their cars in spite of the dense smoke surrounding them (Henke, 2000).

The following lessons were noted:

- Motorists are reluctant to leave their cars, even in the face of imminent danger.
- Most fires develop slowly and there is a real possibility that burning trucks can leave the tunnel.
- The users have sufficient time to get to a safe place (refuge).
- The existence of shelters should be made better known to the users (more and bigger escape signs, leaflets, radio communication).

Palermo, Italy Tunnel

On 18 March 1996, a propane gas tanker was involved in a crash in a highway tunnel near Palermo, Italy. The tunnel is 148 m long, 9.5 m wide and 6.5 m high. The collision gave rise to an escape of propane gas through a crack that formed on the top of the vessel. The ignition of this gas cloud and the subsequent boiling liquid evaporating vapour explosion (BLEVE) of the tank caused 5 fatalities. A further 25 persons were critically burned by the heat radiation (NFPA, 1997).

3.3 Dangerous Goods Road Incidents

Readily available statistics for dangerous goods road incidents in Australia was obtained from relevant agencies in NSW and Western Australia.

Information from the NSW Department of Environment and Conservation for the period 01/01/2001 to 25/09/03 revealed that 28 road incidents occurred involving the loss of containment of goods from heavy vehicles. In two of the 28 cases, a fire ensued. In Western Australia, there were 18 reportable dangerous goods transport incidents in 1999. In all these incidents there was no significant release of dangerous goods and the three incidents involving fatalities were traffic and not dangerous goods related.

Similar data was not readily available from other states.

3.4 Risks Associated with Tunnels

The Ruhr University of Bochum, Institute of Road and Traffic Studies examined a total of 784 accidents during the period 1993 to 1997 in 46 road tunnels in Germany with uni-directional traffic and 22 tunnels with 2-way traffic. The survey results are shown in Table 3.1 with the values in brackets referring to the open road.

Table 3.1: German Survey of accidents within tunnels

Type of Tunnel	Accidents/1 Mvk Personal Injuries	Damage to property
Divided carriageway freeway with shoulder used for emergency stopping	0.074 (0.147)	0.328 (0.619)
Divided carriageway freeway without hard shoulder for emergency stopping	0.130 (0.202)	0.354 (0.923)
Regional road with 2-way traffic	0.141 (0.315)	0.249 (0.983)

This study indicates that the accident rate on the open road is generally higher than it is in a tunnel (by a factor of approximately two for personal injuries and three for damage to property). Vehicle speed may have influenced these accident rates as an 80 km/hr speed restriction typically applied in the road tunnels investigated, whereas the speed limit on the sections of open road investigated was typically higher. In addition, dangerous climatic influences such as frozen snow or black ice, heavy rain, fog, gusts of wind or blinding sunlight may have influenced the accident rates on the sections of open road investigated. While the frequency of accidents in tunnels is lower, the consequences of an accident may be more serious due to the fact that road tunnels are a confined space.

Tunnel egress is restricted to travel along the tunnel or through a cross passage to the adjacent tunnel; this compares to the 360^{o} egress possible from a freeway accident. Travel may be further restricted to a counter flow direction, as smoke will be blown in the direction of vehicle travel. Emergency services access is also restricted within tunnels due to narrow shoulders, lack of turning provisions and potential for smoke to prevent counter flow access. However an opposite direction tunnel (if available) can provide good foot access.

The smoke from a tunnel fire is confined within the tunnel and so is in closer contact to people, this contrasts with an open air fire where the buoyant plume is free to rise into the sky. Even if the hot smoke layer is above head height, the hot smoke can radiate sufficient heat to incapacitate occupants of the tunnel. A smoke layer below head height can incapacitate due to toxic effects and prevent egress by reducing visibility.

With a fire in the open, radiation and convection dissipate heat. When a fire occurs in a tunnel, the smoke is confined and forms a hot layer which radiates back to the fuel. This results in a significantly increased heat release rate compared to a free burning object in the open. Whilst tunnel fire safety systems can be designed to mitigate these effects, they cannot totally eradicate them.

4. Hazard Identification

4.1 Types of Dangerous Goods

Guidance relating to the transportation of dangerous goods by road and rail is provided within the Australian Dangerous Goods Code (sixth Edition). Dangerous Goods are divided into nine classes depending on the risk associated with the substance transported. Each of these classes has further subdivisions. Regulations relating to the handling of dangerous goods are covered in various NSW WorkCover publications

The nine classes of dangerous goods are:

Class 1 Explosives

Substances and articles used to produce explosions and pyrotechnic effects. These include high explosive, fireworks and cartridges

Class 2 Gases

These are gases, which have been compressed, liquefied or dissolved under pressure and included:

Class 2.1 - Flammable gases. Examples: acetylene, hydrogen, liquefied petroleum gas (LPG)
Class 2.2 – Non flammable, non toxic gases. Examples: oxygen, nitrogen, air, argon
Class 2.3 – Toxic gases liable to cause death or serious injury to human health if inhaled. Examples: ammonia, chlorine, carbon monoxide

Class 3 Flammable liquids

These are liquids, mixtures of liquids or liquids containing solids in suspension, which in most cases can be ignited and will burn. The subdivision also depends on the three Packing Groups (PG) defined as:

I. High hazard / Great danger
II. Medium Hazard / Medium danger
III. Low Hazard / Low danger

Class 3 PG I are flammable liquids with a flash point less than 23 ^{o}C and an initial boiling point not greater than 35 ^{o} C. Examples: Diethyl ether, carbon disulfide. Class 3 PG II are flammable liquids with a flash point less than 23 ^{o}C and an initial boiling point greater than 35 ^{o} C, examples are petrol, acetone, paint thinners. Class 3 PG III are flammable liquids with a flash point of 23 ^{o}C or more, but less than or equal to 60. ^{o} C. Examples are kerosene, mineral turps. Containers of combustible liquids with a flash point above 60.5^{0}C are not required to be marked. Examples are diesel fuel and lubricating oils.

Class 4 Flammable solids

Class 4.1 Flammable solids, self reactive and related substances and desensitised explosives – solids easily ignited and readily combustible. Examples: nitrocellulose, phosphorus, matches.
Class 4.2 – substances liable to spontaneous combustion. Examples: aluminium alkyls, white phosphorus.
Class 4.3 – Substances which emit flammable gases when in contact with water. Examples: aluminium phosphide, calcium carbide.

Class 5 Oxidisers

Class 5.1 – Oxidising agents. Examples hydrogen peroxide, calcium hypochlorite (dry pool chlorine)
Class 5.2 – Organic peroxides (liquid or solid). Examples methyl ethyl ketone, dibenzoyl peroxide.

Class 6 Toxic and infectious substances

These are poisonous (toxic) and infectious substances (excluding toxic gases, which are class 2.3)

Class 6.1 – Toxic substances. These are liable to cause death or serious injury to human health if inhaled, swallowed or absorbed through the skin. Examples: cyanides, arsenic compounds.
Class 6.2 Infectious substances. These are substances containing viable micro-organism that are known or believed to cause disease in humans or animals. Examples: viruses, pathology specimens.

Class 7 Radioactive substances

These emit ionising radiation. Examples are radioisotopes used in medicine

Class 8 Corrosives

These are substances (either solid or liquid) which will damage living tissue, goods or equipment on contact by chemical action. Examples: hydrochloric acid, sodium hypochlorite (liquid pool chlorine), sodium hydroxide (caustic soda)

Class 9 Miscellaneous dangerous goods

These are substances and articles, which have potentially dangerous properties that are relatively minor. Example: polyester beads, polychlorinated byphenyls.

4.2 Placarded Loads

Dangerous goods become a concern when the quantity carried becomes significant. The duty to display a Dangerous Goods placard on a vehicle (placarded load) is defined by the class and quantity of dangerous goods transported. The placard on the vehicle details the class of the substance carried and emergency response information.

The vehicle placard was used in the Coffs Harbour dangerous goods survey conducted in September 2003 to identify the type of dangerous goods transported. During the survey, the class and in some cases the UN number of the dangerous goods was identified. The UN number is a number assigned in relation to dangerous goods by the UN Committee of experts on the transport of dangerous goods and published by the UN recommendation. Updates are issued by the UN from time to time.

4.3 Dangerous Goods Vehicle Volumes

A vehicle classification survey was conducted by Coffs Harbour City Council from Wednesday 19 to Wednesday 26 February 2003. Heavy vehicle traffic volumes were extracted from that survey and are presented in Table 4.1.

Table 4.1: Heavy Vehicles Survey (from CHCC)

Survey Date: 19-26 Feburary 2003 **Survey Location:** Pacific Highway, 200m south of Bruce King Drive			
	Daytime 7am – 10pm	Night-time 10pm-7am	Total
Sunday	755	114	869
Monday	1244	271	1515
Tuesday	1369	529	1898
Wednesday	1551	673	2224
Thursday	1707	726	2433
Friday	1160	632	1792
Saturday	574	397	971

It is noted that Class 1-2 refers to light vehicles (cars, cars with trailer etc) and Class 3-12 refers to all other vehicles including trucks. The above data relates only to the latter classes.

The survey showed the largest movement of heavy vehicles to occur on the Thursday. As these results are taken to represent typical daily patterns for heavy vehicle movements, the survey of dangerous goods vehicles was conducted on a Thursday. The survey was conducted on 24-25 September 2003 over a 24 hour period and it identified the proportion and types of dangerous goods travelling through Coffs Harbour.

Table 4.2 shows the total vehicles counted on the day of the dangerous goods vehicles survey. Raw data from the survey is contained in Appendix B.

Table 4.2: Total vehicle count on day of Survey

Survey Date: 24 - 25 September 2003 (24 hour period) **Survey Location:** Pacific Highway South of Park Ave, Coffs Harbour					
	Light Vehicles	Rigid Vehicles	Articulated Vehicles	Buses	Total Vehicles
Total	23,211	980	1,565	196	25,952
%	89.4	3.8	6.0	0.8	100.0

The number and percentage of dangerous goods vehicles identified in the survey by class and UN number placarded are presented in Table 4.3. The results indicate a total of 83 dangerous goods vehicles in the survey period and that the main identifiable goods were petroleum fuel (13.2%) and LPG (12%).

Table 4.3: Dangerous Goods Vehicle Count

Survey Date:	24 - 25 September 2003			
Survey Location:	Pacific Highway South of Park Ave, Coffs Harbour			
Type of Dangerous goods	Dangerous Goods class	UN Number	Number of vehicles	% of dangerous goods vehicles
Dangerous Goods mixed	-	-	18	21.69
Petroleum fuel	3	1270	11	13.25
LPG	2	1075	10	12.05
Corrosive	8	-	7	8.43
Miscellaneous Goods	9	-	7	8.43
Gasoline	3	1203	5	6.02
Flammable Liquids	3	-	5	6.02
Elevated Temp liquid Flammable	3	3256	4	4.82
Elevated Temp liquid	9	3257	4	4.82
Flammable Gas or Liquid	2 or 3	-	3	3.61
Corrosive	8	1760	2	2.41
Natural gas	2	-	1	1.20
Explosives	1	-	1	1.20
Argon, refrigerated liquid	-	1951	1	1.20
Magnesium Hydride	-	2010	1	1.20
Infectious Substances	6		1	1.20
Flammable Gas	-	-	1	1.20
Unknown	-	-	1	1.20
Total	-	-	83	100.00

Table 4.4: shows the number and percentage of each class of dangerous goods vehicle as a function of the overall dangerous goods vehicle volumes. The percentage of dangerous goods vehicles was calculated based on the placarded data displayed.

Table 4.4: Dangerous Goods Vehicles by Class

Dangerous Goods	Number of DG vehicles	Percentage
Class 3 Flammable liquid	26	31.33
Mixed load	18	21.69
Class 2 flammable gases	14	16.87
Class 9 miscellaneous DG	11	13.25
Class 8 corrosives	9	10.84
Class 1 explosives	1	1.20
Class 2 non flammable gases	1	1.20
Class 4 flammable solids	1	1.20
Class 6 toxic and infectious substances	1	1.20
Unknown	1	1.20
Class 5 oxidising agents, organic peroxides	0	0.00
Class 7 radioactive substances	0	0.00
Total	83	100

The data shows that flammable liquids and gases including petroleum and LPG (class 3 and class 2) were the more common dangerous goods transported comprising approximately 50% of goods transported. For calculation of the likelihood of a BLEVE (boiling liquid evaporating vapour explosion) the percentage of Class 2 flammable goods was used 16.9 %.

A comparison between Tables 4.2 and 4.3 shows that vehicles carrying dangerous goods comprised approximately 3% of heavy vehicles and 0.3% of total vehicles on the Pacific Highway.

4.3.1 Modelled Traffic Volumes

The predicted traffic volumes for the study area for 2021 detailed in Table 4.5 are taken from the Strategy Report (Connell Wagner, 2004). The table provides figures for the three scenarios of existing highway without upgrade, Inner Bypass and Existing Highway Upgrade. These figures were used for determining vehicle kilometres travelled for calculations of incident likelihood.

Table 4.5: Modelled 2-Way Daily Traffic Volumes for the Study Area in 2021

Location	Base Case	Inner Bypass	Highway Upgrade
Englands Rd to North Boambee Rd	N/A	13,744	N/A
North Boambee Rd to Coramba Rd	N/A	16,901	N/A
Coramba Rd to Mastracolas Rd Extension	N/A	12,045	N/A
Mastracolas Rd Extension to Northern I/C	N/A	14,752	N/A
Pacific Highway			
South of Englands Rd	38,328	40,057	40,504
South of Halls Rd	27,993	23,596	34,401
North of Coff St	35,566	29,401	16,741 (2)
North of Bray St	45,074	35,286	49,877
North of Arthur St	44,095	29,388	36,950 (3)
North of James Small Dr (S)	35,693	21,623	35,693
North of Headland Rd	31,745	30,511	30,451
North of Moonee Beach Rd	26,509	26,509	26,509
North of Bucca Rd	26,161	26,161	26,161

From Coffs Harbour Highway Planning Strategy Report (Connell Wagner, 2004a)
1. Traffic predicted to use Inner Bypass or Existing Highway Upgrade is expected to experience a lower crash rate than the traffic using the existing highway, due to the improved road geometry.
2. These figures are for the Upgraded Highway only and do not include traffic on the adjacent local service roads.
3. These figures are for the Upgraded Highway. In addition, some traffic remains on the old Pacific Highway over McCauleys Headland.

4.4 Radius of Fatal Consequences

In order to determine severity of a dangerous goods vehicle incident the area likely to be impacted needs to be identified. This is achieved by defining a radius of fatal consequences (RFC) for a range of dangerous goods. For example, the largest credible accident involving LPG (a spill of 20 tonnes and a subsequent vapour cloud explosion) is estimated to be capable of causing almost 100 % fatality rate at 50 metres and a very high risk (50 – 100%) fatality at 100 metres (PPK 1999). The RFC is defined as the area where the likelihood of multiple fatalities is significant. Table 4.6 provides the RFC for some of the more common high impact dangerous goods incidents.

Table 4.6: Radius of Fatal Consequences (RFC) (from PPK, 1999)

Hazard	Radius of Fatal Consequence in metres
Ammonium Nitrate explosion	50
LPG vapour cloud explosion	100
LPG flash fire	80
LPG pool Fire	50
LPG BLEVE	250
Chlorine leak	250
Petrol fire	50

Based on research by PPK (1999) for the proposed tunnel in the Bonville project and assuming the ignition of propane (the more flammable of the main ingredients in LPG) from an incident, the RFC is at approximately 250m. This assumes that anyone with light clothing would be affected. Damage to buildings during a catastrophic release of propane is estimated to occur up to around 460 metres.

The potential impacts associated with an incident involving a chlorine truck would only involve exposure hazards as opposed to explosion. The analysis in this report shows that people within a radius of approximately 250 metres of the incident are at risk of exposure to deadly concentrations (1000ppm) of chlorine (PPK, 1999).

Using the data provided in the PPK report (PPK, 1999) a 250m RFC has been adopted for this project. The site map attached as Appendix A shows the 250m RFC for each of the route options. The stakeholder's identified within the RFC are detailed in Table 4.7, along with the possible consequences from potential impacts.

Table 4.7 Stakeholders within 250 metres of proposed options

Recipients	Potential Impact
Residential	Fatalities, Injuries and/or property damage
Business	Fatalities, Injuries and/or property damage
Industrial	Fatalities, Injuries and/or property damage
Special use community purposes such as schools	Fatalities, Injuries and/or property damage
Agricultural land including Banana plantations	Loss of income from contamination of land Limited fatalities and/or injuries due to low population density
Local waterways creeks or rivers	Pollution
Bushland	Bush fire
Road users Including pedestrians	Fatalities, Injuries and/or property damage. The most severe incident would involve a bus

The consequences resulting from an incident would depend on the sensitivity of the surrounding area in terms of density of population, nature of development etc.

The type and area of recipients within the 250 metres RFC is shown in Table 5.1 in the next section of this report.

5. Risk Analysis

5.1 Likelihood of incidents

The likelihood of dangerous goods incidents was calculated based on the following:

- The likelihood of incidents for the base case (existing highway) was based on the recorded accident rate of 51 crashes per 100 Million vehicle kilometres travelled (Mvkt). This figure was determined from the crash data supplied by the RTA for the section of highway relating to this study. Modelled traffic volumes from the CHCC study were adopted for the year 2021 assessment

- Percentage of dangerous goods vehicles on the route and remaining on the bypassed sections of the existing highway

- Information obtained from the traffic surveys conducted for this project

- Information from other traffic surveys conducted in the area

- An assumption that the likelihood of an incident involving a dangerous goods vehicle is proportional to the total number of dangerous goods vehicles as a percentage of the total traffic, i.e. the likelihood of a vehicle carrying dangerous goods being involved in an incident is assumed to be the same as for any other vehicle.

- For the Existing Highway Upgrade and Inner Bypass, it is assumed that the road safety objective of the Coffs Harbour Highway Planning Strategy of 15 incidents per 100 MVKT is achieved.

Table 5.1 summarises the likelihood of incidents presented as the average number of years between a dangerous goods transport incident based on the data presented in the previous section of this report. The table presents three calculations as follows:

1. a comparison of the likelihood of dangerous goods vehicle incidents for each of the overall route options;

2. a comparison of the likelihood of dangerous goods vehicle incidents for those parts of the route options where built-up urban land uses occur within 250m of the incident location. This information is based on the land use map in Appendix A; and

3. a comparison of the likelihood of incidents in the various tunnels being considered in this project.

Table 5.1: Likelihood of Dangerous Goods Vehicle Incidents - 2021

Highway Option	DG Vehicle Crashes (No of Years between crashes)	Serious Crashes - 2 out of 28 cause fire or explosion (No of years between crashes)	LPG Vehicle related Crash (No of years between crashes)
Overall Route – Englands Road to Bucca Road			
Base Case (no upgrade)	1.5	21	9
Inner Bypass	4.2	59	25
Existing Highway Upgrade	5.2	73	31
Within Built-up Areas (Englands Rd to Bucca Rd)			
Base Case (no upgrade)	2	28	9
Inner Bypass - IS1 & IN1	5.2	73	31

Inner Bypass - IS1 & IN2	5.1	71	30
Inner Bypass - IS2 & IN1	5.2	73	31
Inner Bypass - IS2 & IN2	5.2	73	31
Existing Highway Upgrade	6.9	97	41
Within Tunnel Sections			
IS1 & IN2 - A-0T (Total length of tunnel – 0m)	N/A	N/A	N/A
IS1 & IN2 - A-2T (Total length of tunnel – 755m)	268	3752	1586
IS1 & IN1 - B-0T (Total length of tunnel – 0m)	N/A	N/A	N/A
IS1 & IN1 - B-1T (Total length of tunnel – 390m)	518	7252	3065
IS2 & IN2 - C-1T (Total length of tunnel – 560m)	361	5054	2136
IS2 & IN2 - C-3T (Total length of tunnel – 1,315m)	154	2156	911
IS2 & IN1 - D-1T (Total length of tunnel – 560m)	361	5054	2136
IS2 & IN1 - D-2T (Total length of tunnel – 950m)	213	2982	1260
Upgraded Highway – Tunnel under Macauleys Headland (Total length of tunnel – 550m)	144	2016	852

The likelihood assessment presented in the table was based on several key assumptions and parameters including:

- Based on previous comparable traffic investigations for highway planning projects, it has been assumed that 80% of dangerous goods vehicle movements would occur along the relevant Inner Bypass or Existing Highway Upgrade option. This assumption has been made in the absence of specific origin destination data for heavy vehicles in the area
- Existing highway has a total of 51 crashes per 100Mvkt
- Estimated total crashes is assumed to be 15 crashes per 100Mvkt assumed for both Inner Bypass and Existing Highway Upgrade (ie. achievement of Strategy objectives)
- Est. HV crashes = Est. total crashes x No. HV crashes (1998 to 2002)
  No. total crashes (1998 to 2002
- Est. DGV crashes = Est. HV crashes x No. DGV movements on 25/9/03
  No. HV movements on 25/9/03
- To enable the options to be compared, all total, heavy vehicle and dangerous goods vehicle crashes were estimated for future highway options between Englands and Bucca Roads so as to correspond with relevant and available traffic and crash data
- EPA data on dangerous goods vehicle incidents from 1/01/01 to 25/09/03 indicates 28 incidents involving loss of containment and two that caught on fire.
- The dangerous goods survey found that 16.9 % of vehicles carried LPG or other class 2 flammable gas.
- The incident likelihood in built-up areas (such as residential and commercial areas) is based on the length of road where such areas are within the 250m RFC.
- HV – Heavy Vehicle
  DGV – Dangerous Goods Vehicle

From the findings in Table 5.1 the following statements can be made:

- The future highway upgrade options would result in the likelihood of a dangerous goods vehicle incident being at least halved compared to the existing highway.
- For those parts of the highway upgrade option that pass through built-up areas, the likelihood of a dangerous goods vehicle incident would be at least one third that for the existing highway.
- In terms of the overall route options, the Existing Highway Upgrade option would have the lowest likelihood of a Dangerous Goods Vehicle related incident, with one incident expected at an average interval of 5.2 years. The option is also the least likely to have a serious dangerous goods vehicle incident with fire or explosion impacts (viz. 1 in 73 years).
- For the various Inner Bypass combinations, the likelihood of an incident in built-up areas is about the same, being about one third that of the existing highway.
- With an Inner Bypass option, the likelihood of a dangerous goods vehicle incident on the bypassed section of highway through Coffs Harbour would be reduced due to the decrease in total traffic and dangerous goods vehicles on that corridor.
- The likelihood of a serious fire or explosion type incident in one of the possible tunnels ranges from approximately 1 in 2,000 years for the Macauleys tunnel (which forms part of the Existing Highway Upgrade option) to approximately 1 in 7,300 years in IS1 & IN1 with one tunnel. However, as previously noted, some fires may occur from non-dangerous goods vehicles such as occurred in the Mont Blanc fire that involved a truck carrying margarine and flour.

5.2 Consequence / Severity of Incidents

The consequence of dangerous goods vehicle incidents would usually be influenced by a number of factors including:

- The population density within the area of impact of the incident. Impacts on the population are assumed likely for a distance of up to 250m from the incident (refer Section 4.4). For the purposes of this assessment, the area of adjacent built-up / urban land use is taken as the indicator for incident consequence. The calculation uses relevant urban type zones in the Coffs Harbour LEP (viz. residential, business and special uses like schools and hospitals). Land uses covered by open space or rural / non-urban zones are not included in the assessed areas although it is recognised that in some instances these zones can allow residential development.
- The type of dangerous goods carried
- The specific conditions at the site of the incident.

The existing and proposed populated / built-up areas within 250 metres of each of the options were calculated and the results are presented in Table 5.2.

Table 5.2: Populated areas within 250m RFC of the Options

Land use	Base case (no upgrade)	Existing Highway Upgrade	Inner Bypass Options			
			IS1 IN1	IS1 IN2	IS2 IN1	IS2 IN2
Residential (ha)	162	148	44	26	43	25
School (ha)	0.2	0.2	9.8	9.8	0.0028	0.0028
Hospital (ha)	4.9	4.9	0	0	0	0
Other built-up areas (ha)	125	125	9	10	9	10
Existing built-up area within RFC (ha)	292	278	63	46	52	35
Existing built-up area within RFC (% of Base case)	**100**	**95**	**22**	**16**	**18**	**12**
Proposed new urban development (ha)	0	0	92	126	132	166
Existing and proposed built-up area within RFC (ha)	292	278	155	171	185	201
Existing and proposed built-up area within RFC (% of Base case)	**100**	**95**	**53**	**59**	**63**	**69**

From Table 5.2, it is evident that the consequences from a dangerous goods incident for the base case and the Existing Highway Upgrade option could impact on a larger built-up area than the Inner Bypass options. The Existing Highway Upgrade would have 95% built-up area compared to the base case (allowing for the Macauleys tunnel which reduces the effective built-up area by approximately 14ha). The built-up area potentially impacted by the Inner Bypass options would be between 12% and 22% of the base case for the existing population and 53% to 69% of the base case for existing and proposed development, as shown as areas 1 and 2 in Appendix A.

5.2.1 Consequence of tunnel incidents

Literature search has indicated that incidents in tunnels are very dependent on the tunnel design including ventilation facilities and systems, fire fighting equipment and access to emergency services. Other aspects of severity of tunnel incidents are dependent on management aspects of the tunnel.

A serious incident in a tunnel can be very costly in terms of human lives, the environment, tunnel damage and transport disruption. On the other hand needlessly banning dangerous goods from tunnels may create unjustified economic cost. Moreover, it may force operators to use more dangerous routes, such as through densely populated areas and thus increase the overall risks.

5.3 Comparative Risk Assessment

The comparative risk assessment for this study is based on the following:

- the likelihood of a serious incident occurring with a particular option (as presented in Table 5.1); and
- the consequence of a serious incident occurring with a particular option. For the purposes of this assessment, the consequence of such incident is considered to be proportional to the area of urban zones in the Coffs Harbour LEP (including residential, business and special uses like schools) within 250 metres of the option (ie. within the radius of fatal consequence (RFC)). This data is obtained from Table 5.2

The composite comparative risk ranking for each option can be obtained from Table 5.3 The matrix is based on for the assessment of the incident likelihood and consequence shown in the preceding Tables 5.1 and 5.2

Table 5.3: Comparative Risk Ranking

Consequence	Likelihood Number of years between serious accidents				
⇓ Built-up area (% of Base case)	0 – 20	20 - 40	40 - 60	60 - 80	80 - 100
80 - 100	High	High	High	High-Med	Med
60 - 80	High	High	High-Med	Med	Med-Low
40 – 60	High	High-Med	Med	Med-Low	Low
20 - 40	High-Med	Med	Med-Low	Low	Low
0 - 20	Med	Med-Low	Low	Low	Low

Using the above matrix and the assessed likelihood and consequences of a serious incident for both current and proposed urban development, the overall risk rating of the options has been compiled as shown in Table 5.4. It is emphasised that the ratings are for the purposes of comparing the options and, as such, should be not be interpreted as the absolute risks of the options. Such an assessment would be completed for the adopted highway proposal at the environmental impact assessment stage.

Table 5.4: Overall Risk Rating for DG Vehicle Incidents

Option	Likelihood (yrs between serious accidents (Table 5.1)	Consequence - Built-up area (% of Base case) (Table 5.2)		Risk Rating	
		Existing built-up	Existing + Proposed	Existing built-up	Existing + Proposed
Base Case (no upgrade)	28	100	100	High	High
Existing Highway Upgrade	97	95	95	Med	Med
IS1 & IN1	73	22	53	Low	Med-Low
IS1 & IN2	73	16	59	Low	Med-Low
IS2 & IN1	71	18	63	Low	Med

IS2 & IN2	73	12	69	Low	Med

From this table, it is evident that the option with the highest overall risk is the base case for both the current and future land use scenarios. Under the existing population / land use scenario, the options with least risk are the Inner Bypass options - all four having an overall risk rating of Low. Taking into account the likely future development in the study area such as the North Boambee urban release area, the options with least risk are Inner Bypass Options IS1 / IN1 and IS1 / IN2 having the same comparative overall risk rating of Medium - Low. In each land use scenario, the Existing Highway Upgrade option has a relative risk similar to or higher than the Inner Bypass options.

5.4 Risk Quantification

While the appropriate focus of this report is on the relative risks associated with dangerous goods transport for the various options, a preliminary quantitative assessment has also been carried out to consider the likelihood of a fatality in a tunnel and to relate that to relevant planning guidelines.

Risk criteria for land use planning and safety are contained in the relevant NSW Department of Planning guidelines (1990) (now Department of Infrastructure Planning & Natural Resources). The individual fatality risk criteria for residential land uses suggested is one in one million years ($1x10^{-6}$). The guidelines identify the risk of a fatality to individuals travelling by motor vehicle in NSW as 145 per million years ($1.45x10^{-4}$).

The calculations undertaken for this assessment were based on the likelihood of a dangerous goods vehicle incident (viz. LPG explosion) that causes fatality occurring at a point on the highway adjacent to built-up areas (such as residential property) and impacting over a radius of 250m. The assumptions adopted in Table 5.1 were applied for these calculations and the results are presented in Table 5.5 below.

Table 5.5: Likelihood of Fatality from a Serious LPG Incident

Highway Option	Likelihood (per year)
Base Case (existing highway)	5.3×10^{-5}
Existing Highway Upgrade	2.9×10^{-5}
Inner Bypasses	1.9×10^{-5}

The above data indicates that the likelihood of a fatality occurring due to a serious dangerous goods vehicle incident (viz. LPG tanker explosion) on both the Existing Highway Upgrade and Inner Bypass options would be significantly less than for the base case (existing highway), with the Inner Bypass having the least risk of a fatality.

Table 5.6 presents the assessed likelihood of a person experiencing a fatality due to a serious LPG incident occurring within one of the tunnel sections associated with the Existing Highway Upgrade and Inner Bypass options. Two scenarios are assessed to provide an indication of the influence of the length of time spent in the tunnels on the likelihood of experiencing a fatality incident. The first scenario is for the risk for a person stationed (or located permanently) in the tunnel and the second scenario is for the typical situation of a road user travelling through the tunnel.

Table 5.6: Likelihood of a Person experiencing a Fatality in Tunnel from a Serious LPG Incident

Tunnel Sections	Likelihood of fatality incident (per year)	
	For a person stationed (or located permanently) in the tunnel	For a road user travelling through the tunnel
Inner Bypass IS1 & IN2 – A-0T (Total length of tunnel – 0m)	NA	NA
Inner Bypass IS1 & IN2 – A-2T (Total length of tunnel – 755m)	2.7×10^{-4}	1.5×10^{-8}
Inner Bypass IS1 & IN1 – B-0T (Total length of tunnel – 0m)	NA	NA
Inner Bypass IS1 & IN1 – B-1T (Total length of tunnel – 390m)	1.4×10^{-4}	0.8×10^{-8}
Inner Bypass IS2 & IN2 – C-1T (Total length of tunnel – 560m)	2.0×10^{-4}	1.1×10^{-8}
Inner Bypass IS2 & IN2 – C-3T (Total length of tunnel – 1,315m)	4.6×10^{-4}	2.7×10^{-8}
Inner Bypass IS2 & IN1 – D-1T (Total length of tunnel – 560m)	2.0×10^{-4}	1.1×10^{-8}
Inner Bypass IS2 & IN1 – D-2T (Total length of tunnel – 950m)	3.4×10^{-4}	1.9×10^{-8}
Upgraded Highway – Tunnel under Macauleys Headland (Total length of tunnel – 550m)	5.0×10^{-4}	2.9×10^{-8}

From the table above it is evident that the likelihood of a person experiencing a fatality in any of the tunnel sections is significantly influenced by the length of time spent in the tunnel. The table also indicates that the likelihood of a person experiencing a fatality in any of the tunnel sections is also influenced by the length of the tunnel sections.

6. Summary and Conclusions

Route options have been developed for the future upgrading of the Pacific Highway at Coffs Harbour. These are:

- Existing Highway Upgrade along the current corridor to urban motorway standard
- Inner Bypass options made up of two southern and two northern route options. The options are interchangeable and combine to give four Inner Bypass variations.

This comparative risk assessment compares the likelihood and severity of potential incidents involving dangerous goods vehicles for the route options detailed above. When compared to incidents involving passenger or other vehicles, incidents involving dangerous goods vehicles are likely to lead to a more severe outcome in terms of energy released and area affected.

The risk assessment involved calculation of incident likelihood along the various route options as well as an assessment of potential consequences for sensitive receptors.

The likelihood of an incident involving a dangerous goods vehicle was defined in the assessment as the number of years between incidents or crashes. The results are detailed in Table 5.1, with the Existing Highway Upgrade having the least likelihood of having a serious incident involving dangerous goods (1 in 97 years) and the existing Pacific Highway with no upgrade (base case) having the greatest likelihood of an incident. (1 in 28 years). With an Inner Bypass option, the likelihood of a dangerous goods vehicle incident on the bypassed section of highway through Coffs Harbour would be reduced due to the decrease in total traffic and dangerous goods vehicles on that corridor.

In terms of incident consequences, the adopted indicator is the area of built-up / populated land that can potentially be impacted by a dangerous goods incident within the 250 metre radius of fatal consequences (RFC). The smaller the built up area in proximity to the route, the less severe the consequences of an incident. For the existing population / land use situation, the option with least consequence would be Inner Bypass option IS2 / IN2. For this option the existing built-up area within the RFC would be 35 hectares. The option with greatest consequence would be the existing unimproved Pacific Highway (base case) with 292 hectares of adjacent urban land use within the RFC. Considering future urban development, the option with least consequence would be Inner Bypass option IS1 & IN1 with 155 hectares of built-up area within the RFC.

The tunnels proposed for this project are considered to be relatively short, with each tunnel being less than 600 metres. The severity of a tunnel incident is dependent on a range of matters including the tunnel design, operational features and management practices. The likelihood of a serious incident (eg LPG explosion) in the subject tunnels ranges from about 1 in 2,000 years to about 1 in 7,200 years - the range essentially depending on the total tunnel length of an option.

The overall risk ranking for the various options was determined with a matrix that integrates the likelihood and consequence data. For the existing land use situation, all of the Inner Bypass options have a Low overall risk rating. When future urban development is considered, the options with least risk are Inner Bypass options IS1 / IN1 and IS1 / IN2 with both having an overall Medium-Low risk rating.

An incident involving a dangerous goods vehicle within a tunnel has the potential for more severe impacts on road users than an incident on a surface road. This is due to confinement of road users within the tunnel and prevention or restriction of dissipation of fumes or smoke. In addition, there is also likely to be damage to the tunnel itself. Conversely, the confinement of impacts from a dangerous goods incident to the tunnel may reduce the impact on the surrounding environment.

An initial quantitative assessment of fatality potential has indicated that the likelihood of a person experiencing a fatality in any of the tunnel sections is influenced primarily by the length of time spent in the tunnel and also by the length of the tunnel sections.

The risk assessment has identified that all of the upgrade options would significantly reduce the risks of incidents involving dangerous goods vehicles when compared to the current base case situation (ie. the unimproved Pacific Highway)

While this assessment has concentrated of highway options for Coffs Harbour, the results are also broadly applicable to comparable options for Woolgoolga.

References

BBC (2002) News Bulletin 12 September 2002

BBC (2003a) News Bulletin 11 February, 2003

BBC (2003b) News Bulletin 19 March, 2003

Connell Wagner, (2004). *Coffs Harbour Highway Planning. Coffs Harbour Section. Strategy Report*. February 2004

Department Of Minerals and Energy Western Australia (1999) Summary of Incident Reports

Department of Planning, Sydney (1990). *Risk Criteria for Land Use Safety Planning*. Hazardous Industry Planning Advisory Paper No. 4. Department of Planning, Sydney

Federal Office of Road Safety, 1 January 1998 Australian Dangerous Goods Code Sixth Edition

French Government Minister of the Interior report *Task Force for Technical Investigation of the 24 March 1999 Fire in the Mont Blanc Vehicular Tunnel* dated 30 June 1999.

Henke, A (2000) Tunnel Management International, July/Aug 2000. Lessons learned from the St Gotthard road tunnel fire

Jones, M (2000) Committed fans, Tunnels and Tunnelling International, Sept 2000.

National Fire Protection Association (NFPA) , 1997 Hazardous Materials Transportation incidents Publication SPP 49December 1997The risk of transportation of dangerous goods : BLEVE in a tunnel Annals of burns disasters vol X n.4

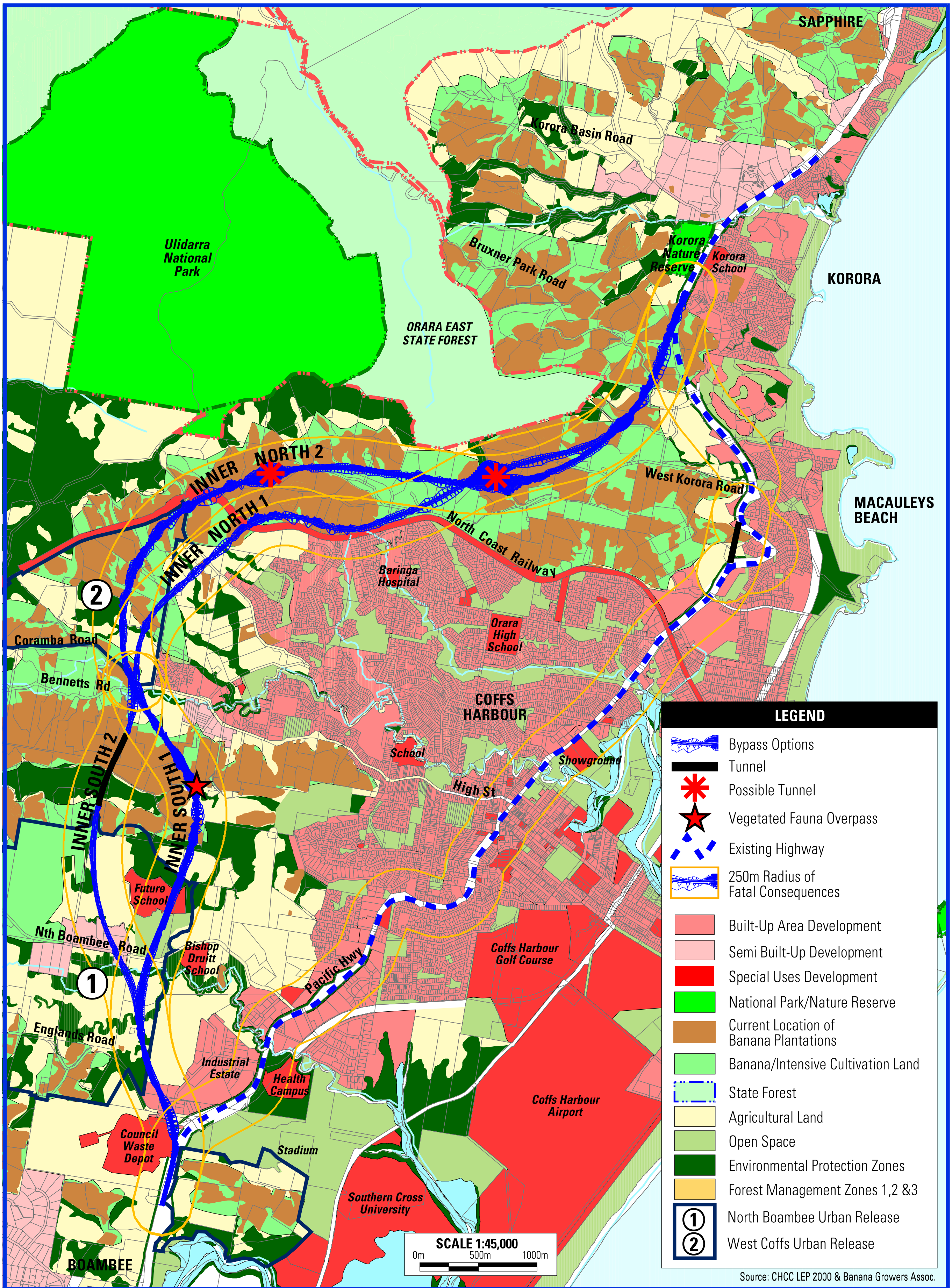
PPK June 1999 Environment & Infrastructure Report - Bonville Project , Pacific Highway, Coffs Harbour Risk Assessment of twin tunnels in pine Creek State Forest RTA

Ulm, F-J., Acker, P. and Levy, M. (1999), “The Chunnel Fire. Analysis of concrete damage.” Journal of Engineering Mechanics, Vol. 125, No. 3, pp 283-289.

Ulm, F.J., Coussy, O., and Bazant, Z.P (1999) The “Chunnel Fire: Chemoplastic Softening in rapidly heated concrete.”, Journal of engineering mechanics, Vol, 125, No.3, 1999.

Appendix A

Site Map



COFFS HARBOUR HIGHWAY PLANNING
COFFS HARBOUR SECTION
DANGEROUS GOODS TRANSPORT RISK ASSESSMENT

APPENDIX A
RADIUS OF FATAL CONSEQUENCES FOR A DANGEROUS GOODS INCIDENT

Appendix B

Dangerous Goods Survey

SH 10 Pacific Highway South of Park Ave, Coffs Harbour.
25th September, 2003

	Northbound				Southbound				
Interval Ending	Light Vehicles	Rigid Vehicles	Articulated Vehicles	Bus	Light Vehicles	Rigid Vehicles	Articulated Vehicles	Bus	
0:15	19	3	16	0	20	1	11	0	
0:30	13	0	12	1	17	1	14	1	
0:45	10	1	14	0	19	1	12	0	
1:00	15	0	8	1	12	1	14	1	
1:15	10	0	5	0	6	0	9	0	
1:30	10	3	16	0	11	1	8	0	
1:45	14	1	20	0	7	0	10	0	
2:00	12	4	12	0	5	0	7	0	
2:15	6	1	6	0	7	2	6	0	
2:30	5	0	13	0	1	3	1	0	
2:45	12	0	18	0	5	0	11	0	
3:00	9	1	19	0	8	2	5	1	
3:15	7	2	17	0	6	1	6	0	
3:30	9	1	16	0	10	0	4	0	
3:45	9	1	20	1	5	1	3	0	
4:00	11	0	18	0	7	1	2	1	
4:15	11	0	21	2	4	0	8	0	
4:30	11	2	12	0	13	0	6	0	
4:45	3	1	13	0	12	0	4	0	
5:00	15	3	12	0	15	4	0	0	
5:15	12	0	10	2	14	2	1	0	Interval missing 5:04-5:07
5:30	20	3	10	0	22	0	4	0	
5:45	16	7	9	0	25	3	3	0	
6:00	34	7	11	1	44	9	5	0	
6:15	45	9	10	0	55	4	3	0	
6:30	45	6	5	0	72	4	3	0	
6:45	75	11	10	2	102	6	8	0	
7:00	99	10	9	2	152	6	6	0	
7:15	98	14	6	0	118	13	5	0	
7:30	107	8	6	2	129	9	7	0	
7:45	133	14	8	8	140	14	5	1	
8:00	194	6	4	10	219	12	14	0	
8:15	212	9	6	4	203	10	5	2	
8:30	223	15	13	0	237	8	4	4	
8:45	241	8	7	3	245	13	8	6	
9:00	274	4	6	2	249	13	8	3	
9:15	227	13	5	2	214	14	3	4	
9:30	250	9	3	2	208	6	10	0	
9:45	226	10	7	1	218	12	5	2	
10:00	225	9	4	2	250	14	5	1	
10:15	186	10	9	3	191	10	5	2	Interval ends 10:12
10:30	DATA NOT AVAILABLE								
10:45	202	13	5	1	223	10	7	2	
11:00	238	9	6	1	199	10	4	1	
11:15	255	20	4	1	237	16	2	2	
11:30	205	16	6	1	221	8	4	1	
11:45	192	10	4	0	228	15	7	2	
12:00	251	14	0	2	189	7	2	2	

SH 10 Pacific Highway South of Park Ave, Coffs Harbour.
25th September, 2003

	Northbound				Southbound			
Interval Ending	**Light Vehicles**	**Rigid Vehicles**	**Articulated Vehicles**	**Bus**	**Light Vehicles**	**Rigid Vehicles**	**Articulated Vehicles**	**Bus**
12:15	202	8	1	1	229	7	5	1
12:30	192	9	6	2	221	13	10	1
12:45	210	6	4	1	216	6	2	2
13:00	171	6	3	3	234	16	6	0
13:15	208	9	5	0	185	5	3	1
13:30	187	5	7	1	232	8	10	0
13:45	168	5	6	3	213	10	6	1
14:00	199	5	2	1	227	10	7	2
14:15	174	8	5	0	229	3	3	1
14:30	182	12	9	2	200	11	4	2
14:45	202	8	3	2	237	10	6	4
15:00	183	4	7	2	268	7	9	1
15:15	197	7	3	5	226	9	9	3
15:30	259	8	8	3	270	11	12	2
15:45	331	12	4	4	222	10	1	2
16:00	258	4	6	2	213	11	16	1
16:15	286	6	5	3	261	10	9	8
16:30	262	7	11	2	243	5	8	7
16:45	205	7	4	0	185	9	6	5
17:00	218	6	3	1	244	8	17	2
17:15	214	4	3	1	273	5	10	1
17:30	217	4	6	1	219	1	16	0
17:45	196	2	1	0	199	3	16	2
18:00	173	5	1	1	199	1	16	0
18:15	161	5	5	0	171	2	5	0
18:30	155	2	1	0	134	4	11	0
18:45	130	1	4	0	124	2	7	0
19:00	118	1	2	0	117	6	4	1
19:15	92	2	7	1	140	2	18	0
19:30	92	0	10	0	113	4	18	0
19:45	72	1	9	0	111	2	15	0
20:00	74	3	5	0	100	4	9	0
20:15	55	0	4	1	71	1	2	0
20:30	71	0	3	0	105	2	17	0
20:45	45	0	10	0	101	4	15	0
21:00	96	1	6	1	103	0	12	1
21:15	51	0	7	0	97	2	11	0
21:30	60	2	7	0	96	3	12	1
21:45	54	1	11	1	58	2	9	0
22:00	65	1	13	0	51	0	14	0
22:15	49	0	12	0	55	2	18	0
22:30	39	5	11	1	50	3	11	0
22:45	33	1	16	0	40	0	13	0
23:00	24	1	7	0	36	0	20	0
23:15	25	0	11	1	19	0	12	0
23:30	22	1	11	0	27	3	17	0
23:45	22	1	5	0	22	0	18	0
0:00	16	0	13	1	20	2	12	0

Coffs Harbour Dangerous Goods Survey 25th September, 2003 Results
Pacific Highway South of Park Ave, Coffs Harbour.

Direction	*Time* *Hour*	*Minutes*	*UN #*	*Description*	*Type of Material per Label*	*Extra Details*
Northbound	0	1	1203	3	Flammable Liquids	RED DIAMOND
Northbound	0	27			Dangerous Goods	
Northbound	0	48			Dangerous Goods	
Northbound	1	19	????		Dangerous Goods	UN NO.HANDWRITTEN
Northbound	1	23			RED DIAMOND	
Northbound	1	43			Dangerous Goods	
Northbound	1	58			Dangerous Goods	
Northbound	3	8		8	Corrosive	
Northbound	3	10			Dangerous Goods	
Northbound	3	21			Red Diamond	
Northbound	3	28			Dangerous Goods	
Northbound	3	31			Dangerous Goods	
Northbound	3	32			Dangerous Goods	
Northbound	3	42			Dangerous Goods	
Northbound	4	40	1951	2 2	Flammable Gas	
Northbound	5	38	1075	2 1	Flammable Gas	
Northbound	6	40	1203	3	Flammable Liquids	
Northbound	6	45			Dangerous Goods	
Northbound	7	12	1075	2 1	Flammable Gas	
Northbound	7	14	1270	3	Flammable Liquids	
Northbound	7	45		3	Flammable Liquids	
Northbound	7	55		3	Flammable Liquids	
Northbound	8	40	3256	3	Flammable Liquids	
Northbound	9	12	1270	3	Flammable Liquids	
Northbound	9	40	1075	2 1	Flammable Gas	
Northbound	10	11	1270	3	Flammable Liquids	
Northbound	10	14		3	Flammable Liquids	
Northbound	10	17	3257	9	Miscellaneous Goods	
Northbound	10	30	1270	3	Flammable Liquids	
Northbound	11	10	1270	3	Flammable Liquids	
Northbound	11	14	3256	3	Flammable Liquids	
Northbound	11	21	1270	3	Flammable Liquids	
Northbound	12	59		6	Infectious Substances	
Northbound	13	17	1075	2 1	Flammable Gas	
Northbound	13	38	1760	8	Corrosive	
Northbound	14	57		9	Miscellaneous Goods	
Northbound	15	16	1075	2 1	Flammable Gas	
Northbound	20	39		9	Miscellaneous Goods	
Northbound	20	46	1203	3	Flammable Liquids	
Northbound	21	52	1203	3	Flammable Liquids	
Northbound	23	43		9	Miscellaneous Goods	
Southbound	0	20			Dangerous Goods	
Southbound	1	4			Dangerous Goods	
Southbound	1	42			Dangerous Goods	
Southbound	2	3			Dangerous Goods	
Southbound	2	51		8	Corrosive	
Southbound	3	6			Dangerous Goods	
Southbound	3	8	3257	9	Miscellaneous Goods	
Southbound	3	43		8	Corrosive	
Southbound	5	30			Dangerous Goods	
Southbound	5	45			Dangerous Goods	
Southbound	7	59		3	Flammable Liquids	RTA
Southbound	9	4	1270	3	Flammable Liquids	
Southbound	9	18		1	Explosives	
Southbound	9	45	1270	3	Flammable Liquids	
Southbound	10	37	3256	3	Miscellaneous Goods	
Southbound	10	52	3257	9	Miscellaneous Goods	
Southbound	10	56	1075	2 1	Flammable Gas	
Southbound	11	11	1270	3	Flammable Liquids	
Southbound	11	28		2	Flammable Gas	
Southbound	12	24	1075	2 1	Flammable Gas	
Southbound	14	19	3257	9	Miscellaneous Goods	
Southbound	14	21	3256	3	Miscellaneous Goods	
Southbound	15	16	1270	3	Flammable Liquids	
Southbound	15	46	1075	2 1	Flammable Gas	
Southbound	16	53	1203	3	Flammable Liquids	
Southbound	16	54	1270	3	Flammable Liquids	
Southbound	18	3	1075	2 1	Flammable Gas	
Southbound	18	18	1075	2 1	Flammable Gas	
Southbound	19	17		2 or 3	Flammable Gas or Liquid	
Southbound	20	33	2010	4 3	Flammable Solids	
Southbound	21	33	????		????	
Southbound	21	40		8	Corrosive	
Southbound	21	50	1760	8	Corrosive	
Southbound	22	7		8	Corrosive	
Southbound	22	29	1257	9	Miscellaneous Goods	
Southbound	23	7		3	Flammable Liquids	
Southbound	23	33		8	Corrosive	
Southbound	23	40		9	Miscellaneous Goods	
Southbound	23	45		9	Miscellaneous Goods	
Southbound	23	46		9	Miscellaneous Goods	
Southbound	23	55		8	Corrosive	
Southbound	23	58		9	Miscellaneous Goods	

Same Vehicle

Delays Due to Accidents on Pacific Highway 25th September, 2003

Media reports at about 10:30 am on Thursday 25th September indicated that traffic was being delayed at Moorelands. Further media reports at about 1:30pm advised that delays of up to one hour were being experienced on the Pacific Highway north of Karuah.

Initial details of these events and there potential impact on the survey being carried out at Coffs Harbour were reported to Jessica Fung of Connell Wagner at about 2pm.

				Source
SH10 Moorelands	North of Taree	7am	Alternating traffic flows up to 10:50pm with delays of up to 15 minutes. 10:50am to 12:50pm on and off closures to complete salvage and clear the roadway. Road reopened to traffic at 12:50pm.	Peter King. RTA Grafton Mobile 422002200
SH10 Corrindi	North of Coffs Harbou	10:50am	Minor delays from 10:50am to 11:55am.	Peter King. RTA Grafton Mobile 422002200
SH10 Branch Lan	North of Karuah	12:40pm	Significant delays of more than 1 hour from 12:40am to 6pm.	Steve Grew RTA Newcastle Ph: 49240240
F3 Freeway	Ourimbah	12:00pm	Minor delays due to smoke from nearby factory fire. Traffic restricted to one lane northbound and one lane southbound for approximately 2 hours.	Craig Lekkie RTA Newcastle Ph: 43797006

Impact on Survey Results

Based on these events and the media coverage warning drivers of the delays being encountered, it is possible that interstate drivers could have diverted to other routes in order to avoid the accident sites at Moorelands and Karuah.

The impact of these road accidents on the transport of Dangerous Goods on the Pacific Highway could be quantified by using the attached vehicle count data extracted from video records taken throughout the survey. These counts can be compared with existing survey data if available from nearby sites to determine if the number of heavy vehicles is significantly lower than normal.

Coffs Harbour Dangerous Goods Survey 25th September, 2003
SH 10 Pacific Highway South of Park Ave, Coffs Harbour.

NTPE carried out a survey of Hazardous Goods Vehicles travelling through Coffs Harbour from 12 midnight Wednesday 24th September to 12 midnight Thursday 25th September in accordance with instructions provided by Connell Wagner.

Observations were carried out by survey team members from a site located just south of Park Ave, Coffs Harbour as detailed in the photograph below. A Video Camera was also used to record all vehicle movements past the survey site throughout the survey.

Details on the Dangerous Goods Labels carried by vehicles passing the survey site were recorded for both Northbound and Southbound traffic. The information recorded on the Hazard Diamond was recorded for all vehicles and where available UN numbers were also recorded.

The UN number is used to uniquely describe all goods identified as dangerous goods by the United Nations. The Australian Dangerous Goods Code provides a complete list of all UN numbers together with a description of the material. In particular it defines the Hazard Class of the material i.e: Class 1 - Explosives, Class 2 - Gases, Class 3 - Flamable Liquids, Class 4 - Flammable solids, Class 5 - Oxidizers, Class 6 - Toxic and infectious substances, Class 7 - Radioactive substances, Class 8 - Corrosives, Class 9 - Miscellaneous

Vehicles carrying a mixture of dangerous goods carry a Hazard diamond labelled "Miscellaneous Goods" with no reference to a particular Class.

A review of the video records of the survey indicates that the vehicle carrying UN Number 3256 was a local fuel truck, which passed the survey site on four occasions.

A summary of all of the data collected during the survey is presented on the attached Dangerous Goods Survey Results report sheet.