1.2 Construction

1.2.1 Timeframe

The construction of the pipeline is expected to take approximately 10 - 12 weeks, with work progressing along the route continuously; the potential exists for numerous work-zones to be operating concurrently.

1.2.2 Work-Zone Construction

For the majority of its length, it is proposed that the pipeline be installed utilising a trenching method in an adjacent road or rail reserve. For these sections, the construction team would establish a work-zone (generally of 5m – 7m in width, which would allow for its containment within the road or rail reserve) and install the pipeline progressively along the route, i.e. it will be a moving work-zone. In sections where the trenching can be be completed at a good rate without significant impact on adjacent traffic and parking demands (for example in Fletchers Lane and along the railway corridor) the work-zone may be up to 500m in length.

Sections of the route where there are potential impacts associated with trenching (and specifically the associated disruptions to road or rail traffic) will be constructed using a boring method, with work-zones established on the side/s of the road/railway and boring (it is anticipated) occurring from both sides. These locations include the Princes Highway (as per the RTA correspondence), Meroo Road, Edward Street and Bolong Road.

The potential impacts of construction at these and other key sections of the the route are examined in more detail in **Section 2** below.

1.3 Work-Zone Vehicle Generation

The Construction Project will generate staff and heavy vehicle (material delivery) trips on a daily basis over the course of the construction period. Up to 25 staff would be employed during the construction period, with the potential for all staff to be on-site (i.e. within the work-zone) on any one-day. In addition, trucks bringing materials to the Site are estimated at 10 trucks per day for the majority of the construction period, and up to 13 trucks per day in the final two-weeks of construction.

The work-zone staff and material demands raise issues in regard to traffic generation and parking demand, as well as the provision of an appropriately safe and efficient work-zone environment such as that existing access, traffic and parking demands are not significantly impacted (as per the DGRs assessment requirement). These issues are examined in **Section 2** below.

2 Potential Impacts

2.1 Traffic

2.1.1 Traffic Generation & Peak Periods

As discussed in **Section 1.3**, the construction work-zone could generate a demand for up to 25 staff, and up to 13 trucks on a daily basis. Considering a worst case assessment, where all staff drove individually to/from the work-zone, a total of 25 staff vehicle trips could be generated during the arrival peak at the start of the work day, and in the departure peak at the end of the work day. Additionally, the start of work each day could entail a requirement for 2 – 3 trucks worth of materials.

The total potential generation of the work-zone could therefore be up to 30 vehicles per hour (vph) during an arrival peak hour and the departure peak hour.

Based on standard construction work hours (7:00am through to 4:00pm/5:00pm) it is our opinion that the majority of staff trips will occur outside of the existing local commuter peak periods, which – based on our previous work in the local area – occur between 8:00am and 9:00am, and then between 5:00pm and 6:00pm.

At some locations where the work-zone has the potential for impact on traffic flows (i.e. it requires the use of part of the carriageway) night and weekend works may be required; however, these would be coordinated to commence and end outside of the commuter peak periods.

2.1.2 Trip Distribution

The distribution of trips will be based on the location of the work-zone over the course of the Construction Project.

For the Bolong Road and Railway Street sections, trips will arrive from/depart to Bolong Road (in turn to/from the east and west); and from Cambewarra Road (and in turn to/from the Princes Highway and Meroo Road).

For the railway corridor section, access is to be provided from Fletchers Lane, and as such trips will arrive from the north (Princes Highway) and south (Cambewarra Road); the same distribution of trips would occur for the Fletchers Road construction, and for the crossing of Meroo Road.

No direct access to the pipeline route will be required/provided from the Princes Highway; the provision of appropriately located work-zones for the boring task on the southern side of the Highway (and for the western side of Meroo Road) will need to be determined.

Access to Pestells Lane is available via the Highway directly.

2.1.3 Traffic Impacts

Based on our previous work in the local area, including the completion of numerous traffic surveys and detailed trip assignments, it is the conclusion of STAP (agreed with Council) that the very short term generation of these moderate levels of traffic would have little if any impact on the operation of local roads or intersections. This conclusion is supported by: -

- The variety of access routes available to each of the sections of the pipeline route, and therefore the minimisation of additional flows in any single location (other than the immediate work-zone area).
- By association, the minimal additional flows at any single local or sub-regional intersection.
- The available capacity in local roads (and specifically Railway Street and Fletcher Lane), such that the total flows during the construction phase would be unlikely to exceed RTA environmental amenity targets or general capacity limits as outlined in the RTA Guide, and AustRoads Guide to Traffic Engineering Practice Part 2: Roadway Capacity.
- **The provision in all cases of appropriate traffic management measures.**

Further to this conclusion in regard to general traffic capacity impacts in the local network, there is an essential requirement to ensure that the construction does not significantly impact the existing operation of local roads in regard to general accessibility and safety. These issues are examined below.

2.2 Work-Zone Operations

The work-zone will at all times be required to operate under appropriate traffic management/control so as to ensure the safety of not only the work-zone staff but also passing traffic, pedestrians and cyclists (though STAP notes that there is little pedestrian or cycle demand along most sections of the route).

To this end, **it is the recommendation of STAP that a detailed Construction Traffic Management Plan (CTMP) be developed and implemented in compliance with the appropriate Australian Standards, and further to consultation with Council and the RTA**.

STAP has outlined below some of the key considerations in regard to the various sections of the pipeline route, and specifically access and traffic control measures which we would recommend be incorporated into the CTMP.

2.2.1 Bolong Road

Bolong Road looking west to the Railway Corridor

Boring will be used to install the pipeline across (under) Bolong Road between the primary SSPL Site to the south and the future SSPL Packaging Plant to the north; the crossing location is to be finalised, but at this time is proposed in close proximity to the railway corridor that crosses Bolong Road.

These works would require the excavation of a bore pit on both sides of Bolong Road; the workspace area is to be determined, but it is anticipated that it would be located on SSPL land. No disturbance to the road surface is anticipated.

STAP is aware that some boring techniques have a requirement for the bore head to be followed across the road/area being crossed. While not anticipated, if this were to be the case then full traffic control would be required. Bolong Road is an important collector and sub-regional route, and it is not preferable to provide any closure during weekday daylight hours (generally 6:00am to 7:00pm); any activity requiring work on the road would therefore have to be done at night/weekends. Any such night/weekend works would in our opinion have little impact on traffic as a result of partial lane closures and the likely reduction of speed limits, particularly when it is considered that this would be a short-term installation.

In order to minimise additional access requirements to the Bolong Road work-zone, STAP would recommend the use of available space within the future SSPL Packaging Plant site (accessed from railway Street) for construction and staff vehicles; this site can provide parking in close proximity to the work-zone. Any additional requirement for truck parking within either the road or rail reserve (i.e. immediately adjacent to the work-zone) will need to be considered as part of the CTMP.

2.2.2 Railway Street, Future Packaging Plant to Cambewarra Road

Railway Street looking north from outside the SSPL Packaging Place; note wide verge available

It is anticipated that the majority of the work-zone in Railway Street (between the future SSPL Packaging Plant site and Cambewarra Road) can be contained within the road reserve. However, there may be a demand for the use of the kerbside lane in some locations.

Railway Street looking north adjacent to the narrower section of carriageway restricted by the narrow western verge adjacent to the railway corridor.

Parking is currently not permitted on the eastern side of much of Railway Street as a result of the width of the carriageway, particularly in close proximity to the Cambewarra Road intersection, and near the future SSPL Packaging Plant site where the western verge is minimal. Parking is generally available on the western side of the carriageway, provided by verge parking (gravel) and by some wider sections of run-off adjacent to local businesses.

Railway Street towards Cambewarra Road, with wide western verge/frontage to local sites

Given the relatively short time-frame of the construction it is the opinion of STAP that the temporary provision of a work-zone requiring the use of the kerbside lane could still provide two-way traffic flow in most sections of Railway Street. Appropriate traffic management would be required, but the lack of significant parking demand and the available width of carriageway and verge would in our opinion not require the provision of one-way traffic flow (i.e. stop-go conditions) though this could be employed if necessary with little impact based on the relatively low flows in Railway Street. Such measures would be fully detailed in the CTMP.

STAP would also recommend as a means of maintaining as short a work-zone length as possible, and to reduce additional on-street parking demand, that construction vehicle parking be provided off-street; in this regard, we would again recommend the use of the future SSPL Packaging Plant site for parking for this section of the construction.

2.2.3 Railway Street & Cambewarra Road Intersection

Railway Street & Cambewarra Road intersection – swept path for trucks from Cambewarra Road to Railway Street south would generally exclude the use of the kerbside (eastern) lane for the work-zone

It is anticipated that the majority of the work-zone in Railway Street through the intersection with Cambewarra Road can be contained within the road reserve. However, the appropriate management of truck access to this section will need to be examined, as the use of the eastern kerbside lane (i.e. the southbound Railway Street through lane) would potentially reduce the swept path available for vehicles turning to and from Cambewarra Road.

Should additional width for the work-zone be required, it may be the case that a stop-go operation will need to be provided. The existing traffic flow between Railway Street and Cambewarra Road is moderate at best through the day; nonetheless, STAP would recommend that if a partial closure is required then night works be investigated to minimise impacts on existing traffic flows.

As for the southern Railway Street section of the route, parking could be provided in the future SSPL Packaging Plant site if required.

2.2.4 Railway Street north of Cambewarra Road

Railway Street immediately north of Cambewarra Road

Railway Street further north with narrower carriageway

It is anticipated that the majority of the work-zone in Railway Street north of Cambewarra Road can be contained within the available wide road reserve. The formed carriageway width in this section of Railway Street provides for formal kerbside parking only for a short distance, after which a narrower carriageway is available with wide grassed verges on both sides of the road. Traffic generation in this section of Railway Street is very low, based on the small number of adjoining sites and no through traffic.

Given the relatively short time-frame of the construction, and the availability of the wide reserve, it is the opinion of STAP that existing two-way traffic flow could be retained in this section of Railway Street for the duration of the project, i.e. there would be no significant impact on existing traffic or parking demands. However, if some of the carriageway were required for the work-zone then a simple stop-go operation may be required; these operations would need to be detailed in the CTMP.

STAP is of the opinion that the provision of staff parking in Railway Street itself for this phase of construction would have little impact on either traffic flows or existing parking demand (minimal); however, the use of the future SSPL Packaging Plant site, or space within the adjacent railway reserve, provides alternative options for parking.

2.2.5 Railway Corridor

It is our opinion that the works within the railway corridor would have no direct impact on traffic flows; as described above, the project would generate minor peak flows to [access] this section of the route, with vehicles access anticipated to be provided via Fletchers Lane. STAP notes that access from the northern end of Railway Street would similarly not compromise existing traffic capacity or safety as a function of the low existing and construction traffic demands.

Appropriate signage and access to the corridor would need to be detailed in the CTMP, as would the provision of a suitable access point which ensures only construction access is provided.

The installation method for the pipeline across the railway line (at Fletchers Lane) is still to be determined, but it is likely that boring will be required. The provision of a work zone or work-zones to provide for boring (or indeed other installation method) will likely require some type of temporary traffic management at the crossing point, which would need to consider the angled turn of the Fletchers Lane carriageway immediately east of the railway. Based on the very low traffic flow at this location, STAP is of the opinion that simple management control around any work-zone would be more than adequate.

2.2.6 Edwards Avenue

Edwards Avenue looking west towards narrow bridge over railway

It is anticipated that the pipeline would be constructed within the rail reserve under Edwards Avenue using boring. Works sites would be established on both sides of Edwards Avenue, and tunnels bored from both sides of the road. The use of boring allows Edwards Avenue to be retained for two-way traffic flows, which are very minor; STAP notes again the potential for traffic control if the bore head needs to be followed.

The Edwards Avenue railway bridge provides only one-way flow, and has weight restrictions which may require that any materials trucks utilise only the railway corridor for access. As for the access to the railway corridor from Fletchers Lane, any potential access point from Edwards Avenue to the railway corridor would need to be appropriate controlled, and detailed in the CTMP.

2.2.7 Fletchers Lane

Fletchers Lane at Meroo Road, short formal carriageway then gravel

It is anticipated that the majority of the work-zone in Fletchers Lane between the railway corridor and Meroo Road can be contained within the road reserve and kerbside lane. Fletchers Lane provides a narrow graded carriageway with wide grassed verges on both sides of the road. Traffic generation in Fletchers Lane is very low, based on the small number of adjoining sites and no through traffic.

Given the relatively short time-frame of the construction, and the availability of the reserve, it is the opinion of STAP that existing two-way traffic flow could be retained in Fletchers Lane for the duration of the project, i.e. there would be no significant impact on existing traffic demands. Even if some of the carriageway were required for the work-zone then the sight distances available along what is a very straight road would generally allow for safe passing of a work-zone in a single lane, or at worst the provision of a simple stop-go operation may be required, and would be detailed in the CTMP.

2.2.8 Meroo Road & Fletchers Lane

Meroo Road at Fletchers Lane

Boring will be used to install the pipeline across (under) Meroo Road at Fletchers Lane. As for the railway crossing and Edwards Avenue crossing, the provision of work-zones on one or both sides of the carriageway will require further assessment, specifically accounting for the turning demand to/from Fletchers Lane; the higher speed in this section of Meroo Road (80km/h); and the retention of verge width appropriate to the speed and traffic flow (i.e. as a run-off safety consideration).

While the CTMP would detail such provisions, a temporary work zone with lower speeds and appropriate barriers may be appropriate if the work-zone/s are required within the existing road reserve (i.e. if they cannot be contained outside of the reserve) or if the bore-head needs to be followed during the crossing. Given the flow in Meroo Road and its importance as a distributor between the Princes Highway and Bomaderry, it is our opinion that night and weekend works would likely be required for any road closure requirements.

2.2.9 Princes Highway

Princes Highway at Pestells Lane

The Princes Highway crossing will be completed using boring. Works would include excavation of a bore pit on both sides of the Highway (a workspace area of approximately 20 metres by 40 metres is anticipated at this time). No disturbance to the road surface is anticipated.

As discussed in regard to the boring proposed for other locations, some boring techniques have a requirement for the bore head to be followed across the road/area being crossed. If this is the case then full traffic control would be required; STAP notes that the RTA would not generally allow the closure of any lanes on the Princes Highway during daylight hours (generally 6:00am to 7:00pm) and as such any activity requiring work on the road would have to be done at night and on weekends.

While access to the northern side of the Princes Highway is available via Pestells Lane, the access point to a potential work-zone on the southern side of the Highway will need to be determined; further to the correspondence from the RTA and our review of the location, access from the Princes Highway itself would be impractical, and as such a potential access lane from Meroo Road should be investigated (potentially along the existing channel which travels north-west from just north of Fletchers Lane to the proposed crossing point).

The provision of a work-zone on the northern side of the Highway at Pestells Lane will also require safe management, specifically accounting for the turning demand to/from Pestells Lane; the higher speed in this section of the Highway (100km/h); and the retention of verge width appropriate to the speed and traffic flow (i.e. as a run-off safety consideration).

2.3 General Impact Minimisation Strategies

The following impact mitigation strategies would in our opinion maximise the safety and efficiency of the Construction Project, and are recommended for implementation by the construction contractor.

- A Construction Traffic Management Plan (CTMP) must be developed in consultation with the RTA, police and Council in accordance with the appropriate Australian Standards. The CTMP would detail: -

    - Construction hours and protocols for both RTA and Council roads;
    - Heavy vehicle and construction warning signs to be installed at key locations around the work-zone as it progresses;
    - Appropriate management of construction traffic where traffic flow is affected by the construction pipeline, and in particular at locations where the pipeline crosses the road or is located along and within the road reserve;
    - Installation of appropriate traffic control and warning signs where potential safety risk issues exist;
    - Appropriate management of the transportation of construction materials to maximise vehicle loads and thereby minimise vehicle movements;
    - Installation of specific warning signs at local access roads to the construction corridor to warn existing road users of entering and exiting traffic;
    - Appropriate mitigation to be provided where the pipeline crosses property access points or otherwise impacts access to adjoining sites. Wherever possible, all property access crossings would be completed in one day, with any open trenches covered overnight;
    - Distribution of warning notices to advise local road users, residents and site owners of scheduled construction activities and the potential impacts they may have on access (in particular); and
    - Induction of staff and truck drivers on the requirements of the CTMP.

- To as great an extent as possible, the disruption to private property access must be minimised for the duration of the construction works, with access restored and maintained at each property as soon as practicable as work moves along the pipeline corridor

- The reinstatement of road and reserve surfaces to previous condition is essential; any damage to roads or reserves where vehicles have been entering/exiting the work-zone must also be appropriately reinstated.

3 Conclusions & Recommendations

Following our review of the Construction Project, STAP has concluded that the construction of the gas pipeline can be provided for in a safe and efficient manner further to the provision of appropriate traffic management controls; further to our discussions, it is our opinion that Council is of the same opinion in regard to the access, traffic and parking demands of the Construction Project. Specifically: -

- The traffic generation of the Construction Project is low, and distributed to the available road network [generally outside of existing commuter peak periods] would not impact existing levels of service or capacities.

- Where the work-zone can be provided in a road or rail reserve, the potential for impact on the existing traffic and parking demands is low, as a function of both a low base demand and a low potential construction demand.

- In key locations boring will be utilised to retain traffic flows along key roads; any potential disruption to traffic flows along key roads – including the Princes Highway, Meroo Road and Bolong Road – would require additional consideration to ensure minimal impact; this would most likely require night or weekend works with appropriate traffic control.

- STAP recommends the the preparation and implementation of a detailed Construction Traffic Management Plan, which must detail: -

    - Access points to work sites
    - Staff parking areas
    - Safety management proposals with reference to Australian Standards
    - Traffic management proposals with reference to Australian Standards
    - Means of distributing information to local residents and business owners that may be temporarily impacted by the construction.

Following our assessment of the key issues associated with the construction of the gas pipeline, and with the application of the recommendations outlined above, STAP has concluded that the Construction Project is supportable from an access, traffic and parking perspective.

ANNEXURE 12

NSW Coastal Policy

Analysis of Proposal

ANNEXURE 12

NSW Coastal Policy 1997

Compliance Checklist for the Preparation of Development Proposals

Proposed Shoalhaven Starches Gas Pipeline Project

Strategic Action	Provision	Applicable Yes / No	Indicate how the Development Proposal is consistent/inconsistent with the Policy
Protect, rehabilitate and improve the natural environment			
1.1.2	Does the site have areas with land and/or marine and estuarine conservation values? If so, are these to be dedicated?	No	
1.1.3	If the land is Crown land (submerged or otherwise), has it been assessed for dedication/reservation under appropriate Acts (eg. MPA, NPWS, NSWF)?	No	
	If foreshore Crown land, will public access be maintained and/or appropriately zoned?	No	
1.1.5	If open space land, is it to be classified 'community land' under the Local Government Act?	No	
1.1.6	Is a voluntary conservation agreement required to be negotiated?	No	
1.1.7	Will seagrass, mangrove, saltmarsh or other wetland associated species be affected by proposal? How will they be conserved/managed?	No	
1.1.8	Do SEPP 14/SEPP 26 apply to site?	No	No SEPP 14 wetlands or SEPP 26 Littoral rainforest occur on the subject site.
1.1.9	Does the land have recognised conservation values? If so, what zones and/or other provisions are proposed?	No	
1.1.10	Is the land adjacent to a Marine Park? If so, what provisions are included which will give effect to the Marine Park zoning and operational plans?	No	

Strategic Action	Provision	Applicable Yes / No	Indicate how the Development Proposal is consistent/inconsistent with the Policy
1.1.11	Does the plan enable the natural habitats of the site to form part of a regional open space corridor (including water areas)? If so, how?	No	
1.2.1	Does the proposal affect the distribution, diversity/condition of native plants and animal habitats?	No	Refer **Annexure 8**.
1.2.3	Is the proposal likely to affect fish habitats and/or utilisation by fish populations/communities?	No	Refer **Annexure 8**.
1.3.7	Is the site included in a catchment management plan?	No	
	Have water quality objectives been established? If so, in what form (ie. instrument/strategy)?	No	
	Is ongoing water monitoring proposed?	No	
	Does the plan incorporate water quality objectives and water monitoring provisions?	Yes	Refer **Annexure 13**.
1.3.8	Has a stormwater management plan been developed and is it incorporated into the plan?	Yes	Refer **Annexure 13**.
1.3.14	Does the plan create the potential for impacts on groundwater? If so, does the plan incorporate management controls for groundwater?	No	Refer **Annexures 10a** and **10b**.
1.4.5	Will proposal be subject to coastal hazards? Can conditions be imposed which minimise impacts?	No	Refer Section 7.4.1.2 of EA.
1.4.7	Development proposals in or adjacent to estuaries – impacts.	No	

Strategic Action	Provision	Applicable Yes / No	Indicate how the Development Proposal is consistent/inconsistent with the Policy
Recognise and accommodate natural processes and climate change			
2.1.1	Does a coastline, estuary or floodplain PoM apply to the land? If so, does the proposal incorporate provisions to give effect to these plans?	Yes	Refer Section 7.4.1.2.
2.1.4	If the site is affected by Acid Sulfate Soils, does the plan incorporate objectives for their management in accordance with the ASS Manual?	Yes	Refer Section 7.4.1.4 and **Annexure 10a**.
2.2.2	Does the plan include provisions for sea level change as provided by the Inter-governmental Panel on Climate Change?	Yes	Refer Section 7.4.1.2.
Protect and enhance the aesthetic qualities of the coastal zone			
3.1.2	Does the plan include provisions to protect areas or items of high aesthetic value? If so, in what way?	No	
3.2.1	Guidelines – South Coast Design Guidelines/Guidelines for Tourism Development along NSW Coast.	No	
3.2.2	Use of good design principles will be encouraged to ensure more compact, human scale.	No	
3.2.4	How does the plan address design and locational principles listed below (as detailed in Appendix C Table 3 p83 Coastal Policy): • only essential public developments (eg. surf lifesaving club) on beach frontal dunes;	No	Not Applicable
	• overshadowing of beaches and waterfront open space;	No	Proposal will not result in overshadowing of beach.
	• preservation of undeveloped headlands;	No	Proposal does not involve development of headland.
	• new development on developed headlands (require environmental assessment including visual impact from adjoining beaches);	No	Proposal does not involve development of headland.

Strategic Action	Provision	Applicable Yes / No	Indicate how the Development Proposal is consistent/inconsistent with the Policy
	• o buildings greater than 14 m (unless justified following environmental planning considerations);	No	No buildings greater than 14 metres high proposed.
	• do building height controls apply to the land? In what form (eg. LEP, endorsed DCP)?	No	
	• Is DUAP concurrence required or does council have assumed concurrence? If so, up to what height?	No	
	• Does the plan establish a setback line from coastal lakes, estuaries, beaches, foreshores and cliffs? Provide details.	No	
	• Is public access to foreshore to be maintained or provided? If so, how does the plan achieve this?	No	Proposal will not affect public access to foreshore areas.
	• Have provisions been made for dedication or an agreement entered into, to ensure use and maintenance of the public access area?	No	Proposal will not affect public access to foreshore areas
	• Tourist or recreational developments adjacent to or within a National Park, Nature Reserve or State Recreation Area.	No	No tourist or recreational development is proposed.
3.3.1	Has a regional and/or local housing strategy been developed to encourage compact towns? If so, does the plan comply?	No	
Protect and conserve cultural heritage			
4.1.2	How does the plan conserve or protect known regional/local items or areas of coastal heritage?	Yes	Refer **Annexure 9**.
4.1.4	Does the plan protect any significant views or vistas within or from towns?	No	Proposal will not have any visual impacts – underground pipeline.

Strategic Action	Provision	Applicable Yes / No	Indicate how the Development Proposal is consistent/inconsistent with the Policy
Promote ecologically sustainable development and use of resources			
5.1.2	Does a regional industry, economic development and/or tourism strategy apply to the area? Does the plan comply?	No	
5.1.3	Is the land identified as Class I, II or III (Prime Crop and Pasture Land) in NSW Agriculture's Land Classification Scheme? If so, how does the plan protect this resource?	Yes	Refer Section 6.1.3.
5.1.7	Does the plan affect or facilitate the identification or development of areas for aquaculture?	No	
5.1.8	Does the proposal conflict with mineral exploration, mining or extraction? How does the plan ensure ecologically sustainable development of the resource and protect environmentally significant sites?	No Yes	 Refer Section 7.1.3.
5.2.3	Are there plans of management that apply to the site? How does the plan integrate these to ensure responsible and ecologically sustainable development and use of resources?	No	
5.2.11	Does a regional and/or local tourism plan apply to the area? If so, how does the development proposal complement this plan?	No	
Provide for appropriate public access and use			
7.2.3	Coastal safety assessment – considered in relation to any new coastal development.	Yes	Refer Section 7.4.1.
7.2.4	If the plan provides for tourism development, what provisions have been included in the plan to ensure public access to the foreshore?	No	No tourism development is proposed.

ANNEXURE 13

Erosion and Sediment Control Management Plan

prepared by

Allen, Price & Associates

ANNEXURE 13

EROSION & SEDIMENT CONTROL

MANAGEMENT PLAN

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for the

PROPOSED

SHOALHAVEN STARCHES PTY LTD

GAS PIPELINE

at

Meroo Meadow & Bomaderry, NSW

allen, price & associates
land and development consultants

APA Ref: 24710

DATE: February 2012

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Rev	Date	Details
00	06/02/12	For client review
01	13/02/12	Final Report for Client

Report prepared by:

Date: 13 February 2012

Adam Urszulak

MEng (Civil Engineering), BTech (Marine Engineering)

1 Introduction

The Shoalhaven Starches expansion project was approved in 2009 by the Minister of Planning and includes general expansion of the factory to increase ethanol production output, and a proposed gas fired co-generation plant to supply electricity and steam to the factory. To allow competively priced gas supplies to be sourced and to meet any increased energy demand, the company proposes to construct and operate their own gas pipeline. This report examines the management of erosion and sediment control for the proposed Shoalhaven Starches gas pipeline.

A new natural gas main, to be privately owned and operated by Shoalhaven Starches, is proposed to enable the company to source competitively priced gas supplies for its manufacturing operations and contribute to the preservation of the environment by increasing the efficiency of the factory including through a proposed co-generation power plant. Natural gas is currently obtained from via an ActewAGL owned gas pipeline connected to the Eastern Gas Main. The Shoalhaven Starches factory currently sources energy from a combination of coal, natural gas, diesel and electricity. ??

Construction will impact the environment to varying degrees along the proposed 5.5km route. A number of alternative routes for the proposed gas main were assessed by Shoalhaven Starches through a number of consultants including Allen, Price and Associates. This was done to determine the route most likely to minimise possible impacts to the environment. The route described in this report was assessed to have the lowest possibility of environmental impact, especially on sensitive areas which include; local wetlands, waterways, agricultural pasture, road & rail reserves, and Council infrastructure.

The proposed gas main route begins at an existing connection to the Eastern Gas Line (EGL) at Pestells Lane, Meroo Meadow. It will be built mainly in road reserves along the proposed route, through to a proposed gas pressure reduction station on land privately owned by Shoalhaven Starches, on the northern side of Bolong Road at Bomaderry. From this point, the gas main will continue under Bolong Road to the opposite side and into another property owned by Shoalhaven Starches, and will then be distributed for use within the factory.

1.1 Aim & Scope

The aim of this report is to broadly address erosion and sediment control issues outlined in the Director General's requirements, under the heading of Soil and Water, for the Shoalhaven Starches Project (MP 10_0108), issued on 8th November 2010. The specific requirements include providing;

- "specific reference to erosion and sedimentation management during construction".
- "detailed information describing how water bodies or water courses would be traversed and proposed measures to avoid or minimise any predicted impacts".

The Director General's Requirements are addressed in this report in accordance with the guidelines, principles and recommended standards for managing erosion and sediment control, outlined in Landcoms Managing Urban Stormwater – Soils and Construction, Volume 1, 4th Edition (The Blue Book), and Volume 2A- Installation of Services. These are comprehensive erosion and sediment control guides used throughout NSW, and will be referred to frequently throughout this report.

This report provides information for project administrators and managers to gain a better understanding of the erosion and sediment control issues and requirements specifically for the proposed Shoalhaven Starches gas pipeline project. Information is general in nature and does not take place of an erosion and sediment control plan (ESCP), which is required to be produced prior to construction. This report gives guidance for the future completion of the ESCP.

The main aims of erosion and sediment control (ESC) for this project are;

- Protect disturbed areas from the eroding action of stormwater runoff.
- Prevent sediment from disturbed soils entering into waterways and stormwater systems by providing filtration to remove sediment from stormwater..
- Divert clean stormwater runoff that would naturally flow through the proposed construction areas, preventing it from becoming polluted by sediment from soils that have been disturbed during excavation.
- Aid in rehabilitating disturbed soils, riparian zones and waterways.

Traffic control measures are required at certain sections along the proposed route during construction. This report does not take into consideration the need for traffic control, which may impact on the installation and maintenance of erosion and sediment controls outlined. The traffic management plan (TMP) is to take into consideration ESC where required.

Erosion and sediment controls will impact on public and privates services and infrastructure adjacent to the proposed gas pipeline. Impacts to infrastructure are not assessed in this report. A separate report has been written for this purpose by Allen, Price and Associates, titled 'Infrastructure Impacts Report'.

2 Erosion and Sediment Control Management

Effective project development through efficient process management is a significant factor of ecological sustainable development. Erosion and sediment control is a legislated requirement of all work sites, therefore effective management principals is an essential part of the project development process for developing adequate erosion and sediment control on linear service installation projects. This ensures environmental protection.

The following topics are briefly discussed in this section;

- erosion and sediment (E & S) control legislation.
- project planning methods for erosion and sediment control.
- general (E & S) control principals used on service installation projects.

2.1 Legislation

The legislation relating to erosion and sediment control of service installation projects fall under the development assessment framework and provisions of the Environmental Planning and Assessment Act 1979. These include;

- Protection of the Environment Operations Act 1997.
- Rivers and Foreshores Improvement Act 1948.
- Fisheries Management Act 1984.

Other Acts that may require consideration based on the route of the proposed gas pipeline include;

- National Parks and Wildlife Act 2003
- Native Vegetation Act 2003
- Roads Act 1993
- Soil conservation Act 1938
- Threatened Species Conservation Act 1995
- Water Management Act 2000

The first three pieces of Legislation will now be briefly summarized.

2.1.1 Protection of the Environment Operations Act 1997

The Environment Protection Authority (EPA) regulates; any activity listed in schedule 1 of the Protection of the Environment Act 1997 (POEO Act), state or public authority activities, and other activities where a license regulating water pollution is issued. Any other activity, under this Act, falls under the regulatory authority of the local Council.

Water pollution is prohibited under this Act unless it is in accordance with the provision of an 'environment protection license, as issued under this Act.

The Shoalhaven Starches gas pipeline route crosses minor waterways that eventually lead into major waterways.

2.1.2 Water Management Act 2000 and Controlled Activities

The NSW Office of Water administers the Water Management Act 2000 and is required to assess the impact of any proposed controlled activity to ensure that no more than minimal harm will be done to waterfront land as a consequence of carrying out the controlled activity. under the Water Management Act 2000, a controlled activity means:

- the erection of a building or the carrying out of a work (within the meaning of the *Environmental Planning and Assessment Act 1979*), or
- the removal of material (whether or not extractive material) or vegetation from land, whether by way of excavation or otherwise, or
- the deposition of material (whether or not extractive material) on land, whether by way of landfill operations or otherwise, or
- the carrying out of any other activity that affects the quantity or flow of water in a water source.

Waterfront land includes the bed and bank of any river, lake or estuary and all land within 40 m of the highest bank of the river, lake or estuary.

Laying of gas pipes in or across watercourses and adjoining waterfront land constitutes a controlled activity under the Water Management Act 2000. The Shoalhaven Starches gas main crosses a number of minor waterways. As the proposed gas pipeline comprises a 'major project' pursuant to the provisions of Part 3A of the EP&A Act, controlled activity approval is not required pursuant to Section 75U of this act.

2.1.3 Fisheries Management Act 1994

Activities relating to the installation of services that involve dredging or reclamation of waterways have the potential to block the passage of fish and harm marine vegetation, and therefore require a permit, to be issued under this Act by the Department of Primary Industries (DPI). As outlined above the proposed gas pipeline comprises a 'major project' pursuant to the provisions of Part 3A of the EP&A Act, approvals required pursuant to Sections 201, 205 and 209 of the Fisheries Management Act are not required pursuant to Section 75U of the EP&A Act

2.2 Project Planning for Erosion and Sediment Control

Volume 2A of Landcoms Managing Urban Stormwater-Soil and Construction indicates that effective management of erosion and sediment control on linear service installation projects requires systematically addressing the following five main planning activities;

- Developing systems for documentation and communication.
- Assessing constraints and opportunities.
- Preparing an ESCP.
- Restoring and remediating sites.
- Other planning considerations.

2.3 General Soil and Water Management Principals for Service Installation Projects

There are seven general principles of effective soil and water management for land disturbance associated with urban development, according to section 1.5 of Landcoms Managing Urban Stormwater; Soils and Construction, Volume 2A. These broadly apply to the planning, design and construction of most service installation projects. They provide the framework for the application of more specific erosion and sediment controls required on for the proposed gas main project. The seven general principals include;

1. Assess soil and water implications of a project at the planning stage.
2. Plan for erosion and sediment control and assess site constraints during the design phase and before any earthworks begin.
3. Minimise the area of soil disturbed and exposed to erosion.
4. Conserve topsoil for later site rehabilitation/regeneration.
5. Control water flows from the top and through the project area – divert up-slope 'clean' water away from disturbed areas and ensure concentrated flows are below erosive levels.
6. Rehabilitate disturbed lands quickly.
7. Maintain erosion and control measures appropriately

2.4 Developing Systems for Documentation and Communication.

The project principal will be responsible for ensuring all personnel working on the project are made aware of their individual responsibilities for proper environmental management and care. The systems that facilitate this require planning, implementation and control, and make up the Environmental Management System (EMS). The principal and/or contractor(s) are required to develop an EMS, which is presented as part of a Construction Environmental Management Plan (CEMP).[1]

The CEMP outlines environmental objectives and targets, and describes how the contractor(s) will manage and control the environmental aspects of the project to meet these. It must interface with all other plans, describe the overall project management system, and expand on the environmental section of the project business plan.[1]
The CEMP is an active document which is revised and updated as construction progresses. It provides all relevant site personnel, including superintendeant, construction managers, foreman and subcontractors, practical and up to date information on all environmental aspects of the project.

The following key components should be the minimum included in the CEMP, as they identify the aims, actions and outcomes required to meet the project's environmental objectives;

- Description of the principal or contractor's environmental management system.
- CEMP objectives and targets.
- Risk Assessment.
- Constraints.
- Roles, responsibilities and contact details.
- Environmental controls.
- Monitoring and Compliance. [1]

Regular audits or compliance inspections are to be made by the principal or their representative to ensure compliance with environmental conditions specified in the CEMP. This includes ensuring rapid project completion incentives do not promote environmentally harmful practices.[1]

The CEMP should also ensure the contractor's EMS conforms to;

- AS/NZS ISO 14001:2004. Environmental Management Systems – Requirements and guidance for use.

- NSW Construction Policy Steering Committee Environmental management systems guidelines, 1998.[1]

2.5 Assessing constraints and opportunities.

This report was written based on a site assessment of the proposed gas pipeline route. Consideration was given to providing adequate control of erosion and sedimentation with minimum expenditure, and identifying constraints and opportunities. These are explored in more detail in relation to the proposed gas pipeline route.

The proposed gas pipeline route, shown in Figure 1 (Appendix A), was selected based on desktop studies, field work and consultation with Shoalhaven Starches Pty Ltd, Cowmann Stoddart, URS Australia Pty Ltd, Allen, Price and Associates and Shoalhaven City Council. The aim was to avoid environmentally sensitive areas. An area of sensitivity was found along the route. It is shown as a black hatch in Figure 1 (Appendix A), which shows the sensitive coastal location through Bomaderry.

Section 3.3.2 of -Volume 2A gives a list of site characteristics and constraints that were generally considered during the site investigation. The following site characteristics and constraints were investigated during the site inspection along the proposed route;

- Existing exposed areas and likely areas of soil disturbance
- Existing vegetation
- Site topography
- Location of potential drainage lines and waterways.
- Landscape constraints including flood hazard, water logging and rock outcrops.
- Acid sulphate contaminated soils
- Opportunity to repair previous or existing areas of land degradation
- Disposal of surplus excavated material.
- Susceptibility to tunnel erosion

Soil constraints such as erodibility, erosion hazard, dispersibility, salinity, fertility or expansive and reactive soil types were not assessed in this report. These need to be determined during detailed design of the E&SC plan.

Since much of the route is located over land with negligible grade, minimal land degradation was observed. Areas along the banks of waterways where the proposed gas main will cross were found to be susceptible to erosion and degradation. There are no areas along the route that were found to require stabilisation due to past erosion and sediment control issues.

The majority of vegetation along the route is grass and weed found within the road reserves. Native trees were found in all road reserves along the route. Some of these will require removal to facilitate pipeline construction.

The proposed route is mainly flat with a 'gentle' slope to the south east, toward Abernethys Creek and the Shoalhaven River. Some areas are steeper along the route, although generally short in length. These areas require greater erosion and sediment control. Further details are provided in section 3 of this report.

There are a number of waterways and drainage lines that can be used to facilitate erosion and sediment control. These are shown on APA drawing 24710-04 (Appendix C).

Based on information obtained from Shoalhaven City Council, there are minimal areas where acid sulphate soils will pose a problem. The area is classed to have a low probability of acid sulphate soils.

Tunnel erosion may pose a problem on the steeper sections along the route, which are adjacent to a number of waterways. These areas will need further investigation during detailed design. Trench stops and bulk heads may need to be used to stop erosion and damage to the gas pipe or other related issues from occurring.

No areas were observed that could take surplus excavated materials since the majority of the route is within road reserves or adjacent to prime agricultural land.
Erosion and sediment control measures chosen need to minimise adverse impacts to existing vegetation and local wildlife. The passage of native animals through the site shall be allowed and the effect of erosion and sediment controls on native vegetation be considered when selecting controls.
The proposed route was originally selected to minimize disturbance to wildlife and sensitive environmental areas. Correct selection and placement of erosion and sediment controls will minimize impacts to the environment.

Opportunity exists for minor route alteration during detailed design. This aim would be to avoid specific areas along the route that constrain the construction of the proposed gas pipeline, and save time and money by reducing the amount of erosion and sediment control required. These areas are shown in Appendix C, on APA drawing 24710-04, indicated by the words ‘Minor route Alteration?”.

2.6 Erosion and Sediment Control Management Procedures

The following list describes general erosion and sediment control procedures, to be incorporated into the CEMP of the Shoalhaven Starches gas pipeline project;

- All works are to be carried out in accordance with Landcoms Managing Urban Strormwater; Soils and Construction Volume 1, 4th Edition, March 2004 & Volume 2A.
- The contractor shall take all reasonable measures to minimise the effects of dust emissions from the site including the spreading of mulch in areas where construction has been completed.
- All topsoil from the construction areas is to be stripped and stockpiled. Stockpiles are to be located outside areas of concentrated stormwater runoff and are required to be grass seeded or mulched if they are to remain for longer than fourteen (14) days.
- The movement of machinery over the site should be limited to the construction areas to avoid disturbance to existing vegetated areas. No-go areas are to be marked off prior to commencement of works. Machinery should be inspected prior to exiting construction area to ensure excess mud and debris is not tracked onto roadways. During and on completion of the workday contractors should inspect to insure the roadways adjacent to the project site are free of excess mud/debris and clean if necessary.
- Areas of the site that are disturbed by construction works are to be topsoiled, seeded and fertilised immediately after construction works in the particular area have finished and not left till the end of the overall construction.
- Construction areas shall not be left in an open and disturbed state for more than fourteen (14) days. Areas expected to be left open for periods longer than this are to be seeded.
- Filter fences are to be removed only after all disturbed areas have established a good grass covering, minimum 70%.
- Any existing bare or disturbed areas of the site not affected by the construction works are to be topsoiled, seeded and fertilised as soon as practicable after each phase of work.
- Sediment & erosion control structures are to be maintained on a daily basis during construction and on a minimum of weekly basis during the six month liability period (or as required

depending upon weather conditions). All material removed from the traps is to be spread and grass seeded or disposed of, off site in an approved manner.

- All imported fill is assumed to be a material other than dispersive clay. All fill material is to be tested for dispersability prior to placement on the site and if found to be dispersive the superintendent is to be notified prior to placement of any fill for advice on treatment of dispersive soils.
- Sediment fence/filter can be used as E & S control around stockpiles, adjacent to the main trench, around areas where underboring of waterways will occur and be installed around the perimeter of wetlands, and should be installed at all drainage structures receiving stormwater runoff from excavated areas. Filter/sediment fences are to be constructed from an approved filter material and erected in accordance with the manufacturer's instructions.
- Swales and table drains along the route should have staked straw bale or socked mesh dams installed on road reserve shoulders that receive runoff stormwater runoff from excavated soils.
- Waste generated by the construction process should be collected and retained on site in appropriate containers and be removed offsite to a licensed landfill when appropriate
- Washing out of concrete truck chutes should occur at specific locations pre-determined prior to construction. Bermed pits with a large enough volume to take multiple pours should be excavated for this purpose. Material from the pits shall be disposed of and the pits regraded when all concrete work is complete.
- Materials that may be brought on site for construction of the proposed gas main include:
  - Aggregate of various sizes for trench backfill, bedding, and other applications.
  - Pipe and associated fittings.
  - Wood in various forms for staking, marking alignment and forming for concrete work.
  - Paint for marking alignments and the location of various utilities.
  - Where possible materials should be placed above ground on pallets or alternative.

3 Site Specific Erosion & Sediment Control Management

This section of the report provides a general assessment of the erosion and sedimentation controls required at specific locations along the proposed gas pipeline route. Recommended control measures are based on a site assessment conducted by staff of Allen, Price and Associates, and recommendations from Volume 2A of Managing Urban Stormwater – Soils and Construction - Installation of services, available from the Environment Protection Authority.

The road and rail reserves that the proposed gas pipeline will lay in are used as headings in this section of the report. The reserves were systematically assessed, with greater attention given to locations within road reserves that contain a waterway crossing. This is due to the potential for increased erosion and sediment control issues at these locations, when compared to the majority of the route which is over land that is mostly flat.

3.1 Route

A site assessment was undertaken by staff of Allen, Price and Associates to better understand the erosion and sediment issues caused by the proposed pipeline construction. The full length of the route was inspected and photographed so that the site was well identified for the purpose of writing this report.

The proposed Shoalhaven Starches gas main route is through two rural areas; Meroo Meadow and Bomaderry, approximately 7km and 5km respectively north of the Nowra Township in NSW. It will be constructed mainly through the following road reserves, which include the positions as given in Figure 1 (Appendix A);

- Pestells Lane (from 1 to 4).
- Princes Highway (3).
- Meroo Road (4).
- Fletchers Lane (from 5 to 6).
- An un-named road reserve adjacent to the railway reserve (from 7 to 13).
- Edwards Lane (10).
- Railway Street (from 13 to 15).
- Bolong Road (15).

The route is described in more detail below:

- Begin at tie-in station of the existing ActewAGL gas pipeline to the Eastern Gas Pipeline, on Pestells Lane. This is the proposed location for the Shoalhaven Starches gas pipeline meter and valve block arrangement (1).
- Continue south east along the southern road shoulder of Pestells Lane (2).
- Continue through the Princes Highway intersection, into the east shoulder of the Princes Highway road reserve (3).
- Continue south-east along the unformed section of Pestells Lane (3).
- Continue through the Pestells Lane/Meroo Rd intersection, to the east shoulder of Meroo Road (4).
- Change direction and continue south - south east along Meroo Road (4).
- Continue through the intersection of Meroo Road/Fletchers Lane, to the south shoulder of Fletchers Lane (4).
- Change direction and continue east along Fletchers Lane (5).
- Change direction at the intersection between Fletchers Lane and Railcorps rail reserve, and continue south for approximately 50m, just beyond the large culvert under the railway track (6).
- Change direction within the rail reserve and continue south east under the track ballast to the eastern side of the rail reserve. Continue through to the un-named road reserve adjacent to the rail reserve (7).
- Change direction and continue south through the un-named road reserve, parallel to the railway reserve (7).
- Cross waterway (8) (9).
- Continue south, through Edwards Ave intersection, back into the un-named road reserve adjacent to the railway reserve (10).
- Cross waterway (11).
- Continue south along the un-named road reserve into the east shoulder of the un-sealed section of Railway Street (12).
- Continue south along Railway St, transitioning from the un-sealed section to the sealed section of Railway Street into the east side road reserve (13).
- Continue past the intersection between Railway Street and Cambewarra Road (14).
- Continue along the east shoulder of Railway Street past the Cambewarra Road intersection until Lot 16 DP572583 on Railway St is reached (15).
- Change direction toward the east and follow the open channel drain along the north boundary of Lot 16 DP572583

- Change direction toward the south at a point that provides a 100m buffer between the proposed gas main and Abernethys creek. This is the approximate boundary of a sensitive coastal area, shown hatched in black criss-cross in Figure 1 (Appendix A) (15).
- Continue parallel along the 100m buffer boundary, until reaching the position of the proposed gas pressure reduction station on lot 16 DP572583 (15).
- Exit the pressure reduction station and continue south along the 100m buffer boundary (15).
- Cross Bolong Road into Manildra Factory Land (15).

3.2 Trenching

There are differing requirements for erosion and sediment control depending on whether the proposed trench runs across grade, down grade or obliquely. The gradient of the land is also an important factor. Much of the proposed gas main route is flat with exceptions at waterway crossings, Edwards Avenue and Railway Street. General erosion and sediment control techniques useful for these areas can be observed in Figures 2 and 3 of Appendix D

Across grade:

- Heaped soil from trench to be placed on up-hill side to form an earth bank

Down grade:

- Measures to be taken to filter sediment laden water downstream.
- Sediment fences can be used at the majority of steep sections on the proposed site to catch silt.
- Earth banks can be used across backfilled sections of the trench to slow moving water down and direct it out away from trench.
- Trench stops may be required on slopes that grade down to waterway crossings.

Obliquely:

- Heaped soil from trench to be placed on up-hill side to form an earth bank.
- Steep grades may require trench stops.

See section 6 of the DECCs Managing Urban Stormwater-Soils and Construction, Volume 2A, for further details.

3.3 Soil and Stockpile Management

Stockpiles will be required along the proposed route to store materials, excavated soil and top soil. The minimum depth of pipeline cover is 0.75m giving a total trench depth of approximately 1m. Minimum width of trench is 0.6m. Therefore the calculated volume of soil to be excavated per meter length of pipe is 0.6m^3. The required depth of cover is greater at waterway crossings. There is to be no trenching of waterway crossings, hence the volume of soil removed at these points along the route is reduced in comparison to trenched areas.

The most suitable location for stockpiles would most likely be over the backfilled trench of the previously completed stage or on the opposite side of the road reserve within the verge or footpath area. The stockpile size and spread needs to be limited to allow machinery to pass, and also to reduce the mass sitting above the newly installed gas main and other existing services.

Erosion and sediment control will consist of sediment fence and straw bale filters on the low side of the stockpile. Dust emissions need to be minimized. Due to the relatively short construction period required during staged construction, stockpiles would most likely not be in place for more than a one week, although it may be possible to utilize one stockpile location for consecutive stages of construction, increasing the time that disturbed soils are exposed.

Section 4.3 of the Blue Book contains further information on stockpile construction. A typical stockpile detail is available in Appendix D (SD4-1).

3.4 Road Reserves

A number of road reserves will be impacted by construction of the proposed gas pipeline. This section assesses each systematically and addresses general erosion and sediment controls required.

A small portion of Railcorps land (20-50m) will be used for the proposed gas main, located at position 7 in Figure 1 (Appendix A). The track in the reserve is active with passenger and freight trains passing through each day to the nearby Bomaderry Railway Station and Manildra Factory. Manildra's private rail reserve will also require underboring, adjacent to Bolong Road.

Under each road reserve heading in this section, the areas in the given road reserve requiring erosion and sediment control, and the proposed erosion and sediment control have a unique identification number from 1 to 51, that corresponds to with the same number used in APA drawing 24710-04 (Appendix C) to show the position being discussed. For example, area 1 corresponds to the proposed valve and meter station on Pestells Lane, with a sediment fence and straw bale filter proposed as the possible control measure, as shown below. In APA drawing 24710-04 (Appendix C), this is shown as "E

& S (1):" followed by a blue book identification number, for example "SD6-7, SD6-8, SD6-14", corresponding to the construction guide in the Blue Book for the recommended control.

3.4.1 Pestells Lane

The proposed gas pipe line begins on Pestells Lane as shown at position 1 in Figure 1 (Appendix A). This location corresponds to sheet 2 and 3 of APA drawing 24710-04 (Appendix C) in Appendix C.

The majority of the gas main route in Pestells Lane will be open trenched. Staged construction of the pipeline along Pestells Lane is recommended to allow adequate room for storage of topsoil and material stockpiles within the road reserve, behind the section of pipe being trenched.

The exit out of the proposed valve/metering block, across Pestells Lane into south side verge could be underbored to minimize disturbance to the road and reduce erosion and sediment controls required.

Erosion and sediment control

Areas requiring erosion and sediment control;

1. Proposed and existing valve/metering station
2. Table drain along boundary of road and southern shoulder of Pestells Lane.
3. Cattle yard gravel access driveway on the south side of Pestells Lane.
4. Culvert and table drains at south west corner of Princes Highway.

Proposed erosion and sediment control;

1) Sediment fence and Straw bale filter.
2) Sediment fence.
3) Sediment fence and Straw bale filter.
4) Sediment fence and Straw bale filter.

3.4.2 Princes Highway

The proposed gas pipeline will cross the Princes Highway at position 5 in Figure 1 (Appendix A). This location corresponds to sheet 4 of APA drawing 24710-04 (Appendix C) in Appendix C.

To mitigate impacts to the road surface and pavement, the crossing of the Princes Highway shall be by underbore. A stabilised access and storage facility approximately 20m x 40m will be required in the south west side of the road reserve for underbore operations.

Erosion and sediment control

The following areas will require erosion and sediment control;

5. Large culvert and headwalls passing stormwater under the highway.
6. Table drain on the south side of the intersection, flowing parallel to the Princes Highway and feeding into and out of the culvert inlet and outlet.
7. Table drain on south side of Pestells Lane where proposed gas main approaches the intersection.
8. Soil and construction material stockpiles to possibly be located on south west shoulder of Princes Highway road reserve.
9. Marsh area at culvert outlet on east side of Princes Highway road reserve.

Proposed erosion and sediment control for the given areas include;

5) Sediment fence and straw bale filter.
6) Sediment fence and straw bale filter as check dams.
7) Straw bale or rock check dams in table drain to prevent sediment flowing along table drains.
8) Sediment fence around base of stockpiles.
9) Sediment fence around perimeter of reed bed/marsh. Temporary culvert to outlet into table drain on Pestells Lane

3.4.3 Pestells Lane (Unformed Section)

The un-formed section of Pestells Lane intersects the Princes Highway and Meroo Road, as shown at position 4 in Figure 1 (Appendix A). This location corresponds to sheet 5 of APA drawing 24710-04 (Appendix C).

The unformed section of Pestells Lane on the east side of the Princes Highway is relatively flat. It contains a table drain on the north side.

Waterway Crossings

There is no waterway crossing through the unformed section of Pestells Lane.

Erosion and sediment control

The following areas require erosion and sediment control;

10. Table drain parallel to boundary on northern side of road reserve.
11. Soil and construction material stockpiles.

Proposed erosion and sediment control for the given areas include;

10. Straw bale or rock check dam to be laid inside table drain.
11. Sediment fence around soil and material stockpiles.

3.4.4 Meroo Road

The proposed gas main will cross Meroo Road at position 4 in Figure 1 (Appendix A). This location corresponds to sheet 5 of APA drawing 24710-04 (Appendix C). Associated photographs shown on this sheet are found in Appendix B.

An underbore would be the best option for crossing Meroo Road in order to minimize damage to the road and prevent associated traffic control issues. A stabilised site will be required for machinery, the most likely position being the west side of the intersection in the un-formed portion of Pestells Lane, where the underbore will be made.

Erosion and sediment control

The following areas will require erosion and sediment control;

12. Table drains and culvert downstream of proposed underbore inlet, on west side of Meroo Road.
13. Table drain downstream of proposed underbore outlet, on east side of Meroo Road.
14. Culvert entrance on east side of Meroo Road, at intersection with Fletchers Lane.
15. Soil and construction material stockpiles.

Proposed erosion and sediment control for the given areas include;

12. Straw bale filter laid across table drains and surrounding culvert headwall.
13. Straw bale filter laid across table drain. Ensure excavated material laid on high side of trench.
14. Straw bale and Sediment fence filter at entrance of culvert
15. Sediment fence around soil and material stockpiles.

3.4.5 Fletchers Lane

Fletchers Lane extends from position 4 to position 7, and intersects Meroo Road at position 4, as shown in Figure 1 (Appendix A).This location corresponds to sheets 5, 6, 7 and 8 of APA drawing 24710-04 (Appendix C) in Appendix C.

A large culvert takes water from the west side of Meroo Road, and outlets at the south west side of the Fletchers Lane and Meroo Road intersection, which leads to an open channel drain. An underbore crossing of Fletchers Lane would limit the excavation in that area, lessening the chance of sediment and erosion.

A stabilised site will be required for machinery, the most likely position being the north side of the intersection in the verge of Fletchers Lane, where the underbore will be made.

Erosion and sediment

The following areas will require erosion and sediment control;

16. Position of proposed Fletchers Lane underbore.
17. Large culvert inlet and outlet, fed by table drain on Meroo Road's west side shoulder.
18. Diversion drains situated on the south side of Fletchers Lane that leads into the open channel drain.
19. Culverts under Fletchers Lane.
20. Table drain in Fletchers Lane south side road shoulder.
21. Soil and construction material stockpiles.

Proposed erosion and sediment control for these areas include;

16. Sediment fence or straw bales along edge of bitumen on inlet side of underbore construction area and straw bale sediment filters in table drain on north side road shoulder.
17. Sediment fence and straw bale filters in table drains and at inlet of culvert.
18. Divert stormwater runoff in the south side table drain via a geo-textile lined swale adjacent to road, to prevent stormwater flowing through diversion drains.
19. Straw bale filter at ends of diversion drains.
20. Straw bale filter in table drain at inlet to culverts.
21. Sediment fence around soil and material stockpiles.

3.4.6 Railcorp land and un-named road reserve

The intersection of Railcorps land and the un-named road reserve adjacent, with Fletchers Lane, is located at position 7 in Figure 1 (Appendix A). This location corresponds to sheet 8, 9, 10, 11, 12 and 13 of APA drawing 24710-04 (Appendix C) in Appendix C.

Erosion and sediment control

The following areas require the erosion and sediment control;

22. Table drain parallel to train track for approx 50m on west side of rail reserve.

23. Stabilised site access for underbore of train tracks.
24. Stockpiles for topsoil and materials.
25. Large culvert under train tracks.
26. Waterway crossing through intermittent creek that flows onto flood prone land, and into the Tullian Creek, at position 7 in Figure 1 (Appendix A).
27. Large swale on the south side of Fletchers Lane that flows into Tullian Creek at position 8 in Figure 1 (Appendix A).
28. Abernethys Creek at position 9 in Figure 1 (Appendix A).
29. Mulgen Creek at position 11 in Figure 1 (Appendix A).
30. Steep land sloping downgrade toward waterway crossing at position 9 and 11 in Figure 1 (Appendix A).

Proposed erosion and sediment control for these areas include;

22. Sediment fence along and straw bale filters laid across table drain.
23. Compacted rock, sediment fence, straw bale filters, temporary culvert/pipe.
24. Stockpiles will require sediment fence around base.
25. Straw bale filter and sediment fence at culvert inlet and outlet.
26. Mechanical underbore, sediment fence, trench stop.
27. Mechanical underbore, sediment fence, trench stop.
28. Mechanical underbore, sediment fence, trench stop.
29. Mechanical underbore, sediment fence, trench stop.
30. Check dams and trench stops along steep section of trench toward Edwards Avenue and area along route between Edwards Avenue and Railway Street.

3.4.7 Edwards Avenue Intersection

Edwards Avenue intersects the un-named road reserve at position 10, as shown in Figure 1 (Appendix A).This location corresponds to sheet 11 of APA drawing 24710-04 (Appendix C).

The proposed gas main is to be routed perpendicularly through Edwards Ave, which sits on the northern side of a small hill, in an east-west direction. Significant Erosion and sediment controls, especially along the trench will be needed to prevent erosion and pollution of the roadway, stormwater runoff and nearby creeks. An underbore crossing will be required at this point to minimize erosion and sediment control issues and prevent traffic management problems. A stabilised work site will be required either side of Edwards Ave for the underbore machine.

Erosion and sediment

The following areas of the Edwards Ave require erosion and sediment control;

31. Stabilised access for underbore machinery and access to un-named road reserve.
32. Table drains on north and south side of road reserve.
33. Trench on south side of Edwards Avenue.

Proposed erosion and sediment control for the given areas along Fletchers Lane include;

31. Compacted rock, sediment fence, straw bale filters, temporary culvert/pipe.
32. Sediment fence along and straw bale filters laid across table drain.
33. Trench stop or collar. Stop trench 3m before road reserve boundary.

3.4.8 Railway Street and Lot 16 DP1121337

Railway Street continues on from the un-named road reserve and runs parallel to the train tracks on Railcorps land. Railway Street begins at position 12, as shown in Figure 1 (Appendix A).This location corresponds to sheet 13, 14 and 15 of APA drawing 24710-04 (Appendix C).

Greater attention to erosion and sediment control is required here due to it being;

- Mainly Bitumen sealed with numerous traffic movements, and pedestrians
- Connected to the Shoalhaven Councils urban stormwater system through kerb & gutter, pits and pipes which lead to the Shoalhaven River.
- Numerous services and concrete or gravel driveways
- Open view of proposed works to the public.

There is limited room to store materials and excavated soil on Railway Street. A more suitable location would be the large vacant lot 16 DP1121337 where the proposed gas pipeline is to lay. A haul road is required to construct the proposed pipeline in this location, the material and topsoil stockpiles could be positioned in proximity to the proposed route.

Erosion and sediment

The following areas of the Railway St will require erosion and sediment control;

34. East side boundary of Railway Street.
35. Outlet of culvert.
36. Table drain.

37. Underbore of driveways.
38. Trench through east side of un-formed section of Railway Street.
39. Trench through east side of sealed section along Railway Street.
40. Kerb and Gutter.
41. Stormwater pits.
42. Large culvert and open drain through lot 16 DP1121337.
43. Haul road through Lot 16 DP 1121337

Proposed erosion and sediment control for the given areas include;

34. Provide temporary geo-textile lined table drain and sediment fence.
35. Sediment fence and straw bale filter over and around headwall of culvert outlet.
36. Straw bale check dams in table drain.
37. Sediment fence on boundary of property and along kerb and gutter.
38. Excavated material placed on high side of trench with temporary geo-textile lined table drain provided, and drained to table drain further behind stage being completed.
39. If excavated material to be stored in road reserve, enclose in sediment fence.
40. Gravel mesh check dams laid inside kerb and gutter.
41. Straw bale and gravel mesh filters placed around pit inlet.
42. Sediment fence, strawbale filter check dams
43. Stabilised site, sediment fence, strawbale filters, temporary geo-textile lined table drain

3.4.9 Bolong Road

Bolong Road is located at position 15 in Figure 1 (Appendix A). This location corresponds to sheet 16 of APA drawing 24710-04 (Appendix C).

The proposed crossing of the Shoalhaven Starches gas main at Bolong Road will require an underbore of Manildra's privately owned railway reserve, will continue under Bolong Road, and exit into the Shoalhaven Starches Interim Packing Plant. There is no possibility of open trenching due to the volume of traffic on Bolong Road and the number of services underground.

Erosion and sediment

The following areas will require erosion and sediment control;

44. Right of way (haul road) along route.
45. Proposed gas pressure reducing station.

46. Boundary of sensitive environmental area buffer zone.
47. Underbore location at railway pedestrian crossing.
48. Underbore outlet at Interim Packing Plant.
49. Culverts and headwalls.
50. Topsoil and material stockpiles.
51. Downstream gutter inlet pits
52. Stormwater pit
53. Shoalhaven Starches Railway reserve

Proposed erosion and sediment control for the given areas include;

42. Stabilised site access.
43. Stabilised site access, sediment fence and straw bale filter
44. Sediment fence.
45. Sediment fence and straw bale check dams in table drain.
46. Sediment fence and straw bale check dams in table drain.
47. Sediment fence and straw bale filters.
48. Sediment fence and straw bale filters.
49. Mesh and gravel filters.
50. Sediment fence or strawbale inlet filters.
51. Sediment fence.

3.5 Waterway Crossings

Four waterway crossings have been identified, in accordance with the Director General's requirements. These are located at positions 7, 8, 9 and 11 along the route as shown in Figure 1 (Appendix A). The water ways to be crossed include;

1. A small drainage channel, at the outlet of the first culvert/bridge immediately downstream of Fletchers Lane, flowing onto the floodplain and eventually into the Tullian Creek (position 7)

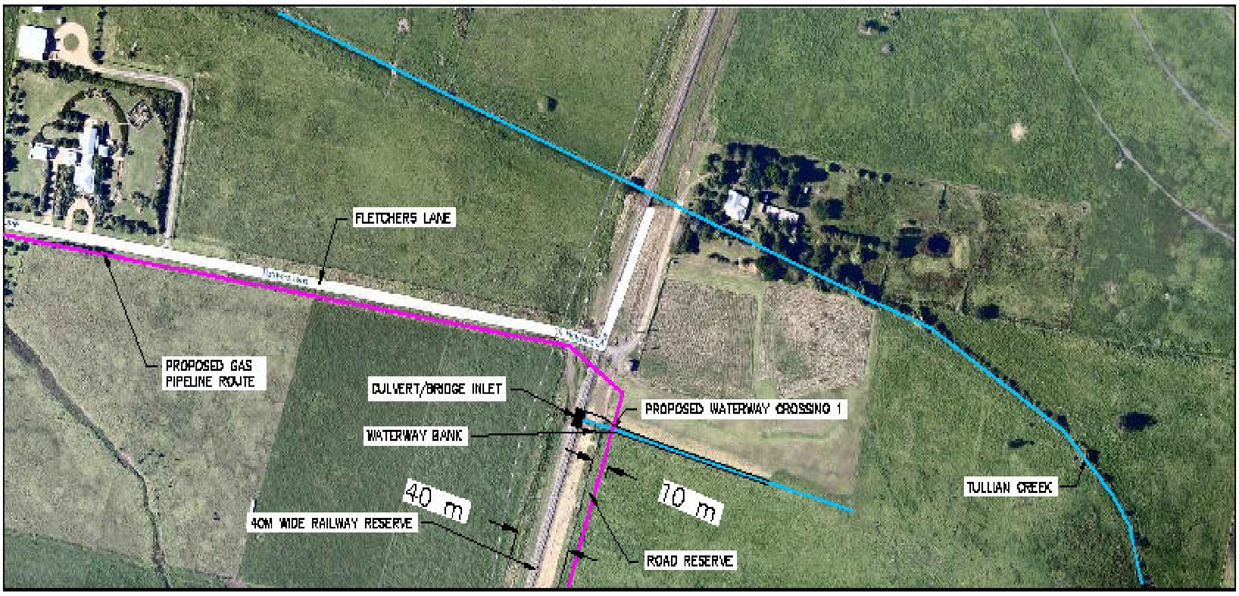

Image 1: Plan view of waterway crossing 1

2. A small tributary waterway of Tullian Creek, flowing through the 2nd main railway bridge/culvert south of Fletchers Lane. An intermediate culvert with no waterway is located between waterway 1 and waterway 2 (position 8)

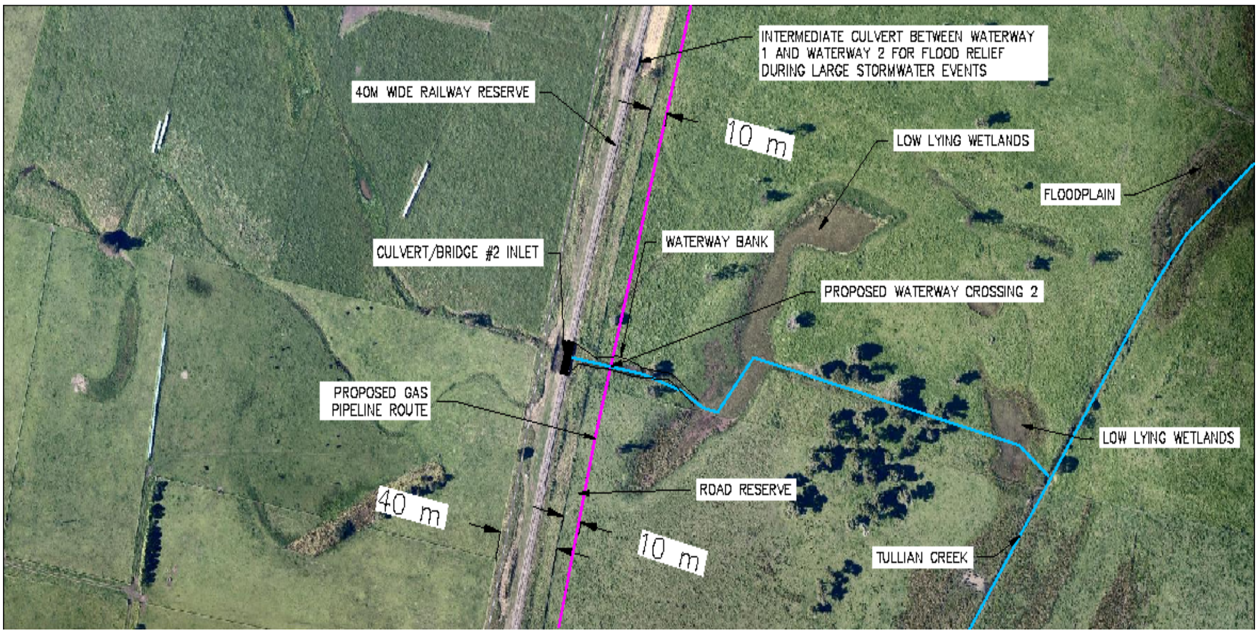

Image 2: Plan view of waterway crossing 2.

3. Abernethys Creek (position 9). Culvert/bridge #3 is located just upstream of the crossing point in the railway reserve.

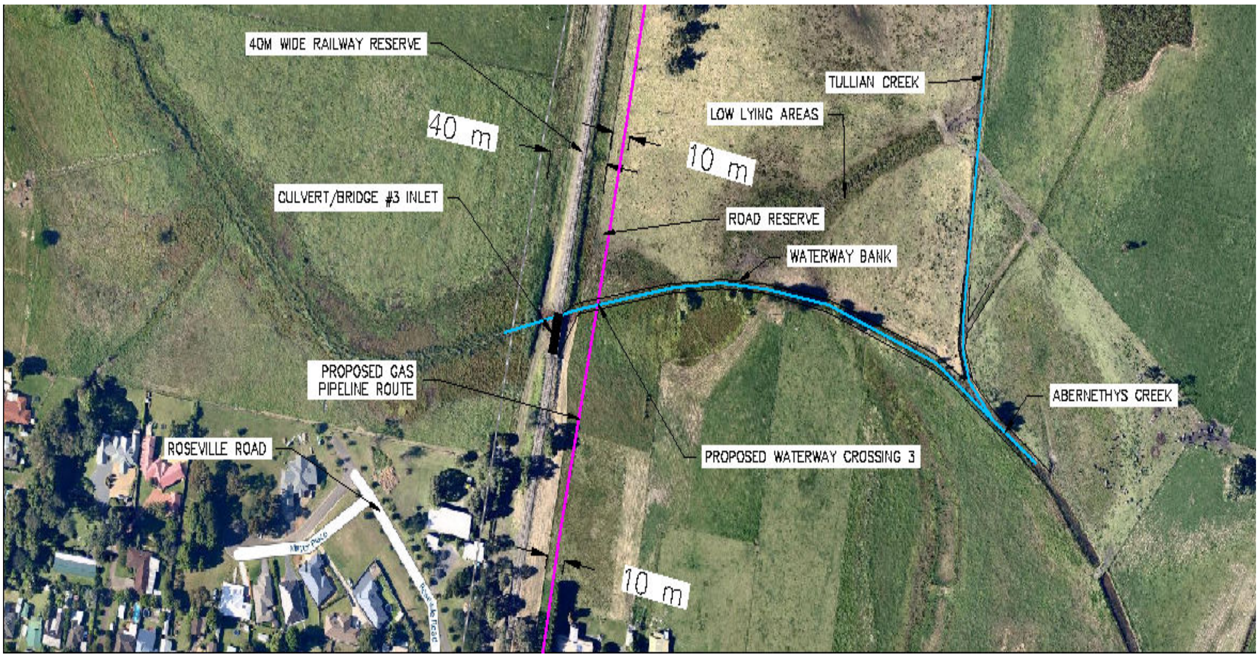

Image 3: Plan view of waterway crossing 3

4. Mulgen Creek (position 11). Culvert/bridge #4 is located just upstream of the crossing point in the railway reserve.

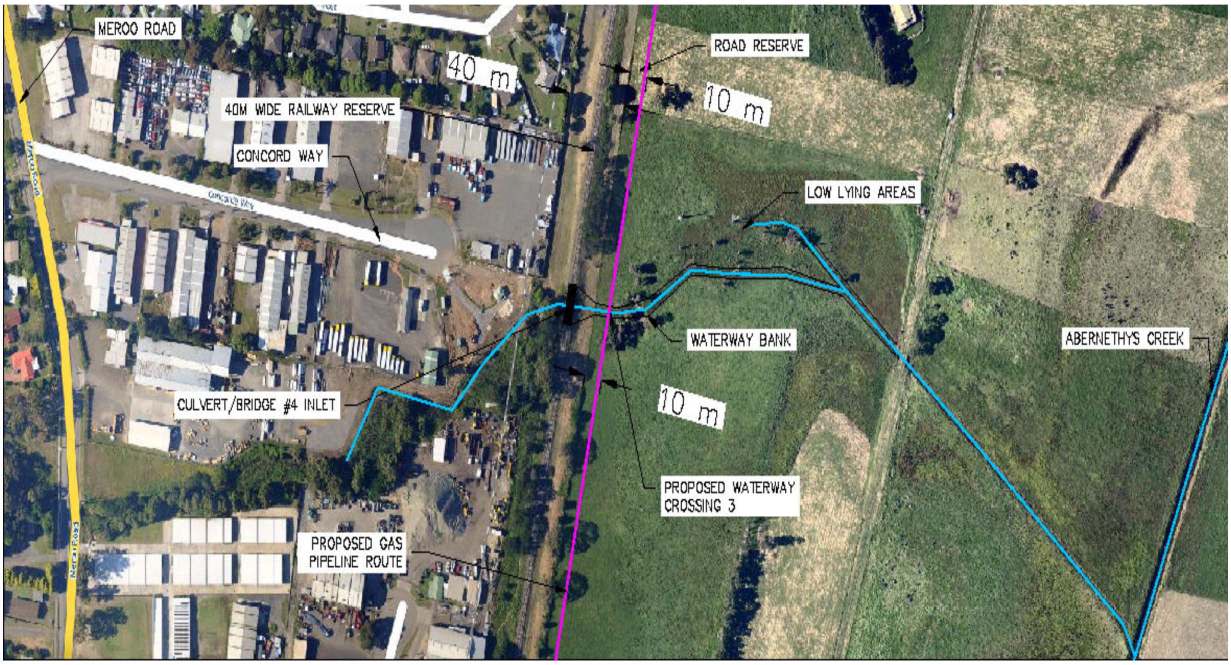

Image 4: Plan view of waterway crossing 4

The proposed waterway crossings are also shown in detail in APA drawing 24710-04 sheets 1 – 16 (Appendix C) with references given to photographs in Appendix B, taken at the waterway crossing sites. Typical long and cross sections of waterway 3 is available in Appendix E.

The immediate area surrounding waterways (Riparian zones) are susceptible to erosion and sedimentation due to the increased possibility of flowing water in these areas. The four waterways are minor and flow intermittently throughout the year, depending on the size of the storm event affecting the associated catchment. Erosion and sediment control management for waterway crossings will depend on the weather preceding, during and after proposed construction period. The ESCP should provide alternative controls based on weather forecasts and size of storm events expected.

Waterway crossings shall not be made by open trenching. All waterways shall be crossed by mechanical underbore, to mitigate impacts on waterways and surrounding riparian zones. Open trenching shall be stopped at the boundary of the core riparian zone waterway and trench stops put in place until a suitable waterway crossing has been made. The width and boundaries of waterway riparian zone are addressed in the geomorphic assessment that follows this section of the report.

Waterways will require temporary vehicle crossings for stabilised machinery access over the 5 m – 7 m wide right-of-way to be built within un-formed road reserves. Significant erosion and sedimentation is possible at waterway crossings and adequate control measures are needed to mitigate impacts to soils, vegetation and waterway geomorphic condition. Detail SD5-1 in Appendix D shows a typical construction method for a temporary waterway vehicle crossing.

Stabilised work sites approximately 20m x 40m are to be positioned at either side of waterway crossings for underbore machinery to be positioned to lay pipe under the bed of the waterways. Stabilised work sites are also require at other locations along the proposed route where underboring is required and other machinery will be best positioned during non-work periods. Stabilised work sites are to be built only when required as staged construction of the pipeline progresses along the route. Rehabilitation is to begin immediately when trenches and waterway crossings are backfilled and completed, respectively.

The proposed gas pipeline is to be buried under waterway beds with a minimum depth of cover from the bed to the top of pipe equal to 2.0m minimum. This value will increase if scour is an issue at the waterway crossing.

There is potential for fluvial geomorphic impacts on the proposed gas pipeline at waterway crossings. Changes may occur to the waterway characteristics, especially from the scouring action of flowing water at the outlet of the culverts and bridges immediately upstream of the proposed waterway crossings. A geomorphic assessment was made of the waterway crossings and associated core riparian zones to assess this potential..

To mitigate impacts on the pipeline due to fluvial geomorphic changes, the effect of scour on the waterway crossing was determined and the scour depth at each waterway crossing calculated to determine the depth of cover required under each waterway bed being crossed.

3.6 Fluvial Geomorphic Assessment

To assist in the environmental assessment procedure and to ensure on-going stability of the creeks being crossed by the proposed pipeline, a geomorphic assessment of the four proposed waterway crossings was made, in order of the waterways as identified in figure 1 (Appendix A), from location 7 to 11, by a photographic study obtained from site inspections and desktop study.

Over time, the shape, size and behavior of active waterways change, which increases the potential for significant impacts to the proposed gas pipeline at the waterway crossing points. This section of the report assesses the degree of impact that is likely to occur to the pipeline at the waterway crossings.

The objectives of the geomorphic assessment are;

- determine current geomorphic condition of the waterways and their associated riparian zones.
- determine geomorphic history of the proposed waterway crossings.
- determine future geomorphic effects on the waterways and impacts on the pipeline at the waterway crossings.
- provide machinery and construction site setbacks from waterways.
- Provide recommendations to mitigate potential geomorphic impacts to the pipeline, and to mitigate impacts of construction on riparian zone and bank stability.

To meet the objectives, the following aims were addressed:

- Site inspections of waterways and riparian zones.
- Determine waterway categories for riparian zone distance classification of waterway crossings.

- Modelling to determine characteristic behaviour of waterways and floodplain due to stormwater runoff.
- Determine culvert and bridge flood outlet velocities
- Calculate depth of scour at outlet of culverts and bridges
- Outline pipeline construction impacts to the waterway and riparian zones and mitigation measures.

Site Setting

Four proposed waterway crossings are to be made, between Fletchers Lane and Railway Street, on the northern bank of the Shoalhaven River, and Lower Shoalhaven River Floodplain, within the 10m wide unformed road reserve directly adjacent the Illawarra Railway Reserve and Railway track. These are located along the proposed route as shown in Figure 1 of Appendix A, with each waterway crossing location numbered 7, 8, 9 and 11.

Figure 1 below shows the boundaries of four catchments (CA1 to CA4) that flow into local waterways, and more specifically into the culverts and bridges at proposed pipeline waterway crossings. The catchments are bounded by Cambewarra Road, Moss Vale Road, Tourist Road and Cambewarra Lookout Road. Stormwater runoff flows into tributaries over Cambewarra Mountain, into the Tullian and Abernethys Creeks and eventually onto the Lower Shoalhaven River Floodplain. Appendix H contains catchment peak flow rate calculations.

An elevated railway track formed fill and capped with blue metal ballast approx 2-3m above the natural surface level, is located centrally in a 40m wide rail reserve running in a north-south direction, on the Lower Shoalhaven River Floodplain.

Flood water from Abernethys Creek and Tullian Creek are prevented from building up behind the elevated railway track by a number of concrete box culverts and steel bridges. The proposed gas pipeline route runs parallel to the railway line, within the un-named road reserve positioned directly downstream of the track on the Lower Shoalhaven River floodplain.

See APA plan 24710 sheets 1-16 for further details and Appendix B for photographs taken of the proposed route

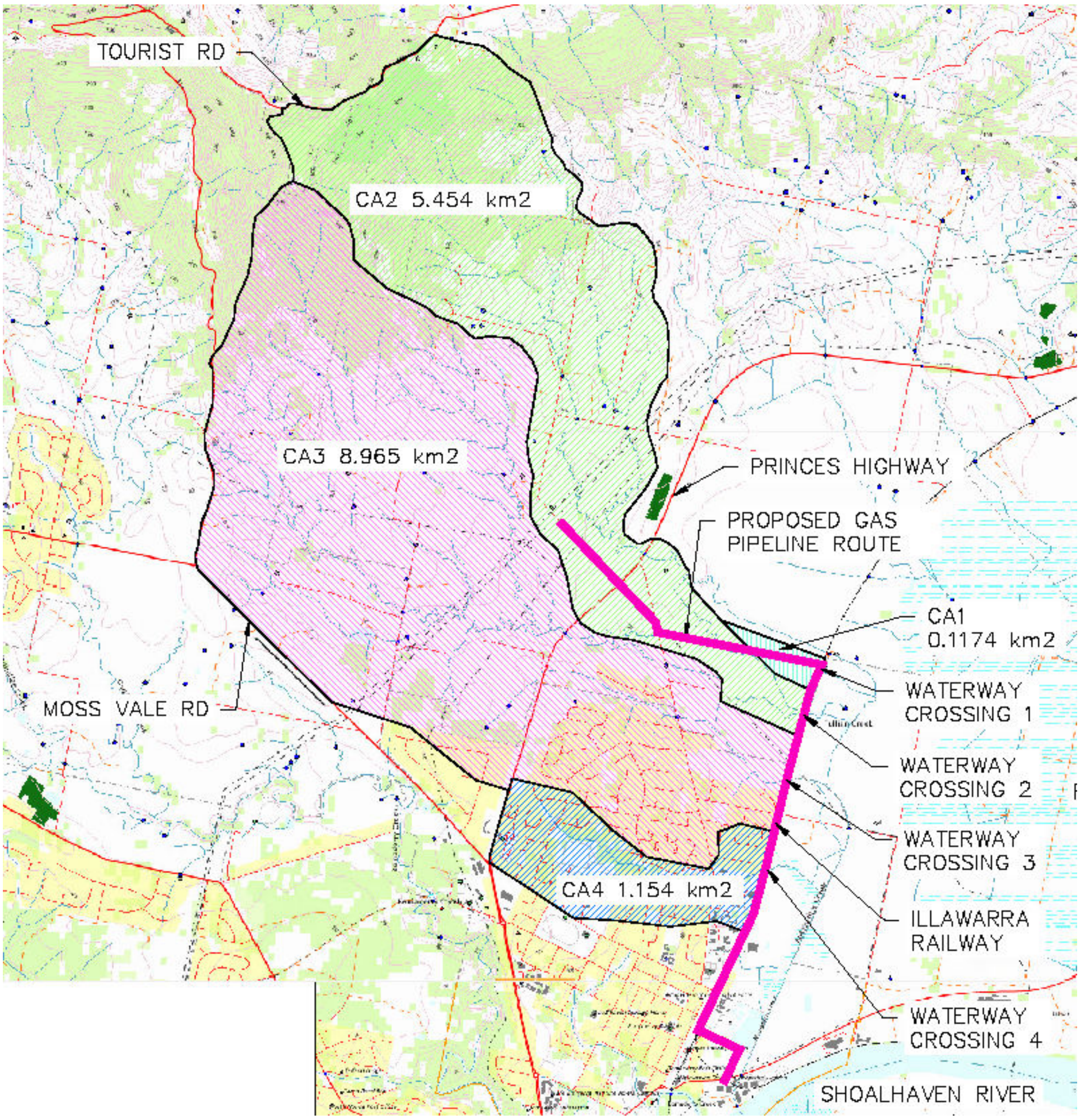

Figure 1: Catchment details for Proposed Gas Pipeline Geomorphic Assessment

3.7 Photographic Study of Waterway Crossings

3.7.1 Waterway Crossing 1

Figure 2: Culvert /Bridge #1 upstream of waterway crossing, and South of Fletchers Lane.

Figure 3: Looking South along the proposed pipeline route at waterway crossing 1, in the un-named road reserve between Fletchers Lane and Edwards Ave.

Figure 4: Looking downstream of waterway crossing 1, notice the reducing waterway cross section.

Figure 5: Looking upstream of waterway crossing 1, toward proposed crossing location and culvert/bridge

Figure 6: Waterway 1 vegetation at proposed crossing point

Figure 7: Looking downstream of waterway 1, toward floodplain and Tullian Creek (trees in background delineate creek)

Figure 8: Low lying wet area at intermediate culvert between waterway 1 and waterway 2

Figure 9: Intermediate Culvert at low lying area between waterway crossing 1 and waterway crossing 2

Figure 10: Looking South along proposed pipeline route, toward waterway crossing 1, whilst standing at the intermediate culvert outlet, with in the un-named road reserve.

3.7.2 Waterway Crossing 2

Figure 11: Culvert #2 and downstream reach of waterway crossing 2

Figure 12: Heavy weed infestation at boundary of road and rail reserves, at outlet of culvert/bridge #2

Figure 13: Looking south along proposed route in the road reserve at waterway crossing 2.

Figure 14: Bank Instability and Erosion at waterway crossing 2.

Figure 15: Looking east toward low lying area downstream of waterway crossing 2

Figure 16: Looking north toward waterway crossing 1, showing riffle zone and secondary waterway at waterway crossing 2

Figure 17: Riffle zone between main waterway 2 and secondary waterway 2, looking east toward floodplain

Figure 18: Water main infrastructure within road reserve, between waterway crossing 1 and waterway crossing 2

Figure 19: Wild life and vegetation at low lying area on the floodplain downstream of waterway 2

Figure 20: Wildlife and vegetation in riffle zone downstream of waterway 2 crossing

Figure 21: Merge of waterway 2 into low lying area and floodplain downstream of culvert/bridge #2

3.7.3 Waterway Crossing 3

Figure 22: Looking north toward culvert/ bridge #3 and proposed waterway crossing 3 at Abernethys Creek

Figure 23: Looking east toward floodplain and Abernethys Creek, downstream of waterway crossing 3.

Figure 24: Railway Bridge #3 showing main flow path of Abernethys creek with waterway 3 flowing under one cell

Figure 25: Heavy weed infestation at waterway crossing 3, looking upstream.

Figure 26: Vegetation in downstream reach, looking east toward floodplain

Figure 27: Looking south toward Edwards Avenue, at waterway crossing 3

Figure 28: Looking south toward steep section leading down to waterway 3.

3.7.4 Waterway Crossing 4

Figure 29: Looking south along proposed gas pipeline route, on crest of hill before relatively steep down grade to waterway crossing 4, along un-named road reserve.

Figure 30: Looking south down un-named road reserve, toward waterway crossing 4

Figure 31: Large bridge #4 just upstream of waterway crossing 4.

Figure 32: Heavy weed infestation at waterway 4 crossing

Figure 33: Existing stabilised vehicle crossing over waterway 4, immediately upstream of proposed pipeline crossing point

Figure 34: Looking South along un-named road reserve at proposed waterway crossing 4, with vegetation types shown

Figure 35: Waterway crossing 4, showing terrestrial and aquatic vegetation.

Figure 36: Floodplain and downstream reach of waterway crossing 4

Figure 37: Looking East over floodplain (northern bank of Shoalhaven River), downstream of waterway crossing 4

Figure 38: Low lying area downstream of waterway crossing 4

3.7.5 Waterway History

Changes to the waterways seem to have occurred only recently from European settlement in the area. An early Parish map obtained from the Department of Lands was proclaimed on the 31st of May 1895, (Appendix F) and discontinued in December 1916. From this it can be seen that the waterways are approximately in the same locations as they can be seen today.

Information obtained from the NSW Office of Environment and Heritage shows the single track, Illawarra Railway continued from Kiama Station and terminated at Bomaderry Station on the 2nd of June 1893.

It would seem that the culverts and bridges located just upstream of the waterway crossings were built for natural waterways that existed prior to construction of the elevated railway.

The configuration of the waterways, upstream of the railway line was observed to have changed based on the differences noticed between the latest 1:4000 topographic map of the area (Appendix F) and a 1:4000 topographic map dated 31st of May 1895 (Appendix J). It is most likely that natural waterways leading into low lying areas were extended as modified drainage channels and continued through to the Tullian and Abernethys Creeks.

Although these findings show that the waterways being crossed by the gas pipeline have changed slightly over the last 116 years, it is unlikely that significant changes will occur at the waterway crossing positions due to upstream varying conditions. Most of the areas immediately upstream of the waterway crossings are stable due to being occupied and utilized for farming or residential housing. The culverts and bridges at these positions are fixed and are likely to remain fixed points of impact for the lifespan of the pipeline.

3.7.1 Soil and Land

Meroo Meadow and Bomaderry are situated adjacent to and partly on the Lower Shoalhaven River floodplain. Main soils types in this area originate from Permian siltstone and shales of the Berry Formation, and Gerringong Volcanics (mainly west of the Princes Hwy), with quaternary river alluvium in the Shoalhaven floodplain (mainly east of the Princes Hwy).

Soils are typical of the area and do not require special treatment during excavation, except where acid sulphate soils are disturbed. The main component of significance in these soils is iron sulphide, which reacts with the atmosphere to form sulphuric acid. Erosion and excavation provides the means by which the iron sulphide is uncovered or disturbed and therefore exposed to the atmosphere. The area surrounding Meroo Meadow and Bomaderry contains small wetland areas prone to flooding with a low probability of disturbing acid sulphate soils along the proposed gas main route. These areas are shown in the Shoalhaven LEP and should be identified in the ESCP, with appropriate treatment procedures developed.

Rainfall erosivity factor (R) for soils in the region is approximately 4250 mm/ha.hr.yr, as shown on Map 11: Rainfall Erosivity of the Wollongong 1:250,000 topographic Sheet, obtained from Landcoms Managing Urban Stormwater – Soils and Construction, Volume 1, 4th Edition, March 2004. The soils are described as having 'low permeability and low wet bearing strength, High run-on; localized shallow soils with localized rock outcrop'(1).

The proposed route follows a path mainly over 'prime agricultural land'. The current Shoalhaven Local Environmental Plan (1985) states that land classified as 1, 2 or 3 under the Department of Primary Industry's land classification system is regarded as 'prime crop and pasture' land. The proposed route is situated mainly through class 2 classified areas. Even though the proposed route is through prime agricultural land, it is located over existing formed and unformed road reserves, and a small portion of the railway reserve.

The longitudinal and transverse grade of the proposed route is generally flat, with gentle fall predominately toward the south-east. A number of areas along the route are relatively steep both longitudinally and transversely (greater than 1:4). Fortunately the longitudinal grades of waterways at proposed crossings are relatively flat and grade back toward the north and north-west. These positions are located generally at the Edwards Ave intersection, and along the un-named road reserve and Railway Street, adjacent to the train track.

The waterway cross sections at crossing points are trapezoidal, with flat bottomed beds. The longitudinal grade of the waterway beds at proposed crossings points are 0.4%, 0.5%, 0.5% and 0.8% respectively. Gradients were determined from 1:4000 topographic map contours.

The transverse gradient of land at the crossings is flat along the un-named road reserve, except for the land to the south of proposed waterway crossing at position 9, which falls relatively steeply back toward the waterway from Edwards Avenue. The waterway crossing at position 11 is situated in a gully, with two steep sections either side grading back toward the waterway.

The potential for sedimentation and erosion issues is greatest at the steeper locations of the proposed gas pipeline route, especially adjacent to waterways, table drains, culverts and the Shoalhaven City Council stormwater system.

3.8 Waterway and Riparian Zone Assessment

Riparian lands are transition zones between terrestrial and aquatic environments. Section 5.2 of the Landcoms Managing Urban Stormwater – Soils and Construction, Volume 1 Fourth Edition (Blue Book) describes three broad categories for riparian land. These include;

Category 1 – Environmental Corridor

Category 2 – Terrestrial and Aquatic habitat

Category 3 – Bank stability and water quality

Depending on the category, different management regimes apply to each. Site investigation, and study of the draft Shoalhaven LEP has determined that the riparian zones of the waterways at the crossing locations, as given in Figure 1 Appendix A, are categorised as follows;

- Waterway crossing 1 : Category 3
- Waterway crossing 2 : Category 3
- Waterway crossing 3 : Category 2
- Waterway crossing 4 : Category 2

Although waterway crossings 1 and 2 could be classed as category 2, since they have the potential to allow animals to cross over from one side of the floodplain to the other side, the waterways are greatly modified and located mainly on grazed agricultural land.

Waterway classification is used to identify minimum riparian corridor widths along waterways. Category 2 – Terrestrial and Aquatic Habitat classification aims to provide for a viable and robust node or reach of riparian habitat (both aquatic and terrestrial), with minimum CRZ width of 20m (measure from top of bank) along both sides of the watercourse with a 10m vegetated buffer zone either side.

The aim of maintenance and restoration of Category 2 waterways is to maintain native riparian vegetations, water quality, bank stability and provide suitable native animal habitats.

Due to the nature of these category 2 waterways, at the crossing locations with cattle grazing within the 20m wide CRZ over both banks, and the lack of existing diversified vegetation, the 10m wide vegetation buffer is not considered necessary.

Waterways classified as Category 3 require minimisation of sediment and nutrient transfer to provide bank stability, water quality and native vegetation protection. These are generally achieved where possible by emulating a naturally functioning stream, providing terrestrial and aquatic vegetated habitat refuges, using pipes and other engineering devices as a last resort and treating stormwater runoff before discharging to riparian zones or waterway.

The two Category 3 waterways are highly modified from natural conditions with a lack of diversified native vegetation. Cattle grazes within the 10m wide core riparian zones on either bank.

See Appendix E for further Details

3.8.1 Sea Level Rise

Shoalhaven City Council has commissioned revised flood modeling of the Lower Shoalhaven River Floodplain to assess the impacts on climate change induced sea level rise on flood levels. The information that follows was obtained from their recently made available climate change assessment report titled 'Lower Shoalhaven River Floodplain Management Study and Plan – Climate Change Assessment (CCA).

Based on the following information using the 1% AEP flood event for comparison, during the proposed gas pipeline's minimum service design life of 30 years the amount of flood level rise at the proposed development site due to sea level rise is insignificant. The possible increase in flood levels across the proposed gas main site due to sea level rise is comparatively small with respect to current flood levels during the 1% AEP flood event (0.36% max). Due to this, erosion and sediment control during construction of the proposed gas pipeline will not be affected by sea level rise, nor will there be need to tailor erosion and sediment control to compensate for sea level rise.

The proposed development is located approximately 12 to 15 km from the entrance of the Shoalhaven River. The proposed position of the gas main corresponds to cells 8 & 14 of Figure 1 in the CCA report. Referring to Figure 3 of the CCA report, by 2050 the anticipated benchmark 400mm rise in sea level will possibly cause a corresponding maximum 10 mm flood level rise during the 1%AEP flood event. By

2100 the increase to the flood level during the 1%AEP flood event across the site from an anticipated 900mm rise in sea level will be approximately 20mm.

Figure 46 of the Lower Shoalhaven River Flood Study (April 1990) shows the peak flood level during the 1% AEP flood event to be approximately 5.6m AHD. Comparing Figure 1 of the CCA report which shows the existing 1% AEP flood extent, to figures 2 and 4, the anticipated 1% AEP flood event in the years 2050 and 2100 respectively show there is no significant change to the flood extent across the proposed gas pipeline site.

Referring to figure 3 of the CCA report, the flood hazard category in the year 2050 over the area where the proposed gas pipeline will be situated remains consistent with the existing flood hazard category of 'High Hazard Flood Storage' as shown in figure 2 of the 'Lower Shoalhaven River Floodplain Risk Management Plan'.

Since over half of the proposed gas main will be situated in High Hazard flood storage area on the Shoalhaven River flood plane, an assessment of sea level rise on the proposed gas pipeline was made. It was found that there will be insignificant impacts to the gas pipeline, with respect to erosion and sediment control.

NSW Government Policy on Sea Level Rise

The NSW Department of Planning has issued a policy statement entitled "NSW Sea Level Rise Policy Statement" October 2009 which outlines the NSW Government's attitude towards the impacts of sea level rise on regional planning and new development.

The policy states the following:

The NSW sea level rise planning benchmarks are an increase above 1990 mean sea levels of 40 cm by 2050 and 90 cm by 2100, with the two benchmarks allowing for consideration of sea level rise over different timeframes. The benchmarks were established by considering the most credible national and international projections of sea level rise and take into consideration the uncertainty associated with sea level rise projections. The Government will continue to monitor sea level rise observations and projections and will periodically review these planning benchmarks, with the next review likely to coincide with the release of the fifth IPCC report, due in 2014.

and

The sea level rise planning benchmarks will support consistent consideration of the influence of sea level rise on any coastal hazards and flooding risks that may influence a development or redevelopment site. The benchmarks are not intended to be used to preclude development of land that is projected to be affected by sea level rise. The goal is to ensure that such development recognises and can appropriately accommodate the projected impacts of sea level rise on coastal hazards and flooding over time, through appropriate site planning, design and development control.

Flood Risk Management Guide: Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments

The NSW Department of Environment, Climate Change and Water has issued a report entitled "*Flood Risk Management Guide: Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments",* August 2010.

The report adopts the planning benchmarks of the *NSW Government Policy on Sea level Rise* and provides guidance as to how to apply sea level rise benchmarks to flood risk assessments which are undertaken for flood affected areas.

The Guide states the following:

This guide applies to areas where projected sea level rise is likely to have a discernable impact on predicted flood levels. This includes the NSW Coastal Zone and areas in the vicinity of lower coastal waterways, including rivers, creeks, estuaries and ICOLLs. In particular, this is likely to apply if the land is:

- *likely to be inundated if water levels were 1.0 m above the upper limit of the current tidal range, generally defined by mean high water springs*
- *likely to be inundated if water levels were 1.0 m above the current flood planning level*
- *within 1.5 m of the maximum historic height of the entrance berm or the upper limit for management intervention identified in entrance management plans for any ocean entrance to the waterway which controls flooding (this commonly applies to ICOLLs)*
- *below 4 m AHD.*

The Guide also states:

Where a flood investigation has been prepared, the modeling can be updated to include sea level rise projections or a conservative assumption can be made about sea level rise impacts. Where the site is below 4 m AHD, an appropriate conservative assumption to estimate the 1-in-100 year ARI flood level is to add the sea level rise benchmarks to the 1-in-100 year ARI flood level relevant to the site.

3.8.2 Soil Analysis

Soil data was obtained from a borehole log report prepared by Coffey Environments on the 21-06-2011. Boreholes 17, 16, 12 and 10 correspond to waterway crossing locations 7, 8, 9 and 11 respectively and are available in Appendix G.

In general, the soils at proposed waterway crossings were fine grained, cohesive, highly plastic, clays and sandy clays, with shear saturated shear strengths between 100 and 400 kPa.

A soil sieve analysis for grain size was not made.

3.8.3 Vegetation

Vegetation within the waterways and riparian zones were found to be common between the four waterway crossings. Remnant vegetation adjacent the proposed gas pipeline route on the Shoalhaven floodplain is most likely from forested or saline wetlands, which would have been removed to make way for the railway reserve, train track and agriculture (dairy farming).

Overall condition of existing riparian vegetation was poor with low structural and floristic diversity, significant weed infestation, and exposed soils observed along stream banks.

The main vegetation type found in riparian zones was kikuyu grass with sporadic plantings of native trees and shrubs, mainly at low lying areas downstream on the floodplain.

Waterway vegetation consists mainly of aquatic weeds and reed beds that have grown through the grass lined waterways.

Extensive weed infestations were identified along all of the proposed waterway crossings, which included a number of noxious weeds, listed under class 4 and 5 of the Shoalhaven Local Government Area.

Lantana and blackberry was found at number of locations along the un-named road reserve and waterway crossings. It is recommended that these be removed during work site and haul road preparation to improve overall ecosystem health and allow the re-establishment of native species.

Lantana can be removed by cutting and mulching back into the ground. This method will provide some soil protection following weed removal to reduce both erosion and further weed infestation.

A vegetation management plan (VMP) is generally required to ensure riparian areas are managed appropriately and in accordance with strategic objectives. The VMP outlines management zones and establish guidelines for riparian management, focusing on the required actions to carry out the above recommendations. In addition, the VMP also incorporates site specific measures relating to personnel access, weed management, incident management, ASS, surface drainage and erosion controls.

For the Shoalhaven Starches gas pipeline project, a VMP is not considered necessary due to the proposed route being mainly in road reserves with little to no native vegetation along the route being disturbed. The majority of vegetation being disturbed is Kikuyu grass, which can be replaced by seeding or turfing.

To counteract the lack of a VMP, the ESCP should go into greater detail than normal regarding rehabilitation of disturbed vegetation, making every effort to ensure that disturbed areas are rehabilitated to existing conditions. Areas along the proposed route with native vegetation, such as waterways and road verges that contain shrubs and trees, should be identified in the ESCP and details given of how removed native vegetation will be replaced.

3.9 Erosion and Scour

Fluvial scour and bank erosion was observed at all waterway crossing locations. The majority of scour and erosion has occurred between the proposed waterway crossings and the culvert or bridge in the railway reserve immediately upstream of the crossing points. Limited erosion and scour has occurred downstream of the waterway crossings.

Outlets of culverts and bridges are known areas of significant scour and erosion. The waterway crossings were modelled to estimate the maximum scour depth due to a 1 in 100 year flood event. This is to determine the minimum depth of cover required to mitigate scour impacts on the gas pipeline under the waterway crossings. It should be noted that over time, a balance is reached at scour holes, where the depth remains constant and does not keep on growing, unless a significant morphologic change occurs to the waterway. Eroded sediment is transported from upstream and gets deposited at the scour hole. The 1 in 100 year storm event was chosen since it is used by Shoalhaven Starches for their planning policies.

3.9.1 Scour Depth

There is potential for a buried pipeline to be uncovered at waterway crossings. The minimum depth of burial, or soil cover over the pipeline is stipulated so that damage is prevented to the pipeline. Once buried, the pipeline is to remain in its covered state unless specifically removed.

Determining an adequate amount of cover over a pipeline that crosses under the bed of a waterway requires consideration of the effect of scour caused by the flooding characteristics of the waterway and the floodplain immediately in the vicinity of the crossings. As water flows through a waterway or over a surface, scour or erosion of the surface will occur when conditions are suitable. This is generally dependant on the characteristics of the waterway; materials used to construct the waterway; flow velocity and soil type.

Information from site inspections and desktop studies was used with HY-8 software form the United States Department of Transportation – Federal Highway Administration, to determine the scour potential and minimum depth of cover required between the beds of each waterway crossing. This software is based on the document, ‘Hydraulic Design of Energy Dissipaters for Culverts and Channels’, Publication No. FHWA-NHI-06-086 July 2006 Hydraulic Engineering Circular No. 14 Third Edition which is also used as a reference manual for the Australian Rainfall and Runoff Manual.

This report presents preliminary scour depth modelling results obtained from a simplified deterministic analysis. Sstatistical variance of the storm events, sediment transport, flow rates etc is not considered. Modelling was determined to be feasible, without the need for detailed survey data of the flood plain and waterways, by obtaining relative measurements of bridges and culverts, waterways, railway track and ballast, and undertaking a desktop study to obtain interpolated data from existing topographic maps and soil test results.

It is recommended that probabilistic modelling of scour depth be undertaken as part of the detailed design of the gas pipeline, and results compared with those presented in this report.

The most significant form of scour occurring at the waterway crossings is localised scour at the outlet of bridge/culverts, due to the large catchment coupled with the size of the bridge/culverts, and constriction of the waterways as they flow under the railway track, increasing the velocity through the opening. Peak flow rate calculations for catchments are available in Appendix H

The following assumptions were made for scour depth modelling presented in this report;

- All culverts are 5m wide.
- There is zero fall through bridge/culverts.
- Railway deck above bridge/culvert is level.
- Mannings is constant for banks and channels.
- Waterway cross sections are trapezoidal and level
- Culvert invert is at the same level as the waterway invert.
- Sub-catchments do not join together during large stormwater events.

A sensitivity analysis was made on important waterway variables including longitudinal waterway gradient, waterway bank and channel Mannings numbers, soil Plasticity Index and saturated shear stress. It was found that the most significant variables to affect scour depth are soil Plasticity Index and saturated soil shear stress.

HY-8 recommends an Atterberg limits test to determine the plasticity index (PI) by using the procedure outlined in ASTM D423-36. This test was not done as part of Coffey Environments Soil Analysis Report. The report does give descriptions of the plasticity of the soil. For all waterway crossings the soils were of medium to high plasticity'. HY-8 requires an input between the limits of 5-15 for the Plasticity Index, which corresponds to medium and high plasticity soils.

It is also recommended to obtain Saturated Shear Stress values from a test done in accordance with ASTM D211-66-76. The Coffey Environments soil analysis report shows a pocket petrometer test being done, with values of shear stress ranging from approximately 50kPa to 400kPa along the route. This is an equivalent test to the recommended HY-8 test, ASTM D211-66-76.

A sensitivity test of the Plasticity Index (PI) and Saturated Shear Stress (SSS) with respect to scour depth was made between PI values of 10 and 15, and SSS values from +50 and -50 kPa from values given in the Coffey Environments Bore hole log report. The results of the sensitivity analysis showed that incrementing the HY-8 plasticity Index from 10 to the upper limit of 15 caused the modelled scour depth to increase by approximately 200mm, (5.7%). By altering the SSS results, a 180mm (5.5%) change in scour depth resulted. This can be considered insignificant as a factor of safety will need to be considered which will result in the depth of covers increasing well beyond these values.

Scour depth results are available in Appendix I. A summary table of each waterway crossing is provided in the following section, including calculated scour depth.

3.10 Geomorphic Assessment Conclusions and Recommendations

- Changes to waterway morphology is limited with no major changes to waterways observed in 116 year period.
- Minor morphological changes are occurring at outlets of bridges/culverts under railway tracks, just upstream of proposed waterway crossings.
- The major cause of morphological change is erosion occurring at proposed waterway crossings, from localised fluvial scour at outlet of culvert/bridges.
- Velocity of flow over proposed waterway crossings is above 2.0m/s, at three of the four waterway crossings, meaning there is a very high chance of scour occurring at these locations.
- The lack of healthy, diverse and continuous riparian vegetation along the bank of each waterway within the unnamed road reserve is contributing to bank erosion and instability.
- It is likely that revegetation works within the riparian zone will prevent bank recession continuing due to fluvial scour during small stormwater events.

- Protecting the toe and banks of waterway crossings along the width of the road reserve, increasing groundcover and promoting binding root growth as close to the toe of the bank as possible may be adequate to resist scour.
- The Core Riparian Zones of all waterways at their proposed crossings are highly degraded due to weed infestation, large flows and velocities, and the lack of an appropriate cattle grazing setback. It is recommended that waterway crossings 1 and 2 be classified as Category 3, and waterway crossings 3 and 4 be classified as Category 2, as per the draft Shoalhaven LEP, and section 5.2 of Landcoms Blue Book;
- Category 3 waterways have no CRZ width requirements, whilst Category 2 waterways require a 40m wide CRZ over the waterways with 10m wide vegetation buffer zone either side of the CRZ.
- Table 1 below shows scour depths and expected length of scour hole in meters downstream of culvert/bridge outlet. It can be seen that the calculated scour depths may not be reached at the pipeline crossing, especially if the proposed crossing points are at the outer boundary of the un-named road reserve. Since there is approximately 15m of railway reserve between the culvert/bridge and the common boundary between railway reserve and road reserve, it is estimated that greatest amount of scour will occur mainly within the railway reserve, and possibly decrease in depth as it approaches the waterway crossings.
- From the scour depth results, the minimum pipeline depth of cover at waterway crossing 3 will need to be increased from the minimum 2.0m, to a minimum of 5.1m. The minimum 2m depth of cover under the waterway beds at waterway crossings 1, 2, and 4 should be satisfactory.
- Further variance based modelling of scour at the waterway crossings is required, during detailed design, to take into consideration statistical variance of scour depth variables. The estimated scour hole lengths show that the calculated scour depths may be reached at waterway crossings 2 and 4. See Appendix E for further Detail

Table 1: Summary of Waterway Crossings and Scour Results

Water-way	***Waterway cross-section***			***Long-Grade***	***1%AEP Flow Rate***	***Soil Shear Strength***	***Culvert Outlet Velocity***	***Scour Depth***	***Scour Hole length***
	Depth (m)	***Bed Width (m)***	***Bank Widths (m)***	***%***	***(m^3/s)***	***(kPa)***	***(m/s)***	***(m)***	***From Culvert outlet (m)***
1	0.5	5.0	1	0.3	2.84	100	1.20	0.9	4
2	1.5	6.5	2	0.5	64.4	200	3.06	2.3	12
3	1.0	7.0	1	0.5	132	100	3.72	5.1	30
4	0.8	5.0	1	0.8	30.0	400	2.72	3.4	14

3.11 Site Rehabilitation, Maintenance and Monitoring

Continual site remediation and restoration is required during the proposed pipeline construction process. Progressive re-vegetation, removal of temporary erosion & sediment control measures, and site stabilization requires detailed planning.

Rehabilitation, maintenance and monitoring of the pipeline route shall be established as part of the ESCP. The photographic evidence presented in this report can be used to aid rehabilitation of disturbed sites, back to pre-existing conditions shown in the photos.

A vegetation management plan (VMP) should not be required from a qualified Landscape Architect shall due to the lack of diversified vegetation found along the proposed route and waterway crossings. To ensure adequate rehabilitation of each waterway's CRZ, vegetation rehabilitation and maintenance should be included as part of the ESCP, with all native trees and shrubs along the proposed route identified, and all native trees requiring removal to facilitate pipeline construction identified on the plan. For those areas requiring removal of native species, the ESCP should outline replacement species and their proposed location.

Top soils removed for trenching and work site preparation shall be stockpiled and reutilised over backfilled trenches and at rehabilitated work sites. If required, a top soil mix shall be prepared and approved by a qualified Landscape architect if further topsoil is required for adequate site rehabilitation.

Vehicle waterway crossings are to remain in place for the full rehabilitation period. Once rehabilitation has been established, vehicle crossings shall be removed and the waterways filled and regarded to match upstream and downstream conditions. Jute mesh is to be laid and secured over disturbed waterway crossing locations and the area re-vegetated through the jute mesh. If heavy flows are expected through re-vegetated waterways before adequate vegetation is established to protect the waterway, a temporary bypass around the disturbed waterway may be required, which is to be installed in accordance with the blue book.

Staged construction provides favorable conditions for re-vegetation. Progressive re-vegetation aims to minimize the area of disturbance during construction. Works should be staged and each stage stabilised immediately on completion of trench backfilling, or on removal of stockpiles placed over previously backfilled trenches. Since the majority of disturbed soils are within agricultural land (pasture), the predominant vegetation affected is grass (kikuyu). The most immediately effective method of stabilization is to seed the disturbed area. More information regarding re-vegetation and site stabilization is available in Volume 1, section 7 of the Blue Book.

Maintenance and monitoring of erosion and sediment controls and rehabilitated areas is required on a periodic basis, to ensure the effectiveness of any mitigation measures implemented during and following the completion of the construction phase. Erosion and sediment controls are to remain in place after site works are officially completed, for a period not less than 6 months, or until 75% of the site has been adequately rehabilitated. This is to be decided by the superintendant of the project. The following table gives Monitoring requirements, frequency of monitoring and the person responsible for monitoring and maintenance;

Table 2: Rehabilitation Monitoring Requirements

Monitoring Requirement	Frequency	Responsibility
Erosion & Sediment Control Inspections	Weekly during construction and rehabilitation periods, and immediately after any storm event	Project Environmental Officer
Inspection of Waterways	Fortnightly until completion of entire project	Project Environmental Officer
Inspection of Vegetation	As per Vegetation Management Plan	Landscape Architect
Photographic Evidence (Riparian Zones and Waterways)	Fortnightly	Project Environmental Officer

4 Conclusion

Shoalhaven Starches have proposed to construct a 5.5km coated mild steel gas main to enable competitively priced gas to be sourced for the manufacturing operations at Bomaderry including a proposed gas co-generation plant,. The proposed pipeline will also provide for any future expansion at the Bomaderry site.

This report was written to address erosion and sediment control issues outlined under the heading of Soil and Water in the Director General's Requirements, Shoalhaven Starches Project (MP 10_0108), dated 8th November 2010, as part of the development application process.

Details of legislative requirements, project planning principles, documentation requirements, assessment of constraints and opportunities, site restoration and remediation, and general erosion and sediment control management procedures have been provided in this report.

Erosion and sediment control of linear service projects, such as the Shoalhaven Starches gas main, is legislated in NSW. The legislation relating to erosion and sediment control of service installation projects fall under the development assessment framework and provisions of the Environmental Planning and Assessment Act 1979 which include; Protection of the Environment Operations Act 1997, Water Management Act 2000, and the Fisheries Management Act 1984. Other legislation may affect the project which is listed in section 2.1.
Effective management of erosion and sediment control on linear service installation projects requires addressing planning activities which include developing systems for documentation and communication, assessing constraints and opportunities, preparing an ESCP, restoring and remediating sites and other planning considerations.

The project principal is responsible for ensuring all personnel are made aware of responsibilities for proper environmental management and care. The is achieved through the Environmental Management System (EMS).The principal and/or contractor(s) are required to develop an EMS, which is presented as part of the developers construction environmental management plan (CEMP). The CEMP is an active document, constantly being updated that; outlines environmental objectives and targets, describes how to manage and control the environmental aspects of the project, interfaces with all other plans, describes the overall project management system, and expands on the environmental section of the project business plan.

The CEMP should include the following to identify the aims, actions and outcomes required to meet the project's environmental objectives;

- Description of the principal's or contractor's environmental management system.
- CEMP objectives and targets.
- Risk Assessment.
- Constraints.
- Roles, responsibilities and contact details.
- Environmental controls.
- Monitoring and Compliance. [1]

Stabilised haul roads and machinery storage and stockpile sites are required along the route. These constrain pipeline construction. They require large surface areas to be disturbed and their position is critical for the efficient construction of the gas pipeline. Their location should be planed during the detailed erosion and sediment control plan construction stage. Stabilised work sites will be required at all waterway crossings, with adequate erosion and sediment controls put in place as per the Blue Book.

Since the majority of the proposed gas main route is over flat land, the use of simple erosion and sediment controls can be used. This includes sediment fence and straw bale filters which can be made to form almost any shape or follow any contour, and will divert and filter stormwater runoff. Geo-textile material placed to form temporary table drains can be used to divert water around work sites, and can be reused during later stages of the project.

Steeper sections along the route will also incorporate the same simple controls although additional controls will be required to adequately control runoff. This will depend on the steepness of the trench and how the contours grade around it. On steep sections along the route, check dams, trench stops and bulkheads placed within the trench will stop transportation of sediment and water toward the waterways. Trenches shall be stopped and a check dam installed at the boundary of all CRZs, before reaching the waterways. Appropriate waterway crossing techniques as described in Chapter 2 of this report, which were obtained from Landcoms Managing Urban Stormwater – Soils and Construction, Volume 1 , 4th Edition are to be used.

It is recommended that where possible, excavated soil is placed adjacent to the proposed main trench on the upstream side, so that stormwater runoff will push the soil back into the trench and not into any adjacent waterways. The mound can be used as a diversion drain by placing geo-textile material at the base of the stockpiles.

Location of waterway crossings was discussed. The recommended method of pipeline waterway crossing is by underbore as it will minimize the disturbance to the waterway and surrounding areas, and reduce the re-vegetation and stabilization stages. Trenching across waterways shall not occur.

Staged construction of the proposed gas main is recommended and should be planned for as it not only benefits re-vegetation and re-stabilisation of disturbed areas, it enables efficient management of topsoil, and material stockpiles along the route.

A geomorphic assessment of the four proposed pipeline waterway crossings determined that the waterways had not changed significantly over a 116 year period, and would not likely change during the lifespan of the gas pipeline.

Waterway crossings lacked adequate riparian zones, with cattle allowed to graze right up to the bank of waterways, contributing to the lack of diverse vegetation, and outbreak of weed varieties. Waterways were also choked with aquatic weeds. An adequate core riparian zone should be established at all waterway crossings, in accordance with the Blue Book, as a Category 2 – Terrestrial and Aquatic habitat, to increase bank stability thereby reducing the erosion potential at the site.

An assessment of scour at the waterway crossings was made with HY-8 modeling software. It was found that velocities through the culverts and bridges just upstream of the crossings were high enough to cause scour at the crossing points along the route. The minimum 2.0m depth of cover needs to be increased to take scour into consideration, in accordance with the scour depths calculated and presented under the Heading of Geomorphic Assessment Conclusions and Recommendations.

A rehabilitation, maintenance and monitoring program is to be established prior to construction, utilizing a vegetation management plan to ensure the environment along the route is returned to the same if not better condition it was in before construction commenced. Erosion and sediment controls will need to be maintained for a minimum period of 6 months, and regular site visits also made to monitor the condition of the erosion and sediment controls and determine when the site has stabilised.

5 Recommendations

Based on the site investigation conducted by Allen, Price and Associates, the Shoalhaven Starches gas pipeline project is achievable with the installation and maintenance off simple erosion and sediment controls during construction. To move the project forward with regards to erosion and sediment control of the proposed project, the following recommendations are made ;

- Determine the exact route that the proposed gas pipeline will follow.
- Begin development of the Environmental Management System, and the Construction Environmental Management Plan.

- Prepare Erosion and Sediment Control Plan for the site.
- Prepare Vegetation Management Plan.
- Obtain detailed survey of the entire site, including upstream and downstream floodplain and waterways, and areas beyond the road reserves where sediment laden waters may be carried.
- Undertake variance based modelling to determine scour depth at waterway crossings.
- Ensure all erosion and sediment control requirements will be met by becoming familiar with the legislative requirements relating to Erosion and sediment management of linear service projects.
- Notify land owners along the proposed route of any erosion and sediment controls that require construction on their property. Obtain written permission.
- Discuss requirements with Shoalhaven City Council.

Allen, Price & Associates

13 February 2012

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Appendix A – Figure 1

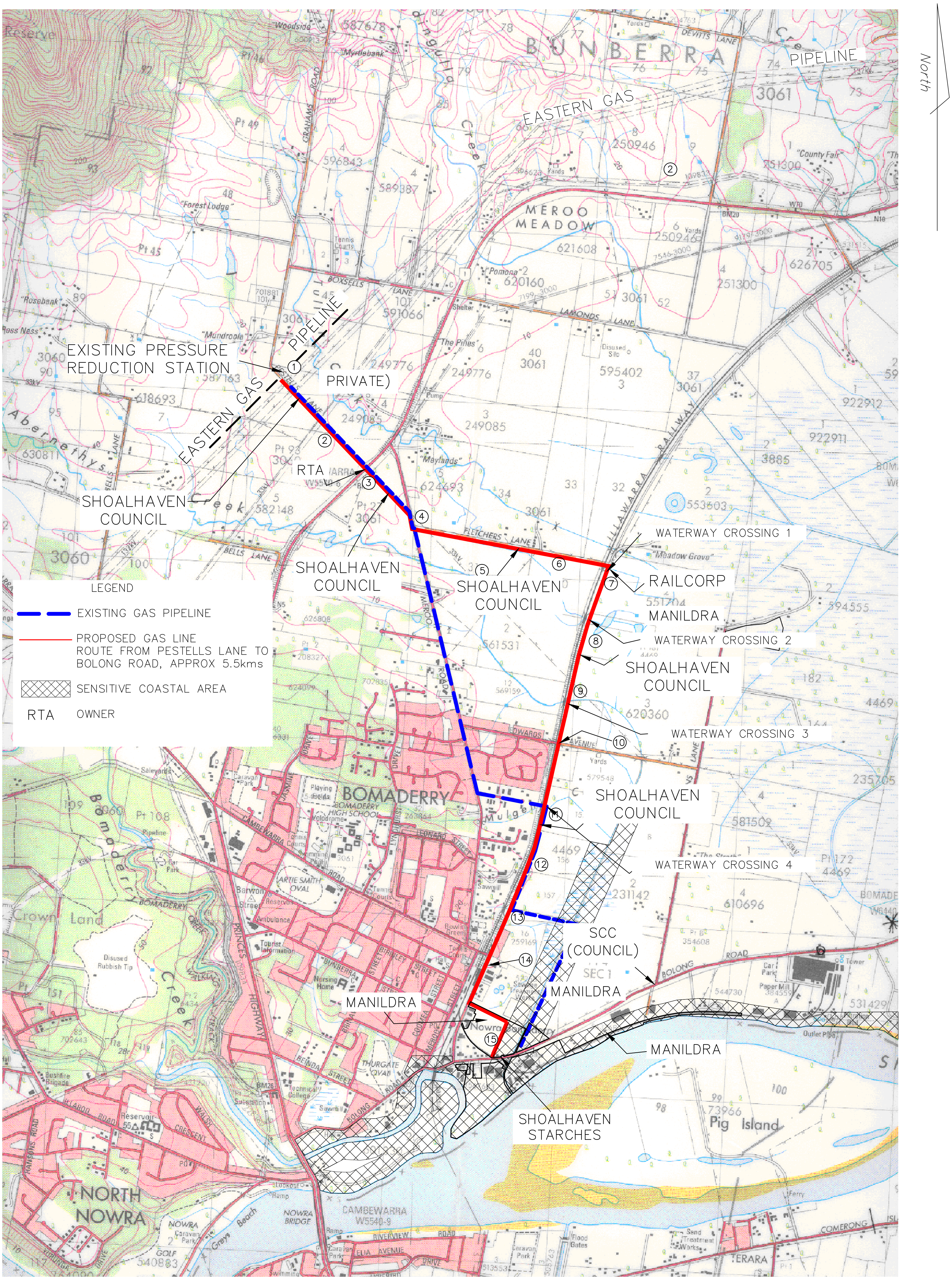

FIGURE 1

FIGURE SHOWING, PROPERTY OWNERS & WATERWAY CROSSINGS ALONG THE PROPOSED GAS LINE ROUTE, FROM EXISTING EASTERN GAS LINE TO SHOALHAVEN STARCHES BOLONG ROAD FACTORY

Rev: 01

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Appendix B – Photographic Investigation of Proposed Route

Appendix B

Photo 1- Eastern Gas Pipeline tie-in point at Pestells Lane (valve and meter station)

Photo 2 Eastern Gas Pipeline tie-in point for existing ActewAGL gas pipeline at Pestells Lane

Photo 3-Pestells Lane verge (south side)

Photo 4-Cattle Loading Station and driveway on Pestells Lane

Photo 5- Existing ActewAGL gas main marker adjacent rural fence at Princes Highway Intersection

Photo 6- Proposed gas main route across Princes Highway

Photo 7- Table drain and culvert on Princes Highway intersection with Pestells Lane

Photo 8- Unformed section of Pestells Lane

Photo 9- Looking down embankment of Princess Highway, along existing gas pipe route

Photo 10- Un-formed Pestells Lane

Photo 11-Intersection of Pestells Lane with Meroo Road

Photo 12-Table drain along Meroo Road

Photo 13- Culvert headwall (bottom right) on Meroo Road and Fletchers lane intersection

Photo 14-Fletchers Lane intersection with Meroo Road

Photo 15-Possible stabilised machinery access and storage area on Fletchers lane intersection

Photo 16- Culvert Headwall and drain leading in Paddock

Photo 17-Open channel drain through paddock on south side of Fletchers Lane

Photo 18- Example of tail-out drains on south side of Fletchers Lane, leading into Open channel drain

Photo 19- Middle of Fletchers Lane

Photo 20-End of Fletchers Lane toward Railcorp railway reserve

Photo 21- Ramp crossing over train tracks at intersection of Fletchers lane and un-named road reserve

Photo 22-Large culvert in Railcorp railway reserve, beyond proposed railway track under-bore location

Photo 23- Gates to Railcorp railway reserve and un-named road reserve

Photo 24a- First waterway crossing, approximately 50m south of ramp over train tracks at end of Fletchers Lane

Photo 24b- First waterway crossing, showing culvert under railway tracks

Photo 24c- First waterway crossing, showing boundary between road reserve and Railcorp rail reserve

Photo 25a-Culvert between first and second waterway crossings for low lying area in rail reserve, adjacent to road reserve

Photo 25b-Vegetation within rail reserve at between first and second waterway crossings

Photo 26a-Low lying area at outlet of second waterway crossing, adjacent to Railcorp rail reserve

Photo 26b-Second waterway crossing, adjacent to Railcorp rail reserve

Photo 26c-Low lying area on approach of proposed gas main toward second waterway crossing

Photo 27a-Scour valve in un-named road reserve adjacent to third proposed waterway crossing, north of Edwards Avenue

Photo 27b-Third proposed waterway crossing, looking north along proposed gas main alignment

Photo 27c- Large railway bridge/culvert at third proposed waterway crossing

Photo 27d- Overhead view of third proposed waterway crossing

Photo 28- Looking north from third waterway crossing, along proposed gas main route

Photo 29- Water main marker at steep approach to Edwards Avenue, in un-named road reserve

Photo 30- Looking north along proposed gas main route in un-named road reserve, toward water main marker

Photo 31- Edwards Avenue crossing point on north side

Photo 32- South side Edwards Avenue crossing in un-named road reserve

Photo 33- Water main infrastructure in un-named road reserve

Photo 34- At gate on crest in un-named road reserve, looking south down into gully to the south of Edwards Ave

Photo 35a- Fourth waterway crossing, looking north, along proposed gas main route

Photo 35a- Approach to fourth waterway crossing, looking north

Photo 35b- Fourth waterway crossing

Photo 35c- Looking along stabilised vehicle track that crosses waterway number three

Photo 36- ActewAGL existing gas main marker on boundary of un-named road reserve, looking south along proposed gas pipeline alignment

Photo 37- Rural fence and gate at end of un-named road reserve and beginning of Railway Street

Photo 38- un-formed section of Railway Street, looking at ActewAGL existing gas main testing station

Photo 39- Railway Street

Photo 40- Water main infrastructure in Railway Street road reserve

Photo 41-Sewer rising main manhole and vent pipe

Photo 42- Water main infrastructure in Railway Street road reserve

Photo 43-Water main, power pole and existing gas main infrastructure in Railway Street

Photo 44- Beginning of sealed section of Railway Street

Photo 45- Stormwater headwall and culvert in Railway Street

Photo 46a- Scour valve shown with Large pipe culvert in background leading into drainage system under Railway Street

Photo 46b- Large pipe culvert in rail reserve on west side of Railway Street

Photo 46c- Small headwall for pipe culvert under Railway Street, taking stormwater from large pipe culvert shown in previous photo.

Photo 47- East side Railway Street road reserve-

Photo 48- West side Railway Street road reserve showing water main marker

Photo 49- Railway Street

Photo 50- Looking at Cambewarra Road intersection with Railway Street

Photo 51- Infrastructure at intersection between Cambewarra Road and Railway Street, on west side road reserve

Photo 52- Example of Railway Street Infrastructure in west side of road reserve

Photo 53a- Stormwater infrastructure in rail reserve on west side of Railway Street

Photo 53b- Stormwater infrastructure under road reserve beginning on west side of Railway Street, leading into pit on east, shown in following photo 53c

Photo 53c- Stormwater pit on east side of Railway Street

Photo 54- Open channel drain through lot 1 DP825808 Railway Street, taking water from pit shown in previous Photo.

Photo 55- Headwall and culvert under Railway Street, at direction change of proposed gas main

Photo 56- Sewer pipe through open channel drain in lot 1 DP825808