Venton & Associates Pty Ltd.

High Level Risk Assessment

Sydney to Moomba Gas Pipeline within the Wilton Junction Precinct

Client:
Wilton Junction Landowners' Group

Date:
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1 Introduction

1.1 Purpose

On 2 May 2013, the then NSW Department of Planning and Infrastructure (now known as the Department of Planning and Environment) issued the Director General's study requirements for the Wilton Junction State Environmental Planning Policy.

The Key Study Requirements at item 18 (Infrastructure, Servicing, Staging and Delivery) required the preparation of a high level risk assessment for the Sydney-Moomba gas pipeline within the Wilton Junction Precinct.

This report, which has been prepared by Peter Brennan from Elton Consulting and Philip Venton from Venton & Associates (refer to **Annexure A**) addresses that requirement and provides an initial high level risk assessment for the Moomba-Wilton gas pipeline and the Moomba-Botany ethane pipeline within the Precinct.

1.2 Background

The Moomba-Sydney Pipeline network (MSP) is a 2,030km pipeline comprising of 1,300km of DN 850 (34") pipeline (Moomba to Wilton) and 730km laterals that link the Cooper Basin gas fields at Moomba in South Australia with distribution networks in Sydney and regional New South Wales. This network is owned by the APA Group. The APA ownership terminates at Wilton. Jemena Gas Networks own and operates pipelines from Wilton to Horsely Park for distribution to Sydney and north to Newcastle.

A smaller DN 200 (8") high pressure ethane pipeline is installed on the Moomba-Sydney pipeline easement, parallel with the DN 850 pipeline and approximately 12 metres from it. The ethane pipeline is owned by Qenos. The APA Group is contracted to undertake the operation and maintenance of the pipeline. Notwithstanding this, the pipeline Licensee is responsible for the ultimate safety of the pipeline in accordance with the design and operating Australian Standard (AS 2885).

The MSP is located in an easement approx. 24m wide and transects the Wilton Junction Precinct in the south, across Picton Road and in a north east direction to Bingara Gorge and then within a buffer eastwards to Wilton.

There are two pipes within the easement each approx. 6m from the edge – ethane and natural gas. The pipes are constructed of steel and are buried about 750mm to about 1.2m underground.

The gas pipeline is 864mm OD with a maximum allowable operating pressure of 6,895kPa. The ethane pipeline is 219mm OD, with a maximum allowable operating pressure of 14,895kPa.

The natural gas pipeline was completed in 1976 and the thickness of the pipe was designed at the time for rural locations, not urban residential development. Residential locations require increased pipe thickness and possibly additional protection.

High pressure steel gas pipelines are required to be designed to meet Australian Standard, AS 2885.0-2008, Pipelines – Gas and petroleum – General requirements (AS 2885).

AS 2885 defines a risk assessment process (Safety Management Study) to demonstrate that identified threats to the pipeline integrity are controlled through a combination of design (external interference protection) and procedural controls. The controls are required to reduce the risk from each identified threat to LOW or NEGLIGIBLE. If this is not possible, the SMS must demonstrate that the risk is as Low As Reasonably Practicable.

AS 2885 includes specific requirements for safety where it is installed in populated (high consequence) areas based on the anticipated use of the adjacent land.

This involves establishing the existing and future land use and classifying the land use into one of four location classes as follows:

» Rural (R1) Land that is unused, undeveloped or is used for rural activities such as grazing, agriculture and horticulture. Rural applies where the population is distributed in isolated dwellings.

» Rural Residential (R2) Land that is occupied by single residence blocks typically in the range of 1ha to 5ha or is defined in a local planning instruments rural residential or its equivalent. Land used for other purposes but with similar population density shall be assigned rural residential location class.

» Residential (T1) Land that is developed for community living. Residential applies where multiple dwellings exist in proximity to each other and dwellings are served by common public utilities. Residential includes areas of land with public infrastructure serving the residential use; roads, railways, recreational areas, caravan parks, suburban parks, small strip shopping centres. Residential land use may include isolated higher density areas provided they are no more than 10% of the land use. Land used for other purposes but with similar population density shall be assigned Residential location class.

» High Density (T2) Land that is developed for high density community use. High Density applies where multi-storey development predominates or where large numbers of people congregate in the normal use of the area. High density includes areas of public infrastructure serving the high density use; roads, railways, major sporting and cultural facilities and land use areas of major commercial developments; cities, town centres, shopping malls, hotels and motels.

Additional land use categories including Sensitive, Industrial, and common infrastructure are also defined to recognise localised development within one of the four primary land use categories, and assigns safety requirements for these location “sub-classes” taken from one of the primary location classes.

AS 2885 mandates that the pipeline must be protected from external interference. It requires a minimum number of physical and procedural protection measures to be adopted to achieve this in each location class. As the land use increases in population density across each location, further measures are required.

2 Key Issues

The land in the Wilton Junction Precinct area in the vicinity of the pipeline was classified as Rural (R1) when the pipelines were designed and constructed. In rural areas the threats to a buried pipeline are minimal and the consequence of a failure usually does not include a threat to life.

2.1 Change in classification

Consequently the pipe thickness was selected for pressure containment only and not resistance to penetration. A change in classification of the adjacent land to Residential (T2) and High Density (T2) as envisaged by the Wilton Junction Masterplan will require the pipelines to be classified as not being capable of being ruptured by a credible threat. Also, the maximum potential release from any loss of containment must be restricted to 10 GJ/s (residential) or 1 GJ/s (any sensitive area). These requirements are to reduce risk from the pipeline to the community from any loss of containment.

2.2 Risk management issues

1. To satisfy these additional safety requirements an existing pipeline must usually be further protected. Physical measures include by burial, barrier or exclusion (eg. fencing) and resistance to penetration by pipe wall thickness, use of concrete slabs, concrete encasement and other physical protective measures. For example, in Bingara Gorge a significant amount of encasing and construction of concrete slabs had to be undertaken.
2. Other strategies to guide the location of infrastructure can be developed to improve safety outcomes such as locating where possible roads and open space closer to the pipelines and locating infrastructure such as schools, child care, hospitals, aged care facilities and any other area where a large number of people may be present for a limited period (eg. sports fields) further from pipelines.
3. Site planning can provide for the construction of buildings as far as possible from the boundaries of the easement to allow for excavation and the future maintenance of the pipeline.

   If the land is rezoned and a higher location classification applied, additional signage will be required. Typically the spacing of signage in the R1 and R2 areas will be reduced from 500m and 250m to 100m and 50m in the T1 and T2 zones.
4. A residential development may also require the Licensee to install additional isolation valves to satisfy the valve spacing in AS 2885 (from “as required” in R1 locations to 15km in T1 locations).

It should be noted that:

1. APA and Qenos negotiated a range of additional protection measures to be applied to the pipelines on the north side of Picton Road to accommodate the Bingara Gorge residential development.

2. The installation of an additional isolation valve was not required in relation to the Bingara Gorge residential development not withstanding a change in classification of the land to residential.

3. Should the proposed Maldon-Dombarton railway proceed, significant modification is likely to be required for each pipeline, including relocation by lowering to accommodate the rail grade. Should this happen in the timeframe for development of the Wilton Junction area, the cost impacts to satisfy pipeline safety requirements associated with the land development may be considerably reduced, compared with it being developed independently of the railway.

3 Consultation

A meeting was held with representatives of the pipeline Owners (APA and Qenos) on 17 July 2013 and an overview of the Wilton Junction Project was provided to them.

The key issues were identified and discussed generally as follows:

» Risk impacts are significant if the pipeline ruptures. The impact will be on the adjacent area up to 100's of meters (could be between 500-800m).

» The owners will not support sensitive uses near the pipeline, such as child care, aging, hospitals.

» Urban development results in a significant amount of money to retrofit the pipeline. The pipeline owner will always seek to recover this cost from the developer, particularly where the development involves a change in land use from that for which the pipeline was designed.

» The existing pipelines are designed for Rural land use. If the land use was changed to a higher density then each pipeline would need to be protected to achieve the safety level consistent with that land use to be achieved. In Bingara Gorge a significant amount of mechanical protection by concrete encasing and concrete slabs had to be undertaken, while at road crossings the pipelines required inspection and in the case of the DN 850 pipeline, recoating, followed by mechanical protection by a load bearing concrete slab. Additional Signs were also required to be put up.

» Separation requirements between the existing pipeline and land development infrastructure introduce challenges in the land development design, particularly in sloping land such as the Wilton site.

» From a risk mitigation point of view if the rezoning is approved then it may be necessary to install another isolation valve on the ethane pipeline, because the land use change to residential requires (AS 2885.1) isolation valves to be installed no greater than 15km apart in residential areas. Currently the closest valve upstream of Wilton on the ethane pipeline is 40km. The MSP may be similarly affected.

» If it was found that a new isolation valve was required to be installed on the ethane pipeline, it may cost $4-5m, and pipeline owners will require the pipeline section to be completely depressurised for the installation. This can only be done when the plant at Botany is shut down for maintenance.

» The gas pipeline capacity is contracted, and there is no opportunity for the pipeline owner to recover unanticipated costs from the gas "shippers". Consequently the rezoning application is something that is going to cost money and effort for no return to the pipeline owner. Consideration should be given by the developers to support the additional costs/works at DA stage.

» There are currently no industry wide statutory controls in relation to planning around gas lines. The Australian Pipeline Industry Association (APIA) has been trying to inform the planning authorities and raise the level of safety.

» Industrial and employment land uses are seen in the same manner as residential uses from a risk mitigation point of view.

» Important to show the whole easement on the Wilton Junction plans so it informs every one of the existence and location of the easement.

» APA deals with each project on a case by case basis, even though there may some general policies in place.

» The pipeline companies may need to excavate the pipeline to maintain it at some time in its life. Excavation safety standards and the depth of the pipeline invert necessarily mean that the width of the excavation at the surface is large. Consequently it is undesirable to have structures built close to the easement boundary.

The pipeline owners (APA and Qenos) indicated that they generally do not consider the risk mitigation measures and cost implications in any detail at the strategic planning level stage. These will be considered via a Safety Management Study with the developers at the DA stage (subdivision), when the detailed land development design is available for consideration.

The general guidance taken from the initial meeting will be used in formulating more detailed concept development plans by the developer.

4 Risk Mitigation Management

The Wilton Junction proponents based on the study assessment and consultation determine the risk mitigation measures, to be undertaken at the DA stage as follows:

a. Meet with and liaise with APS and Qenos to discuss in detail the development plan.

b. Liaise with APA and Qenos and negotiate the installation of additional protection to each pipeline, assumed at the planning stage to be a concrete slab, 100mm thick cast over each pipeline and buried nominally 300mm below the surface, and width equal to the pipe diameter + 900mm, together with additional signage.

c. Special protection will be required at road crossings, expected to require a load bearing slab over the pipeline, and inspection and treatment of the pipeline coating.

d. The landowners further discuss the general design principles to minimise interference of the pipeline by the development and associated infrastructure.

e. The landowners will use these principles in assessing the cost of the development.

f. The pipeline owners to undertake a formal Safety Management Study (SMS) of the development at concept stage. Should the re-zoning be approved, the concept will be developed, and at that time, the land owners will participate with the pipeline owners to undertake an SMS that will consider the plan and define the design changes needed to maintain pipeline safety.

g. Advice will also be sought from the pipeline owners in relation to the following:

    i. Whether following a rezoning it may require either pipeline to install an additional isolation valve to satisfy its obligations under AS 2885, and if so, an approximate cost.

    ii. Their requirements for working over the pipeline so that an estimate of the cost of the protection measures can be determined or alternatively, the pipeline owners can provide an estimate?

    iii. Whether the development of the railway will require modification of the pipeline, and if so, whether this could be used as an opportunity for a more cost effective design of the protection for the development.

5 Conclusions

The Moomba-Wilton gas pipeline and the Moomba-Botany ethane pipeline are located in an easement approx. 24m wide and transects the Wilton Junction Precinct in the south, across Picton Road and in a north east direction to Bingara Gorge at Condell Park Road and then travels in an easterly direction towards Wilton.

There are two pipes within the easement each approx. 6m from the edge – ethane and natural gas. The pipes are constructed of steel and are buried about 750mm to about 1.2m underground.

The gas pipeline is 864mm OD with a maximum allowable operating pressure of 6,895kPa. The ethane pipeline is 219mm OD, with a maximum allowable operating pressure of 14,895kPa.

The natural gas pipeline was completed in 1976 and the thickness of the designed at the time for rural locations. External threats to the pipeline integrity and risks to people, property and the environment were also based on its rural location.

High pressure steel gas pipelines are required to be designed to meet Australian Standard, AS 2885.0-2008, Pipelines – Gas and petroleum (AS 2885).

AS 2885 defines a risk assessment process (Safety Management Study) that provides for a pipeline to be designed in a manner that mitigates threats to the integrity of the pipeline and limits consequences to the environment around, based on the anticipated use of the adjacent land.

The rezoning of the land within the Wilton junction Precinct will result in the location classification of the land traversed by the pipeline to be increased from Rural (R1 and R2) to Residential (T1) and High Density (T2).

This will necessitate the existing pipelines to be further protected. This additional protection is likely to in the form of penetration barriers as specified in AS 2885 such as concrete slabs having a minimum thickness of 100 mm, a minimum width of the nominal pipe diameter plus 600mm and placed a minimum of 300 mm above the pipeline; or concrete encasement having a minimum thickness of 150mm on the top and sides of the pipeline.

AS 2885 allows for other types of penetration barriers and the most appropriate protection will be determined in consultation with the owners of the pipeline.

The location of infrastructure will be designed to improve safety outcomes such as locating where possible roads and open space closer to the pipelines and locating infrastructure such as schools, child care, hospitals, aged care facilities and any other areas where a large number of people may be present for a limited period such sports fields, further from the pipelines.

Site planning can provide for the construction of buildings as far as possible from the boundaries of the easement to allow for excavation and the future maintenance of the pipeline.

Additional signage will also be provided.

It is not considered practical at this stage for the pipeline owners to undertake a detailed Safety Management Study (SMS) of the development because it is still at concept stage. However should the re-zoning proceed, it is proposed to undertake a Safety Management Study (SMS) at that time. The landowners will participate with the pipeline owners to undertake an SMS that will consider the plan for Wilton Junction and define the design changes needed to maintain pipeline integrity and safety.

Further negotiations will held between the pipeline owners and the land owners on all aspects of the protection of the pipeline including contribution of costs at DA stage.

Appendices

A Philip Venton Curriculum Vitae

A Philip Venton Curriculum Vitae

PHILIP B VENTON

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E-Mail: phil @ventonassoc.com.au

DATE OF BIRTH: 5 November, 1947

NATIONALITY: Australian

EDUCATION AND QUALIFICATIONS: BE (Chemical), University of Queensland 1969

Chairman – Standards Australia Committee ME-38 : AS 2885 Pipelines: gas and liquid petroleum

Chairman – Standards Australia Committee ME38-5: AS 2885 Pipelines: gas and liquid petroleum Part 5: Field pressure testing

Chairman – Standards Australia Committee EL1-023: Electrical Hazards on Metallic Pipelines

Lead Advisor – Energy Pipelines Cooperative Research Centre – Program 3 – Design and Construction

KEY EXPERIENCE

Phil has 38 years experience in high pressure oil and gas pipeline system design, operation and commissioning, and has particular experience in the design and operation of long distance slurry transport pipelines.

His experience includes two years engineering and maintaining a natural gas transmission pipeline and associated compression, and 36 years of conceptual and detailed design of high pressure pipeline systems including construction management and pipeline system commissioning.

Phil currently works through Venton & Associates as an independent high pressure pipeline consultant. He managed the engineering of natural gas transmission pipelines to Tasmania and NSW from Victoria for Duke Energy. He is current chairman of the Australian Standards Committee for petroleum pipelines, and until recently, of the design subcommittee. He works with other specialists where required to provide complete feasibility study, cost estimating and project design services.

Prior to his time with PG&E, he was Principal Engineer with Worley Pipeline and Terminals Division and Engineering Manager and Principal Pipeline Engineer with CMPS&F Oil and Gas Division. In these positions he was responsible for project feasibility studies, conceptual and detailed design and project management for a range of oil and gas pipelines and associated facilities.

Prior to entering the pipeline industry, Phil was project engineer and production manager for a soap and speciality chemical manufacturer.

AREAS OF PARTICULAR EXPERTISE

- Project and design management
- Transmission pipeline system conceptual, hydraulic and detailed design
- Pipeline risk assessment
- Slurry pipeline system process and detailed design and operation analysis
- Commissioning.

PROFESSIONAL EXPERIENCE

December 1997 –

Venton & Associates - Consultants, high pressure gas, oil and slurry pipelines.

- Ok Tedi Mining Ltd – Design, construction supervision, commissioning – 130 km tailing slurry pipeline.
- Klohn Crippen Berger – Options Study – Tailing Pipelines – Porgera mine.
- Klohn Crippen Berger – Tailing pipeline – Hidden Valley mine.
- Unsteady state pipeline hydraulic modelling – project development studies for various clients.
- APP – Validation - Adelaide Desalination Plant – system hydraulics and piping advice.

- Magellan Gas Pipeline – Venton & Associates – Project Designers.
- Papuan Oil Search – Export pipeline life extension project study and analysis.
- Zektin Engineering – Technical advisor – QGC project FEED.
- Origin Energy Resources – Hydraulic design services associated with APLNG project.
- Ok Tedi Mining Limited – High Sulphur Tailing Pipeline feasibility study and detailed pipeline design, construction technical support and commissioning.
- SEA Gas Pipeline – Fracture Control Plan revision.
- Safety Management Study to AS 2885 – Facilitation for various clients.
- NP Power – Concept design, capital cost estimate, route selection and project approvals for 175 km gas pipeline Port Hedland-Spinifex Ridge Mine.
- Central Ranges Project Management – Engineering advisor – Central Ranges Gas Pipeline.
- Australian Pipeline Trust – Venton & Associates – Optimised replacement cost study – Roma-Brisbane pipeline.
- McConnell Dowell Constructors - Pipeline Risk Workshop facilitation, various projects.
- Gas transmission pipeline capacity unsteady state modelling for peaking power station in Newcastle area (Moomba-Newcastle).
- Oil Search Limited - Gas transmission pipeline unsteady state modelling – PNG Gas export concepts.
- Oil Search Limited – Pipeline Life Extension project
- Pipeline project development, cost estimating, fracture control, route selection for various clients.
- Delco Australia Pty Ltd – Kambalda-Esperance Pipeline – pipeline design and risk assessment
- Spie Capag Lucas JV – SEA Gas Pipeline – Pipeline engineering consultant, design and risk assessment
- Clough Engineering – Fracture control plan – Yolla gas pipelines
- Slurry Systems Pty Ltd – Goro Nickel Project – pipeline design advice
- Capital Project Services – Macgen Lateral – Fracture control plan
- Duke Energy Tasmanian Gas Pipeline – Consultant.
- Duke Energy International – Engineering Manager – Eastern Gas Pipeline and Tasmanian Gas Pipeline (initially consultant, then term employee).
- Cardno & Davies – Technical advice – Tweed river sand bypassing scheme.
- EAPL – Optimised replacement cost – EAPL pipeline network.
- Epic Energy – Dampier-Bunbury MAOP Upgrade project – fracture risk and project direction analysis.
- Kinhill – Optimised design of Wagga and Albury gas distribution networks.
- A J Lucas -Tender design – Tweed river sand bypassing system.
- OK Tedi Mining Limited - Failure analysis & design review – OkTedi Tailing pipeline project.
- Ok Tedi Mining Limited – Tailing pipeline preliminary design and cost estimate.
- Worley Ltd. - Asset condition assessment, Transmission Pipelines Australia.
- Worley Limited - Coastal Gas - Hydraulic analysis and cost estimating - PG&E Sale.
- CMPS&F - Design review, Ramu Slurry pipeline feasibility study.
- Bechtel-Minproc – Cadia Project, Tailing pipeline installation quality advice.
- Century Minenco Bechtel – Engineering advice, concentrate slurry pipeline. Operating Philosophy, and review of contractor design.
- Worley - Epic Transmission (WA) - Dampier-Bunbury gas pipeline MAOP upgrade.

1997 - 1997

PG&E Corporation, Australia

Principal Project Engineer

Responsible for engineering services supporting the evaluation, development, design and construction of pipelines and associated facilities for PG&E Gas Transmission Australia.

1996 - 1997

Worley Limited

Principal Engineer- Pipelines & Terminals

Philip's role is to provide technical leadership for the Pipelines & Terminals Division in the areas of high pressure oil, gas and slurry pipeline systems.

- Project Manager for a revised feasibility study for the 110 km Ok Tedi gravity tailing pipeline.
- Preliminary engineering and cost estimating for the proposed 1500 km Swan natural gas pipeline.
- Gas pipeline hydraulic and commercial analysis for a range of gas pipeline opportunities considered by PG&E.
- Preliminary design and capital cost estimate for Gold Ridge gravity tailing pipeline.

1989 -August 1996

CMPS& F Pty. Limited.

Engineering Manager and Principal Pipeline Engineer.

Major project work includes:

Gas Pipelines

- Project Manager for detailed feasibility study of 1375 km Moomba to Sydney dense phase ethane pipeline for the Pipeline Authority (1993). Responsible for initial phase of detailed design of this pipeline, and technical advice to project team through final design.
- Project Manager for detailed feasibility study of 1378 km Goldfields Gas Pipeline for Western Mining in WA (1993/4).
- Engineering Manager, Goldfields Gas Pipeline, responsible for initial engineering project office establishment, long lead item specification, compression studies, project studies, and ongoing engineering technical advice to project (1994/95).
- Project Manager, Cost Studies, Longford to Wilton gas transmission pipeline alternatives, undertaken for BHP Petroleum (1994).
- Project Manager for feasibility study of 250 km Moomba to Olympic Dam natural gas pipeline, undertaken for WMC (1994).
- Project Manager for feasibility study of 250 km Moomba to Olympic Dam natural gas pipeline undertaken for WMC (1994).
- Technical advice to tender for Pipelines Authority of South Australia sales (1995).

Hydrocarbon Pipelines

- Design Options Studies for South East Gobe Development, PNG (1993/94).
- Lead Engineer for Kutubu Export Pipeline Pump Station, and pipeline commissioning engineer (1992/3).
- Study for LPG transport pipeline, Botany Bay to Western Sydney (1992).
- Tender design for multiproducts pipeline from Sydney to Canberra (1992/93).

Slurry Transport Pipelines

- Feasibility study, 100 km, 100,000 t/d tailing pipeline for Ok Tedi, Mining Limited.
- Pipeline audit for Freeport Indonesia copper concentrate pipeline within Australia (1995).
- Conceptual detailed process design, design audit and commissioning of Bayswater Power Station Ash Disposal System. This is a world first design transporting 300 t/h of flyash at 72 per cent concentration over a distance of 10 km for disposal using sloped disposal technology (1993-95).
- Pipeline audit for Ok Tedi Mining Limited 150 km copper concentrate pipeline (1992/95).
- Feasibility study for 150 km lead zinc concentrate pipeline for BHP Minerals (1994).
- Feasibility study for 30 km long, 100,000 t/d ore transport pipeline for Placer Pacific. The pipeline considered energy recovery turbines and electricity generation and choke station alternative to dissipate excess static head (1992).
- Project Manager and design leader for tender design for 100 km high pressure sewage sludge pipeline system transporting sludge from Sydney's ocean outfall sewage treatment plants to an inland recycling facility (1989/90).

Petroleum Facilities

- Project Manager for tender design of LPG storage bullet project at Shell Clyde Refinery for Eglo Engineering (1992).
- Project Manager for FEED package, Gore Bay Heating and Pumping systems upgrade (1993/94).

- Design Manager for feasibility study design and cost estimate for PNG Oil Refinery offplots facilities (1992/3).

Other Facilities

- Project Manager and design leader for tender design and turnkey contract for positive displacement mine dewatering pump station, Pasminco South Mine (1989), and subsequent design audit of successful contractor for pump station and rising main (1990).
- Project Manager and design leader for underground positive displacement pump station and 600m single point suspension rising main for KCGM Fimiston mine (1993).
- Design leader for 600m single point suspension rising main for Olympic Dam mine using FRP pipe (1996).

1983 - 1989

Slurry Systems, Sydney

Principal Engineer

Responsible for development, testing, engineering and commissioning of pipeline transportation systems. Projects undertaken during this time included:

- Design of Sand Bypassing system to be installed at Dawesville Channel, by Department of Marine and Harbours, Western Australia.
- Technical review of the operation of the 155 km Ok Tedi Copper concentrate slurry pipeline including on-site supervision of pipeline cleaning operation and advice for pipeline upgrade.
- Study for Dallhold Nickel Management investigating the feasibility of transporting nickel ore between New Caledonia and North Queensland as a slurry. Responsible to project consultants for pipeline engineering including on site pilot plant testing.
- Design and tendering for various slurry handling projects including an 80 km mineral sand pipeline in South Africa.
- Technical investigation and advice regarding the operation of a high concentration tailings disposal system for Argyle Diamond Mines.
- Feasibility of unloading of bulk ship by slurry means, and transporting the material for disposal as landfill.

Project Manager responsible to the Slurry Pipelines (PNG)/Curtain Bros (PNG) Joint Venture for a 155 km high pressure copper concentration pipeline designed and constructed for Ok Tedi Mining Limited, Papua New Guinea. This “fast track” project was designed and constructed during 6 months of 1986 and was commissioned in June, 1987. Responsibilities included design, pump station and terminal facilities construction, pipeline construction supervision, commissioning and performance testing. The design work was completed in Sydney, and other work was undertaken on site.

Project Manager responsible to the turnkey contractor for design, engineering, construction, supervision and commissioning of a buried high pressure ironsands slurry pipeline in New Zealand. This project was a world first, and included a number of significant technical developments. It was successfully commissioned in February 1996, and was demonstrated to operate at the guaranteed throughput and specific energy consumption.

Responsible for technical aspects (including process control) for the Nerang River Entrance Sand Bypassing Scheme. This project automatically to transfer littoral drift sand across the Gold Coast Seaway preventing sandbar formation. The installation is recognised as the world’s first sand bypassing scheme.

1982 - 1983

Slurry Systems

Senior Engineer

Responsible for various design and development projects including:

- Supervision of pilot plant test program for coal washery refuse and high density power station ash disposal by the sloped disposal technique.
- Analysis of operating performance of Queensland Cement slurry pipeline after three years of successful operation.
- Design for tender of a 150 km natural gas pipeline in Central Australia.
- Project Manager responsible for conceptual design and detailed feasibility study of a 220 km, 8 mt/a coal slurry pipeline system in Southern Queensland.

1976 to 1982

Williams Brothers -CMPS Engineers.

Slurry Engineering Manager

Responsible for slurry transportation projects undertaken by Williams Brothers - CMPS

Engineers. Work included studies on coal slurry transportation for the State Electricity Commission of Queensland other clients.

1978 - 1981

Project Manager and Commissioning Supervisor of a 24 km limestone slurry pipeline for the Queensland Cement and Lime Company. This pipeline was successfully commissioned in August 1981.

1978

Seconded to slurry systems group, Williams Brothers Engineering Company, Tulsa, Oklahoma for one year. Engaged in design, feasibility studies and stabilised slurry research.

1976 - 1978

Project Engineer of Slurry Group responsible for the definitive design, specification, route location and cost estimation for a limestone slurry pipeline in Queensland; involved in a number of economic studies slurry pipelines proposed within Australia and involved in field commissioning of the Moomba to Sydney Natural Gas Pipeline.

Commissioning of fired heaters, separators and metering for natural gas distribution station in the Sydney metropolitan area.

1974 - 1976

Associated Pipelines Limited, Brisbane

Pipeline Engineer

Responsible for engineering operation of the Roma - Brisbane Natural Gas Pipeline. This included responsibility for design and construction of additional facilities including gas compression and gathering system extensions, also corrosion control, including design and extension to cathodic protection facilities.

1970 - 1974

Campbell Brothers Limited, Brisbane

1973 - 1974

Production Manager, responsible for a staff of 40 manufacturing wide range of detergents, soaps, chemical specialities and refractories.

1973

Project Manager, responsible for a three month project to establish a branch office and manufacturing plant in Adelaide.

1970 - 1973

Project Engineering responsible for feasibility studies, design and construction of a range of chemical manufacturing plants.

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