Submission to Inland Rail Preferred Infrastructure / Amendment Report
22nd September 2022

1.0 Background

I am a nationally and internationally registered professional civil engineer. I have been a consulting engineer since 1981and have been running my own consulting practice in Narrabri since 1983. My CV is **Attachment 1**.

I first got involved in the Inland Rail (IR) Route near Narrabri when local businessman, Tim Logan, showed me the proposed route corridor in early 2018. Tim had studied the proposed Inland Rail Route and came to my office to ask for my comments. Given that my specialty is Water Resources, my immediate reaction was that placing a new rail line across the Namoi River floodplain immediately downstream of Narrabri Town was madness. My comment was "you have to be kidding, what were they thinking?"

Four years later after reviewing the Preferred Infrastructure / Amendment Report my attitude has not changed.
The proposed IR Route is in the wrong place for the last 40 kms coming to Narrabri and should be shifted.
.
I have been to at least 8 IR Community Consultation sessions in Narrabri since December 2020 and discussed the issues wrong with the IR Route at Narrabri to:

- Rebecca Pickering, Interim CEO IR;
- Duncan Mitchell, Pre-Contracts Director – Southern Program;
- IR Engineer, Joel Acosta;
- IR Engineer, Ryan Noonan; and
- IR Engineering Manager, Brad Godfrey.

The consistent response from all IR staff has been "The route is set and will not change".

We therefore formed The Narrabri Inland Rail Concerned Residents Group to focus our efforts to have the Narrabri Alternative Route assessed against IR's proposed route for the last 40kms of the track.

2.0 Work to Date

We prepared detailed maps showing the IR proposed route and the Narrabri Alternative Route for the line from Leewood on the northern edge of the Pilliga Forest to Murrumbilla Lane north of Narrabri (see **Attachment 2**).
Once the Narrabri Alternative Route was refined and we were able to inspect most of it on-site, we completed the following comparisons between the routes:

- A capital construction cost difference;
- The length;
- The flood impacts;
- The number of dwellings impacted;
- The number of houses required to be purchased;
- Bridge lengths;
- The number of bends;
- Traffic impacts in Narrabri; and
- The need for the IR route to go over Knight's Hill.

Attachment 3 provides a detailed comparison of the two routes.

The Narrabri Inland Rail Concerned Residents Group also funded a Flood Impact Study by WRM -Water + Environment, from Brisbane to determine the required bridge and culvert details for the Narrabri Alternative Route. This study not only resulted in a shorter bridge but was also able to show that no NSW Department of Planning and Environment (DPE) Quantitative Design Limits (QDL's) were exceeded for afflux or flood duration in either the 1% AEP or 0.5% AEP floods. The WRM study is included as **Attachment 4.**

The Narrabri Group also funded a Rail Engineering Consultant from Brisbane to check the likely construction cost difference between the Narrabri Alternative and the Current IR Alternative Route between Leewood and Murrumbilla Lane. A construction cost saving of around $200 to $220m has been identified.

3.0 The Preferred Infrastructure / Amendment Report

I have read the Preferred Infrastructure / Amendment Report completed by IR.
Despite my attendance at least 8 IR Community Consultation sessions which included two private meetings with Duncan Mitchell and providing detailed mapping and comparisons of the IR Route and the better Narrabri Alternative Route, **the Narrabri Alternative Route was not even mentioned in the above report.**

This seems completely contrary to the NSW DPE request in their letter of 30 April 2021 from Glenn Snow to Ms. Sarah Connelly of ARTC which stated in the third paragraph:

- "The PIR must also provide appropriate justification and information on the design of the project and alternative rail alignments considered, particularly in proximity to the towns of Narromine and Narrabri, where substantial residual flooding impacts are predicted, and how these alternatives were analysed to inform the selection of the preferred option. Design alternatives must also be provided demonstrating how residual flood impacts can be reduced."

IR have not only ignored the Narrabri Community but also NSW DPE.

4.0 Conclusion

The Narrabri community alerted IR on 22nd March 2018 that they had selected the wrong route for IR at Narrabri.
Since then, The Narrabri Inland Rail Concerned Residents Group, supported by:

- The Honourable Roy Butler, State Member for Barwon;
- The Narrabri Shire Council;
- The Narrabri Shire Floodplain Risk Management Committee (advising Narrabri Shire Council);
- The Narrabri & District Chamber of Commerce; and
- The Narrabri Branch of the National Party,

have selected a better route, provided detailed maps, funded a flood study of the alternative route and commissioned a cost comparison of the two routes.

The Narrabri Inland Rail Concerned Residents Group have done the work for IR to justify why the Narrabri Alternative Route **MUST be assessed.**

I strongly urge NSW DPE reject the current PIR/Amendment report and insist that IR assess the Narrabri Alternative Route.

Attachment 1

Jim Purcell Detailed CV

NAME: **JAMES D PURCELL (Jim)**

DATE OF BIRTH: 1st November, 1953

NATIONALITY: Australian

EMAIL: jim@aquatechconsulting.com.au

MOBILE: 0429 902 584

QUALIFICATIONS:

Certificate in Farm Water Supplies, Technical Correspondence School, Brisbane (1975)
Bachelor of Engineering (Civil), Capricornia Institute of Advanced Education, Rockhampton, 1980.

REGISTRATIONS AND CERTIFICATIONS

- Chartered Professional Engineer, Engineers Australia.
- National Registered Professional Engineer – (Civil) Number 370036-1996
- APEC Registered Engineer
- International Professional Engineer (AUS)
- Registered Professional Engineer Queensland (Civil Division) Number 1837-1985
- Certified Agricultural Surface Irrigation Design Number ASUR Number 1542-1998
- Certified Storage Meter Installer & Validator Number 25272

AFFILIATIONS:

- Member, Engineers Australia and Registered Professional Engineer
- Member, American Society of Agricultural & Biological Engineers
- Irrigation Australia Limited
  - Life Member 2004
  - North West NSW Regional Committee Member 1983-2003 (Chairman 1986-1992)
  - National Board Member 1992-2000
    - Deputy Chairman 1994-95, 1995-96
    - Chairman 1996-97, 1997-98
    - Member of National Certified Irrigation Designer Management Committee 1999-2003 (Chairman 1999-2000).

LANGUAGES: English

AQUA TECH CONSULTING PTY LTD
WATER RESOURCES & IRRIGATION ENGINEERS
Smart Water

EMPLOYMENT HISTORY:

Aquatech Consulting Pty Ltd, Narrabri, NSW
August, 1999 to Date:
Managing Director and Principal Engineer of consulting engineering practice at Narrabri NSW, specialising in water resources and irrigation engineering.

Barrett Purcell & Associates Pty Ltd, Narrabri, NSW
1983 to 1999
Director of consulting engineering practice Narrabri, specialising in water resources and irrigation engineering.

Sinclair Knight & Partners Pty Ltd

1983	Irrigation Engineer, Ayr, QLD
1982	Irrigation Engineer, Narrabri, NSW
1981	Project Engineer, Brisbane, QLD

Central Queensland University, Rockhampton
1977-1980 Full-time study – Bachelor of Engineering (Civil)

Queensland Water Resources Commission

1977	Farm Advisory Officer, Brisbane, QLD
1976	Farm Advisory Officer, Biloela, QLD
1972-1975	Cadet Farm Advisory Officer, Rockhampton, QLD

EXPERIENCE:

Over forty years' experience in Australia, Mongolia, China, Papua New Guinea and East Africa in all aspects of engineering for water resources and irrigation development projects. Work included planning, surveying, soil testing, investigation, detailed design and construction supervision and project management. Thirty-five years' experience in flood modelling and analysis of river systems and rural floodplains using one- and two-dimensional modelling. Thirty-five years' experience acting as Expert Witness in irrigation, farming operations and floodway and flooding issues. One year's experience in urban development projects; four years' experience in light structures design; and two years' experience in the engineering for saltwater prawn farms.

AUSTRALIA

- **Water Management and Water Use Efficiency Measurement.**

  Managed the project "**Determining the National Framework, Terms and Definitions for Water Use Efficiency in Irrigation"** in 1999 for the Land and Water Resources Research & Development Corporation which has become the standard for Australia. In 2003 completed the next stage of the project "**Gaining Acceptance of Water Use Efficiency Framework, Terms and Definitions"**.

- **Introduced and commercialised the Irrimate™ surface irrigation evaluation service** in 2000 to measure and optimise surface irrigation application. The Irrimate™ range of products currently also includes Storage Meters for measurement and recording of storage volumes and surface area and Seepage & Evaporation Meters which measure seepage and evaporation losses from storages, channels and drains.

- **Introduced and jointly developed the WaterTrack™ whole farm water balance software** products in 2003. The combination of the Irrimate™ and WaterTrack™ products has led to a commercial Whole Farm Water Management service.

- **Total Water Resource and Irrigation Development:**

  - **Surface Irrigation**

    Tasks included project planning, determination of water requirements and availability, detailed design, specification, tenders, construction supervision and contract administration. Works included pumping stations from 0.5 to 2.5 cubic metres per second (cumecs), earthfill ring tank dams, earth supply canals and tailwater drains with reinforced concrete control structures, laser controlled landforming and levee banks for flood protection. Recent examples include:

    - 455 ha furrow irrigated cotton at "Cubbaroo", Wee Waa, NSW;
    - 1100 ha furrow irrigated cotton and maize at "Drayton", Gunnedah, NSW;
    - 630 ha furrow irrigated cotton at "Warilea", Narrabri, NSW;
    - 600 ha furrow irrigated cotton at "Barwon", Walgett, NSW.

  - **Sprinkler Irrigation**

    Tasks including project planning, determination of water requirements and availability, detailed design and performance specification, tender analysis and limited construction supervision. Recent examples include:

    - 16 centre pivot machines servicing 600 ha for effluent reuse Tamworth Regional Council, NSW
    - Two 65 ha centre pivots for fodder at "Kildonan", Goondiwindi, QLD;
    - 90 ha centre pivot for fodder at "St Aubins Without", Scone, NSW.
    - 4 x 220 ha lateral moves for cotton at “Auscott”, Narrabri, NSW
    - 4 x 10 ha pilot schemes for hand move sprinkler of vegetables in Central Mongolia.

  - **Drip irrigation**

    Identification, planning, detailed design, costing and evaluation of existing systems. Projects include:

    - 30 ha above ground drip for banana and nut trees at Yeppoon, QLD
    - 3 x 150 ha sub surface drip for jojoba at Gladstone, QLD
    - 4.5 ha trial of sub surface drip for cotton at Narrabri, NSW

    - evaluation, hydraulic design check and report for existing faulty 200 ha sub surface drip for cotton at Narromine, NSW
    - evaluation of soils, lateral and emitter spacing and detailed hydraulic check of sub surface drip for 30 ha of cotton at Narrabri, NSW

- **Identification and feasibility studies for irrigation potential.** Tasks included identification of irrigable land, system layout, preliminary design, costing and reporting. Recent examples include:

- 450 ha furrow and 150 ha lateral move for cotton and wheat at "Eurone", Goondiwindi, QLD;
- 400 ha border check for fodder at "Dowra", Forbes, NSW;
- 1500 ha furrow and border check for cotton and fodder at "Carlton", Walgett, NSW;
- 75 ha centre pivot for fodder at "Dunmore", Manilla, NSW.
- 3 x 150ha sub-surface drip for jojoba, Gladstone, QLD.

- **Repair and redevelopment of existing irrigation systems.** Determination of existing system problems, redesign for repair and/or redevelopment of surface and sprinkler irrigation systems. Recent examples include:

  - Redevelopment of 600 ha of furrow irrigated cotton at "Oakville", Narrabri, NSW;
  - Redevelopment of 36 ha of furrow irrigation into five research blocks at Myall Vale Agricultural Research Station, Narrabri, NSW
  - Replacement of big gun travelling irrigator with single span linear move for 65 ha of fodder at "Dbar", Goondiwindi, QLD;
  - Repair of 1200m of leaking 5 cumec earth supply canal by reconstruction using clay lining for Tenandra Group Irrigation Scheme, Trangie, NSW;

  - Investigation and reporting on leaking earthfill ring tank storage at "Moreton Plains", Moree, NSW.

- **Design of the supply infrastructure for group irrigation schemes** for the Yambocully Creek (10,000ML per year at 4.5 cumecs) and the Callandoon Creek (6,000ML per year at 3 cumecs) west of Goondiwindi, QLD.

- **Repair and upgrading of existing group irrigation schemes infrastructure**:

  - Murrumbidgee Irrigation Area, NSW
  - Buddah Lakes, Narromine, NSW
  - Tenandra, Trangie, NSW
  - Emerald Irrigation Area, QLD
  - Ord River Irrigation Project, Kununurra, WA

- **Appraisal of existing irrigation systems.** Determination of methodology and development of a standard pro forma for registration of asset details, including assessment of condition and effectiveness. Carried out a detailed appraisal and reported on seven Auscott farms at Warren, Narrabri and Moree, NSW covering 11,400 ha of furrow irrigation.

- **Construction of new compacted earthfill dams.** Predominantly ring tank dams with zoned embankments 4 to 8 metres (m) high. Tasks included planning and site selection, soils investigation and testing, embankment design and specification, tender analysis, construction supervision and compaction testing and contract administration. Recent examples include:

  - 447,000 cubic metre (m^3) embankment storing 4250 megalitres (ML) at "Auscott", Narrabri, NSW;
  - 309,000 m^3 storing 2800 ML at "Elengerah", Warren, NSW;
  - 155,000 m^3 storing 1950 ML at "Broso", Narrandera, NSW;
  - 3 million m^3 storing 24,500 ML at “Hortonvale”, Cunnamulla, QLD.

- **Repair of existing earthfill dams:** repair of damage caused by wind generated waves to a ring tank embankment storing 15,000 ML over 600 ha. Specified repairs included rebuilding a flat inside batter with zoned, compacted earthfill. Investigation and repair of failed embankments (mainly piping failure). Specified repairs included excavation and rebuilding of embankment sections, construction of upstream cut-offs and clay blanketing.

- **Complete pumping station design and specification** including conceptual and detailed design, pump and motor selection, tender analysis, construction supervision and contract administration for river, canal relift and tailwater pumping stations. Recent examples include:

  - 660mm volute centrifugal river pump and 500mm vertical axial flow canal relift pump, both 900 litres per second (L/s) at "Oakville", Narrabri, NSW;
  - 610mm sloping axial flow river and 660mm and 300mm volute centrifugal relift pumps, both 850 L/s at "Glenelg", Narrabri, NSW;
  - 500mm plus 350 mm vertical axial flow river pump and 660mm volute centrifugal relift and storage pump, both stations 1500 L/s at "Drayton", Gunnedah, NSW.
  - 4 x 500mm + 2 x 400mm + 1 x 300mm in four pumping stations for "Cubbaroo", Wee Waa, NSW;and
  - 1 x 900mm + 1x750mm axial flow pumps with a combined capacity of 350 ML/day for Willewa North, Carinda, NSW.

- **Effluent re-use by irrigation** involving identification, water balance, preliminary design and costing of options and selection of the most appropriate irrigation method. Projects include:

  - Layout, technical specification, tender preparation and evaluation and assistance with construction for sixteen centre pivot irrigation machines for Tamworth Regional Council Effluent Reuse Project;
  - Project Management of construction of Narrabri Effluent Re-use Farm;
  - Review and evaluation of Troy Junction Effluent Reuse Project works, Dubbo City Council, NSW;
  - Design and evaluation of reuse water project for irrigation at Ponderosa, Walgett, NSW; and
  - Evaluation of effluent reuse options for Merinda Meatworks, Bowen, Qld.

- **Canal Structures.** Hydraulic and structural design of check, flow measurement and access structures in earth canals of 0.5 to 10 cumecs capacity. Recent examples include:

  - Reinforced concrete cut-throat flume with ultrasonic water level detection and automatic recording for flow measurement up to 7 cumecs for Buddah Lake Group Irrigation Scheme, Narromine, NSW;
  - Intake, control and measuring structures for gravity diversion of up to 9 cumecs at "Cubbie Station", Dirranbandi, Qld; and
  - Reinforced concrete check and control structure for a 6 cumec main supply canal for Trangie Nevertire Irrigation Scheme, Trangie, NSW.

- **Precast irrigation structures.** Structural design using computer modelling for precast irrigation structures for standard culvert headwall units for Humes Ltd, Melbourne, for a range of soil loads and headwall heights. Tasks included determination of design conditions, modelling with structural software (in conjunction with specialist structural engineer), connection details and construction specification. Headwalls ranged from 1.0 to 4.5m high for pipes from 900 to 1800mm in diameter.

- **Weirs.** Hydraulic and structural design, specification and construction drawings for:

  - 2m high steel pile and timber weir on the Balonne River and 2m high reinforced concrete weir on the Culgoa River for "Cubbie Station", Dirranbandi, QLD;
  - 1.5m high x 300m long reinforced concrete weir across an urban floodway at Narrabri, NSW;
  - 3m high x 26m long reinforced concrete weir in main canal, "Auscott", Moree, NSW;
  - 4m high x 50m wide reinforced concrete weir on Ewenmar Creek, Trangie, NSW; and
  - 4m high x 50m wide reinforced concrete weir for bywash on Ewenmar Creek, Trangie, NSW.

- **Flood Studies.** Location and height of levee banks and determination of floodway capacity and impacts of works using one- and two-dimensional computer modelling. Recent examples include:

  - **a**nalysis of the flooding effects of constructing a 300m long reinforced concrete weir across an urban floodway to form a recreational lake in Narrabri, NSW;
  - design of alternative culvert and roadway sections for Glencoe floodway culvert across the Wee Waa-Narrabri road, NSW;
  - levees to protect 1100 ha of irrigated cotton at "Sunnyside", Wee Waa, NSW;
  - relocation of levees for improved irrigation layout while maintaining floodway capacity at "Woomerah", Wee Waa, NSW;
  - extension of existing Wee Waa Airport levee, NSW;
  - relocation of floodway at “Auburn”, Merah North, NSW;
  - many detailed Flood Studies for individual large flood protected farms for Part 8 Licences and modifications to floodways for WaterNSW and NSW Natural Resources Access Regulator;
  - Completion of a Floodway Bypass feasibility study for the Narrabri town;
  - Assessment of the cause of flood damage to Industrial Operations in Narrabri;
  - Assessment of the impacts of proposed residential developments on flooding in Narrabri Town;
  - Technical member of the Narrabri Shire Council Floodplain Risk Management Committee for the Narrabri and Wee Waa Flood Management Plans.

- **Infrastructure modernisation for private and public group irrigation schemes.** Assisted with the scheme water balance and water loss assessment, completed the engineering planning, investigation, detailed design and costing and assisted with the detailed PIIOP funding applications and reports for the Tenandra Irrigation Scheme and Marthaguy Irrigation Scheme, Macquarie Valley, NSW.

- Preparation of draft “**Environmental Guidelines for the Management of Irrigation Farms”** for the Environment Protection Authority of New South Wales. The guidelines describe best irrigation management practices to minimise the potential for environmental contamination, including the management of stormwater and tailwater runoff. Guidelines are given also for siting, design and construction of irrigation layouts.

- **Preparation of Environmental Impact Statements and Review of Environmental Factors** for proposed and existing irrigation projects involving large scale surface irrigation, above ground water storages, canals, levees, etc

- **Detailed design of surface irrigation schemes** for sugar cane and paddy rice for numerous clients in the Burdekin Irrigation Area, QLD supplied by groundwater and Water Board channels.

- Selection, design and operation of a portable pump testing rig for **performance testing of pumps and evaluation of aquifer characteristics Ayr, QLD**.

- **Topographical survey and operation of Gemco rotary drilling rig** for investigation of recharge sites for the Callide Valley aquifer recharge system Biloeld, QLD.

- Investigation for **sealing leaking distribution canals** in Emerald Irrigation Area.

- Experimental **sealing of leaking earth dams** using bentonite clay,

- **Ord River Irrigation Project**, Kununurra, WA:

  - **preliminary design, quantities and cost estimate** for the development of the 1,387 ha Green Swamp area for surface irrigation development into either one, two or four farm units;
  - preparation of the **technical specification for conceptual topographic survey** of the 6,100 ha **Knox Creek Plain** and 1,100 ha **Ord West Bank** by GPS and/or optical methods;
  - **detailed design and construction drawings** for S4 supply culvert to KL399 and heavy-duty machinery crossing of drain H01; and
  - advice on potential for **tailwater and stormwater re-circulation and storage for Stage I Scheme** including selection of pilot farms for assessment.

- Evaluation of **asset design lives, cycle times and basis of costing for major periodic maintenance and provision for deferred maintenance** for earthen channels and drains for Murrumbidgee, Coleambally and Murray Irrigation Areas for Department of Water Resources, NSW as Irrigation Expert for Australian Water Technology, Sydney.

- **Pre-feasibility Study** for diversion of **500,000 megalitres per annum via a 4000 kilometre open canal** from the Fitzroy River in northern Western Australia along the coast to Perth providing town and irrigation supplies en route. Factors considered were diversion weir, unlined and lined canal, bridges, culvert crossing, inverted siphons, cross-drainage structures, floodways, relift pumping stations and rising mains. Full capital and operating costs were considered and piped diversions using several alternative materials considered.

- **Expert Witness, Independent Water Resources and Irrigation Expert and Mediator** for settlement of disputes over banks and floodways, irrigation system performance or construction standards. Tasks included establishment of performance or standards of construction, provision of technical reports, and acting as expert witness in court and land boards. Recent examples include:

  - Mediation for dispute between builder and Principal on Commercial Building;
  - Assessment of water use and crop production with and without a water storage where the approval was revoked and delayed for 7 years. Value of lost production was $6.5 million. “Hazeldene”, Boomi, NSW;

- Poor performance of 500mm axial flow pump at "Bonoura", Boomi, NSW;
- Structural failure of reinforced concrete pumping station at "Keytah", Moree, NSW;
- Poor performance of linear boom sprinkler irrigator at "Traversdale", Forbes, NSW;
- Failed earthfill dam embankment at "Eumorella", Boggabilla, NSW;
- Poor performance of 230 ha surface irrigation development at "Kamilaroi", Moree, NSW;
- Floodway capacity and levee locations, St George, QLD;
- Joint water authority and 2000ha irrigation development “4G”, Walgett, NSW;
- Failure of 200 ha of sub-surface drip irrigation of cotton at “Maranoa”, Narromine, NSW;
- Failure of 93ha of sub-surface drip irrigation of beans at “Valleyfield”, Ayr, QLD;
- Failure of levee system and flood damage to cotton at “Arcturus Downs”, Emerald QLD;
- Failure of 29ha of drip irrigation of nursery vines for Australian Quality Vines, Griffith, NSW;
- Damages from flooding caused by an irrigation channel blocking a natural floodway near Berigan, NSW;
- Damages from illegal levee bank during flooding at Trangie, NSW;
- Damage to a natural wetland from NSW State Water operation of a regulated irrigation supplies through Yanco Creek at Narrandera, NSW;
- Damage caused by blockage to stormwater drain from cotton fields at Narrabri, NSW;
- Damages caused by overspray of crops to neighbour’s cotton at Dirranbandi, QLD; and
- Design and construction review of failed sprinkler irrigation system for international standard artificial turf hockey fields at UQ Brisbane.

- **Training and Adult Education.** Course structure, material preparation and presentation of 20-day heavy machine operators course training 30 men for the Department of Employment Education and Training at Narrabri, NSW. The course consisted of instruction in plan reading, principles of surveying and laser controlled equipment, health and safety, machine operation, servicing and maintenance (dozer, grader, tracked excavator and elevating scrapers); hands-on machine operation (taught by experienced operators); surveying practical; and laser equipment operation. Co-ordinated the construction of the earthworks for a 30 ha recreation lake as part of this project.

- Preparation of course notes and assessment questions for **"Irrigation Design and Farm Layout Principles"** for the University of New England for a postgraduate course "Cotton Production".

- Co-ordination, preparation and presentation of seven one day **educational seminar/workshops** for 50 to 200 farmers as Chairman of a ten man committee. Topics included: financial and labour management, design and construction of pumping stations, earthfill storage embankments, irrigation structures and laser controlled land levelling and environmental considerations of surface runoff from irrigated cotton farms.

- Presentation and **publishing of papers for technical seminars** on 'Development of a Surface Irrigation System' and 'Tailwater and Stormwater Drainage Design for Surface Irrigation'.

- **Aquaculture.** Redevelopment of an existing six ha saltwater prawn farm and hatchery complex at "Seafarm", Innisfail, North Queensland. Work involved full redesign of salt and fresh water supply system and pumps, design of alternative prawn harvesting structures and re-levelling of pond beds for harvesting and pond drainage. Site evaluation, planning, soil testing, water requirement determination, salt balance, preliminary design and costing of engineering components for proposed prawn farms at Bowen, Qld (300 ha of ponds), Gladstone, Qld (10 ha of ponds) and "Inkerman", Karumba, North Queensland (120 ha of ponds). Works included pumping stations, supply system, pond embankments, access and harvesting system, control and harvesting structures and drainage system. Engineering components were designed to the marine and biological specifications of the aquacultural biologist.

MONGOLIA

- Six weeks, 2002 – Irrigation engineer / specialist to identify and cost an Asian Development Bank Project for rehabilitation of the irrigation sector of Mongolia's agricultural crop production.

- One month, 1997 - Irrigation engineer responsible for the selection and detailed design of four separate pilot projects in Central Mongolia to demonstrate small scale sprinkler irrigation of vegetables. This project was a Rehabilitation Project for FAO under the Special Programme for Food Security. The tasks also involved detailing the rehabilitation requirements for existing infrastructure.

CHINA

- One month, 1994 - Technical Specialist (Irrigation) for Inner Mongolia Agriculture Machinery Project and Technical Specialist (Environmental) for Jinan Water Supply Project to assist with preparation of appraisal reports for AIDAB.

  Note: Could not complete field mission because of family illness but assisted replacement with technical issues and report preparation.

PAPUA NEW GUINEA

- One month, 1993 - Evaluation of five sites and preparation of detailed design and costing for two commercial irrigated rice areas for the Department of Agriculture and Livestock.

ETHIOPIA

- One month, 1986 - Identification of irrigable area and feasibility study of surface irrigation development utilising river water supplies on the 26,000 ha Sheneka State Farm. Tasks included selection of a 2500 hectare (ha) irrigation area, preliminary design and costing of a 800 ha border check pilot irrigation scheme and complete stock watering system for the farm (25,000 sheep and 1500 cattle).

INDIA

- Overseas study tour, 1987 (six weeks). Member of a five man team sponsored by Rotary International to study Southern India. Government and private irrigation projects and private farms growing tea, nut palms, rice, rubber and tropical fruits were inspected.

AQUA TECH CONSULTING PTY LTD
WATER RESOURCES & IRRIGATION ENGINEERS
Smart Water

PUBLICATIONS:

"Design of Surface Irrigation Systems." Proc. of Seminar in Irrigation Practice, Irrigation Association of Australia and University of New South Wales, 1985, with Barrett.

"Embankment Design Principles for Earthfill Water Storages." Irrigation Australia, Vol. 4, No. 1, Feb. 1989.

"Tailwater and Stormwater Drainage Design for Surface Irrigation." Irrigation Australia, Vol. 5, No. 1, Oct. 1989.

"Irrigation Design and Farm Layout Principles" Course notes in Applied Cotton Production, Graduate Certificate in Rural Science, University of New England, Armidale, 1995. Updated 2004.

"Reducing the Environmental Impact of Irrigation" Proc. of Symposium on Irrigation Development and the Environment, Irrigation Association of Australia, 1998.

"Guidelines for Ring Tank Storages". The Irrigation Association of Australia Ltd, May 1998 with Barrett.

"Design of Pipes for Irrigation". Course Notes for "Irrigation Fundamentals" National Centre for Engineering in Agriculture, University of Southern Queensland, July 2001
"Improving Efficiency of Water Storages and Water Supply Systems" Proc. 12th Australian Cotton Conference, August 2004

"How to Get More from Your Water" , Cotton Production Seminar , Cotton Consultants Australia Inc , August 2005

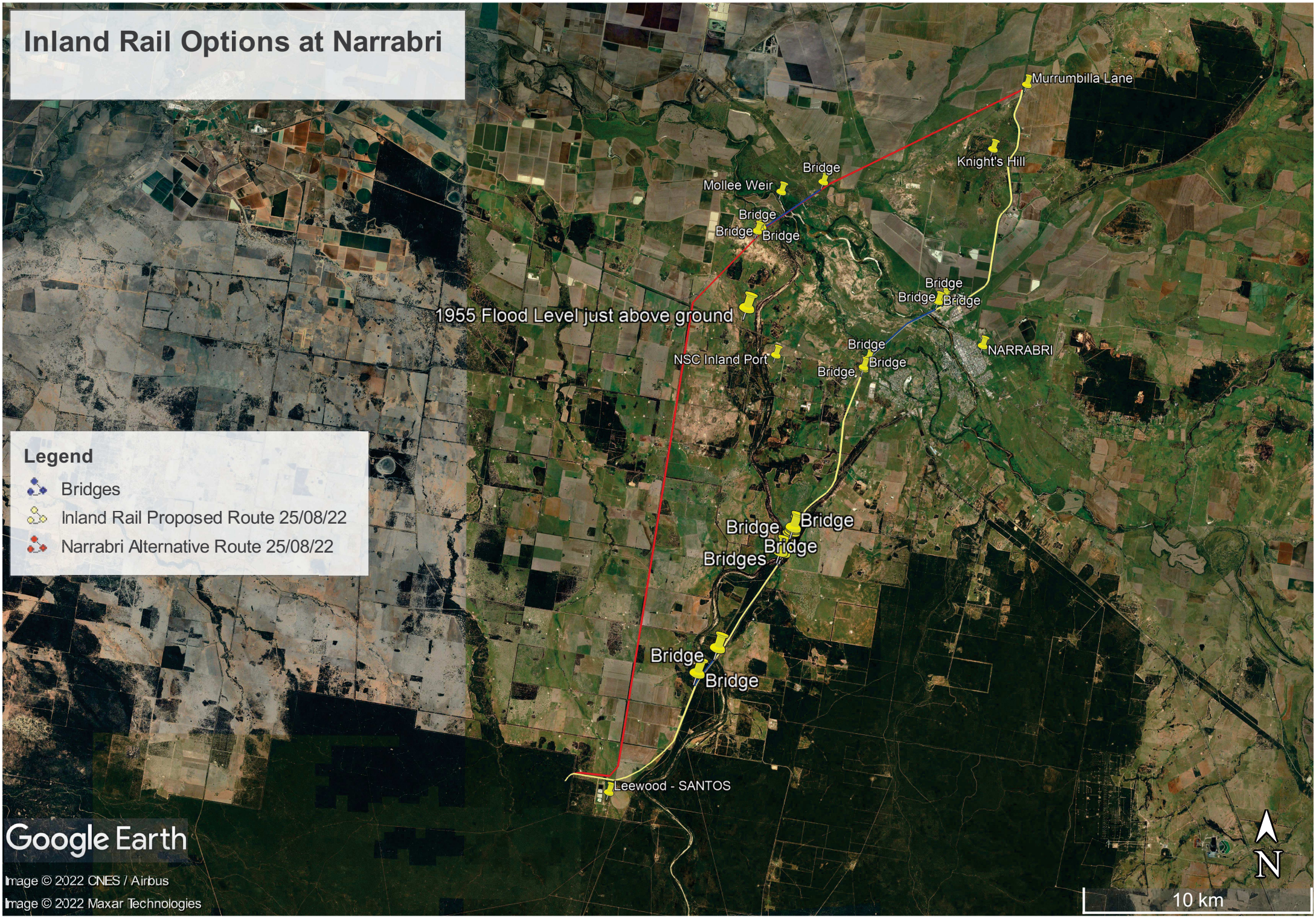
"Water – Measure It And Save It", Farming Systems Forum "Precision Agriculture", CRDC & Cotton CRC, November 2005

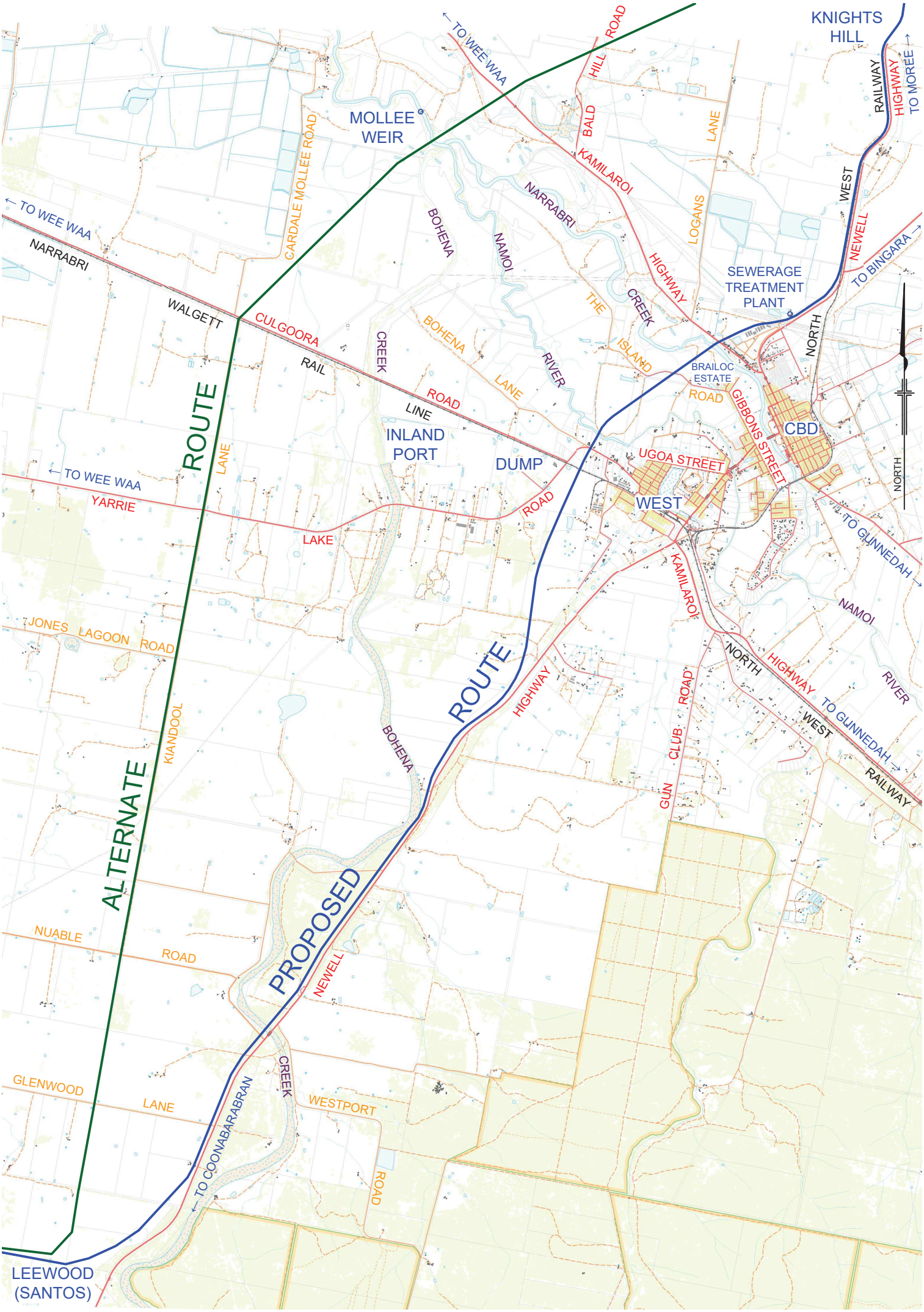
"Surface Irrigation", Chapter 19 of "Irrigation" Sixth Edition, USA Irrigation Association, Falls Church, VA, 2011 with Phillip Price

"Whole Farm Water Balance" Chapter 10b Australian Cotton Production Manual, 2012

"Whole Farm Water Balance – The Key To Better Water Management" The Australian Cottongrower Magazine December 2017

Attachment 2


Inland Rail Options at Narrabri
Murrumbilla Lane
Knight's Hill
Bridge
Mollee Weir
Bridge
Bridge
Bridge
Bridge
Bridge
Bridge
1955 Flood Level just above ground
NSC Inland Port
Bridge
Bridge
Bridge
NARRABRI
Bridge
Bridge
Bridges
Bridge
Bridge
Bridge
Bridge
Leewood - SANTOS
Legend
Bridges
Inland Rail Proposed Route 25/08/22
Narrabri Alternative Route 25/08/22
Google Earth
Image © 2022 CNES / Airbus
Image © 2022 Maxar Technologies
N
10 km


KNIGHTS HILL
TO WEE WAA
HILL ROAD
BALD
KAMILAROI
LANE
RAILWAY
HIGHWAY
TO MOREE
MOLLEE WEIR
CARDALE MOLLEE ROAD
NARRABRI
BOHENA
NAMOI
LOGANS
WEST
NEWELL
TO BINGARA
HIGHWAY
SEWERAGE TREATMENT PLANT
THE ISLAND
CREEK
NORTH
BRAILOC ESTATE
ROAD
GIBBONS STREET
CBD
UGOA STREET
WEST
NORTH
TO GUNNEDAH
WALGETT
CULGOORA
RAIL
LINE
ROAD
INLAND PORT
DUMP
ROUTE
LANE
YARRIE
LAKE
KAMILAROI
NAMOI
RIVER
JONES LAGOON ROAD
KIANDOOL
ALTERNATE
PROPOSED
ROUTE
HIGHWAY
CLUB ROAD
GUN
NUABLE ROAD
NEWELL
GLENWOOD LANE
CREEK
WESTPORT
TO COONABARABRAN
ROAD
LEEWOOD (SANTOS)

Attachment 3

Comparison of IR and Narrabri Alternative Rail Routes 22/9/2022

Proposed Inland Rail Route Near Narrabri

The proposed Inland Rail Route follows the Newell Highway from the south, near Santos' Leewood site until it gets close to Narrabri. It then passes immediately downstream of the town, crossing the Yarrie Lake Road near the WTC depot on the south-west of town and Wee Waa Road at about the 50/80 kmph speed sign on the north-west. It then runs immediately downstream of the AFF or Auscott Sheds in the Northern Industrial Estate and across the Travelling Stock Route and Narrabri Shire Council Sewage Treatment Works access. It then follows beside the Newell Highway, heading northeast, joining the existing Narrabri-Moree railway line just north of the overhead bridge on the Newell Highway. See the attached maps.

According to the published Environmental Impact Statement (ARTC 2020), it is proposed that, once constructed, there will be 10 trains per day in 2025 rising to 14 trains per day in 2040. For 2025, that is a train every 2 hours 24 minutes. These trains are proposed to be 1.8 kilometres long and travelling up to 115 kilometres per hour. The trains are about 6.5 metres high. This height is substantial and this does not even account for the height of the rails above the ground.

This route will severely disadvantage Narrabri for decades.

Proposed Inland Rail Route Disadvantages

The proposed route has a number of major problems, some of which are:

- A new bridge is required over Bohena Creek which is around 1,400 metres long.
- At a point about 5.7km north of Bohena Creek, the outside edge of Bohena Creek is only about 50 metres from the Newell Highway formation. Squeezing the new line into this gap on the outside of creek bend is very unwise and a long second bridge is therefore proposed. This additional bridge is approximately 930 metres long to go over Bohena Ck and Spring Creek.
- The proposed route also crosses the Namoi River floodplain immediately downstream of Narrabri. A bridge/viaduct of 4,045m is required along with 2,790m of embankment and 24 culverts.
- In the section where the bridge/viaduct is proposed, the viaduct is over 8 metres high at the southern end over the Walgett to Narrabri Rail Line and around 7m high at the northern end over Wee Waa Road. The top of the train will be about another 6.5 metres above the bridge level.
- The bridge/viaduct will have a major negative visual impact for the people of Narrabri. The viaduct will have about 220 pylons, about 22 metres apart. There will be a long-term negative impact on Narrabri people.
- The frequency, size and speed of the trains will have a very significant negative impact on the social life of people in Narrabri and its immediate surrounds. This is unacceptable.
- The increased transport during construction will also have a major impact on Narrabri Streets, particularly along Gibbons Street. The latest traffic movements will be 25 heavy vehicle and 155 light vehicle movements/day based on 10hour days.
- Gibbons Street (north of the highway) has The Narrabri Hospital (including the Ambulance Station), two aged care facilities, Nurraby Childcare Centre, Narrabri Golf Club and ninety-four residences which will all be severely affected by these traffic movements.
- Some residential land values within one kilometre of the proposed route have already decreased by 20% even before construction begins and the trains start running.

- The latest flood modelling in Preferred Infrastructure Report details that 13 habitable dwellings and 3 no-habitable dwellings along Wee Waa Road on the north-west side of Narrabri exceed the Department of Planning and Environment (DPE) Quantitative Design Limits (QDL's) for flood afflux for the 1% AEP or 1in 100 year flood. For the whole N2N router a further 11 buildings exceed the DPE QDL's for flood duration.
- No real consideration has been given to the Social Impacts on the people of Narrabri. No real Visual Impact Assessment has been carried out.
- Inadequate Noise Assessments have been carried out.
- A number of residential properties will be affected by noise and these seem to have been ignored.
- Three houses on Yarrie Lake Road and at least two others need to be purchased.

This Is All Unnecessary

An alternative route is available which runs from near Santos' Leewood site beside Kiandool Lane to the north of the Culgoora Road. It then turns to cross the Namoi River upstream of Mollee Weir and joins the existing Narrabri-Moree railway line just north of Knights Hill. See attached maps.

Alternative Route Advantages

- No bridges are required over Bohena Creek or Spring Creek (one 1,400 metre long and one around 930 metre long are needed for the Inland Rail Route).
- No disruption of Newell Highway traffic will be required south of Narrabri during construction.
- The main bridge/viaduct at Narrabri will only need to be 2,730m or 3,300m long rather than 4,045m long.
- There will be no increase in flood levels in the northwest edge of Narrabri and no DPE QDL's exceeded for either the 1% AEP or 0.5% AEP (1in 200 year) floods.
- The construction traffic will be taken away from Narrabri town streets.
- The number of properties accesses affected is less.
- The impacts from noise, flooding, access and visual effects on the alternative route are relatively minor compared to the IR route.
- There is no impact on access to Narrabri Treatment Works, the Travelling Stock Route, or the several major power lines nearby.
- The alternative route has been assessed to cost between $200 and $220 million less to construct than the proposed route. This extra cost is for only approximately 40kms of track!

A Quick Comparison of The IR and Narrabri Alternative Routes

Why is the Narrabri Alternative Route better than the Proposed Inland Rail Route?

There are many reasons. The following comparisons give some idea of why:

Issue	Narrabri Alternative	Inland Rail Proposed
Approximate number of dwellings/commercial buildings within 500 metres of the proposed alignment	12	33
Approximate number of dwellings/commercial buildings within 1000 metres of the proposed alignment	18	108
Approximate number of dwellings/commercial buildings affected by unacceptable flooding depth increase for a 1 in 100 year flood	0	16
Will the line increase flood levels and velocities In Narrabri	No	Yes
Approximate length of bridge over the Namoi floodway	2.73 to 3.3 km	4.05 km
Approximate total length of bridges	2.73 to 3.3 km	6.38 km
Approximate number of bends	6	20
What hills have to be to be negotiated by the trains	None	Knight's Hill
Will the intersection with the Narrabri to Walgett Rail line be at ground level?	Yes	No, 8m up
Will the construction of the line affect Narrabri Streets	No	Yes
Will there be negative impacts on Narrabri for 100 years	No	Yes
Approximate total length of line	40.2 km	39.3 km
Will the line impact the Newell Highway south of Narrabri		
During construction	No	Yes
When finished	No	Possibly

Attachment 4

Alternative Inland Rail route across the Namoi River at Narrabri NSW

Flood impact assessment

0328-13-B3, 30 August 2022

For and on behalf of WRM Water & Environment Pty Ltd
Level 9, 135 Wickham Tce, Spring Hill
PO Box 10703 Brisbane Adelaide St Qld 4000
Tel 07 3225 0200

Greg Roads
Director
RPEQ 6413

Contents

List of Figures

List of Tables

1 Introduction

1.1 BACKGROUND

WRM Water & Environment Pty Ltd (WRM) was commissioned to develop concept designs of the waterway structures required for an alternative alignment of the proposed Inland Rail across the Namoi River at Narrabri. The waterway structures of the alternative alignment are to satisfy the flooding quantitative design objectives adopted by the Australian Rail Track Corporation (ARTC) for the alignment given in the Inland Rail (N2N) Environmental Impact Statement (ARTC alignment). A locality map showing the ARTC alignment, and the proposed alternative alignment is shown in Figure 1.1.

Figure 1.2 shows the location of structures such as the embankments, bridges, and culverts proposed along the alternative alignment.

1.2 QUANTITATIVE DESIGN OBJECTIVES

Table 1.1 shows the quantitative design objectives adopted by ARTC.

1.3 METHOD OF ASSESSMENT

A TUFLOW two-dimensional model was developed for the assessment. The model was based on:

- the MIKE Flood model of the Namoi River developed by WRM for Narrabri Shire Council and presented in the Narrabri Flood Study (WRM, 2016) (Narrabri Study)
- the TUFLOW model of Bohena Creek developed by WRM for Narrabri Shire Council and presented in the Bohena Creek Flood Study (WRM, 2019) (Bohena Study); and
- the TUFLOW model developed by JacobsGHD for ARTC and presented in the Flooding and Hydrology Assessment Technical Report 3 (JacobsGHD, undated) (ARTC Study).

Flood impacts for the proposed alternative alignment have been determined for the 10%, 1% and 0.5% annual exceedance probability (AEP) flood events from both Namoi River and Bohena Creek.

Note that the alternative alignment and proposed culvert/bridge configurations has not been optimised. Should ARTC opt to use this alignment, further work and investigations will be required.

Table 1.1 – Quantitative design objectives

Parameter	Location or land use	Quantitative design objective	Justification / description
Afflux i.e., increase in flood level resulting from implementation of the proposal	Habitable floors	10 mm	For the proposal, the increase in flood level (afflux) should be minimal. A target maximum afflux of 10 mm has been adopted for habitable floors where there us above floor flooding. This target is unlikely to result in a significant impact to land use and hazard. Afflux being the relative difference between the modelled existing flood levels and the predicted flood level after construction of the proposal. This is reported against surveyed flood levels (where available) or assumed floor levels where existing surveyors have not been carried out for both habitable and non-habitable buildings. For the remaining areas (excluding forestry and unimproved agricultural areas) a target of 200 mm afflux at the rail corridor boundary has been generally adopted. For forestry and unimproved agricultural areas, a target of 400 mm afflux has been applied in some circumstances due to lower human exposure and infrastructure in these areas.
	Sensitive infrastructure, assumed to include • Emergency services (e.g., hospitals, ambulance, fire, police stations) • Flood evacuation routes • Electricity substations • Water treatment plants.	10 mm	
	Other urban and recreational	200 mm	
	Agricultural	200 mm	
	Forest and unimproved grazing land	400 mm	
	Highways and sealed roads greater than 80 km/hr	Less than 10 mm at sensitive infrastructure.	Target has been adopted to minimise as far as practicable impacts to transport routes.
	Unsealed roads and sealed roads less than 80 km/hr	Less than 10% change in length of overtopping.	
Scour/erosion potential i.e., increase in flood velocity resulting from implementation of the proposal	Ground surfaces that have been sealed or otherwise protected against erosion. This includes roads and most urban, commercial, industrial, recreational, and forested land. Other areas including watercourses, agricultural land, unimproved grazing land and other unsealed or unprotected areas.	Outlet velocities from the rail corridor to be in accordance with site-specific assessment conducted by an experienced geotechnical or scour/erosion specialist. In addition, the increase in velocity is to be in accordance with the requirements of the NSW Blue Book (DECC, 2008a and 2008b)	In all areas a target of minimising any increase in velocities has been adopted. Scour protection provided downstream of new drainage culverts within the rail corridor where outlet velocities are greater than 0.5 m/s and/or as required in accordance with the NSW Blue Book (DECC, 2008a and 2008b). For bridges in water courses, scour protection provided at piers and abutments as required. Energy dissipaters would be provided downstream of structures where increased velocities may result in scour to adjacent land.

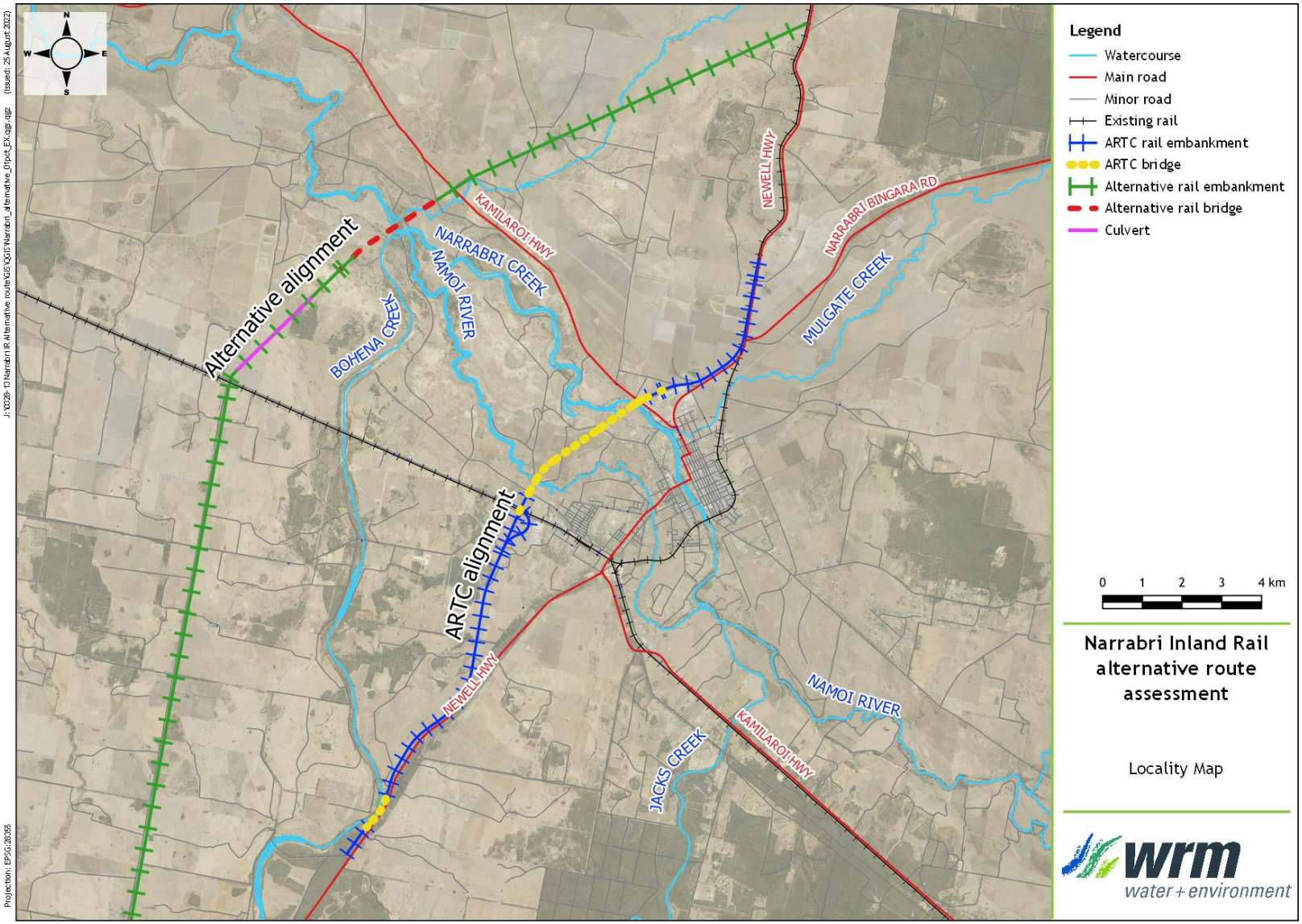


Figure 1.1 – Locality map

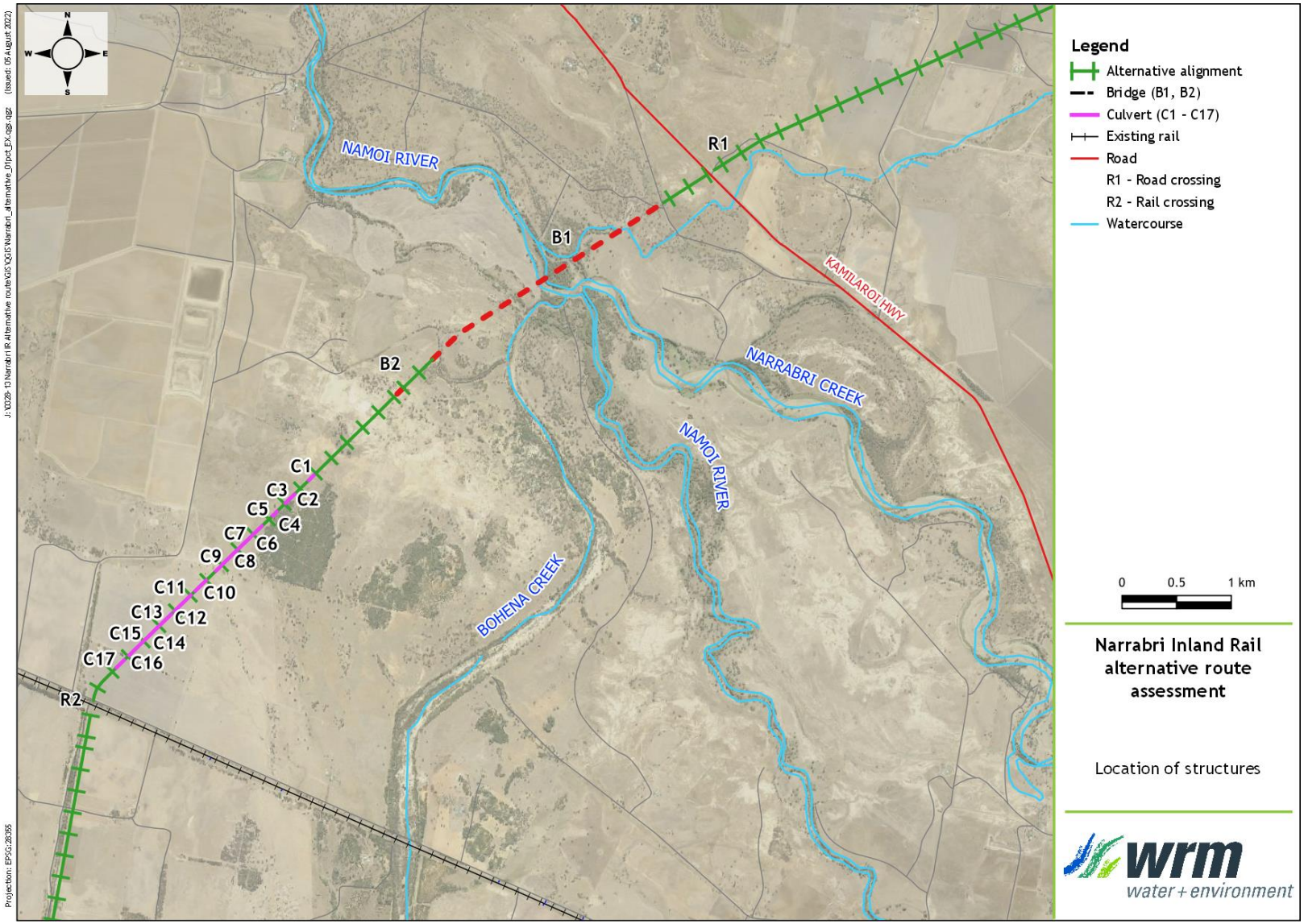


Figure 1.2 – Locations of structures

2 Design discharges

Table 2.1 shows the design discharges adopted for the Namoi River and Bohena Creek. Namoi River design discharges for the 10% and 1% AEP events were adopted from the Narrabri Study (WRM, 2016) and taken from the ARTC study for the 0.5% AEP event. Bohena Creek design discharges were obtained from the Bohena Study (WRM, 2019) for the 10% and 1% AEP events. An approximate 0.5% AEP design discharge was used for Bohena Creek as this was not calculated in the WRM (2019) study. The approximation is expected to be reasonable.

Table 2.1 – Namoi River and Bohena Creek design discharges

AEP	Design discharge (m^3/s)	
	Namoi River	Bohena Creek
10%	1,980	273
1%	4,860	1,562
0.5%	6,360	2,622

For modelling, the Namoi River and Bohena Creek discharge hydrographs were simulated consecutively within the same simulation with the flood peaks offset by more than 24 hours.

Local catchment inflows for Mulgate/Horsearm Creek and across Narrabri for each event were taken from the JacobsGHD model developed for the ARTC study. The local catchment flows at the proposed alternative alignment are not significant when compared to the peaks from Bohena Creek and the Namoi River.

3 Hydraulic modelling

3.1 METHODOLOGY

A TUFLOW (BMT, 2020) two-dimensional hydrodynamic model was developed to estimate design peak flood levels, depths, and extents in the vicinity of the rail. The model extent was based on that adopted for the ARTC study, which included the floodplains of both the Namoi River and Bohena Creek. The ARTC model was based on the model developed for the Narrabri Study (WRM, 2016) but was extended by ARTC to include Bohena Creek.

The topography and Manning's roughness values adopted for the Namoi River/Narrabri Creek floodplain were consistent with the ARTC study model. The Manning's roughness values for Bohena Creek were taken from the Bohena Study. The Bohena Study adopted conservatively high creek roughness values of 0.06, (compared to 0.03 adopted for the ARTC study). This would increase the volume and frequency of overflows from the channel onto the Bohena Creek floodplain and therefore increase the number of culverts required for the alternative alignment.

Note that further assessment of the bridge alignment would require the model to be extended downstream to remove the impacts associated with the downstream boundary assumptions.

Further to this, the model extent does not cover Spring Creek, which drains along the alternative alignment to the north of the Kamilaroi Highway. It is likely that additional structures would be required along Spring Creek. These structures are not expected to be significant.

3.2 BRIDGE AND CULVERT STRUCTURES

3.2.1 Existing structures

The existing bridge and culvert structures within the model extent were obtained from the ARTC study model and were unchanged for this assessment. These structures are upstream of the alternative alignment and will therefore not impact the assessment.

3.2.2 Alternative alignment structures

Figure 1.2 shows the locations of the proposed bridge and culvert structures across the Namoi River and Bohena Creek floodplain.

The following bridges are proposed:

- Kamilaroi Highway overpass (50 m long)
- Namoi River (2,560 m long)
- Pig Creek (120 m)
- Culgoora Road overpass (140 m)

ARTC may consider extending the Namoi River bridge to incorporate the Kamilaroi Highway overpass and Pig Creek if it was found to be less expensive than the embankment. The water level impacts of this option would be less than has been predicted for the above configuration. ARTC may also consider maintaining the rail near ground level at Culgoora Road to reduce the costs associated with the future rail connection to the Narrabri West Walgett Rail line. If this was to occur, a signalled level crossing at Culgoora Road or an overpass would be required. This option has not been assessed but would appear feasible.

The Namoi and Pig Creek bridges were modelled assuming a 10% blockage (associated with the piers) and an obvert of 208 mAHD, which is generally at or above the peak flood level for the 0.5% AEP event.

Table 3.1 shows the dimensions of the culverts proposed across the Bohena Creek floodplain. The locations of the culvert structures are shown in Figure 1.2. A Manning's 'n' value of 0.013 was adopted for all culverts. The embankment was assumed to have a width of 12 m with the embankment elevation set above the 0.5% AEP event (so that it is not overtopped for the events modelled). Approximately 1,300 m of box culverts would be required across the floodplain. Note that the locations and number of box culverts have not been optimised for this assessment.

Table 3.1 - Culvert dimensions

Structure	Type	Width (m)	Depth (m)	Number	Approx. Length (m)
Culvert (C1)	RBC	2.7	0.9	22	62
Culvert (C2)	RBC	3.6	1.2	9	33
Culvert (C3)	RBC	3.6	1.2	7	26
Culvert (C4)	RBC	3.6	1.2	9	33
Culvert (C5)	RBC	3.6	1.2	19	70
Culvert (C6)	RBC	3.6	1.2	19	70
Culvert (C7)	RBC	3.6	1.2	19	70
Culvert (C8)	RBC	3.6	1.2	19	70
Culvert (C9)	RBC	3.6	1.2	28	104
Culvert (C10)	RBC	3.6	1.2	31	115
Culvert (C11)	RBC	3.6	1.2	19	70
Culvert (C12)	RBC	3.6	1.2	19	70
Culvert (C13)	RBC	3.6	1.5	32	118
Culvert (C14)	RBC	3.6	1.2	19	70
Culvert (C15)	RBC	3.6	1.2	19	70
Culvert (C16)	RBC	3.6	1.2	19	70
Culvert (C17)	RBC	3.6	1.2	19	70

RBC – reinforced concrete box culvert

3.3 FLOOD LEVEL IMPACT (AFFLUX)

Figure 3.1, Figure 3.2 and Figure 3.3 show the predicted flood extents and the change in flood levels in the vicinity of the proposed alternative alignment for the 10%, 1% and 0.5% AEP events. The model results indicate:

- the flood level impacts would generally be confined to about 1.5 km upstream of the proposed alternative alignment;
- flood level impacts greater than 0.2 m would be confined to the river corridor or unimproved agricultural areas;
- there would be no flood impacts greater than 0.4 m for the 1% AEP event; and
- there would be no dwellings impacted for any of the events investigated.

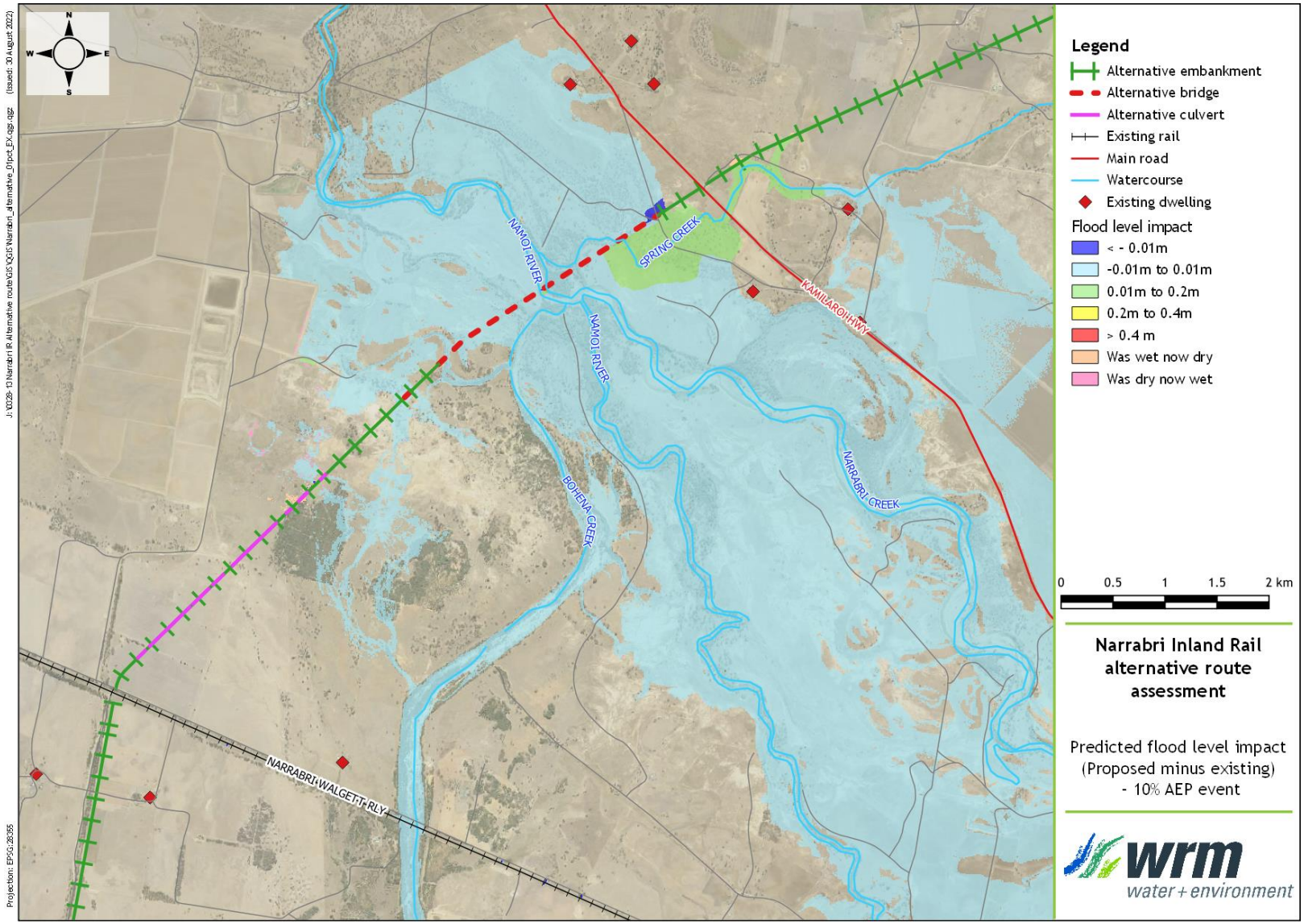


Figure 3.1 – Predicted change in flood level, 10% AEP event

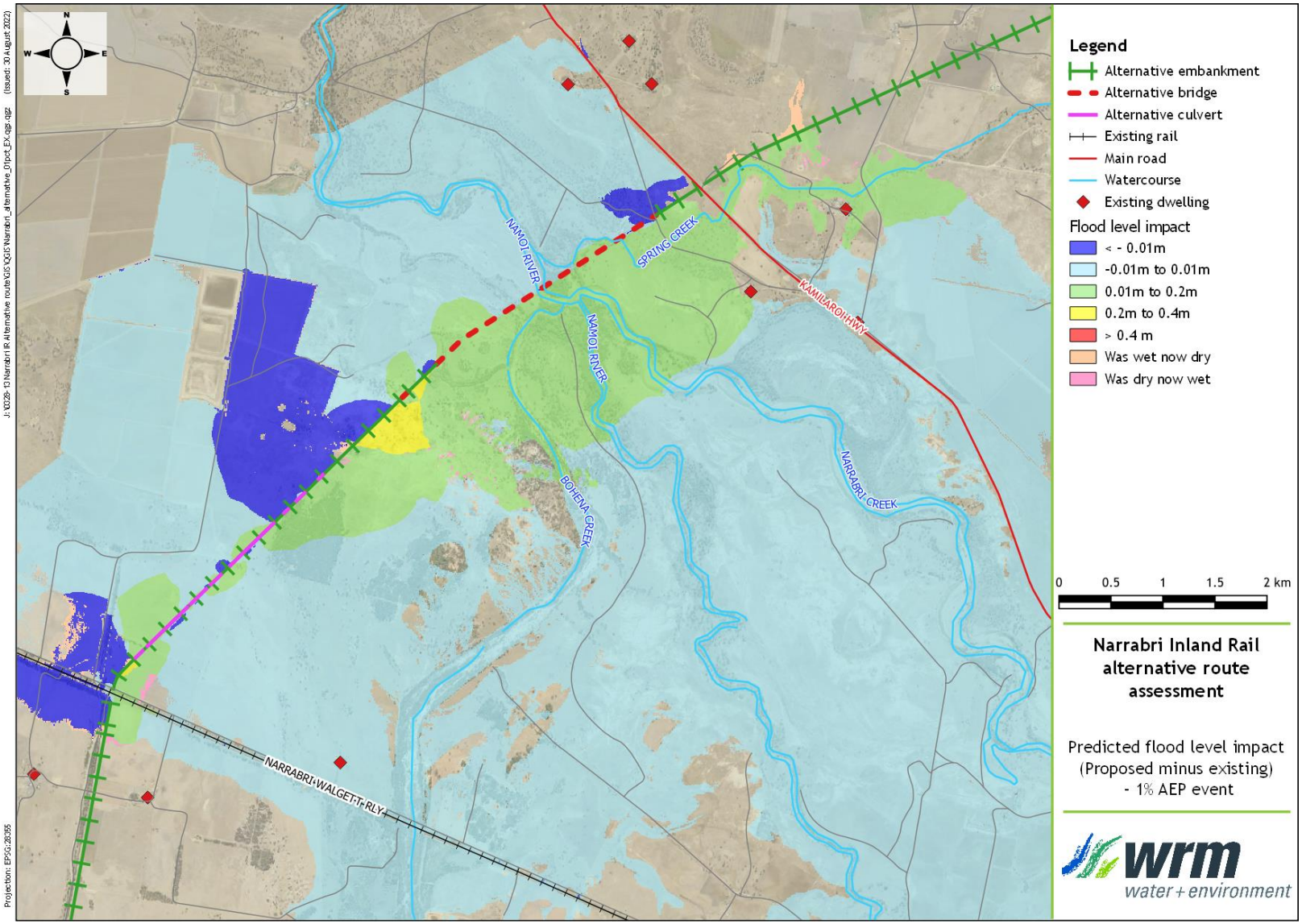


Figure 3.2 – Predicted change in flood level, 1% AEP event

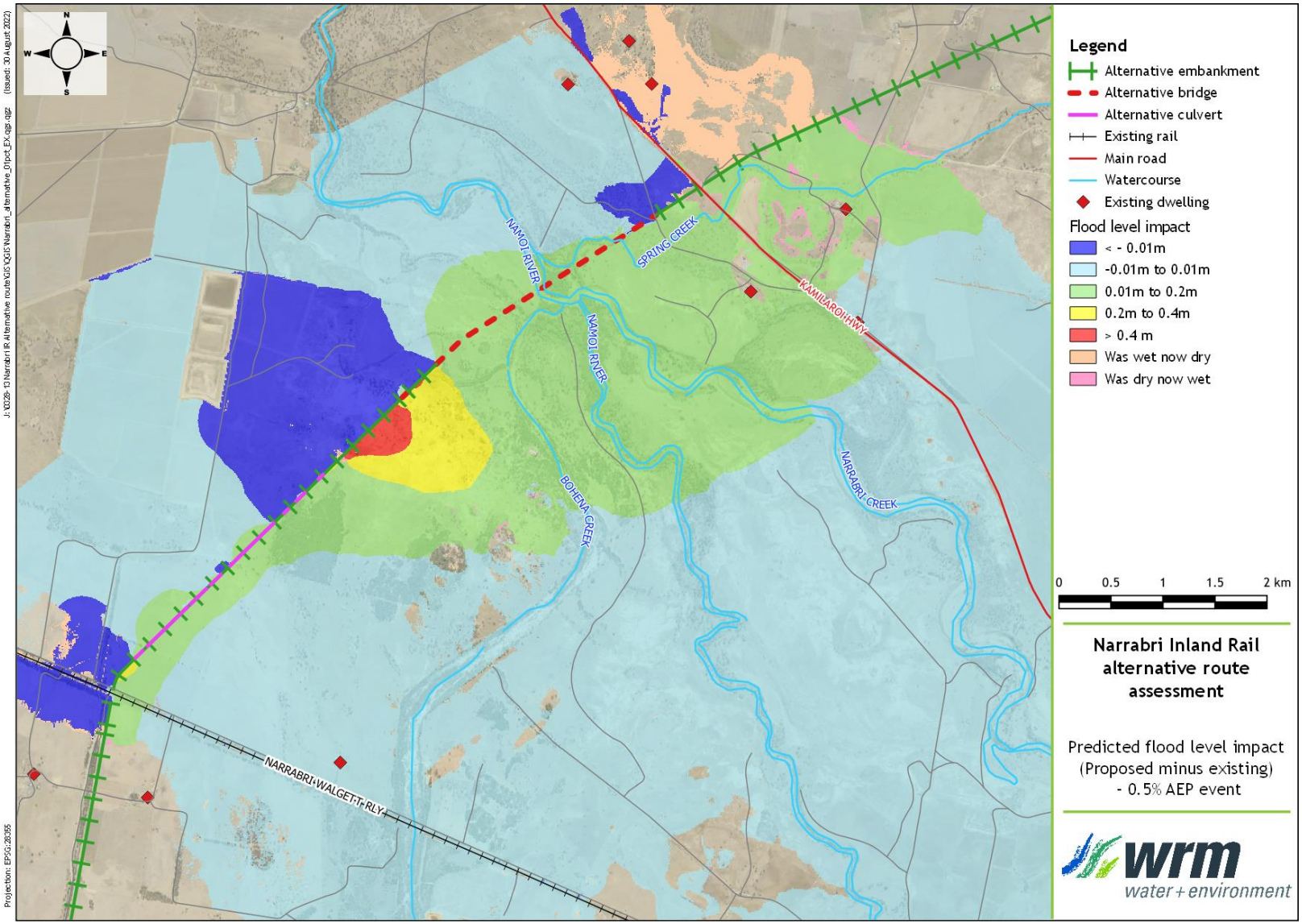


Figure 3.3 – Predicted change in flood level, 0.5% AEP event

3.4 SCOUR/EROSION POTENTIAL

The modelling shows that the peak velocities through the proposed culverts range between 0.5 m/s and 1.1 m/s for the 1% AEP event. These velocities are similar to velocities encountered across the Namoi River floodplain for this event.

The critical velocity for grazing pasture (grass) given in the NSW Blue Book (Landcom, 2004) (assuming moderate soil erodibility) is 1.2 m/s. This suggests that additional erosion would not be expected. Notwithstanding, to satisfy the quantitative design objectives (Table 1.1) scour protection may be required downstream of each culvert.

4 Summary

Concept designs of the waterway structures for an alternative alignment of the proposed Inland Rail across the Namoi River at Narrabri have been developed and assessed. A hydraulic TUFLOW model was developed and run for the 10% AEP, 1% AEP and 0.5% AEP design events from both the Namoi River and Bohena Creek. The results of the modelling demonstrate that the proposed alternative alignment would satisfy the quantitative design objectives adopted by ARTC for both waterways. In particular:

- the flood level impacts would generally be confined to about 1.5 km upstream of the proposed alternative alignment and not extend into the urban areas of Narrabri;
- flood level impacts greater than 0.2 m would be confined to the river corridor or unimproved agricultural areas;
- there would be no flood impacts greater than 0.4 m for the 1% AEP event;
- there would be no dwellings impacted for any of the events investigated; and
- exit velocities for each proposed culvert are generally consistent with existing conditions velocities across the Namoi River floodplain.

The alternative alignment and proposed culvert/bridge configurations have not been optimised as part of this study. Should ARTC opt to use this alignment, further work and investigations will be required.

5 References

BMT WBM, 2020	*'TUFLOW User Manual'*, BMT WBM, 2020.
JacobsGHD, undated	*'ARTC Inland Rail Narromine to Narrabri Project Flooding and Hydrology Assessment Technical Report 3 2-0001-250-EAP-00-RP-0010'* prepared by JacobsGHD IR Joint Venture (JacobsGHD) for ARTC
Landcom, 2004	*Soils and Construction, Volume 1,* (NSW Blue Book), 4th Edition, March 2004
WRM, 2016	*'Narrabri Flood Study, Namoi River, Mulgate Creek and Long Gully'* report prepared for Narrabri Shire Council by WRM Water & Environment Pty Ltd, 2 December 2016
WRM, 2019	*'Bohena Creek Flood Study'* report prepared for Narrabri Shire Council by WRM Water & Environment Pty Ltd, 9 October 2019