

Our Ref: 116087.01L03-b

26 April 2017

Pacific International Development Corporation Pty Ltd
PO Box 1875
BROADBEACH QLD 4218

**PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL**



Approval no: DEV2017/844

Date: 25 October 2017

ATTENTION: TOM REGAN

Dear Tom,

FLINDERS DEVELOPMENT - FLINDERS LAKES EMBANKMENTS ENGINEERING INPUT

1 INTRODUCTION

Further to our recent discussions in relation to the above, we herein provide our initial advice for the purpose of submission to Economic Development Queensland (EDQ) to provide additional information supporting the overall response to the Terms of Reference (ToR) issued by EDQ. ATC Williams Pty Ltd (ATCW) have been engaged by Pacific International Development Corporation Pty Ltd (PIDC) to provide technical engineering support in relation to the lake containment & hydraulic structures. To this extent, this letter provides details in relation to the following:

- ATCW experience and Key Design Staff
- General Description of Proposed Dams and comment in relation to reports prepared to date
- Provide overview on the risks associated with the dam
- Outline proposed methodology for the design and construction of the lake

2 COMPANY EXPERIENCE AND KEY DESIGN STAFF

ATCW is a civil engineering consultancy that has strong capabilities in dam engineering for public and private clients, both in Australia and internationally, with experience in design, construction, surveillance and operation. Several recent project examples are provided below:



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Client	Project	Description	Services Provided
Moreton Bay Regional Council	Lakeside Raceway Dam	Homogenous earthen embankment dam located within and urban setting	• Operations and management planning • Surveillance audits • Failure impact assessment • Emergency planning • Hydraulic performance assessment
Evolution Mining	Mt Rawdon Project	Seven Site water management dams ranging from 20ML to 500ML and river water supply dam (1,200ML)	• Investigations • Detailed design • Construction overview and certification • Operations and management planning • Surveillance audits • Failure impact assessment • Emergency planning • Flood remediation works • Hydraulic performance assessment • Flow measurement structures
Wambo Coal	Wambo Coal Mine	Site water management dams (>1,000 ML capacity) and 6km creek diversion	• Embankment, flood levee and spillway design • Construction and certification • Mine impacted subsidence remediation design • Failure impact assessments • Sediment and erosion control
NICICO	Sar Cheshmeh - Shur River Dam	180m high asphaltic core rock fill dam on the Shur River with and estimated capacity of 35,000ML	• Geotechnical investigations • Embankment, foundation grouting and spillway design
Glencore/Xstrata	Mangoola Coal Mine	2 storages up to 26m high zoned earth and rock fill water dam and estimated capacity of 4,100ML	• Geotechnical investigations • Embankment design including two stage chimney and blanket filter, and a 5m deep vertical filter which fully penetrates the dispersive foundation clays • Spillway design • Surveillance audits
Rio Tinto Coal	Hunter Valley Operations - Lake James	Earth fill water storage dam, 9m high and 800ML capacity	• Raise design • Clean water diversions
MMG	Century Zinc Mine	31m high, zoned earth and rock fill embankment, with an estimated capacity of 60,000ML	• Geotechnical investigations • Detailed design including clay core and downstream filters, foundation grouting • Construction overview and certification • Surveillance audits

Key ATCW personnel undertaking this project are Rob Campbell and Ralph Holding, both of whom are experienced dam engineering practitioners who have played key roles in delivery of significant water dam projects undertaken by ATCW. CVs for Rob Campbell and Ralph Holding are provided in Attachment 1.

3 GENERAL DESCRIPTION OF THE SITE AREA AND PROPOSED DAMS

3.1 Site Conditions

Notable site conditions in terms of the dams/lakes development are summarised as follows:

- Site use currently comprises grazing lands with remnant vegetation on the upper slopes and drainage lines
- Slopes generally described as gently undulating
- Drainage lines eroded in area where vegetation/topsoil was removed
- Significant geotechnical investigations completed to date - Underlying soils comprise generally sandy clays to clayey sands, low to medium plasticity with clays typically dispersive. Areas of alluvium located within the lower reaches of the drainage lines. Basement sequences comprise generally massive sandstones with siltstone inter-bedding.
- Downstream the site discharges into the lower reaches of Teviot Brook, which in turn flows into the Logan River, and comprises a meandering river path within a broad flood plain. Significant urban development has occurred and is considered to continue along the river.

3.2 Dams Proposal

Preliminary concept for the dams based on the above background information, preliminary engineering analyses and in conformance with the proposed site development comprises:

- Purpose of the dams will be to form a manmade lake cascade system as a feature for the development.
- The general dimensions (subject to detailed earthworks and dam design) for the lakes are as follows:

Lake Element	Downstream Lake	Upstream Lake
Embankment Crest Elevation	RL43m	RL53m
Embankment Height	9m maximum	8m maximum
Spillway Invert	RL40m	RL 50m
Spillway Width	70m Approximately	70m Approximately
Lake Depth	Minimum 4m	
Embankment Crest Width	Varies, Minimum 6.0m	
Upstream Batter Slopes	4(h) to 1(v) above full supply level and transitioning to 2.5(h) to 1(v) below	
Downstream Batter Slopes	2.5(h) to 1(v)	

- It is recognised that the structures will be referable/licenced and will require associated management and documentation.
- The lakes will be operated/maintained generally at or near full supply level, with makeup water sourced from catchment inflows and licensed pumped off-takes from Teviot Brook following the release from Wyaralong dam. The spillways will comprise ungated open structures capable of passing the design flood without the need for flood controls.

- Subject to detailed design, embankments to comprise a zoned earthen embankment with internal clay core and associated filter. Other features will include deepened cut-off keys to minimise seepage losses, concrete over-embankment spillway structures and downstream foundation drainage systems. In addition it is recognised that the embankment for the Downstream Lake may be significantly widened with residential development, services infrastructure and landscaping to be provided on the embankment.
- Operations will general comprise ongoing surveillance and monitoring of the structures, including displacement monitoring, seepage flows and stream flows with associated maintenance of vegetation and remedial works as required. It is also recognised that treatment of the water bodies in terms of water quality will also be required, either passive or active systems.

4 GENERAL OVERVIEW OF PROJECT RISKS, REGULATORY REQUIREMENTS AND DESIGN STANDARDS

4.1 Typical Risk Framework for Dams Development

Typical risks associated will be included in the risk assessment framework, such as:

- Risks associated with the design and construction of the assets;
- The operational type risks that include operational procedures used during normal and abnormal circumstances, and risks associated with failure to supply water (not including water quality risks associated with the supply water or the stored water);
- Maintenance type risks that are related to regular inspections and keeping the asset in-line with the designed aspects of the asset as well as that of the supporting infrastructure;
- External influences, which are considered to have potential to evolve over time; and
- Cumulative influences considered individually not as a risk, but collectively or sequentially posing a major risk.

4.2 Regulatory Requirements

Notwithstanding the current development application, specific requirements for the design, construction and operation of Referable Dams in Queensland are outlined by the following guidelines:

- DNRM 2002: State of Queensland, Department of Natural Resources and Mines; 2002; Queensland Dam Safety Management Guidelines.
- DEWS 2012: State of Queensland, Department of Energy and Water Supply; 2012; Guidelines for Failure Impact Assessment of Water Dams.
- DEWS 01-2013: State of Queensland, Department of Energy and Water Supply; January 2013; Guidelines on Acceptable Flood Capacity for Water Dams.
- DEWS 06-2013: State of Queensland, Department of Energy and Water Supply; June 2013; Emergency Action Planning for Referable Dams.

4.3 Engineering Standards

Engineering design standards for the dam and associated works will be informed based on the above Regulatory Requirements, direction provided in approval conditions and associated guidelines produced by Australian National Committee on Large Dams (ANCOLD). Relevant guidelines will include:

- Guidelines for Dam Instrumentation and Monitoring Systems (1983)
- Guidelines on the Consequence Categories for Dams (October 2012)
- Guidelines on Risk Assessment (2003)
- Guidelines on Dam Safety Management (2003)
- Guidelines on the Environmental Management of Dams (2001)
- Guidelines on Selection of Acceptable Flood Capacity for Dams (2000)

- Guidelines on Design of Dams for Earthquake (1998)

5 DESIGN AND CONSTRUCTION METHODOLOGY

In context of the above background information, the following outlines the typical process from the concept development through to the construction and commissioning of the dam structures.

5.1 Data Gap Analysis and acquisition

This step will comprise gathering of available data in terms of site environmental and approval conditions, survey, geology, geotechnical, seismic hazard, hydrological, hydrological and environmental, with a subsequent data validation process and gap analysis to identify and scope additional investigation work as required.

5.2 Basis of Design

Key aspects of the Basis of Design task will include:

- Confirmation of design criteria to satisfy requirements of the client and the regulators.
- Confirmed concept layout of all structures, identifying key assumptions, envisaged construction materials and typical cross sections
- Designer's Risk Assessment (Safety in Design) identifying key design control measures adopted to manage primary risk factors.

5.3 Detailed Design and Documentation

Design works for civil infrastructure elements would comprise the following components:

- Hydrological and Hydraulic Analyses including Failure Impact Assessment (FIA). This assessment is required to understand the risks associated with the structure under worst case flood failure conditions to define detail design criteria. The hydraulic modelling will be used to determine the impacts of flooding from the proposed site infrastructure as well as to design/size site drainage features.
- Detailed design works would address the following:
 - (i) Embankment configurations, including foundation preparation and internal drainage requirements.
 - (ii) Spillways dimensions and assessment of hydraulic performance.
 - (iii) Associated infrastructure and erosion protection.

The following key issues are to be considered as part of design:

- Safety, in terms of long term integrity of the storage embankment, as well as in relation to protection from harm of the various users of the new works.
- Serviceability, such that all but reasonably anticipated maintenance requirements are substantially avoided over the active life of the works, as well as making provision for the convenient access and use of the facility.
- Containment performance, related to minimising seepage losses.

Specific design tasks would include the following:

Embankment Design

Embankment design works would include slope stability and seepage analyses, considering a range of embankment configurations, subject to varying foundation conditions. End-of-construction, long term stability and seismic loading conditions would be analysed. Appropriate foundation preparation and treatment requirements, and general fill construction methodologies would also be developed to ensure the stability of the embankment section.

Water Management Structures

Noting that the general site storm water management system and water quality management systems would be provided by others to maintain the lake water quality, primary water management structures in term of the dam embankment and internal drainage systems will include:

- Spillways.
- Internal embankment drainage (such as filter drain and embankment underdrains).
- Construction sediment and erosion control structures, to manage sediment and contacted runoff.

Design detailing would also include storage floor treatment or other seepage management systems, if required.

5.4 Documentation/Deliverables

An outline of deliverables from the detailed design process is provided below:

5.4.1 Design Report

The primary purpose of the design report would be to support the commercial and regulatory approvals processes. The design report would provide appropriate project background, supporting data, outline the relevant criteria adopted in design and summarise the final design configurations and construction requirements.

5.4.2 Operation and Management Plan (OMP)

The OMP would be prepared as the basis for operation and ongoing management and monitoring of the dam. The document would describe the obligations of the operator with respect to acceptable standards for operation of the storage, as a means of maintaining the long term integrity of this facility. In addition, the OMP is intended to assist with training of staff in matters related to management of the storage and maintenance of appropriate operating records.

Specifically, the purpose of the OMP is as follows:

- Description of the storage
- Description of relevant background site conditions
- Relevant operating targets as required
- Monitoring and surveillance schedule and reporting requirements
- Emergency identification and response plan.

5.4.3 Construction Documentation

Construction documentation would include the following:

- Overall construction work scope
- Technical specifications
- QA Plan including ITPs/ITCs
- Construction drawings
- Schedules of quantities.

5.5 Construction Attendance and Input

Construction of the dam will be supervised by a suitably qualified and experienced engineer. The intent of the construction inspections by ATCW and final construction reporting is to provide a certification statement for the works along with construction details, specification and documentation to current engineering standards based on the design criteria, as well as regulatory requirements as appropriate. The components of site attendance during construction, and associated reporting, is provided below:

- Construction Attendance - Site attendance will be provided during the period of construction, to the extent necessary to confirm the suitability of adopted construction techniques, use of specified materials and standards.
- Final Construction Report - A final construction report will be issued following the completion of construction works. The approach to preparation of the construction report is based on the following:
 - (i) Updated accurate survey information for the site and surrounding areas
 - (ii) As constructed drawings for the element and associated structures
 - (iii) All QA and QC test certificates
 - (iv) Construction photographs
 - (v) Inspection and Testing Plans (ITP)
 - (vi) Inspection and Testing Checklists (ITC)
 - (vii) Form of certification.

5.6 Construction Methods

Envisaged construction methods for the structure will comprise the follow aspects:

1. Site Establishment including laydown areas, construction water sourcing/supply, initial surveys and site permitting
2. Installation of sediment and erosion controls, surface water management structures. Likely to include coffer dams and pumped/pipe diversion of creek flows.
3. Clearing and topsoil stripping of the storage and embankment areas and stockpiling of topsoil. Additional grubbing of roots within the embankment footprint will also be required.
4. Excavation of unsuitable materials from the embankment footprint and excavation of the cut-off key. It is currently envisaged that the cut-off key will be a significant excavation up to a likely depth of 12m.
5. Foundation drainage downstream of the embankment core and upstream treatment of the storage areas, as required.
6. Embankment construction, including embankment core, filter zone and earth fill shoulders. Materials will be typically sourced from within the storage and or development area. Filter material will comprise a washed manufactured sand product likely to be imported to site.
7. Construction of the spillway structure and downstream erosion protection and/or energy dissipation works.
8. Surface erosion protection works including stabilisation of dispersive surface soils (typically to 2m depth), upstream batter armouring for wave protection and crest and downstream

protection typically using topsoil (from stockpiles) and vegetation (turf or erosion protection blankets).

9. Installation of monitoring equipment, including settlement, piezometer and seepage flow instrumentation.

Based on the above details and our review of the studies already completed to date, it is considered that the general lake and embankment arrangement can be appropriately engineered and constructed to current engineering standards, which subject to operations in accordance with the design and operational guidelines that will be developed as part of the detailed design, the facility will provide a significant asset to the community.

We trust the above addresses your current requirements and should you have any queries, please contact the undersigned.

Yours sincerely,



RALPH HOLDING
Principal Engineer
ATC Williams Pty Ltd



ROB CAMPBELL
Principal Geotechnical Engineer
ATC Williams Pty Ltd

Encl. Attachment 1 - Curricula Vitae



Rob Campbell
Principal Geotechnical Engineer

Master of Engineering Science (Geomechanics), University of Western Australia (1995)
Bachelor of Engineering (Civil), University of Western Australia (1991)

Member, Institute of Engineers, Australia (MIEAust)
Chartered Professional Engineer (CPEng)
Registered Professional Engineer of Queensland (RPEQ)

SPECIALTY AREAS

- Project management
- Engineering management
- Multidisciplinary design management
- Construction support
- Infrastructure, water dams, tailings dams
- Civil and geotechnical engineering

BACKGROUND

Rob Campbell has 24 years of professional experience on engineering projects:

- In Australia, NZ, USA, American Samoa, Singapore and Panama;
- For public and private organisations, within the water, wastewater, hydropower, mining and metals, transport, irrigation, industrial chemicals and building construction industries;
- Such as freeways, bridges, tunnels, pipelines, tank farms, water dams, flood levees, tailings dams, canals, mine pit high-walls, landslides, retaining walls, buildings, building foundations and mineral processing facilities.

Rob has been responsible for business development, bid delivery, client and stakeholder management, project management, multidisciplinary engineering management and civil and geotechnical engineering for a range of infrastructure projects up to \$AU12M in single project design fee value.

A significant proportion of Rob's experience has been in lead roles on large water dam and tailings dam projects, where complex multidisciplinary issues are commonly faced. This experience has armed Rob with the capabilities to play a lead role in challenging infrastructure projects across a broad range of industries. Rob's experience includes:

- Managing teams to deliver all phases of evaluation, risk assessment, design and document preparation (including design reports, technical specifications, construction issue drawings and facility safety emergency management plans) for new and existing infrastructure;
- Leading geotechnical investigation teams for new infrastructure, and forensic investigation of existing infrastructure;
- Leading construction support teams in maintaining design intent.

EXPERIENCE EXAMPLES

- **Numerous Infrastructure, Tailings and Dams Projects, Australia (2015 - present)**

As manager of the ATC Williams Brisbane tailings, dams and geotechnical team, Rob plays a key role, either as project manager, project director or peer reviewer, in the delivery of many infrastructure, tailings and dams projects, through all phases of evaluation, design, construction, enhancement and rehabilitation. Example clients include: Evolution Mining, Consolidated Tin Mines, Red River Resources, Moreton Bay Regional Council, Qld DEHP, Atherton Resources, AusTin Mining, Glencore, Rio Tinto and BHP Billiton.

- **Panama Canal Expansion, PAC4 Borinquen Dam 1E, Panama (2014/15)**

Relieving resident engineer, responsible for management of the construction support team and ensuring that the physical works achieved the design intent. As the key Design Representative on site, the role involved significant interaction with the Design team (based in the USA) and the Owners and Contractors teams (based on site, in Panama). The physical works involved construction of a new approach channel for the new locks being constructed at the Pacific end of the canal. The major component of which was construction of the eastern bank of the new channel, which is formed by Borinquen Dam 1E, an earth and rock fill dam ~3km long, that spans numerous active faults. A key challenge with the works was management and control of earth fill core construction in a very high rainfall climate.

- **BHP Billiton Mitsubishi Alliance, BSO Flood Protection, Qld (2009 - 2013)**

Rob was the project manager and design manager for the design and construction support team (responsible for maintaining design intent) for flood protection works which form part of the expansion of the Broadmeadow underground mine. The flood protection works include a 6km long flood levee, two filter buttresses (one of which did not need to be built) to upgrade existing water retention embankments, plus ancillary drainage and water transfer pipeline modification works. The project commenced with conceptual design in 2008, and construction was practically completed in 2013. The flood protection works are a critical element of the overall mine expansion project, with a total capital works value in excess of \$AU1B. The project was fast tracked, which presented numerous logistical challenges through both the design (Selection and Definition) and construction (Execution) phases.

During the design phase Rob lead the multidisciplinary design of the flood protection and ancillary works. This involved: (1) managing a site investigation and design effort performed by ~40 personnel from ~10 URS offices across Australia, NZ and USA; (2) implementation of risk based design methods to develop designs; (3) responsibility for preparation and delivery of conceptual, detailed and construction issue design documentation, technical specifications and drawings; and (4) interaction with other project stakeholder organisations to manage competing demands, communicate risks and assist with construction contractor tender evaluations.

The construction phase of the project involved a team of ~13 full time site based construction support personnel, recruited from various locations across Australia, NZ, USA, UK and Saudi Arabia, in support of a 7 day per week, day and night shift construction schedule. Rob was responsible for management of this team and ensuring that the physical works achieve the design intent, to allow RPEQ certification. Rob was also responsible for interaction with the numerous other stakeholder organisations involved in the project. During the construction phase a number of challenges were faced by the Contractor, and where possible, Rob lead the provision of significant engineering input to justify modifications to the original design, to assist the project commercially, while maintaining the intent of the design.

- **Seqwater, Cooloolabin Dam Safety Review, Qld (2014 - 2015)**

Project Manager and Design Manager for 20 year comprehensive safety review and conceptual design of filter buttress and spillway modification upgrade works for Cooloolabin Dam.

- **Seqwater, Lake MacDonald Safety Upgrade Option Selection and Upgrade Design, Qld (2013)**
Geotechnical Work Stream Lead - responsible for investigation and interpretation of geotechnical conditions and development of conceptual design of embankment upgrade works, as input to the overall dam upgrade option selection and concept design.
- **Goulburn-Murray Water, Tullaroop Dam, Vic (2011)**
Forensic geotechnical investigations and installation of additional embankment instrumentation following unusual instrument readings.
- **Gympie Eldorado Mines Pty Ltd, Qld (2011)**
Design Manager for evaluation of Tailings Dam 3 stability in the light of unusual seepage and piezometer behaviour.
- **BHP Billiton Mitsubishi Alliance, Goonyella Riverside Mine, Qld (2011)**
Project Manager for risk based evaluation of several non-engineered embankments being utilised as mine water impoundment structures.
- **Greenfield Coal Formation Water Storage Ponds, Qld, (2009 - 2011)**
Peer Reviewer for embankment design and construction support for various dams.
- **Hydro-Tasmania, Rowallan Dam Upgrade Partnership, Tasmania (2009 - 2010)**
Forensic geotechnical engineering to develop a geotechnical model for the embankment and foundations of an extreme hazard category earth and rockfill embankment dam. The purpose of the model was to feed into development of a preferred concept for upgrade of the dam - to address a number of geotechnical, structural and hydraulic design issues. Geotechnical issues included piping - the dam experienced a piping incident soon after construction in the late 1960's. The geotechnical model was developed based on existing records as well as new geotechnical information obtained via investigations.
- **BHP Billiton Mitsubishi Alliance, Goonyella Riverside Mine, Qld (2009)**
Project Manager for development of: (1) Operations plan for management of tailings deposition for RS1 tailings storage facility; (2) Perimeter embankment monitoring plan for GS1, GS1A, RS1 and GS4B tailings and water storage facilities.
- **Rio Tinto Alcan, Pond 8 Basic Engineering Design, NT (2009)**
Project Manager for geotechnical investigations and basic engineering design for a proposed high hazard category, HDPE lined process water dam. Composite liner system for the impoundment was required to resist uplift pressures associated with a high regional groundwater table (when empty) and also contain up to ~18m of head of caustic process water (when full).
- **Rio Tinto Alcan, Pond 6 South Remedial Measures, NT (2009)**
Project Manager for design of remedial measures for conversion of a recently built impoundment that was originally intended for storage of tailings to a high hazard category process water storage facility. Remedial measures included retro-fitting a composite liner system to the perimeter embankments.
- **Seqwater, Hinze Dam Alliance, Qld, (2008 - 2009)**
Member of Designers Representative Team during construction. Duties: Supervision of grout curtain construction works; Monitoring of foundation preparation and embankment construction works, to allow the works to be expedited as economically and efficiently as possible while ensuring that the intent of the design was met.

- **Seqwater, Hinze Dam Alliance, Qld (2007 - 2008)**

Embankment Design Team Member, tasked with performing / coordinating the bulk of the work associated with design of a \$50M plastic concrete cut-off wall, to mitigate the potential for piping through the right abutment of the dam. Significant interaction with the preferred Constructor was undertaken to allow a "realistic" cost estimate for the works to be developed. The outcome was the cut-off wall was completed ahead of schedule which alleviated a major construction schedule risk for the project. Other duties included initial development of a dam safety emergency management plan for high risk construction activities when tying into existing filters at the downstream toe of the dam.

- **Seqwater, Hinze Dam Alliance, Qld, Oct (2006 - 2007)**

On-site Geotechnical Investigations Task Leader. Duties included management of geotechnical field personnel and subcontractors and liaison with design team. Duties also included insitu stress (dilatometer) testing of rock for design of a plastic concrete cut-off wall.

- **Emu Swamp Dam Preliminary Design, Qld (2006)**

Geotechnical investigation of the proposed dam site, to support the preliminary design.

- **Four Different Confidential Clients, Australian Mining Industry (2007)**

Project Manager for engineering studies associated with several nickel heap leach projects. Studies ranged from preliminary geotechnical testing of ore to a bankable feasibility study. Composite liner system design for each heap leach pad included specific geomembrane / ore interface friction testing to determine maximum lined batter slopes.

- **Solid Energy, A-Drive Dam, A-Drive Sump, Ford Creek 3 & 4 Dams, Stockton, NZ (2005 - 2006)**

Design Manager for design and construction monitoring of several earthen sediment control dams, up to 33m in height. A key feature of the design and construction of these dams was the utilisation of site won materials as much as possible to construct the dams, in a very high rainfall climate, while maintaining an acceptable level of dam safety risk.

- **Aviemore Dam Wave Wall, Waitaki Valley, NZ (2004 - 2005)**

Design Manager for design and construction monitoring of a wave wall to inhibit seiche wave overtopping of the dam due to potential fault rupture beneath the dam and reservoir. Part of seismic safety evaluation and upgrade works to the dam. Project won a Silver Merit Award at the 2007 ACENZ awards.

- **McCaskey Dams, Waipara, NZ (2004 - 2005)**

Design and construction monitoring of a new irrigation dam. Design of remedial measures and construction monitoring for upgrade and completion of an incomplete irrigation dam.

- **Waimakiriri River Levee, Dickies Road to Motorway Bridge, Canterbury, NZ (2004 - 2005)**

Project Manager for geotechnical investigations, numerical modelling and design of reconstruction measures for a section of the secondary river levee.

- **Christchurch City Council, various projects (2004 - 2005)**

eg Avon River Bank Reconstruction; St Albans Creek Realignment; City Outfall Drain Subsidence Assessment; Geotechnical investigations, analyses, design and construction monitoring of various stabilisation / reconstruction works along rivers and other watercourses. Condition assessments of buildings adjacent to watercourses effected by ground subsidence due to lateral spreading, slope instability or sub-surface piping of sands.

- **Roxburgh Dam Right Abutment, Otago, NZ (2004)**

Two-dimensional slope stability assessment of the right abutment for the dam and after consultation with the dam owner, recommendation of a monitoring regime to manage the slope instability risk.

- **Project Aqua Geotechnical Investigations, Waitaki Valley, NZ (2003 - 2004)**

Geotechnical investigations for a proposed hydroelectric scheme involving 60 km of canals and 6 power stations. Investigations included Menard G-AM pressure-meter testing to determine stress-strain behaviour of in-situ tertiary deposits. Works also included supervision of construction of trial canal embankments with alluvial gap graded sandy gravel - as a key input to design of the canal lining system.

- **Mangere Waste Water Treatment Plant, Auckland (2002 - 2003)**

Embankment design for a biosolid landfill and preparation of Contract Documents for Construction. The impoundment included a composite liner system for the perimeter embankment.

- **Other Examples**

Geotechnical investigations, analyses, design and/or construction support for numerous other projects eg: Van Zanten Lower Clutha Levee Piping Risk Assessment (2006); Christchurch City Council Pump Station Ground Treatment (2006); Gladstone Pacific Nickel Residue Storage Facility (2006); Central Plains Water Wainiwanuiwa Dam (2006); Stockton and Rotowaro Mines Highwall Assessments (2005, 1999); Orica Mountview Tankfarm (2002); American Samoa Tankfarm (1999); Project Rosedale Sewer Outfall Tunnel (1999); Waikato River Water Source Project (1998); State Highway 20 Extensions (2002, 1998); I15 Freeway Reconstruction, Utah USA (1997); BP Fuel Lines, Ports of Napier (1999); Tui Mine Tailings Dam (1999); Matahina Dam (1997); Macraes Gold Mine Land Slides and Tailings Dam (1996); Coeur Gold Landslide and Tailings Dam (1996-1998); Waihi Gold Mine Pit and Tailings Dam (1997, 1999).

EMPLOYMENT HISTORY

- Principal Geotechnical Engineer, ATC Williams, 2015 to present
- Progression to Principal Geotechnical Engineer with URS (now AECOM), through 17 years of service, from 1996–2000 & 2002–2015, based in NZ (9 yrs) & Australia (8 yrs), with projects also in USA, American Samoa, Singapore and Panama;
- Technical Specifications Manager with Fosroc, providing construction chemicals technical support, for 2 years, 2000–2002, based in NZ;
- Civil Engineer with Firth Industries, managing manufacture and supply of precast / prestressed concrete products, for 1 year, 1996, based in NZ;
- Geotechnical Engineer with SRC Laboratories, performing in-situ and laboratory geotechnical testing, for 1 year, 1994–1995, Western Australia;
- Post-Graduate Research and Teaching with the University of Western Australia, developing methods to improve alumina refinery secondary thickener performance, for 2 years, 1992–1994.

CITIZENSHIP

Australian citizen residing in Brisbane Australia.

RECENT VOLUNTARY ROLE

Organizing committee member for the 2015 ANCOLD (Australian National Committee on Large Dams) Conference.



RALPH HOLDING

Principal Engineer

Bachelor of Engineering - Civil, University of Southern Queensland (1992)

Member, Institute of Engineers, Australia

Member, Australian Geomechanics Society

SPECIALTY AREAS

Tailings and mine water management, mine waste management, site rehabilitation, embankment design, geotechnical engineering, earthworks design, hydrology and hydraulic design, sediment and erosion control, construction supervision.

BACKGROUND

Mr Holding is a Principal with ATCW. He has over 20 years experience in a wide range of civil and geotechnical engineering projects servicing mining, industrial and local government clients. He possesses particular experience in the area of mine tailings and mine water storage and management applications. Involvement has included dam siting, geotechnical/foundation assessment, embankment design, construction management and earthworks quality control. He also has expertise in other mine waste facilities and mine post-closure design developed on the basis of the study of tailings and mine water geotechnics. This expertise includes:

- Storage configuration, site characteristics and environmental setting;
- Storage development/augmentation;
- Water management; and
- Closure/decommissioning strategies.
- Surface water management systems for mine waste disposal areas
- Waste dump and tailings dam capping technologies and rehabilitation design.

EXPERIENCE

Tailings

• **Mt Rawdon Gold Project (Qld) - Tailings Storage**

Sole provider of tailings management for Mt Rawdon from 2001 to current (2014), with TSF comprising 7 stages of development and a capacity of some 40Mm³. Tailings services included siting studies, embankment stability, seepage analysis and tailings deposition modelling. Detailed drawings and specification for storage embankments and associated work, budget costings. Construction involvement included site inspections of foundations, clay fill, rock fill, filter zone and rock armour, QA auditing and construction reporting. Related services included water supply options, failure impact assessment, site water management, drainage system designs, waste rock dump management and remedial works.

- **Garden Well Project (WA) - Tailings Storage**

Tailings management and storage design for a 30,000ML storage (200ha). Tailings services included siting studies, embankment stability, and seepage analysis. Detailed drawings and specification for storage embankments and associated work, budget costings. Construction involvement included site inspections of foundations, clay fill, rock fill, QA auditing and construction reporting. Related services included flood study, plant site geotechnical investigation and drainage system designs.

- **McArthur River Mine - Tailings Management and Storage**

Provider of tailings management for McArthur River between 2004 and 2014 (current), with TSF comprising 2 existing tailings cells and water management dam (approx. 300ha total). Tailings services included life of mine tailings storage strategies, annual inspections/audits and detailed cell design. Detailed engineering included embankment stability, seepage analysis. Detailed drawings and specification for storage embankments and associated work, budget costings. Construction involvement included site inspections of foundations, clay fill and rock armour, QA audits and construction reporting.

- **Kagara (Qld) - Tailings Storages**

Sole provider of tailings management for Mt Garnet, Thalanga and Mungana sites from 2002 to 2014 (company in liquidation), with TSFs comprising 3 TSFs. Tailings services included siting studies, embankment stability, seepage analysis and tailings deposition modelling. Detailed drawings and specification for storage embankments and associated work, budget costings. Construction involvement included site inspections of foundations, clay fill, rock fill and rock armour, QA auditing and construction reporting. Related services included site water management, water balances and drainage system designs, waste rock dump management and remedial works.

- **Rocklands (QLD) - Tailings Storage**

Management of options assessment, geotechnical investigations and detailed design of a TSF. Works included geotechnical interpretation, embankment layout and design for regulatory approvals. Preparation of construction drawing and specifications, and input to construction.

- **Bonikro Mine (Cote d'Ivoire) - Tailings Storage**

Conceptual and detailed design for TSF, including siting studies, embankment stability, seepage analysis and tailings deposition modelling. Detailed drawings and specification for storage embankments and associated infrastructure. Construction involvement included site inspections of foundations, clay fill, rock fill and rock armour, QA auditing and construction reporting. Related services included site water management and drainage system designs.

- **Cadia Mine (NSW) - Tailings Management**

Feasibility Studies including tailings and heap leach optimisation studies, tailings dam preliminary design, waste dump siting and layout and preliminary geotechnical investigations for the tailings dam and plant site. Water supply investigations and hydraulic design encompassing pipelines, culverts, spillways, groundwater extraction and surface water storages.

Site Water Management

- **Duralie Coal Project, NSW**

Site water management comprising three water management dams with a capacity of some 4,000ML, creek diversion, including culvert design, stepped channel and construction detailing. Detailed embankment designs, seepage and embankment stability, clean water diversion drains, spillway design, construction inspections and reporting, and surveillance inspections.

- **Cows Coal Project (Qld) - Site Water Management**

Conceptual site water management for regulatory approvals comprising clean and dirty water diversion/containment systems and integration to adjacent project and coal rejects management.

- **Design works for two site water storages Burton Coal (Qld) - Teviot Dam Water Storage**

Geotechnical investigation and materials search. Detailed design including seepage analysis, embankment stability, earthworks volumes, floating intake pontoon and risk assessment for construction. Construction involvement included site inspections of foundations, clay fill, rock fill, filter zone and rock armour, QA auditing and construction reporting.

- **Wambo Coal (NSW) - Site Water Management**

Design works for two site water storages (1,000ML total) and 6km permanent creek diversion. Works included siting studies, embankment stability, seepage analysis, detailed drawings and specification for storage embankments and associated works and budget costings. Creek diversion comprised replicating a meandering creek with low flow channel, high flow channel and maximum flood bunding. Construction involvement included site inspections of foundations, embankment fill and rock fill and construction reporting.

Mine Waste

- **Thalanga (Qld) - Waste Rock Dump and Capping Design**

Design works included landform development, stability, PAF cell containment system, seepage and vadose analysis and surface water runoff management.

- **Mungana (Qld) - Waste Rock Dump and Capping Design**

Design works included basal landform and seepage collection system, final landform development, seepage and vadose analysis and surface water runoff management.

- **Horn Island Gold Mine, Torres Strait (Department of Mines and Energy)**

Mine rehabilitation design and geotechnical investigations

Other Projects

A list of other tailings and mine waste management projects involved with, in a similar capacity as described above is provided below:

- **Wolfram Camp (Qld)** - remediation works to historical TSF, lift design, site water management, waste rock dump design and PAF cell encapsulation, and TSF conceptual design.
- **Goondicum Project (Qld)** - dam safety inspections, tailings dam lift design and tailings development strategy.
- **Cape Flattery Silica Sand Mine (Qld)** - management of site water management plan development including water balance and groundwater modelling of a window in the water table lake system.
- **McPhillimays Gold Project (NSW)** - scoping assessment for a 37,000ML TSF and water supply using river harvesting and waste water treatment plant effluent.
- **Cracow Gold Mine (Qld)** - management of preparation of a site water management plan including site water balance, metaliferous and acid mine drainage assessment, consequence assessment, site water drainage augmentation works.
- **Lake Vermont (Qld)** - Management of a haul road and surface water management detailed design, including drawings, specifications.

- Thalanga Base Metals Project (Qld) - geotechnical investigations and detailed design for earth and rock two new cells (total capacity 1000ML), site water management design and water balance modelling, regulatory approvals, Superintendent's representative for the construction of two tailings cells.
- Kainantu Gold Project (PNG) - tailings dam peer review, engineering input to construction, construction inspections and site water balance modelling.
- Lady Loretta (Qld) - surface water and seepage management for ore stockpile, including containment design incorporating GCL lining, construction inspections and regulatory approvals.
- Lake Cowal Gold Mine (NSW) - waste rock dump design including vadose modelling, basal drainage and capping systems.
- Yabulu Nickel Refinery (Qld) -tailings characterisation (physical), embankment stability, seepage analysis, consolidation analysis, tailings deposition modelling, geo-reinforced foundation, tailings delivery pipelines and review of existing pumps, motors and drives.
- Maldon Gold Project (Vic) - geotechnical investigations, detailed design for earth fill tailings dam (capacity 270ML, maximum height 15m) and site inspections.
- Nolans Gold Project (Qld) - geotechnical investigations, feasibility and detailed design for earth and rock fill tailings dam (capacity 20 000ML, maximum height 15m, embankment length 2km)
- SENT Landfill (Hong Kong) - construction supervision including field inspections, quality control testwork, construction quality assurance, environmental monitoring and reporting for works including bulk earthworks, dredging, seawall construction (rock and vertical block), pipelines (steel, ductile iron and HDPE), liner Construction (HDPE, bentonite, geotextiles), pavement construction, concrete and block work (culverts, drains, foundations, manholes, buildings)
- Croydon Gold Mine (Qld) - Superintendent's representative for the mine site rehabilitation works.
- Rishton Gold Project (Qld) - site inspections, material evaluation for upstream tailings fill lift construction.
- Cadia Gold Mine (NSW) - site based Environmental Management for the construction of the mine infrastructure, including overseeing of the site environmental management system, preparation of environmental management plans (EMPs), review of contractors' EMPs, site water management (ground water and surface water, including dam release for environmental flows) sediment dam design, site auditing, liaison with the construction manager, client and NSW EPA, environmental monitoring (meteorological, water, air and noise). Construction supervision for the sediment control works and leachate dams. Geotechnical/foundation investigations and preliminary design for earth and rock fill tailings dam (capacity 143 000ML, maximum height 90m). Foundation inspections for plant site infrastructure.
- Taman Seri Gombak (Malaysia) - detailed slope stability analyses for earthworks associated with large multistorey housing development in Kuala Lumpur, including data analysis, stability modelling under various conditions, and site seismic analyses. Design of drainage systems associated with development as well as development of digital terrain model to optimise earthworks, maximise useable land and estimate final earthwork volumes for contract purposes. Ongoing involvement to review and check contractor's quantities.