Appendix 19

RETURN TO APPENDICES LIST

Condition Evaluation of Raw & Treated Water Pipeline Systems & Associated Assets Stage 2A Report

(Alf Grigg & Associates Pty Ltd)

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Specialist Engineering Consultants

GLADSTONE AREA WATER BOARD

CONDITION EVALUATION OF RAW & TREATED WATER PIPELINE SYSTEMS & ASSOCIATED ASSETS

STAGE 2A REPORT

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30th September, 2007

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Stage 2A Report
Executive Summary

This report summarises the second stage in the condition evaluation of the water supply pipelines and associated infrastructure, and includes the initial outcomes of an internal CCTV inspection of the 700 mm diameter MSCL pipeline.

With the exception of the 700 MSCL pipeline, the strategic condition evaluation task on most pipelines is now substantially concluded.

Significant sections of two pipelines, the 300 CI Goolegumma and the 300 DICL East End pipelines are considered to be effectively life expired and capable of failure now. The life expired section of the 300 DICL Boyne Island pipeline is less than 250 metres long. Replacement of that section would (subject to one other condition confirmation) return the balance of the pipeline to an acceptable, reliable condition for an extended service life.

Cut-in exposures, a corrosion failure event, and subsequent internal CCTV inspection of significant sections of the 700 MSCL pipeline have revealed extensive internal lining failures and consequent internal corrosion processes that, if not rehabilitated, will reduce the residual service lifespan estimate of the pipeline. The pipeline is considered worthy and capable of cost-effective rehabilitation. Extended internal inspection by CCTV equipment will progress the condition evaluation process, and enable the scope and severity of the internal protective lining loss to be accurately quantified. This task now constitutes one of the forward condition evaluation tasks.

The other primary forward condition evaluation challenge is to better understand the impact of acid sulphate soils (ASS) on existing calcium and ferrous pipeline systems. A number of key pipelines appear to be located in areas that are reported to be active, low pH soil zones. The impact of such soils on calcium and ferrous pipelines could produce significant external pipe wall corrosion and reduce the service lifespan of the pipelines.

The 900 raw water Mt Miller corrosion rectification, and the evaluation of the 700 and 1440/1290/1086 raw water Awoonga pipelines within ASS zones, together with other minor evaluation tasks, should be the focus of Stage 3 of the project. Each task can be costed and implemented as consultancy and/or contractor tasks where required given existing Board commitments.

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1.0 Report Objectives

This report presents a revised summary of the outputs from Stage 2 of the condition evaluation of the raw and treated water pipelines and associated infrastructure of the Gladstone Area Water Board supply system. The report compliments the July, 2007 Stage 2 report, and that of Bill McEwan of CTI Consultants.

The report presents an overall summary of project progress and proposes forward condition evaluation projects that will conclude the pipeline assessment phase of the project.

The objective of the condition evaluation process is to determine whether pipeline assets considered at increased risk of failure due to known environmental, original construction, or service history factors are in fact in an advanced stage of deterioration and require rehabilitation or replacement.

The primary amendment is the addition of the findings of the internal CCTV inspection of the 700 MSCL pipeline following the discovery of significant loss of internal lining and a failure due to internal corrosion producing a perforation.

2.0 Abbreviations

The following abbreviations are utilized in this report:

- GAWB is Gladstone Area Water Board;
- Qld DNR/DNR is the Queensland Department of Natural Resources;
- MSCL is mild steel cement lined, or mortar lined pipe;
- DICL is ductile iron cement lined pipe;
- CICL is cast iron cement lined pipe;
- AC is asbestos cement pipe;
- ASS is acid sulphate soils;
- uPVC is unplasticised poly vinyl chloride pipe;
- NDT is non destructive testing of a material;
- BEM is a non-destructive broadband electromagnetic scanning;
- UT is ultrasonic thickness measurement of ferrous material;
- PCM is Pipe Coating Mapper, a system for evaluating external coating systems on electrically continuous pipelines.

3.0 Stage 1 Report Recommended Actions

The Stage 1 report provided a suite of recommendations for immediate consideration and implementation regardless of when Stage 2 proceeded.

It is understood and/or assumed that these recommendations have been implemented or will be implemented shortly.

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4.0 Stage 2 Implementation

4.1 Stage Plan

Stage 2 was to feature further asset locations, field inspections, and some exposures of pipelines where justified. The proposed implementation was to consist of a field application approach with the detailed field tests and evaluations being conducted by Bill McEwan of CTI Consultants.

Bill's report, which has been presented to senior staff and accepted, is a very detailed technical evaluation of a number of pipelines previously identified in Stage 1 of the project. His findings are discussed later in this report.

This report compliments Bill's report, and attempts to avoid unnecessary repetition.

4.2 Stage 2 Field Activities

The following is a summary of the tasks and activities that were undertaken during the visit of the 27th – 29th March by Bill McEwan, Dean Tappin and the author.

Monday, 26th March

Bill McEwan arrived in Gladstone and prepared for the three-day project.

About the same time as Bill arrived, Dean Tappin contacted the author and explained that the 900 Sintakote MSCL raw water pipeline to the Yarwun industrial area had failed in a valve pit. He asked whether either of us had arrived in Gladstone.

Dean subsequently contacted Bill and provided him with an opportunity to inspect the failure and evaluate the cause/s. Bill subsequently provided a detailed causal evaluation in Item 9, page 15 of his report.

The short section tee piece was constructed and internally coated, not with a cement mortar as in the normal pipeline sections, but with a high-build epoxy paint system.

Bill's assessment was that an epoxy coating had failed on a very small surface area producing a pinhole corrosion failure that was accelerated by the galvanic series formed between the mild steel pipeline body and the stainless steel trim of the butterfly valve.

Bill is correct when he stated that current NDT techniques would not detect such small pit corrosion points. The simplest approach will be to utilize either CCTV or optic fibre inspection systems via the air valve tee to evaluate the individual adaptor pipe sections.

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There is a range of options to remediate the potential of future similar galvanic series failures, including the following:

- Internally rendering the pipe wall with a range of additional protective coating systems. One issue with each of these render options will be the time required to prepare the existing high-build epoxy coating system to accept an additional coating. The time may too extensive to take the pipeline out of service;
- Deploy an inert liner system into the short section of the adaptor pipe. Companies such Veolia offer appropriate non-structural corrosion protection liner systems that can be deployed and cured in-situ within a 3 – 4 hour pipeline occupancy period.

A detailed suite of recommendations for evaluating and rectifying these potential defects is provided in Item 9.

Tuesday, 27th March
We traveled to the office for an initial discussion of the approach to the field inspections. We then proceeded to the Boyne Island mud dam project site where we completed a site safety induction.

We then proceeded to the site on the 300/375 pipelines where the 300 DICL pipeline had failed previously. Bill advised that the soil was not acidic but was water logged.

We inspected a shard of 375 AC pipe in a cast iron fitting, and noted the AC to have a wall thickness of 33 mm and to be in good condition.

The excavation was then completed revealing the 300 DICL and a 375 AC pipeline. The AC pipeline was in good external condition with no evidence of surface softening that would have indicated an acidic soil attack.

The 300 DICL pipeline was in poor condition with general corrosion of 2-3 mm pits over the top of the pipe and 3-4 mm pits in the sides. Bill evaluated the corrosion process as active.

The immediate conclusions were that:
- The 300 DICL is in poor condition and remains at risk of continual failure, and;
- The 375 AC Boyne Island treated water pipeline appears to be in good condition and provides an obvious explanation as to why that pipeline has not suffered the failures of the 300 DICL raw water pipeline.

The key recommended actions are:

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- Replace the 300 DICL from the last high ground to the drainage alignment elevated bridge crossing and then from the crossing (at chainages 5125 – 5475 metres per Plan #79612) to a point where the pipeline begins to demonstrate acceptable external corrosion appearance;
- Expose and prove the extent of the AC pipeline from the last high ground point to the point east of the drainage channel where the pipeline changes direction to the south as it proceeds to the Boyne Island service reservoir.

We then proceeded to inspect the tidal channel pipeline bridge structure and the elevated pipelines back to high ground and at the intervening low points traveling east.

We were advised that there was anecdotal evidence of failures of either one or both pipelines at the trench line point where the pipelines ended the elevated sections and became buried pipelines.

The key recommendation is that these stories be either confirmed or refuted. If confirmed, both pipelines should be evaluated by exposure to ensure that the external corrosion condition of both pipelines is confirmed as acceptable. Both are presumed to be DICL at that point.

Finally, a site was selected at a low point where soil conditions could be considered to be potentially of the acid sulphate type. The exhumed pipelines were both DICL and both were considered to be in good condition for age with minimal external corrosion.

While Bill remained with the pipeline exposure task, Dean and the author inspected the 700 and pipeline routes. Key issues arising from the inspection were:

- Both pipelines are buried in sections north of Toolooa pump station site in soils mapped and identified as acid sulphate soils. These sites should be checked at some time in the future to assess soil conditions and to assess the performance of the external pipe coating and cathodic protection systems;
- The loss of internal mortar lining and the quantities found in the reservoir, seemingly from the 700 MSCL pipeline, must be due to causes other than machinery causing minor impacts and damage to the pipeline.

Bill has suggested that the pipeline internal mortar lining could suffer significant failure and loss if the pipeline was ever left in a drained state for any significant time. Heating of the exposed, above-ground pipeline could have resulted in the steel pipe section expanding more rapidly than the internal mortar lining so producing a weakened bonding and ultimate lining failure.

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The Board subsequently undertook a field cut-in of a magnetic flow meter assembly into the 700 mm diameter pipeline, and discovered further evidence of partial delamination of the internal mortar lining. The delamination effect was not full depth to the steel pipe section, and the residual mortar lining demonstrated good calcium content and depth through the section.

We provided commentary to the images of the internal lining of the 700 mm pipeline, and the significance of the partial lining delamination.

Sections of pipeline where the internal mortar lining is confirmed missing can be subjected to NDT assessment of the steel wall section for corrosion processes and reduced section thickness.

Internal corrosion protection lining loss cannot be compensated for by other internal protection systems. The Board would be faced with either relining of the pipeline or to accept a shorter service life.

Summary recommendations from inspections of Tuesday, 27 March are presented in Item 9, Recommendations:

Wednesday, 28th March
We commenced with an exposure of a pipe joint on the 600 MSCL QAL raw water pipeline in the car park immediately south of the access road and west of the entrance gates to the facility.

The 600 MSCL pipeline site proved to be a dry site with a neutral pH soil and low resistivity on the saltpan area. The pipeline joint was well wrapped in corrosion protection tape with the metal surfaces in very good external condition. There were no closing welds on the joint meaning that the pipeline is not electrically continuous.

Our provisional assessment is that there may remain sections of the pipeline that are located in AS soils that might be subjected to external corrosion processes. We recommend protecting the pipeline against external corrosion by installing electrical continuity straps between pipes to achieve an electrically continuous pipeline, and then install cathodic protection.

During the excavation process, we traveled to the 50 Ml and 16 Ml raw water service reservoir tanks to enable Bill McEwan to inspect the Macalloy bars and the condition of the walls of the tanks.

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Bill expressed reservations at the condition of various structural elements of the tanks, and recommended that all tanks be subjected to structural evaluation to determine whether the tanks require remedial repairs and planned condition monitoring.

We then traveled to Hansons Road to excavate and evaluate the 375 AC raw water pipeline. This pipe was found to be installed in a clear poly sleeve in a sand-bedded and topped trench off the road shoulder in compacted imported road fill.

The pipeline was examined and found to be in excellent external condition. As the pipeline conditions were assumed to be in equivalent conditions to Yarwun, no further excavations were undertaken.

Assuming that this pipeline has been constructed in a poly sleeve, and in critical AAS zones within a sand bed in the trench that is located within imported road base fill, the rating of the 375 AC pipeline is revised in Attachment No. 2.

Finally, we proceeded to the Boat Creek pump station site to examine the 300 DICL treated water pipe shard from the previous failure located east of the station.

Two excavation sites were chosen downstream of the pump station, and excavation works commenced.

In the interim, we proceeded to examine the 300 DICL and 150 galvanised pipelines on the road bridge.

Bill confirmed my previous assessment that the 150 galvanised pipe bridge crossing section is life expired and should be replaced.

We then proceeded to inspect the route of the 300 DICl pipeline past the stone quarry through to the first road exist to the Mt Larcom road, before returning to the Boat Creek site. The pipeline in both exposures was in poor condition with extensive areas of corrosion pits of 2 – 3.5 mm depth. The pipeline is considered to have a limited residual service life.

Thursday, 29th March

We commenced with selecting a gully site on the 300 DICIL pipeline for an exposure. We then proceeded to travel along the pipeline route, stopping to inspect discarded pipe shards before arriving at the four-pipe site where ex-railway alignment pipes have been stacked for re-use by the landowner.

The condition of the four pipe lengths was a serious challenge to rationalizing the corrosion processes on this pipeline. An inspection of the pipeline diversion site for the

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railway revealed a point on the former pipeline route close to a high point on a low physical feature, a site that should have been well drained and distinctly different to the swampy ground and low creek crossings that might otherwise be considered to be the most likely sites for high groundwater concentrations and external corrosion.

The four discarded pipes displayed localized corrosion that could have proceeded to pipe failure had the pipe remained in surface.

Another two pipes at another site that were removed from the diversion were in distinctly different condition with virtually no obvious external corrosion. The variation in external pipeline condition represented a conundrum for evaluating the external corrosion process that is causing this pipeline to fail.

We then proceeded to the East End service reservoir to inspect the tank and associated pipelines, with the trenching conditions in red soil and at significant depth.
Pipe condition appeared to be very good.

We returned to the excavation site to inspect an exposure of the 300 DICL pipeline that was in very good external condition. The site featured high soil resistivity and neutral groundwater, so constituting a benign site.

During the route inspection, we were able to inspect the slurry pipeline sections removed for the railway project. The pipes were thick walled steel pipe with an external coal tar coating, with no external corrosion evident. This pipeline appears to have a cathodic protection system that has apparently been serviced up until recent years.

We discussed the possibility of utilizing the slurry pipeline for the interim period during which the long term demands on the pipeline route can be established and a replacement pipeline constructed and commissioned.

We then returned to the water treatment plant to provide Bill with an opportunity to inspect the reported impellor wear as identified in the original project report. His assessment, as with my assessment, is that the impellor is probably not ideally suited to the duty, and that the system resistance curve and the impellor performance curves need further evaluation.

We then proceeded to following the route of the 300 CI pipeline and to inspect some of the sites of pipeline exposures and known failures. Bill was concerned with the lack of cover over the pipeline, and expressed concern that future development of land along the pipeline route will increase the number of pipeline failures arising from impacts from surface activities.

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Bill's assessment of the 300 CI at the air valve failure site in Mann's paddock was that the pipe section was very good with little corrosion and the failure due to a hydraulic surge/hammer effect that caused the pipe to fail in a brittle manner. His assessment of the pipes at the pipe dump further into Mann's paddock was that the pipes had been weakened due to external corrosion and then fail in brittle cracking due to water hammer impacts. Our joint assessment, as per previous reports, can be summarized as follows:

- The pipeline is old, long, and shallow;
- The pipeline is located in variable soil conditions;
- The pipeline has suffered a number of known failures such as the 9th April failure, and will continue to do so as long as hydraulic water hammer impacts exceed the residual strength of the weakest pipes;
- All pipes inspected have failed due to structural brittle failure from hydraulic impacts. Some of the failures have been created by an externally corroded and weakened pipe.

We visited the Awoonga water supply pump station and reservoir, and inspected corrosion in metal wall sections of the superstructure. Bill explained that the corrosion has been caused by rainwater and condensate entering the steel hollow section members then creating corrosion inside the uncoated steel member sections.

Our recommendation is that the Board obtain an assessment by a structural engineer to assess the current risk of the wall structure, to formulate immediate action plans to modify the structure to ensure structural stability under wind loads, and then to devise a project strategy to rehabilitate the wall structure to eliminate the sections affected by corrosion.

Bill had a limited opportunity to inspect the 700 and 1440/1290/1086 pipelines and raised issues regarding the management and output information from the cathodic protection system. He agreed that the buried sections of both the 700 and the 1440/1290/1086 pipelines within confirmed AAS zones should be the subject of an external coating integrity assessment utilizing a system such Pipe Coating Mapper. Any coating integrity breaches should be evaluated by exposure, and coating defects rectified.

Bill encouraged the Authority to formalize and utilize the output information from the 1440/1290/1086 pipeline cathodic protection system as part of better understand the operating environment and possible corrosion issues.

He further suggested that cathodic protection should be applied to the 700 pipeline, particularly in sections where the pipeline is buried for significant distances, and is apparently located in confirmed ASS zones.

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5.0 Subsequent Field Inspection Events

Board operational teams subsequently completed a cut-in in the 700 MSCL pipeline to install a flow meter, and found evidence of internal mortar lining delamination and failure. Photographs were forwarded to Bill McEwan and the author.

A corrosion perforation failure was subsequently detected just prior to the 14th June at a site some 300 metres downstream of the flow meter site. The photographs localized delamination indicated advanced internal corrosion.

Accessible sections of the pipeline were subjected to a CCTV internal inspection to determine the extent and visual consequences of the loss of the internal mortar lining. The CCTV record depicted extensive loss of the internal cement mortar lining, and sites of advanced internal corrosion of the steel pipe wall.

The shards of the internal liner were found when a reservoir was cleaned around 2004-05. The quantity of shards was considered to be excessive and of concern. The circumference of the shards indicated that the material had derived from the 700 MSCL pipeline.

The cause of the loss of the internal lining has yet to be definitively established but may be due to one or a combination of the following factors:

- Corrosive impact of low pH water on the calcium matrix of the mortar liner caused by chlorination of the raw water at the Awoonga Reservoir, an operational procedure that is understood to have ceased some years ago;
- Possible temperature compression and arching of the mild steel pipeline between rigid supports that might have put the steel pipe and internal liner into tension and differential expansion, thus contributing to liner delamination from the pipe wall;
- Any period in the service history of the pipeline when the pipe may have been emptied and left for an extended period during which solar heating of the upper pipe wall section may have resulted in differential expansion of the steel pipe and the cement mortar liner so resulting in delamination of the liner from the wall;
- Defective original installation of some parts of the liner.

Further inspection of the pipeline towards the urban area should reveal whether the liner failure problem reduces with distance from the Awoonga reservoir, and/or is not visible in the buried sections near Toloola.

The CCTV images identified liner loss and revealed some sites of visual ferrous corrosion. The extent of unprotected, corroded sites appears to be such that carefully identified sections could be removed and replaced while the balance of the pipeline between cutout sections is grit-blast cleaned then relined with cement mortar.

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It is recommended that the CCTV inspection be continued along the pipeline as opportunities for access are presented. The CCTV images should be condition rated in accordance with the WSAA Conduit Inspection Reporting Code of Australia, WSA 05-2006, and be logged accurately, definitively and numerically to quantify the extent of liner loss and visually obvious sites of ferrous corrosion.

6.0 Evaluation of Pipelines by GAWB Matrix and SMEC Valuation

The summary of risk assessment of the inspected pipelines by both the GAWB and SMEC assessment systems provides the provisional assessment as per Attachment No. 2.

In short, only four pipelines inspected during the Stage 1 visit require condition assessment as a first order priority to confirm the risk ratings.

7.0 Stage 3 Forward Condition Evaluation Activities

The evaluation of the following pipelines is now complete:

- 300 CI treated water pipeline to Goolegumma;
- 450/375 AC raw water pipeline, Hanson road;
- 600 MSCL raw water pipeline to QAL;
- 375 AC treated water pipeline to Boyne Island;
- 300 DICL treated water pipeline, Boat Creek to East End;

Further investment of condition evaluation time into the 300 DICL East End raw water pipeline would be economically unviable given that the cost of such evaluation would be unlikely to produce much predictable benefit. Significant sections of the pipeline are life-expired, and have a high probability of failure.

Further investment in the 300 CI Goolegumma treated water pipeline might enable better definition of the corroded and weakened pipeline sections, though is likely to reveal that significant sections of the pipeline in gullies and any zones of corrosive soils are significant in terms of total affected length.

The most effective strategy is to monitor, detect, analyse, and eliminate any water hammer effects in the pipeline to optimise residual service life.

Stage 3 condition evaluation tasks should be focused on:

- Further evaluating the 700 pipeline to confirm the condition of the internal protective mortar lining and to establish the extent to which the partial delamination has progressed; to be undertaken by specialist service providers;

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- Where lining loss is detected and mapped, undertaking non destructive testing to assess the actual wall thickness and most probable residual service life without remediation works;
- Review and codify the completed CCTV image of the 700 mm MSCL pipeline. The CCTV images should be condition rated in accordance with the WSAA Conduit Inspection Reporting Code of Australia, WSA 05-2006. The codified results should be logged to the Code to accurately, definitively and numerically log the extent of liner loss and visually obvious sites of ferrous corrosion;
- Continue the CCTV inspection along the pipeline as opportunities for access are presented.
- Where lining loss is detected and mapped, undertaking non destructive testing to assess the actual wall thickness and most probable residual service life without remediation works;
- Based on the logged condition rating, complete a cost-benefit analysis of the rehabilitation of the 700 MSCL pipeline by preferential grit cleaning and cement mortar relining, with limited cutouts of corroded pipeline sections for access for relining equipment. Compare with full replacement cost of new pipeline;
- Evaluating the buried sections of the 700 and 1440/1290/1086 pipelines within the ASS zones utilising PCM and exposure evaluation;
- Evaluating the sections of the 375 AC treated water pipeline to Boyne Island where that pipeline may be installed with confirmed ASS zones, and at its point of transition from an elevated to a buried pipeline east of the tidal channel pipeline bridge;
- Evaluating the 300 DICL raw water Boyne Island pipeline at its point of transition from an elevated to a buried pipeline east of the tidal channel pipeline bridge;
- Revising and expanding the value of the output data from impressed current cathodic protection system on the 1440/1290/1086 pipeline. This task could be undertaken by the existing service provider;
- Further evaluating the actual duty systems resistance curve for the high lift pump station pump sets and attempt to identify impellor design/reconfiguration options to minimises cavitation erosion of the existing impellors

The recommendations contained in Item 9 will confirm pipeline status, will optimise the service lives of these pipelines, and/or provide the justification to replace part or the entire pipeline asset.

The Stage 3 project stage can be formally designed and costed once the Board determines its priorities of forward projects.

The original overall project brief (Attachment No. 1) could now be reviewed to determine which components are to be progressed to conclusion. Those components of sufficient priority could be included in Stage 3.

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8.0 Conclusions

The pipeline and infrastructure condition evaluation project is progressing towards completing all major pipeline assets.

Most pipelines are in good condition and should provide extended service life spans. Two significant pipelines are close to being life expired, and will remain in service until the burst rate due to water hammer effects on weakened pipe sections becomes unacceptable.

Sections of the 700 MSCL pipeline are now confirmed to have suffered significant loss of the internal mortar liner with one corrosion perforation failure and evidence of advanced section corrosion at other sites.

Acid sulphate soil zones pose a significant threat to some Board pipeline assets, and should be assessed for corrosion effects on calcium and ferrous pipelines.

Stage 3 activities should clarify this and other risks and operational issues.

9.0 Recommendations

- **900 Raw Water Yarwun Pipeline:**
    - Investigate the availability of appropriate CCTV and/or optic fibre visual evaluation equipment to internally inspect the two adaptor pipe sections at the six valve pits;
    - Inspect each pipe section for any evidence of pit corrosion points caused by the galvanic series between the mild steel pipeline section and the stainless steel trim on the butterfly valves;
    - If the inspection program reveals a number of pipeline sections that require renewal of the lining or placement of a superior lining, investigate, evaluate, and select a preferred lining option then implement a lining program.

- **300 DICL raw water pipeline, Boyne Island:**
    - Replace the 300 DICL from the last high ground to the drainage alignment elevated bridge crossing and then from the crossing to a point where the pipeline begins to demonstrate acceptable external corrosion appearance;
    - Investigate reports of prior failures of this pipeline at the point where the elevated section from the tidal channel bridge transitions into the buried section. If confirmed, expose and evaluate the condition of the pipeline for evidence of deteriorated sections due to external corrosion;

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- **375 DICL/AC treated water pipeline to Boyne Island:**
  - Expose and prove the extent of the AC pipeline from the last high ground point to the point east of the drainage channel where the pipeline changes direction to the south as it proceeds to the Boyne Island service reservoir.
  - Investigate reports of prior failures of this pipeline at the point where the elevated section from the tidal channel bridge transitions into the buried section. If confirmed, expose and evaluate the condition of the pipeline for evidence of deteriorated sections due to external corrosion;
  - Confirm the route and relationship of the AC pipeline section to ASS conditions where it crosses the tidal channel at the Boyne Island end of the pipeline. If confirmed, expose and evaluate the external condition of the pipeline for evidence of acidic attack;

- **700 MSCL raw water pipeline:**
  - Assess the condition of the external coating of the 700 mm MSCL pipeline using PCM where the pipeline is buried, and in particular the sections south and north of redundant Toolooa booster pump station where ASS conditions are indicated on the DNR plan sets;
  - If the PCM survey reveals coating defects, expose and assess the condition of the pipeline with respect to external acid corrosion processes;
  - Investigate the feasibility of implementing a cathodic protection system for the buried sections of the pipeline;
  - Continue the CCTV inspection along the pipeline as opportunities for access are presented.
  - Evaluate, codify and log the completed and future CCTV images of the 700 MSCL pipeline in accordance with the WSAA Conduit Inspection Reporting Code of Australia, WSA 05-2006 to definitively and numerically log the extent of liner loss and visually obvious sites of ferrous corrosion.
  - Where lining loss is detected and mapped, undertaking non destructive testing to assess the actual wall thickness and most probable residual service life without remediation works;
  - Complete a cost-benefit analysis of the rehabilitation of the sections of the 700 mm MSCL pipeline to determine whether the pipeline can be economically rehabilitated.

- **600 MSCL QAL Raw water pipeline**
  - Protect the pipeline against external corrosion by installing electrical continuity straps between pipes to achieve an electrically continuous pipeline, and then install cathodic protection to minimize external corrosion in the ASS zones along the pipeline route.

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- **Major Water Storages**
  - All post-tensioned reservoir tanks be subjected to structural evaluation to determine whether the tanks require remedial repairs associated with the failure of some Macalloy bars failing.

- **150 mm Galvanised Steel Pipe Crossing on the Boat Creek Bridge:**
  - Replace the galvanised steel bridge crossing on and leading to and from the Boat Creek Bridge.

- **300 DICL East End Treated Water Pipeline**
  - Investigate the possibility of leasing the slurry pipeline from Cement Australia for use as a treated water pipeline for the interim period until the plans for the future of major pipeline assets within the region and immediate area are finalised;
  - If successful in leasing the slurry pipeline, review the pumping duty curves and capacity at the Boat Creek pump station to ensure that the pump performance matches the increased heads of the smaller diameter slurry pipeline;
  - Once the pump performance is matched to the pipeline, engage the current service providers to review and rehabilitate the cathodic protection system on the slurry pipeline.

- **Duty Impellors at High Lift Pump Station, Water Treatment Plant**
  - Review the duty curve of the impellor and compare it to the actual duty curve for the pump station. If the latter does not exist, construct the curve from actual flow versus head data under operating conditions;
  - If the curves do not represent an ideal match, refer the performance and erosion issue to the manufacturer for revision and manufacture of an impellor that offers an ideal match to the actual duty;
  - Install and monitor performance and wear over a 12-month period.

- **1440/1290/1086 Raw Water Pipeline**
  - Review the management and monitoring program of the cathodic protection system to ensure that significant changes in system currents are detected and investigated for cause and resolution.
  - Assess the condition of the external coating of the 1440/1290/1086 mm MSCL pipeline in the ASS zones south and north of Toolooa using PCM;
  - If the PCM survey reveals coating defects, expose and assess the condition of the pipeline with respect to external acid corrosion processes.

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30th September, 2007

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Attachment No. 1 Original Project Brief

The scope of the condition evaluation project is to include but not exclusive to those portions of work nominated below:

- Detailed condition assessment of all GAWB's pipelines. This will include an evaluation of the pipeline materials by both destructive, non-destructive methods and soil corrosivity testing.
- Inspection, assessment & data collection of all associated pipeline infrastructure including air, scour, isolation valves, and booster pump stations and surge vessels.
- Pressure monitoring and leak detection suggestions for the most appropriate systems to achieve a high degree of confidence in the integrity of GAWB's pipelines.
- In-field identification of pipelines physical location within the easement and review of easement documentation to identify problematic areas where pipeline is outside or no easement exists.
- Digital photo's and summery with the attached condition rating and other relevant documentation for that asset.
- The final report is to include a list of the most critical pipelines that place GAWB at the most risk on a customer basis. The development of a program of works starting with the most critical condition assessed and working toward the least. This information will need the ability to make capital suggestions for coming budgets with approximate cost estimates for rehabilitation.
- In addition to the final report, we will provide an "Operation & maintenance" manual for each pipeline system, with these manuals being developed in conjunction with GAWB staff.
- The "Operation & Maintenance" manual is to include:
    - Customer database with key contact personnel, names and numbers for all customers on the raw and treated water reticulation networks.
    - Nature and frequency that maintenance should be carried out. This will include but not be exclusive to the exercising of valves, scouring of pipelines, cleaning air valves, replacing bolt sets in flanges and painting of above ground infrastructure.
    - Normal operating procedures
    - Emergency operating procedures
    - Physical location of all pipelines and related infrastructure, to include GPS coordinates.
    - Map of pipelines
    - Map of pipelines including correct location of Easement
    - Table of criticality & risk of each asset on that system.

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Stage 3 will be subject to the approval of an overall implementation and detailed sub-stage plans that will include design, costing, and formal approval prior to any assessment work proceeding.

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Attachment No. 2 - Condition Rating of Pipelines

The following residual life estimates are based on estimated service lives for various pipeline systems as referred to in a number of asset management manuals currently utilised throughout Australia. The prime reference is NSW Department of Energy and Utility Services Asset Reference Manual.

Pipeline & Evaluation Criteria & rating.	SMEC Service Potential Rating.	GWAB Estimated Service Potential Consumed.	Estimated Residual Life (years).	Status of Assmt.
300 DICL Boyne smelter raw water pipeline. At chainages 5125 – 5475 metres per Plan #79612, and west of smelter internal boundary fence. Expected usage: Unreliable. Expected wear & tear: Asset is in an unsatisfactory condition. Technical obsolescence: Asset operating unsafely day to day. Age: Life expired.	 0 0 0 0	Severe	0	Final.
300 DI Boyne smelter raw water pipeline. Balance of pipeline from Toolooa to 5125 m per Plan # 79612. Expected usage: Operating with 100% capacity. Expected wear & tear: Asset is in good condition Technical obsolescence: Asset operating safely and risks are tolerable. Age: > 30 years service life available.	 4 3 3 3	Severe	> 30 years.	Interim. Note 1.
300 CI treated water pipeline, South Gladstone to Golegumma. Expected usage: Asset is unreliable. Expected wear & tear: Asset is in an unsatisfactory condition. Technical obsolescence: Asset operating unsafely. Age: 95 – 100% of service life.	 0 0 0 0	Severe	0 – 5 years.	Final

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150 Galv. Iron treated water pipeline on Boat Creek bridge to CA. Expected usage: Asset is unreliable. Expected wear & tear: Asset is in unsatisfactory condition. Technical obsolescence: Asset is operating unsafely. Age: Life expired.	 0. 0 0 0	Severe	0 – 5 years.	Final
600 MS QAL raw water pipeline within ASS zone and through to QAL smelter. Expected usage: Asset is reliable. Expected wear & tear: Asset is in good condition. Technical obsolescence: Asset operating safely. Age: 15-30% of useful life.	 3 3 3	Significant	12 – 24 years.	Prog. Note 2.
600 MS QAL raw water pipeline from reservoir to ASS zone. Expected usage: Asset is reliable. Expected wear & tear: Asset is in good condition. Technical obsolescence: Asset operating safely. Age: 15 – 30% of useful life.	 3 3 3	Moderate	12 – 24 years.	Final
375 AC raw water pipeline to QAL Expected usage: Asset is reliable. Expected wear & tear: Asset is in good condition. Technical obsolescence: Asset operating safely. Age: 15 – 30% of useful life	 3 3 3	Moderate	12 – 24 years.	Prog. Note 3.
450/375 AC raw water pipeline to Yarwun WTP Expected usage: Asset is reliable. Expected wear & tear: Asset is in good condition. Technical obsolescence: Asset operating safely. Age: 15 – 30% of useful life.	 3 3 3	Low	> 30 years.	Final

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375 AC raw water pipeline South Gladstone Res. to Calliope Booster Expected usage: Asset is reliable. Expected wear & tear: Asset is in good condition. Technical obsolescence: Asset operating safely. Age: 15 – 30% of useful life.	3 3 3	Low	> 30 years.	Final
700 MSCL Awoonga raw water pipeline. Expected usage: Asset is in fair condition with known deteriorated sections due to internal lining loss. Expected wear & tear: Asset has sections of assessed full thickness deterioration and high perforation risks, which will be intolerable. Technical obsolescence: Asset not operating safely. Age: <10% to 50% of useful life depending on whether the lining has been lost.	2 2 2	Moderate	Two sections. Lost internal lining section. < 5 years. Lining intact: > 30 years.	Prog. Note 4.
1440/1290/1086 MSCL Awoonga raw water pipeline. Expected usage: Asset is reliable. Expected wear & tear: Asset is in good condition. Technical obsolescence: Asset operating safely. Age: 20 - 30 % of useful life.	3 3 3	Moderate	>30 years.	Prog. Note 5.

Note 1: Assess the pipeline at the point of transition from elevated to buried pipeline east of tidal channel pipeline bridge.

Note No. 2: Subject to completion of installation of electrical continuity and application of cathodic protection system.

Note No. 3: Assess condition of pipeline in any ASS zone to assess impact of acid attack on external surfaces of pipeline.

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Note No. 4: Continue to complete CCTV survey of pipeline to assess extent of loss of internal lining, and of pipe coating system in buried sections.

Place equal emphasis on buried sections in ASS zones. If defects identified, expose and assess. Consider applying cathodic protection system to pipeline.

Note No. 5: Complete pipe coating system in buried sections in mapped ASS zones. If defects identified, expose and assess. Rectify coating defects.

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