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CONDITION ASSESSMENT & MAINTENANCE COSTS

FOR

CLEVELAND AQUATIC CENTRE

(July, 2021)

FINAL

PREPARED BY

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This Report on the pool water treatment plants at the Cleveland Aquatic Centre:

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JHC and its employees expressly disclaim responsibility to any person other than Redland Bay City Council arising from or in connection with this Review.

The limited services undertaken by JHC in connection with preparing this report are as follows:

- *Inspect the pool water treatment plants at the Cleveland Aquatic Centre and report on their condition making reference to JHC's 2014 "Updated Pool Condition Assessment and Maintenance" where there is relevance.*
- *Estimate Cleveland Aquatic Centre's pool water treatment plant maintenance costs for the next 10 years.*

The opinions, conclusions and any recommendations in this Review are based on assumptions made by JHC when undertaking services and preparing the Report;

JHC expressly disclaims responsibility for any error in, or omission from, this Review arising from or in connection with any of the assumptions being incorrect;

Subject to the paragraphs in this section of the Report, the opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the time of preparation;

Non-conformances associated with statutory building regulations (BCA), Disabled Access Provisions (DDA), Work Place Health and Safety (WH&S), AS3000 Wiring Rules and Earthquake Loading Code AS1170.4 requirements have not been identified and assessed;

Where the extent of work is not known or where technical difficulties may be evident, fees may be indicated for detailed investigation and identification of the problem for use in subsequent budget periods.

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Document control

Issue	Description	Date
P1	Preliminary Draft	25/5/2021
P2	Preliminary Draft	25/6/2021
	Final	23/7/2021

1.0 INTRODUCTION

1.1 Commission

The Cleveland Aquatic Centre has the following five pools:

- Outdoor 50 metre pool
- Indoor 20 metre pool
- Outdoor 25 metre pool
- Rapid river pool
- Leisure pool

Consulting Engineers J.H. Cockerell Pty Ltd (JHC), who have over 40 years experience in designing public pools and their water treatment plants, have been commissioned by Council to:

- Inspect the pool water treatment plants at the Cleveland Aquatic Centre and report on their condition, making reference to JHC's 2014 "Updated Pool Condition Assessment and Maintenance", when relevant;
- Provide cost estimates for required capital expenditure on pools at the Cleveland Aquatic Centre for the next 10 years.

Visual inspections were carried out by J.H. Cockerell's Mr Allan Cockerell, in an effort to identify and document pool water treatment plant defects and required capital expenditure on pools for the next 10 years.

1.2 Pool Water Quality

Council Pool Users rightfully assume that when using an Aquatic Facility it will be a positive experience i.e. there is little or no risk of injury or illness associated with the Facility's current condition. In JHC's experience of having reported on the condition of over 100 Council pools and their water treatment plants, this assumption particularly with regard to pool water quality is nearly always incorrect.

It is often thought that State Government Guidelines for Pool Water Quality provide the design standards for public pool water treatment plants. They don't. The Guidelines were written for use by the Operators of public pool water treatment plants. In JHC's experience, the Operators are often unable to consistently provide pool water quality in accordance with the Guidelines, because of inadequacies in the design of the pool water treatment plant. Australia's lack of Standards for the design of public pool water treatment plants and equipment in those plants exposes pool users to a wide range of health risks including the following:

1.2.1 Pool Water Pathogens

Most pool users are aware of health hazards associated with pathogens in pool water. Few are aware of the range of pathogens that create a potential health risk which include the following:

Viruses
- Adenoviruses
- Hepatitis A
- Noroviruses
- Enteroviruses
- Molluscipoxvirus
- Papillomavirus

Bacteria
- Shigella spp
- E. coli 0157
- Legionella spp
- Pseudomonas spp
- Mycobacterium spp
- Staphylococcus aureus
- Leptospira spp

Protozoa
- Giardia
- Cryptosporidium
- Naegleria fowleri
- Acanthamoeba spp
- Plasmodium spp

The most vulnerable to the above health risks, caused by pool water pathogens, are children under 6 years old whose immune systems are still developing and the elderly who often have a compromised immune system.

1.2.2 Pool Water Chlorine By-Products

Few pool users are aware of the health hazards associated with chlorine by-products. Most public pool users will have smelt what they thought was chlorine at pool venues, without understanding that the smell is not chlorine but chlorine by-products. Chlorine by-product gases are 4 times heavier than air and are created when chlorine reacts with nitrogen compounds in pool water. Those gases have health risks including the following:

- Research has linked the use of indoor pools with scoliosis - curvature of the spine.
- Promotion of asthma.
- Increased incidence of hay fever & rhinitis which is inflammation of the mucous membrane in the nose.
- Skin and eye irritation. The skin irritation is typically contact dermatitis.

Chlorine mixed with clean water does not smell of chlorine.

Those most vulnerable to the above detailed health risks, caused by chlorine by-products in pool water, include the following:

- Children under 6 years old, with developing neural pathways and respiratory systems, while learning to swim.
- The elderly who often have a compromised respiratory system.
- Learn to swim teachers whose respiratory systems are exposed to the gases for several hours a day.
- Lap swimmers whose respiratory systems are exposed to the gases during lengthy training sessions.

1.2.3 Standards & Guidelines for Public Pool Water Quality

The difficulty with pool water hygiene is that pathogens and chlorine by-products are not visible to the naked eye and as a result often pass unnoticed. When a pool user experiences a health problem caused by substandard pool water quality, it is usually several days after pool use, making it unlikely they will associate their health problem with pool use. Even when they do think their health problem has been caused by pool use, it has been difficult, if not impossible, to prove in all cases except when it is from cryptosporidium. Fortunately, change is under way with new technology now making identification of substandard pool water quality much easier and relatively inexpensive.

The German standard DIN19643 is the only standard in the world that adequately addresses all aspects of design, construction and operation for public pool water treatment plants. DIN19643 has been successfully used for the design, construction and operation of many European pools for over 20 years. Many European Countries have largely adopted the DIN19643 standard.

Queensland Health's document "Water quality guidelines for public aquatic facilities – Managing public health risks" was updated in 2019 to include the following:

- DIN19643
- A statement that "Effective filtration is essential pre-treatment to effective chlorination"
- The Guidelines nominate daily turbidity testing of pool water, in an effort to confirm effective filtration.

Although the updated Queensland Health Guidelines were published over 18 months ago, daily turbidity tests have not been, to date, carried out on any of the five pools at the Cleveland Aquatic Centre.

It is important for Councils to understand that Courts of Law, when considering risks and reasonably foreseeable damage/injury/illness associated with water quality in public pools, will consider best current practice, not just guidelines, before apportioning liability and compensation between pool owners, contractors and consultants.

1.3 Useful Life of a Municipal Pool

Municipal pool water treatment plants designed, constructed and operated in accordance with DIN19643, can be expected to have a relatively trouble free, useful life of 50 years. Water treatment plants for most Australian municipal pools have not been designed or manufactured in accordance with DIN19643. This is the case for the 5 pool water treatment plants at the Cleveland Aquatic Centre, creating a range of health risks for pool users. As detailed in JHC's 2014 Report, copy of which has been attached in Appendix E, "immediate maintenance" was required to reduce those health risks. Most of the required pool water treatment plant maintenance has either not been undertaken or been undertaken to an unacceptable standard. To eliminate health risks, all the water treatment plants must be replaced by plants designed, constructed and maintained in accordance with DIN19643.

Municipal pools designed and constructed in accordance with relevant Australian standards, can be expected to have a relatively trouble free, useful life of 50 years. The only pool at the Facility that may have been designed and constructed in accordance with relevant Australian standards is the 50 metre pool. The 50 metre pool's concrete shell may have been designed in accordance with AS3735 Concrete structures for retaining liquids. However, it is unlikely that the pool's tiles were selected and installed in accordance with any standard. As a result, pool tile maintenance has been expensive. Every 4 or 5 years Council spends over one hundred thousand dollars on tile maintenance, in an effort to prolong the life of the pool's tiled finish.

JHC's 2014 Report recommended that all the Facility's pools be replaced over the next 3 to 10 years ie between 2017 and 2024. To date, none of the pools have been replaced.

2.0 INSPECTIONS OF POOL WATER TREATMENT PLANTS

Prior to undertaking site inspections, JHC requested copies of the "Operation & Maintenance Manual" for each of the pool water treatment plants. To date, none have been provided.

JHC has carried out several site inspections, in an effort to identify the following:

- Whether maintenance has been carried out on the Facility's pool water treatment plants, in accordance with the recommendations of JHC's 2014 Report.
- Whether that maintenance has been carried out to a reasonable standard.

2.1 Pool Water Treatment Plant - Filters

2.1.1 Ineffective Filters

Effective filtration is critical for adequate public pool water quality. As stated in Queensland Health's Guidelines, "Effective filtration is essential pre-treatment to effective chlorination". None of the pool water treatment plants have filters designed in accordance with a standard e g DIN19643, including the 4 new filters installed in the 50 metre pool water treatment plant earlier this year. As a result, they will all become blocked with use, rendering them ineffective.

2.1.2 Filter Backwashes

Without the "Operation & Maintenance Manual" for each of the pool water treatment plants, JHC has been unable to review and comment on whether the filter backwash procedures, detailed in each manual, remove contaminants trapped in the filter's bed or just wash contaminants off the surface of the filter's media.

As detailed elsewhere in the Report, new flow meters recently installed in all the pool water treatment plants are not suitable for their intended use and, in addition, have often been inadequately positioned to allow measurement of the backwash flow to each filter, further compromising filter effectiveness.

2.1.3 Filter Media

JHC has been advised that AFM glass media has recently been installed in all filters. AFM glass media has remarkably similar gradings to traditional well-chosen sand and gravel filter media. However, it is considerably more expensive than traditional well-chosen sand and gravel filter media. JHC have requested details of the thicknesses and gradings of AFM media layers installed in each filter, in order to comment on their specification. To date, none have been provided.

2.2 Pool Water Treatment Plant - Flow Meters and Pressure Gauges

2.2.1 Installed Flow Meters

JHC's 2014 Report recommended, as "required immediate maintenance" for all pool water treatment plants, installation of "flow meters and pressure gauges to allow monitoring of plant performance". Pressure gauges have not been installed at the locations required to monitor plant performance. Flow meters have been installed in all the pool water treatment plants. During a site inspection on 24 March 2021, JHC reviewed the performance and position of the recently installed flow meters in each of the Facility's five pool water treatment plants. Consideration was also given to improved positioning for replacement flow meters, given many of the flow meters were found to be inoperable. A copy of JHC's 24 March 2021 Site Inspection Report has been attached in Appendix A.

The installed flow meters have considerable limitations, including the following:

- Paddle wheel flow meters have been installed. They are not suitable for measuring flow rates in public pool water treatment plants. The paddle wheel becomes fowled with particles suspended in the water eg hair, making their output unreliable. This has been confirmed by Council and JHC, during recent site inspections.
- Many of the flow meters have been poorly positioned. This has been confirmed during JHC's site inspections. As a result, they cannot measure, as required, both the circulation flow rate and the backwash flow rate to each filter. One of the flow meters in the outdoor 25 metre pool water treatment plant cannot be accessed for a reading.

2.2.2 Testing of Alternative Flow Meters

An ultrasonic flow meter has been tested on each pool water treatment plant, in an effort to confirm that they would be capable of providing flow rates to the required accuracy. A copy of JHC's 15 April 2021 Report on those tests has been attached in Appendix B. The tests confirmed that ultrasonic flow meters would not be capable of providing flow rates to the required accuracy. The Report concluded that "consideration should be given to using full-bore magnetic flow meters". Subsequent discussions with Krohne, a European based manufacturer with offices in Australia, regarding full-bore magnetic flow meters, has confirmed that they manufacture a flow meter that would be suitable.

2.3 Pool Water Treatment Plant – Air Intake on Pump Suctions

JHC's 2014 Report recommended, as "required immediate maintenance" for the indoor 20 metre pool, outdoor rapid river and leisure pool, the repair of underground pipework "to eliminate air intake into pump suction". JHC's site inspections have identified that air intake continues to significantly compromise the performance of all three pool water treatment plants.

3.0 25 METRE POOL'S DELAMINATING PAINT

During one of JHC's site inspections, Council advised that the Outdoor 25 metre pool had been recently repainted and paint was now coming off, as pool users walked on the pool floor, compromising pool water quality. This pool should be shut immediately, to allow the problem to be addressed and made good.

4.0 JHC's 2014 REPORT – REQUIRED UPGRADES

JHC's 2014 Report recommended that before replacing any of the Facility's pools, a Master Plan be prepared for the site's proposed redevelopment. To date, a Master Plan has not been prepared.

4.1 Upgrades required within 3 years (2017)

JHC's 2014 Report recommended that, on completion of the Master Plan, the Indoor 20 metre pool and Outdoor 50 metre pool be replaced as soon as possible, given their relatively poor condition.

4.2 Upgrades required within 3 to 7 years (2017 - 2021)

JHC's 2014 Report recommended the Outdoor 25 metre pool be replaced next.

4.3 Upgrades required within 7 to 10 years (2021 - 2024)

JHC's 2014 Report recommended the Facility's final upgrade include replacement of the entry and amenity buildings, along with an upgrade of the carpark and provision of new leisure water attractions to replace the existing Spa, Rapid River and Leisure Pool.

5.0 RECOMMENDATIONS FOR THE NEXT 10 YEARS

In view of the above detailed health risks associated with the Facility's substandard pool water treatment plants, together with other pool water quality health risks detailed in JHC's 2014 Report, all of the pools and their water treatment plants should be replaced as soon as possible. With regard to pool water quality, the most significant pool and pool water treatment plant defects identified included the following:

a) Inadequate circulation of water in the pools and between the pools and their pool water treatment plants. Those defects can only be rectified by replacing the pools.
b) Ineffective filtration of pool water ie the filters become progressively blocked with use. This defect can only be rectified by replacing the existing filters with filters designed, manufactured and operated in accordance with standard DIN19643. Only the 50 metre pool water treatment plant could accommodate new filters, without also having to replace the pool water treatment plant. It is unfortunate that the four new filters, recently installed in the 50 metre pool water treatment plant, were not designed and manufactured to a standard that would ensure they did not become progressively blocked with use. Installation of an in-line turbidity meter will allow monitoring of the filter's effectiveness and should be undertaken immediately.
c) Inadequate sizing of pumps and pipework in the plant rooms together with substandard positioning of plant room equipment and pipework. These defects can only be rectified by replacement of the pool water treatment plants. The one exception is the 50 metre pool water treatment plant which has an adequately sized pump and pipework, together with reasonably well positioned equipment and pipework.

5.1 Operation of Pool Water Treatment Plants

As detailed in this Report, design and construction of the Facility's pool water treatment plants have been substandard, creating pool water quality health risks for pool users. Those health risks would be reduced a little, if the pool water treatment plants were operated at their optimum, in accordance with well written Operation & Maintenance Manuals.

- The Operation & Maintenance Manual for each of the five pool water treatment plants should be reviewed, to confirm that procedures detailed in each Manual are up to date, accurate and understood by the pool water treatment plant Operator. The Manuals will also require updating, following the replacement of equipment including flow meters, automatic chemical controllers etc.

- Daily turbidity testing of all five pools, in accordance with Queensland Health's Guidelines, should be added to current pool water testing.

5.2 Maintenance of Existing Pool Water Treatment Plants

JHC's recommendations for work required to, where possible, make good substandard work carried out in the pool water treatment plants since JHC's 2014 Report follows.

5.2.1 Replacement of Automatic Pool Water Chemical Controllers

Pool water Oxidation Reduction Potential (ORP) has been used to automatically control the dosing of sodium hypochlorite (ie liquid chlorine) in all five pool water treatment plants. ORP should never be used to control the dosing of chlorine in a public pool.

The ORP of pool water, in accordance with DIN19643, should however always be clearly displayed in a plant room. It tells the pool water treatment plant Operator, at a glance, whether chlorine is being used effectively as a disinfectant, at the current level of free chlorine and pool water pH. The automatic chemical controllers in all five pool water treatment plants require immediate replacement.

5.2.2 Replacement of Flow Meters

As detailed in this Report, the recently installed flow meters in all five pool water treatment plants require immediate replacement.

5.2.3 Installation of Turbidity Meter in 50 metre Pool Water Treatment Plant

The four new horizontal filters installed in the 50 metre pool water treatment plant have not been designed to an acceptable standard. As a result, they will become blocked with use. An in-line turbidity meter installed on pipework downstream from the filters is required to initially identify when the filters must be backwashed and ultimately to determine when the filters' media requires either cleaning or replacement.

During the next 10 years, in addition, equipment in the pool water treatment plants will obviously require maintenance due to fair wear and tear.

5.3 Repainting of the Outdoor 25 metre Pool

Paint on the pool floor is powdering as pool users walk up and down the pool for exercise, discolouring the pool's water and compromising pool water quality. The pool should be repainted, as soon as possible.

5.4 Site Master Plan

As recommended in JHC's 2014 Report, a Master Plan should be prepared for the site, with consideration given to the site being redeveloped in several stages.

5.5 Sequence for Replacing Pools

Once the Master Plan has been approved by Council, the pools should be replaced before the buildings, given the health risks associated with pool water quality. The sequence of pool replacement should be as follows:

Stage 1 Indoor 20 metre Pool. Of all the pools, as a learn to swim pool, water quality in this pool creates the biggest health risks for children under 6 years old and should therefore be the first pool to be replaced. It is also the pool that has the greatest income earning potential.
Stage 2 Outdoor 25 metre Pool. Consideration, during production of the Master Plan, should be given to replacement of the 20 metre and 25 metre pools at the same time, given their current proximity to the Facility's entry and change rooms, both of which are advantageous.
Stage 3 Rapid River and Leisure Pool with a Water Play Park.
Stage 4 50 metre pool

6.0 PRELIMINARY COST ESTIMATES AND TIMING FOR RECOMMENDATIONS

Preliminary cost estimates have been calculated based on current costs of delivery ie June 2021.

Activities requiring Immediate Action

1. Daily testing of turbidity in each pool.
2. Review and Updating of Operating & Maintenance Manuals for Pool Water Treatment Plants.
3. Replacement of substandard equipment in Pool Water Treatment Plants.
4. Installation of inline turbidity meters on inlet and outlet pipework to 50 metre Pool Filters.
5. Repaint Outdoor 25 metre Pool
6. Site Master Plan

Activities requiring Action as soon as possible

1. Replace Indoor 20 metre Pool
2. Replace Outdoor 25 metre Pool
3. Replace Rapid River and Leisure Pool with Water Play Park
4. Replace Outdoor 50 metre Pool
5. Replace Entry/Amenity Buildings

Operational Cost Estimates attached in Appendix C

Capital Cost Estimates attached in Appendix D

APPENDIX A

SITE INSPECTION CLEVELAND AQUATICS CENTRE (24/3/21)
(Allan Cockerell with Peter Honeysett - Redland City Council)

INSPECTION OF POOL WATER TREATMENT PLANT PIPE WORK TO IDENTIFY SUITABLE LOCATIONS FOR ULTRASONIC FLOW METERS TO REPLACE EXISTING PADDLE WHEEL FLOW METERS

Plant pipework for the 50 metre pool

The existing paddle wheel flow meter has been installed on a tapping band to the 300mm diameter PVC pipe that connects the circulation pump to the four new sand filters. The tapping band for the flow meter has been positioned 1.4 metres downstream from a 90 degree pipe bend and 2.1 metres upstream from a T fitting which supplies backwash water to the filters. SiteLab, who manufacture the SL1168 Ultrasonic flow meter proposed as a replacement flow meter, recommend 10 times the pipe diameter (ie 3.0 metres) be provided between the meter and 90 degree bends, both upstream and downstream. They also recommend clearance of 10 times the pipe diameter (ie 3.0 metres) for T fittings downstream from the meter. SiteLab have advised that the SL1168 meter reading accuracy when installed with only approximately half the recommended clearance to pipe fittings, would best be confirmed with a free onsite test.

It should also be noted as follows:

- The 300 mm diameter PVC pipe connecting the circulation pump to the four new sand filters reduces to 200 mm just before a 200 mm T branch. This may prevent the backwash flow rate through the filters from reaching the velocity required to fluidise the AFM filter media and thereby allow the release, to waste, of material trapped in the media. Confirmation would require the installation of a reliably accurate flow meter.
- At several locations there has been welding of the pipework's PVC solvent welded joints. This appears to have been required to seal leaks associated with faulty installation of pipework joints.
- PVC pipe take-offs for pool water heating should be separated by a butterfly valve which, when partially closed, promotes flow to the heater.
- Automatic air relief valves have been supplied but not installed to the top of all four new sand filters. Each valve will require the attachment of pipework, to discharge water safely.
- The bund for the 50 metre pool's sodium hypochlorite tank does not meet current work place health and safety requirements.

Plant pipework for the rapid river and leisure pools

On the leisure pool water treatment plant, the 150mm diameter PVC pipe with 2.1 metres between fittings, running across the width of the plant room, appears to be the best location for installation of a SiteLab SL1168 ultrasonic flow meter. Refer attached photo IMG0679. However the available pipe length of approximately 2.1 metres is slightly less than the 2.25 metre length recommended by SiteLab. SiteLab have advised that under these circumstances, meter reading accuracy would best be confirmed with a free onsite test.

On the rapid river pool water treatment plant, the 100 mm diameter PVC pipe with 2.3 m between fittings that runs along the length of the plant room, appears adequate for installation of a SiteLab SL1168 ultrasonic flow meter.

It should also be noted as follows:

- The existing paddle wheel flow meter has been installed on the leisure pool water treatment plant's filter discharge manifold, just before the last of three filters. As a result, during filter mode, it will only display the flow rate through the first two filters and not include the additional flow rate through the third filter. During backwash mode, it will only be able to display the backwash flow rate for the third filter and not the backwash flow rate for each of the first two filters.
- The existing paddle wheel flow meter has been installed on the rapid river pool water treatment plant's filter discharge manifold, just after the first of three filters. As a result, during filter mode, it will only display the flow rate through the last two filters and not include the additional flow rate through the first filter. During backwash mode, it will only be able to display the backwash flow rates for the last two filters and not the backwash flow rate for the first filter.
- The bund for the rapid river and leisure pools' sodium hypochlorite tank does not meet current work place health and safety requirements.

Plant pipework for the 25 metre and 20 metre pools

On the 25 metre pool water treatment plant, the vertical 100 mm diameter PVC pipe, on the circulation pump discharge, currently has a length of approximately 0.8 metres between the pump and a T fitting. That pipe length could be increased to approximately 1.6 metres and thereby provide the recommended minimum 15 diameter (ie 1.5 metre) length for installation of a SiteLab SL1168 flow meter.

It should also be noted as follows:

- In our Report "Cleveland Aquatic Centre Updated Pool Condition Assessment and Maintenance Plans (July 2014)" we advised with regard to backwashing the 25 metre pool's filters as follows:

  "On closer inspection of the filters, we noticed that they all have 50mm diameter multi-port valves. Manufacturers of this size valve typically specify their maximum flow rate of approximately 8 LPS. Installation of filters with multi-port valves that are too small to allow the filters to be adequately backwashed is not uncommon in our experience with reviewing pools delivered by Design and Construct contracts. Currently 50mm multi-port valves sell for approximately $300 whereas 80mm valves, required to allow adequate 1200mm diameter filter backwash, sell for $1200."

At a backwash flow rate of 8 LPS (ie 28.8 cubic metres/hr) the backwash velocity on a 1200mm diameter filter would be 25.4 metres/hr which is significantly less than the back wash flow rate the manufacturer of AFM media, Dryden Aqua recommends for the filters' existing Grade 1 AFM glass media. Our 2014 Report strongly recommended immediate replacement of the filters and upgrading of the filter pipework and valves.

- The bund for the 25 metre and 20 metre pools' sodium hypochlorite tank does not meet current work place health and safety requirements.

On the 20 metre pool water treatment plant. the existing 100mm diameter pipe, connected to the circulation pump;s discharge, appears to have sufficient horizontal length between pipe fittings to accommodate the installation of a SiteLab SL1168 flow meter.

It should also be noted as follows:

- In our Report "Cleveland Aquatic Centre Updated Pool Condition Assessment and Maintenance Plans (July 2014)" we advised with regard to the 20 metre pool's filter backwash flow rate as follows:

  "The minimum backwash flow rate that will be required to fluidise each filter's sand bed will be approximately 14 LPS. With the backwash water supplied from the pool via the pool's skimmer boxes, the required back wash flow will not be achieved."

  Our 2014 Report strongly recommended installation of an above ground tank to provide water for filter backwash.

APPENDIX B

ULTRASONIC FLOW METER TEST - CLEVELAND AQUATIC CENTRE (15/4/21)
(Allan Cockerell with Peter Honeysett - Redland City Council)

INTRODUCTION

Renoy Paul from Proconit tested SiteLab's SL1168 ultrasonic flow meter with a view to their use in the site's five pool water treatment plants, as replacements for recently installed paddle-wheel flow meters that have proved to be very unreliable. The estimated cost for supply and installation of 5 ultrasonic flow meters is $20,000. Ultrasonic flow meters have been widely used in public pool water treatment plants. However, if they were used in the five pool water treatment plants at the Cleveland Aquatic Centre, they would not have the flow meter manufacturer's recommended upstream and downstream clearances to pipe fittings. The tests were intended to determine whether the reduced minimum clearances would significantly impact the accuracy of flow meter readings.

There are several ways of measuring the flow of water in a pipe under pressure, including the following:

- Paddle wheel flow meters
  Paddle wheel flow meters have been widely used in pool water treatment plants. They are cheap but unreliable, as they are prone to blockage. As a result, they are seldom used to measure flow in a pool water treatment plants, now that there are more reliable alternatives.
- Magnetic flow meters
  Magnetic flow meters, particularly full-bore magnetic flowmeters, are very reliable. Unfortunately, full-bore magnetic flowmeters increase in price with increasing pipe diameter.
- Ultrasonic flow meters
  The price of ultrasonic flow meters do not increase with increasing pipe diameter. However, they do require more maintenance than full-bore magnetic flow meters. Approximately every 12 months, the gel used to ensure adequate connection between the flow meter attachment and the pipe requires replacement, in order to ensure reliable output. The reliability of both magnetic and ultrasonic flow meters is dependent on the distances between the meter and pipe fittings upstream and downstream. Ultrasonic flow meters require larger clearances than magnetic flow meters for some pipe fittings and their accuracy appears to be more susceptible to pipe vibrations and the presence of air in the water, as seen in the test results detailed in this Report.

TESTING

A SiteLab SL1168 ultrasonic flow meter was trialled on the following pool water treatment plants:

1) **50 metre pool water treatment plant**

   At the time of the trial, the installed paddle-wheel flow meter was not working.

   The trial confirmed the following:

   - The flow rate reading of 296 cm/hour, during pool water filtration, appeared to be relatively unaffected by pipe fittings upstream and downstream from the meter being closer than recommended by the flow meter manufacturer. The flow meter display indicated a 98% reliability for the flow reading.
   - Although the flow meter also displayed a reliability of 98% for a flow rate of 268 cm/hour during filter backwashing, the reading appeared to be significantly affected by the T pipe fitting, located less than the recommended minimum distance of 10 pipe diameters downstream from the flow meter. The backwash flow rate should have been higher than the filtration flow rate.
   - Had pressure gauges been fitted on the circulation pump's inlet and outlet pipes, they could have been used to estimate pump flow rates during both filtration and filter backwashing and thereby provided a check on the flow rate readings.

   Conclusion:

   Consideration should be given to using a full-bore magnetic flow meter which should be more reliable than an ultrasonic flowmeter, in this situation.

2) **Leisure pool and rapid river pool water treatment plants**

a) Leisure pool water treatment plant

   At the time of the trial, the installed paddle-wheel flow meter was not working.

   The ultrasonic flow meter was unable to provide a flow reading when connected to the 150 mm diameter pipe downstream from the leisure pool circulation pump. Pipe vibration and circulation pump cavitation were thought to be the cause.

b) Rapid river pool water treatment plant

   At the time of the trial, the paddle-wheel flow meter, installed on the rapid river pool water treatment plant, was reading 1,450 litres/minute (87 cm/hour), during filtration. With the paddle-wheel flow meter installed on the filters' outlet pipe manifold, downstream from the first of 3 filters, the flow reading would not have included the flow rate through the first filter. Taking this into account and using the flow meter reading of 1450 litres/minute, the flow rate through all 3 filters would be approximately

2,175 litres/minute (130 cm/hour). At that flow rate, the velocity of flow through a 100 mm diameter PVC pipe would be approximately 4 metres/second which is very high for flow through a 100 mm diameter PVC pipe, casting doubt over the accuracy of the paddle-wheel flow meter reading.

The ultrasonic flowmeter was able to provide flow readings when connected to the 100 mm diameter pipe, downstream from the rapid river circulation pump. Unfortunately, the flow readings were found to be unreliable. Flow readings ranged between 15.3 cm/hour and 37.1 cm/hour, each with a displayed reliability of 96 or 97%, casting doubt as to the reliability of the displayed accuracy percentage. Pipe vibration and circulation pump cavitation were thought to have caused the variability in flow readings.

Conclusion

Consideration should be given to using a full-bore magnetic flow meter on both the rapid river and leisure pool water treatment plants. The full-bore magnetic flow meter should be more reliable than an ultrasonic flowmeter, in these situations.

3) Outdoor 25 metre pool and indoor 20 metre pool water treatment plants

a) Outdoor 25 metre pool water treatment plant

The paddle wheel flow meter, installed on the 25 metre pool water treatment plant, was inaccessible for a reading. The flow meter was installed on the return to pool pipe. As a result, the meter would be unable to provide flow readings during filter backwashing.

The ultrasonic flow meter was connected to a 100 mm diameter vertical PVC pipe connected to the 25 metre pool's circulation pump discharge. The downstream distance between the flow meter and the circulation pump was less than the flow meter manufacturer's minimum distance recommendation as was the upstream distance to a T fitting in the pipe work. As a result, the ultrasonic flow meter was unable to provide a reading.

b) Indoor 20 metre pool water treatment plant

The paddle wheel flow meter, installed on the 20 metre pool water treatment plant, had a reading of 468 litres/minute (28 cm/hour), at the time of the trial. This flow rate has reasonably good agreement with the 20 metre pool's estimated circulation flow rate of between 360 and 540 litres/minute as detailed in JHC's 2014 Cleveland Aquatic Centre Report.

The Ultrasonic flow meter was installed on a 100 mm diameter horizontal pipe, downstream from the 20 metre pool's circulation pump discharge. The ultrasonic flowmeter was unable to provide a reliable reading, despite the flowmeter having adequate distances both upstream and downstream from pipe fittings. It was thought that air in the water was creating a problem. A doppler flow meter was installed and used to confirm the presence of air in the water.

Conclusion

Consideration should be given to using a full-bore magnetic flow meter on both the outdoor 25 metre and indoor 20 metre pool water treatment plants. The full-bore magnetic flow meter should be more reliable than an ultrasonic flowmeter, in these situations.

APPENDIX C

Operational Cost Estimates

Operational	50m Pool	25m Pool	Indoor pool	Play pool/RR
Year 1	• Review & update operations & maintenance manual, including cyclical preventative maintenance programs $5,000 • Daily water quality testing and reporting, including pool water turbidity • Condition assess treatment plant equipment including pump renewal • Analysis of electric/gas/hybrid heating systems	• Review & update operations & maintenance manual, including cyclical preventative maintenance programs $5,000 • Daily water quality testing and reporting, including pool water turbidity • Condition assess treatment plant equipment including pump renewal • Renew floor surface to eliminate wear and impact on water quality - $60,000	• Review & update operations & maintenance manual, including cyclical preventative maintenance programs $5,000 • Daily water quality testing and reporting, including pool water turbidity • Condition assess treatment plant equipment including pump renewal	• Review & update operations & maintenance manual, including cyclical preventative maintenance programs $9,000 • Daily water quality testing and reporting, including pool water turbidity • Condition assess treatment plant equipment including pump renewal
Year 2	Water quality - online monitoring and reporting to RCC systems	Water quality - online monitoring and reporting to RCC systems	Water quality - online monitoring and reporting to RCC systems	Water quality - online monitoring and reporting to RCC systems
Year 3				
Year 4				
Year 5	• Tile repairs - $100,000 • Pant concourse - $35,000			

All price estimates exclude GST

APPENDIX D

Capital Cost Estimates

Capital	50m Pool	25m Pool	Indoor pool	Play pool/RR
Year 1	• Flow meter $18,000 • Inline turbidity meter $11,000 • Replace automatic chemical controllers $22,000	• Flow meter $7,000 • Replace automatic chemical controllers $22,000	• Flow meter $7,000 • Replace automatic chemical controllers $22,000	• Flow meter $15,000 • Replace automatic chemical controllers $40,000 • Shade structure over RR - $30,000
	Facility master plan $75,000			
Year 2	• Replace pool heating system?			
Year 3				
Year 4				
Pool Renewal				
Priority 1			Replace indoor pool $4,500,000	
Priority 2		Replace 25m pool $3,500,000		
Priority 3				Replace play pool/RR
Priority 4	Replace 50m pool $6,000,000			

All price estimates exclude GST

APPENDIX E

J.H. COCKERELL PTY LTD
Specialist Pool Engineers

J.H. COCKERELL PTY. LTD.
CONSULTING ENGINEERS
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CLEVELAND AQUATIC CENTRE
UPDATED POOL CONDITION ASSESSMENT
AND MAINTENANCE PLANS
(July 2014)

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This Cleveland Aquatic Centre Updated Pool Condition Assessment and Maintenance Plan:

- *Has been prepared by JH Cockerell Pty Ltd (JHC) for the Redland City Council;*
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- *The buildings, pools, associated plant and equipment, structures, pavements and other external elements were visually assessed to establish their condition and position in their lifecycles;*
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- *Where the extent of work is not known or where technical difficulties may be evident, fees may be indicated for detailed investigation and identification of the problem for use in subsequent budget periods;*

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P1	Preliminary Issue for Review	03/07/2014

1.0 INTRODUCTION

Council Pool Patrons rightfully assume that when using an Aquatic Facility it will be a positive experience i.e. there is little or no risk of injury or illness associated with the Facility's current condition.

In around 1850, leaders in the medical community refused to believe that something as simple as washing their hands before a procedure could prevent an infection. Germs that could not be seen were akin to witchcraft. A similar problem exists with swimming pools. Because disease carrying organisms are microscopic in size, infected pool water usually cannot be identified by pool users. It is only when a pool with inadequate pool water treatment experiences heavy bather loading (e.g. School Carnivals) that the pool's water becomes noticeably cloudy, providing pool users with a warning. Monthly microbiological testing is used to provide Council with a guide to the effectiveness of a pool's disinfection, at the time of the test and at the location in the pool where the test sample was taken. A pool's regular, all clear microbiological testing provides no guarantee to pool users that when using the pool, the water does not expose them to a health risk. That health risk can only be confirmed to be at an acceptable level by having a suitably qualified and experienced Pool Engineer review and report on the performance of all the important components of a pool's water treatment system.

Cleveland Aquatic Centre's first pool was a 50 metre pool constructed in 1978. The Centre's Lessee then built a 20 metre indoor pool in 1988 and an outdoor 25 metre pool and wading pool in 1994. In 2007 an outdoor water play area which included a Spa, Rapid River and Leisure Pool was constructed. We understand that all of the pools, with the exception of the 50 metre pool, were delivered by Design and Construct (D&C) type contracts. Municipal swimming pools delivered by D&C contract almost always lead to a relatively low construction cost and an extremely high whole of life cost together with substandard pool water quality. These pools appear to be no exception.

In an effort to quantify the scope of work required to upgrade the Aquatic Centre to a reasonable standard, Council commissioned an Audit Report in 2010 and a Condition Assessment and Planning Report in 2012. The 2010 Report clearly identified that the water treatment plants for the 20, 25 and 50 metre pools were in need of replacement. Unfortunately the 2010 Report provided little guidance for Council regarding the condition of the pools and the pipework connecting the pools to their water treatment plants. The 2012 Report used an elaborate scoring system to tabulate ratings and years of life remaining for each of the Aquatic Centre's assets. The 2012 Report's "present condition" rating of "fair" for the 25m and 50m pools and "poor" to "fair" for the 20m pool appear to conflict with its claim that the water treatment plants for all three pools were nearing "end of life". Like the 2010 Report, the 2012 Report provided little guidance for Council regarding the condition of the pools and the pipework connecting the pools to their water treatment plants.

2.0 COMPONENTS THAT HAVE INFLUENCE ON A POOL'S CONDITION

2.1 Pool Water Quality

Disease causing organisms can be introduced into pools from many sources but are mainly associated with bathers. These organisms can be brought into a pool on the bather's skin and their saliva, urine and faeces. Organisms can also be introduced from dust, bird droppings, make-up water, and soil carried on bather's feet. Some disease causing organisms live and may even multiply in pool water, unless the pool water is adequately filtered and properly and continuously disinfected.

2.1.1 Pool Water Testing

2.1.1.1 Regular Testing for Chemicals

Queensland Health Swimming and Spa Pool Water Quality and Operational Guidelines require pool water chemical testing three times a day in Council pools, in an effort to prevent the transmission of infections between pool users. Unfortunately what is not highlighted in the Guidelines is the important role played by the pool's filters and the need for regular recirculation of pool water through the filters. If small often microscopic particles are not removed by the filters, infections can be transmitted between pool users, even when pool water chemical levels are in accordance with the Guidelines. An even worse situation occurs when due to inadequate pool water circulation, pool water does not pass through the pool water treatment plant several times a day. Under those conditions, the pool will have areas of stagnant water that lack both filtration and the required levels of chlorine to act as a disinfectant.

2.1.1.2 Regular Microbiological Testing

The Queensland Health Guidelines recommend pools have monthly microbiological testing. Microbiological testing is intended to provide only a guide to the effectiveness of the pool's disinfection program.

2.2 Pool Quality

When reviewing the existing quality of a pool's components for a Condition Report, consideration needs to be given to the following components:-

- Pool's Applied Finish.
- Pool Concourse Hazards.
- Pool water loss through joints or concrete cracks.

2.3 Pipework Quality

When reviewing the quality of pipework connecting the pool to its water treatment plant, consideration needs to be given to the following:-

- Condition of the pipes.
- Location of the pipes in the pool.
- Capacity of the pipes to carry water.

3.0 OVERVIEW OF 2010 AND 2012 REPORTS

3.1 Overview of 2010 Report

In a Cleveland Swimming Pool Audit Report dated 15 November 2010, Stevenson & Associates have provided comments on each of the pools in the Centre and in an Appendix to the Report attached Spreadsheets detailing the Age, Condition, Anticipated Future Life and Estimated Additional Maintenance Costs for individual components of the pools and their water treatment plants. A review of the Report's comments and the contents of the attached Spreadsheets follow.

3.1.1 50m Pool

The 50m pool shell is described as "sound" with the pool's applied finishes, especially the gutters, described as "failing". The pool's balance tank is reported to have cracks. The water distribution in the pool is described as "poor". These comments provide Council with very little useful information. In the spreadsheets, cost estimates have been provided for the following:

Pool Maintenance	(1 to 5 years)	$150,000
	(6 to 10 years)	$437,000
	(11 to 20 years)	$174,000
New Pool Water Treatment Plant		$335,000 to $380,000
Pool Modernisation		
• Level Deck Gutters		$250,000
• Raised Ends		$ 70,000
• Replace Centre row of inlets		$ 70,000
• Retiling		$300,000
	TOTAL	$1,786,000 to $1,831,000

3.1.2 Indoor 20m Pool

The 20m pool and finishes were described as being in "reasonable condition" and the concourse as being "generally in good condition". The pool water treatment plant was said to be "in need of complete replacement". In the spreadsheets, cost estimates have been provided for the following:

Pool Maintenance	(1 to 5 years)	$ 41,000
	(6 to 10 years)	$ 49,500
	(11 to 20 years)	$ 82,000
New Pool Water Treatment Plant		$120,000 to $130,000
Pool Modernisation		
• Level Deck Gutters		$100,000
• Raised Ends		$ 15,000
• Tiles		$ 40,000
	TOTAL	$447,500 to $457,500

3.1.3 Outdoor 25m Pool

The 25m pool and finishes were described as being in "reasonable condition". The concourse was said to have "failed in each corner" and that the concourse topping slab "needs replacement". The pool water treatment plant was said to be "in need of complete replacement". In the spreadsheets, cost estimates have been provided for the following:

Pool Maintenance	(1 to 5 years)	$105,000
	(6 to 10 years)	$ 45,000
	(11 to 20 years)	$ 64,000
New Pool Water Treatment Plant		$143,000 to $168,000
Pool Modernisation		
• Level Deck Gutters		$125,000
• Raised Ends		$ 30,000
• Tiles		$ 90,000
	TOTAL	$602,000 to $627,000

3.1.4 Outdoor Spa Pool

The Spa Pool and finishes were described as being in "reasonable condition". A few minor improvements were recommended for the pool water treatment plant.

3.1.5 Outdoor River Pool

The River Pool and concourse were described as "generally in good condition". A few minor improvements were recommended for the pool water treatment plant.

3.1.6 Outdoor Leisure Pool

The Outdoor Leisure Pool and finishes along with the concourse were described as being in "reasonable condition". It was recommended that the slides be removed at an estimated cost of $2,000 or replaced at an estimated cost of $30,000. It was recommended that the water features be replaced however no cost estimate was provided. A few minor improvements were recommended for the pool water treatment plant.

3.2 Overview of 2012 Report

In a Condition Assessment and Maintenance Planning Report for the Cleveland Aquatic Centre dated April 2012, GHD clearly understood Council's requirements for the Report. The "Background" section of their Report listed the following items as specific Council requirements for the Report:

- A clear understanding of the current condition of the pool bowls and their associated buildings and filtration equipment.
- The works necessary for the centre to be restored to the desired standard.
- A 10-year forecast of maintenance costs to assist with budget preparations and funding models.

The report identified that the 50m pool, outdoor 25m and indoor 20m pools all had water treatment plants "nearing end of life" and that the 50m pool had "poor circulation" and concourse concrete in "poor condition". Despite these stated limitations, the 50m and 25m pools' "present condition" were assessed as being "fair" and the Indoor 20m pool's "present condition" was assessed as being "poor" to "fair". The 50m pool was assessed to have a remaining life of 24 years, the 25m pool 42 years, and the Indoor 20m pool 39 years. It appears illogical that the Indoor 20m pool which was assessed to be in worse condition than the 50m pool has a reported significantly longer remaining life than the 50m pool.

4.0 LIMITATIONS OF 2010 AND 2012 REPORT

4.1 Limitations of the 2010 Report

The 2010 Report concluded that the water treatment plants for the 20, 25, and 50 metre pools were in need of replacement. The Report provided cost estimates for work required to maintain the pools and their water treatment plants in reasonable working order for the next 15 years, without considering water quality limitations caused by the following:

i. Poor water circulation in the pool.

ii. Size and condition of pipework connecting the pool to its water treatment plant.

If there is poor water circulation in the pool shell, there will be areas of stagnant water creating potential health risks for bathers. Those risks will not be addressed by changes made to the pool's water treatment plant.

The size, location in the pool and condition of pipes connecting the pool to its water treatment plant will often prevent, or at least restrict, pool water quality improvement made by changes to the pool's water treatment plant.

By ignoring consideration of water circulation in the pool and size and condition of the pool's pipework, the 2010 Report has recommended expenditure on pool water treatment plants that alone will have little or no impact on pool water quality.

4.2 Limitations of the 2012 Report

Under the heading "Maintenance and Backlog Budget Estimates" the 2012 Report provides budget estimates for the next 15 years. Unfortunately the budget estimates are not broken down into work on pools and work on buildings, making our comments on pool cost estimates difficult.

A "Backlog" estimate of $228,195 is provided for work required "to return parts of the facility to the appropriate condition standard of 3 (fair)". Parts of the facility that are rated 4 (poor) and therefore require upgrading include the Kiosk/Amenities Building, 25m/20m Pool Plant Enclosure, 20m Indoor Pool Building and the 20m Indoor Pool. All of those parts involve buildings except the 20m Indoor Pool which has, according to the Report, pool finishes beginning to deteriorate and pool plant nearing end of life. It is unlikely that the estimate includes the 20m pool's plant as the 50m and 25m pools' plant have not been included in the "Backlog" estimate. The cost estimate for replacement of Pool Plant for the 20m, 25m and 50m pools appear to be contained, along with replacement of the 20m pool enclosure and other items in the $1,491,970 "Capital Replacement" cost estimate.

The above recommended work, for which cost estimates have been provided, has limitations including the following:

1) Remedial work on the 25m/20m Pool Plant Enclosure is included in "Backlog" work requiring "immediate attention". It is most likely that the 25m/20m Pool Plant Enclosures will be inadequate for the subsequent 25m/20m Pool Plant Replacements. Remedial work on the Plant Enclosures should have been programmed together with Pool Plant Replacements.

2) Once the 20m Pool Enclosure has been replaced, access to the 20m Pool for replacement will be difficult, particularly if the new pool shell requires support on bored concrete piers, as we suspect it will.

3) As was the case for the 2010 Report, the 2012 Report has not considered water quality limitations caused by the following:

   i) Poor water circulation in the pool.

   ii) Size and condition of pipework connecting the pool to its water treatment plant.

If there is poor water circulation in the pools, there will be areas of stagnant water creating potential health risks for bathers. These risks will not be addressed by changes made to the pool's water treatment plant.

The size and condition of pipes connecting the pool to its water treatment plant will often prevent, or at least restrict, pool water quality improvements made by changes to the pool's water treatment plant.

By ignoring consideration of water circulation in the pool, and the size and condition of the pool's pipework, the 2012 Report has recommended expenditure on pool water treatment plants that alone will have little or no impact on pool water quality.

5.0 OUR CONDITION ASSESSMENT OF THE POOLS

A well designed pool water treatment plant must have suitably placed pressure gauges and a flow meter in order to allow the Pool Plant Operator to identify adverse changes in water treatment plant performance.

None of Cleveland's pool water treatment plants have a flow meter or suitably placed and sized pressure gauges. As a result, the Pool Plant Operators, charged with the day to day running and long term maintenance of the plants, have had no opportunity to monitor plant performance. This has been further complicated by an almost total lack of "As Constructed" drawings for the pools and their water treatment plants. When you add to this mix a lack of adequate documentation for operation of the water treatment plants, it will come as no surprise that all of the pools in the Centre have substandard pool water quality. The lack of required equipment for monitoring plant performance together with little or no plant documentation is a common occurrence in public pools delivered by Design and Construct Contracts.

In an effort to establish the current performance of pool water treatment plants at the Cleveland Aquatic Centre, we engaged the services of a company that hires out portable flow meters together with an operator. Their equipment was used to quantify the flow in pipes when we carried out our review of the Facility's water treatment plants, details of which follow.

5.1 50 Metre Pool

5.1.1 Pool's Circulation Flow Rate

The volume of water in the 50 metre pool is approximately 1.52 megalitres. When this pool was designed, the turnover period (i.e. time taken for the pool's volume of water to pass through the water treatment plant) adopted would have been approximately 6 hours. While this turnover period still satisfies current Queensland Guidelines, it is significantly higher than current best practice of 3 to 4 hours. A pool water circulation flow rate of 70 litres per second (LPS) would be required for a 6 hour turnover, and 140 LPS for a 3 hour, best practice turnover.

During flow testing of the 50 metre pool's water treatment plant, prior to filter backwashing, the circulation flow rate was only 37 LPS, i.e. approximately half the flow rate required for a 6 hour turnover and only a quarter of the flow rate required for a 3 hour turnover.

5.1.2 Filter Backwash Flow Rate

We have estimated that a flow rate of approximately 90 litres per second would be required to backwash each cell of the pool's filter. When we started to backwash one cell of the 4-celled filter, we noticed that a valve, which had seized up open, was allowing approximately 50% of the 60 LPS recorded backwash flow to return to the pool. With only approximately 30 LPS of backwash flow passing through the filter cell, there is no way the sand bed was being fluidised, to release particles trapped in the bed. We therefore conclude that for some time now the 50 metre pool's filter bed has been blocked, rendering it entirely ineffective in filtering the pool's water, exposing pool users to potential health risks. We are also of the opinion that even when the faulty valve is fixed, the existing system of pipes and pump will not be capable of producing the required backwash flow of approximately 90 LPS.

5.1.3 Water Circulation in the 50 metre pool

Filtered and chemically treated water is returned to the 50 metre pool through numerous inlets uniformly spaced along the centreline of the pool's floor. Soiled water leaves the pool by flowing into channels located on both sides of the pool.

During our site inspection, we noticed that more water was flowing into the channel on the pool's north-eastern side than the south-western side. We also noticed that there was very little flow into the northern end of the pool's south-western channel. When the lack of uniform flow into both of the pool's side channels is combined with the pool's current turnover rate of approximately 11 hours, pool water quality could only be described as substandard, even if the filter were operating effectively.

There are several pipes connecting the 50 metre pool to its balance tank. During filter backwash, water is drawn from the pool's balance tank. If, during filter backwashing, water level in the balance tank drops too far, then a flow of water from the pool into the balance tank is activated by floats on pipes interconnecting the two bodies of water. Flow of water through those pipes has the potential to create an entrapment hazard for bathers in the pool. This is obviously an unacceptable risk.

5.1.4 Size and Condition of Underground Pool Pipes

The Pool Lessee has advised that the 50 metre pool is losing a considerable amount of water. Water loss could be from joints or cracks in the pool's concrete shell, or it could be from damaged underground pipework connecting the pool to its water treatment plant. It will be difficult to establish exactly where the water loss is taking place.

Council have advised that they have no drawings for the 50 metre pool. However, they have also advised that the pipe connecting the pool's balance tank to the water treatment plant is significantly larger in diameter than the 150mm diameter pipe that has been connected to that pipe to create a new pump suction. Whoever installed the new pump with a 150mm diameter pump suction had inadequate knowledge of the pool water treatment plant's operation as it will significantly limit that pool's water circulation flow rate.

5.2 20 Metre Indoor Pool

We understand that this pool experiences very heavy usage from young children being taught to swim. Young children often have low body fat requiring a pool water temperature of 33°C which is close to their body temperature of 36.9°C to prevent them from getting cold during a swimming lesson. They also have an immune system which is still developing, making control of the risk of infection from pool water more important than ever, particularly at an elevated temperature of 33°C.

5.2.1 Pool's Circulation Flow Rate

The volume of water in the Indoor Pool is approximately 130,000 litres. When this pool was constructed in 1988, it like so many other pools at that time would have been, most likely, designed for a pool turnover period of 6 hours, i.e. a circulation flow rate of approximately 6 LPS. If the pool were designed today, current best practice would have our office adopting a 1 hour turnover period, i.e. a circulation flow rate of 36 LPS. The 1 hour turnover period would be chosen in recognition of water temperatures of 33°C and a pool used by young, often incontinent, children for learn to swim, which necessitates improved water treatment to prevent outbreaks of rapid bacterial growth.

We have been advised that the pool's circulation pump was relatively recently replaced in an effort to increase the pool's circulation flow rate. A much larger replacement pump was chosen, based on a Council pool plan which detailed underground pipe sizes ranging from 80mm to 150mm in diameter. What the plan did not detail however was the fact that the 50mm diameter outlet pipes from the pool's skimmer boxes limit flow through each skimmer box to approximately 2 LPS to 3 LPS. The pool has 3 skimmer boxes which means that the 50mm diameter pipes on the skimmer boxes will limit pool water circulation flow rates to between 6 and 9 LPS. At these flow rates, the existing pump would be operating very inefficiently i.e. at approximately 50% efficiency instead of 75 to 80% which could have been achieved with a better choice of pump. The electricity cost associated with the pump inefficiency will be considerable, given the pump operates 24 hours a day, 7 days a week.

During flow testing of the Indoor Pool's water treatment plant, we were unable to obtain reliable flow readings using the portable flow meter. This was found to be due to an excessive quantity of air in the pool's pump suction. The most likely source of air is a break in the pool's underground pipework, as there were no signs of vortices (i.e. air intake) in the pool's skimmer boxes. When we used valves to restrict pool water circulation flow rate to approximately 6 LPS, air intake was reduced to a level that enabled a reliable flow meter reading. As detailed above, at a circulation flow rate of 6 LPS, the pool has a 6 hour turnover period which satisfies the 6 hour maximum turnover period recommended by the current Queensland Health Guidelines, but is significantly higher that the best practice required rate of 1 hour. Obviously the damaged pipe needs to be located and repaired as soon as possible.

5.2.2 Filter Backwash Flow Rate

The Indoor Pool has two 1200mm diameter sand filters. The minimum backwash flow rate that will be required to fluidise each filter's sand bed will be approximately 14 LPS. With the backwash water supplied from the pool via the pool's skimmer boxes, the required backwash flow will not be achieved.

5.2.3 Water Circulation in the Indoor Pool

Filtered and chemically treated water is returned to the Indoor Pool through 5 inlets spaced evenly along the pool's southern wall. Four of the inlets are located approximately 150mm below top water level and the fifth inlet approximately 500mm below top water level, midway along the pool's side wall. Assuming that each of the 5 inlets provide approximately even flow, with soiled water being removed by the pool's three skimmer boxes, located on the other side of the pool, there will be poor water circulation below the pool's surface water. This situation will create a potential health risk for pool users.

5.2.4 Size and Condition of Underground Pool Pipes

As discussed in Section 5.2.1 above, the 50mm diameter outlet pipes from the pool's skimmer boxes will restrict pool circulation flow rates to between 6 and 9 LPS. As a result, any upgrading of the pool's water treatment plant will provide only marginal improvement in pool water quality. The pool's existing filtered water inlets will also limit any possible improvement in pool water quality.

As also discussed in Section 5.2.1 above, there appears to be a break in the pool's underground pump suction pipework that requires fixing as soon as possible.

5.2.5 Pool Water Chloramines

Young often incontinent children urinate in a pool during learn to swim lessons. Ammonia in the urine reacts with chlorine in the pool's water to create chloramines. Chloramines are responsible for the heavy smell of chlorine, often associated with indoor pools. Chloramines are effectively trapped in poorly ventilated indoor pools, like the one at the Cleveland Aquatic Centre, and have been proven to adversely affect the health of both users and staff who regularly frequent Indoor Pools. This health risk can be minimised with a combination of ultra violet treatment of pool water and good ventilation within the pool's enclosure. The Indoor Pool has neither of these available.

5.3 25 metre Pool

5.3.1 Pool Circulation Flow Rate

The volume of water in the 25 metre pool is approximately 357,000 litres. When this pool was constructed in 1994, it like so many other pools at that time would have been, most likely, designed for a pool turnover period of 6 hours i.e. a circulation flow rate of approximately 16 LPS. If the pool were designed today, as a learn to swim pool, current best practice would have our office adopting a pool turnover period of 1.75 hours i.e. a circulation flow rate of approximately 56 LPS.

We have been advised that the pool's circulation pump was replaced relatively recently. A larger pump was chosen. It appears that the larger pump was chosen in an effort to increase the pool's circulation flow rate to approximately 40LPS.

During flow testing of the 25 metre pool's water treatment plant, prior to filter backwash, the pool's circulation flow rate was approximately 15 LPS. After backwashing the filters, flow increased to approximately 16 LPS. These flow rates confirm that the larger replacement pump has not successfully increased the pool's circulation flow rate. The apparent poor choice of pump has been an expensive mistake, not so much because of the increased cost of a larger pump, but because the larger pump will be more expensive to run 24 hours a day, 7 days a week.

5.3.2 Filter Backwash Flow Rate

The 25 metre pool has three 1200mm diameter sand filters. We understand that, just prior to our site inspection, Zeolite media in the three filters was removed and replaced with a grade 7M sand supplied by River Sands. The Pool Lessee advised that at the time of replacement, the top of the Zeolite bed was clogged. This clogging was, in our experience, to be expected. Zeolite is a biological filter media which should never be used as a replacement for a granular filter media (i.e. sand). During the recent media replacement, one of the three filters was found to be damaged and at the time of our site inspection was still awaiting replacement.

The installed sand filters will require a backwash flow rate of approximately 14 LPS. When we attempted to backwash each of the filters separately, the maximum backwash flow rate recorded by the portable flow meter was 7.5 LPS, significantly lower than the 14 LPS backwash flow rate required. At a backwash flow rate of 7.5 LPS the filters sand bed will not fluidise to allow the release particles trapped in the bed. In a short period of time, the filter's new sand beds will become clogged and there will be virtually no filtration of the pool's water. This situation will create a potential health risk for pool users.

On closer inspection of the filters, we noticed that they all have 50mm diameter multi-port valves. Manufacturers of this size valve typically specify their maximum flow rate of approximately 8 LPS. Installation of filters with multi-port valves, that are too small to allow the filters to be adequately backwashed is not uncommon, in our experience with reviewing pools delivered by Design and Construct contracts. Currently 50mm multi-port valves sell for approximately $300 whereas 80mm valves, required to allow adequate 1200mm diameter filter backwash, sell for $1200.

5.3.3 Water Circulation in the 25 metre Pool

Filtered and chemically treated water is returned to the pool through 10 wall mounted inlets along the pool's western side wall, 8 wall mounted inlets along the pool's eastern wall and 5 evenly spaced inlets located along the centreline of the pool's floor. Unfortunately Council do not have any drawings detailing the pool's underground pipework which connects the pool to its water treatment plant. At the time of our inspection, no flow could be detected from several of the pool wall inlets.

Soiled water leaves the 25 metre pool through 4 skimmer boxes mounted on each side of the pool. With 18 of the pool's 23 filtered water inlets located on the pool's side walls, almost directly below skimmer boxes, filtered water entering the pool through those inlets will flow straight up to the nearest skimmer box, providing little or no improvement in pool water quality. This is obviously not desirable.

5.3.4 Size and Condition of Underground Pool Pipes

Unfortunately Council do not have any drawings detailing underground pipework connecting the pool to its water treatment plant. However we do know that the skimmer boxes installed typically have a 50mm diameter pipe connection which limits flow from each skimmer box to between 2 and 3 LPS. As a result, with 8 skimmer boxes, pool water circulation flow rate will be limited to between 16 and 24 LPS (i.e. a turnover period of between 2.25 and 1.5 hours).

5.4 Outdoor Spa

5.4.1 Spa Circulation Flow Rate

The volume of water in the Spa is approximately 4,400 Litres. During flow testing of the Spa Pool's water treatment plant, prior to filter backwash, the circulation flow rate was approximately 5.8 LPS. At this flow rate, the Spa has a turnover period of approximately 13 minutes, which is less than the 20 minutes minimum requirement of the current Queensland Health Guidelines.

5.4.2 Filter Backwash Flow Rate

The Spa has a single 1200mm diameter sand filter. The installed sand filter will require a backwash flow rate of approximately 14 LPS, and during a minimum backwash of 3 minutes will require 2,800 litres of water which is approximately 65% of the Spa's water volume. When we attempted to backwash the Spa's filter, the maximum flow rate recorded by the portable flow meter was 6.6 LPS. At that backwash flow rate, the filter's sand bed will not fluidise to allow the release of particles trapped in the bed. This situation will create a potential health risk for spa users.

5.4.3 Water Circulation in the Spa

With the Spa having a relatively small volume of water, it is unlikely that the circulation of water in the Spa will be inadequate.

5.4.4 Size and Condition of Underground Pipes

The pipes connecting the Spa to its water treatment plant appeared to be in good working order. They are, however, inadequately sized to provide the required filter backwash flow rate to the installed sand filter.

5.5 Rapid River

We have been advised that when the two pumps that have been installed to circulate water in the Rapid River are in use, flow in the pool is excessive with reports of pool users being injured. As a result, we have been advised that only one pump is ever used.

During flow testing of the Rapid River's water treatment plant, repairs were being carried out on the pools underground suction pipework. As a result, we were unable to carry out any flow tests on the Rapid River's water treatment plant.

5.6 Leisure Pool

"As Constructed" drawings for the Leisure Pool show that the pool was originally designed to be two pools, a Toddler's Pool and a Leisure Pool.

5.6.1 Pool Circulation Flow Rates

"As Constructed" drawings appear to show the Toddler Pool and Leisure Pool have separate pool water circulation pipework. We have been advised that the two pipe networks have since been combined into a single pipe network, in an effort to overcome a problem with priming the Toddler's Pool circulation pump due to air intake on the suction pipe work. This arrangement is far from ideal as we understand it has not eliminated the air intake. Air in pipework and filters will compromise their efficient operation.

During flow testing of the Leisure Pool's water treatment plant, the circulation flow rate was approximately 26 LPS. At this flow rate, the pool will have an approximate turnover period of 2.7 hours. Although this turnover period is less than the 6 hours required by current Queensland Health Guidelines, it is significantly higher than best practice turnover times of 10 to 45 minutes for leisure pools less than 0.5 metres deep, and 1 to 2 hours for leisure pools 1 to 1.5 metres deep.

5.6.2 Filter Backwash Flow Rates

The recorded filter backwash flow rate of 19 LPS appears to be adequate to fluidise the sand beds of the three installed 1200mm diameter sand filters.

5.6.3 Water Circulation in the Leisure Pool

On the "As Constructed" drawings, the Toddler's Pool has 2 skimmer boxes located on the southern side of the pool to take soiled pool water to the water treatment plant and four floor mounted inlets, located on the western side of the pool to return filtered and chemically treated water back to the Toddler's Pool. With this arrangement, the eastern half of the Toddler's Pool will have inadequate pool water circulation, potentially exposing pool users to health risks.

On the "As Constructed" drawings, the Leisure Pool has 6 skimmer boxes, two located on the pools southern side and four located on the western side. Filtered and chemically treated water is returned to the pool through pool floor inlets and water features positioned around the pool.

5.6.4 Size and Condition of Underground Pool Pipes

As discussed in 5.6.1, we have been advised that air is being drawn into the pipework through the Toddler's Pool pump suction line. We understand that the source of this leak is not known. Locating and repairing the broken pipe which is allowing air intake will require uncovering most, if not all, of the Leisure Pool's underground circulation pipework. This will most likely be difficult and therefore expensive. The Leisure Pool's "As Constructed" Drawing Number TAY14310/501, Revision A has a Section A taken through a trench of pipes that have been stacked one on top of the other. The trench has three layers of pipes, with pipework for the Leisure Pool on the bottom. In our experience, poor construction standards like this are common in Design and Construct Contracts for Council Pools, and make access for pipe maintenance understandably difficult.

6.0 REQUIRED IMMEDIATE MAINTENANCE

As detailed in Section 5 of this report, all pools in the facility have significant problems with pool water quality, exposing pool users to potential health risks. To reduce those risks, we strongly recommend that immediate maintenance work be carried out as follows.

6.1 Outdoor 50 metre Pool

Immediate maintenance should include the following:

- Replace seized valve
- Increase diameter of pump suction pipework
- Increase diameter of pump discharge pipework
- Check condition of sand in filters and replace if necessary
- Install flow meter and pressure gauges to allow monitoring of plant performance

6.2 Indoor 20 metre Pool

Immediate maintenance should include the following:

- Repair pipework to eliminate air intake into pump suction
- Check condition of filter media and replace if necessary
- Install temporary above ground tank to provide water for filter backwash
- Install flow meter and pressure gauges to allow monitoring of plant performance

6.3 Outdoor 25 metre Pool

Immediate maintenance should include the following:

- Replace sand filters
- Upgrade filter pipework and valves
- Install flow meter and pressure gauges to allow monitoring of plant performance

6.4 Outdoor Spa

Immediate maintenance should include the following:

- Install pressure gauges to allow monitoring of plant performance
- Remove existing sand filter and replace with a cartridge filter

6.5 Rapid River

Immediate maintenance should include the following:

- Install flow meter and pressure gauges to allow monitoring of plant performance
- Check for air in suction pipework and repair pipework if required
- Confirm pump is maintaining prime

6.6 Leisure Pool

Immediate maintenance should include the following:

- Install flow meter and pressure gauges to allow monitoring of plant performance.
- Locate and repair broken suction pipe to eliminate air intake

6.7 Cost Estimate for Immediate Maintenance

Our cost estimate for the items detailed in this section of the Report as requiring immediate maintenance are as follows:

Cost estimate of work	$150,000
Contingency	$ 50,000
Specialist Pool Engineering (20%)	$ 40,000
TOTAL COST ESTIMATE	$240,000

7.0 REQUIRED UPGRADES

7.1 Upgrades required within 3 years (Stage 1)

Following completion of the immediate maintenance recommended in Section 6 of this report, we anticipate that the Outdoor Spa, Rapid River, Leisure Pool and 25 metre Pool will satisfy current Queensland Health Guidelines. The indoor 20 metre and outdoor 50 metre pool however are in such relatively poor condition that if their use within the Facility is important, then they should be replaced as soon as possible. If as we suspect, this is required, then that process, at best, is likely to take 2 to 3 years and cost approximately $6M to $7M.

7.2 Upgrades required within 3 to 7 years (Stage 2)

With the new Indoor Pool and Outdoor 50 metre Pool completed, Council should next address replacement of the facility's 25 metre Outdoor Pool. We estimate that replacement of the 25 metre outdoor pool will cost $3M to $4M.

7.3 Upgrades required within 7 to 10 years (Stage 3)

The facility's final upgrade will involve replacement of the entry and amenity buildings (e.g. change rooms, swim club room, gymnasium etc.) along with the provision of new leisure water attractions to replace the existing Spa, Rapid River and Leisure Pool. An upgrade of the car park will also be required. Given that there are no details for that work, we are unable to provide a cost estimate.

8.0 REQUIRED MASTER PLAN

Before commencing the design for replacement pools within the Facility, it will be important that a Facility Master Plan is prepared by a suitably qualified and experienced Architect. Strategic Leisure and our office should be engaged to assist the Architect with preparation of the Master Plan in an effort to ensure the Master Plan satisfies facility and pool operational issues. The Master Plan will need to address amongst other things the following important criteria:

- Stage 1 of the facility's redevelopment is recommended to be the removal of the Indoor 20 metre Pool and Outdoor 50 metre Pool. Given the Cleveland Aquatic Centre is Council's only mainland aquatic centre, we anticipate that a new 50 metre pool will be required. We also anticipate that a new indoor pool, with water heated to 33°C will be required, to accommodate learn to swim classes and exercise by the elderly and the infirmed. This pool should also have an entry ramp. When these pools are removed and replaced, the existing Spa, Rapid River, Leisure Pool and 25 metre Pool should provide reasonable temporary aquatic opportunities for the Redland Bay Community.
- Stage 2 of the facility's redevelopment would involve replacement of the existing 25 metre pool with a new 25 metre pool. The proposed Master Plan will need to consider the provision of access to the new indoor and 50 metre pools while the 25 metre pool is replaced.
- Stage 3 of the facility's redevelopment would involve replacement of the facility's entry and amenity buildings (e.g. change rooms, swim club room, gymnasium etc.). Also included in Stage 3 would be removal of the Spa, Rapid River and Leisure Pool and replacement with a Splashpad or similar leisure water attraction. An upgrade of the car park will also be required.