

# **Engineering Investigation Report**

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| FMG REF:      | S37718 - 258126                       |
|---------------|---------------------------------------|
| ISSUE DATE:   | 03 November 2017                      |
| SITE ADDRESS: | 100 Esplanade, WILLIAMSTOWN, VIC 3016 |
| CLIENT:       | Hobsons Bay City Council              |
| CLIENT REF:   | PO151942                              |

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#### **Document Status**

| Rev | Author                                   | Reviewer                                | Issue Date       |
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## 1.0 Introduction

- 1.1 FMG Engineering ('FMG') has been engaged by Hobsons Bay City Council, to undertake an engineering investigation of the swimming pool at 100 Esplanade, WILLIAMSTOWN, VIC 3016 (Surf Life Saving Club). A site inspection was carried out by Ashley Holmes, Senior Aquatic Engineer at FMG, on 06 October 2017.
- 1.2 The purpose of FMG's investigation is as follows:
  - Observe and record the extent of damage to the swimming pool.
  - Description of critical works which are required in order to operate this season.
  - Description of works required in order to maintain the facility long term. This will allow council / the surf lifesaving club to determine the future plans for the site.
  - General issues relating to construction of a new pool at the site.
  - Estimate remaining life of the existing pool structure and existing tiling.
- 1.3 An aerial photograph and photographs taken during the inspection are provided in Appendix A. These photographs are referenced in the report as [1], [2], [3] etc. A plan is provided in Appendix B outlining the recommended destructive investigations.

## 2.0 Description of Site and Building

- 2.1 For the purpose of this investigation the front of the subject pool is assumed to be orientated in a north-south direction with the deep end located towards the north.
- 2.2 The filtered water-return pipes (4 number) are located at the southern end of the pool. The soiled water flows back to the balance tank through three gravity suction pipes in the deep end as well as numerous scum gutter returns located relatively evenly around the pool perimeter.
- 2.3 The pool is approximately 9.3m wide and 30m long. There are two construction joints across the pool. The pool depth varies from approximately 930mm at the shallow end to 1.55m at the northern construction joint (20m point) to 2.23m at the deep end of the pool. There are stairs located in the south-west corner of the pool and ladder access located near the north-west corner of the pool.
- 2.4 The pool is located approximately 20m from the ocean. It is understood that historically the pool was 'treated' by simply turning over the water with fresh sea water.

## 3.0 Investigation

#### Site Observations

- 3.1 FMG made the following observations during the inspection. Note that this is a general description of the observations that FMG deems relevant. It is not intended to be a complete list of damage and/or defects.
  - Slight corrosion of ladder fixings (located towards the north-west corner of the pool) [2].
  - Coping beam tiles have delaminated [3, 4, 6]
  - Concourse drain near northern control joint, western end. Overflowing with sand when flow was reversed due to emptying the pool. [5]
  - Crack between the render/tiles and the concourse. Western side of the pool, towards the northern end of the pool. [7]
  - Approximately 45mm of render and tile overhangs the concourse [8].
  - Corners of pool are relatively 'acute' [9, 12]
  - There is compressible foam between new section of concourse and pool along northern end of pool. Calcium build up evident. [10]
  - Tiles delaminated on northern end of coping beam [11]
  - Cracking along the centre of coping beam (northern end of pool). [12]
  - Cracked coping tile located near the north-east corner of the pool [13]
  - Crack between the render/tiles and the concourse. North eastern side of the pool [14].
  - Mastic missing from northern construction joint, eastern end [15].
  - Grout is missing from the between the coping beam tiles [16]
  - Mastic is missing from northern control joint, eastern end [17].
  - General cracking of the tiles around south-east control joint. The coping beam tiles are not discontinuous over the joint. No mastic has been used to allow movement to occur. [18]
  - Mastic missing from southern control joint, eastern end [19].
  - Chipped coping beam tile near southern stairs [20].
  - Chipped coping beam tiles located near the south-east corner [22].
  - Damaged scum gutter tiles and wall tiles above the water line. Northern control joint, western end. [23]

- Damaged scum gutter tiles [26] and wall tiles above the water line. Horizontal crack below the coping beam tiles (approximately 1.5mm wide [25]). Southern control joint, eastern end. [24]
- Horizontal crack below the coping beam tiles (approximately 1.5mm wide). Southern control joint, eastern end. [25]
- Damaged scum gutter tiles and missing mastic. Southern control joint, eastern end.
  [26]
- Damaged scum gutter tiles [28] and wall tiles above the water line. Horizontal crack below the coping beam tiles. Southern control joint, western end. [27]
- Significant damage to the scum gutter tile. Southern control joint, western end. [28]
- Damage to the wall tiles above and below the water line. Scum gutter tiles are also damaged. Northern control joint, western end [29]
- Minor damage to tiles around pipe returns. [30]
- General damage to wall tiles throughout [31, 32, 38].
- Damaged scum gutter tile piece being held in place by mastic allowing movement of the damaged tile. Southern control joint, eastern end. [33, 34]
- No grout remains between mosaics at the steps [35]
- Scum gutter tile is continuous over the construction joint (Northern control joint, western end) and has cracked as a result. [36]
- Evidence of previous repairs around gravity suction [37]
- Typical photograph of concourse. Possible corrosion of concourse reinforcement. [39]
- Joint between original and new PVC filtered water return pipes is a possible source of water loss. [40]
- Corrosion of lane rope anchors [41]
- Sodium hypochlorite storage located directly against hydrochloric acid [42].
- Hydrochloric acid is not stored within a bund [43]
- Water could be seen entering into the pool through both construction joints. [44]
- There was no ceiling in the plant room. The roof was constructed using timber trusses with galvanised steel nail plates.

### Floor Level Survey Results

3.2 FMG conducted a levels survey (consisting of spot levels) of the coping beam using a 'Zip LevelPro-2000', manufactured by Technidea. The manufacturer's specifications indicate the levels measured are accurate to within +/- 2mm. 3.3 The levels vary from 68mm with the lowest point being the south-western corner of the pool and the highest point being the north-eastern corner of the pool.

### Site Geology and Foundation Soil Reactivity

- 3.4 The Australian Standard AS2870–2011 *Residential slabs and footings* enables assessment of the foundation soils at a given site by identification of the mapped soil profile without taking site specific soil samples. To that end FMG has undertaken the following for the subject site:
  - Review of the Geological Survey of Victoria maps. These maps indicate that the subject site is located within the province of quaternary aged basaltic deposits. Referring to the AS2870–2011, Table D1, it is known that this soil profile is reactive.
  - Review of the Climatic Zone maps provided in AS2870–2011 Figures D1 and D2. These maps indicate that the subject site is located within Climatic Zone 3. Therefore, referring to AS2870–2011 Table 2.5, the depth of soil suction (i.e. the depth of soil affected by normal climatic moisture variations) for the subject site is expected to be 2.3m.
  - Given that the site is located so close to the beach it is reasonable to also assume that the pool is founded in sand.
- 3.5 A geological investigation could be undertaken however FMG do not believe that it is required in order to provide a response to the items outlined in section 1.2 of the report.

## 4.0 Discussion

- 4.1 As discussed in section 1.2 of this report the purpose of FMG's investigation is as follows:
  - Observe and record the extent of damage to the swimming pool. (as described in Section 3 of this report and appendix A)
  - Description of critical works which are required in order to operate this season.
  - Description of works required in order to maintain the facility long term. This will allow council / the surf lifesaving club to determine the future plans for the site.
  - General issues relating to construction of a new pool at the site.
  - Estimate remaining life of the existing pool structure and existing tiling.

#### General discussion

- 4.2 FMG is of the opinion, based purely on the visual inspection at this stage, that the pool is in a reasonable condition. However, it was likely never designed to be 'water retaining' given that the water was being pumped from the ocean directly into the pool and then flushed back out to the ocean. Now that the pool uses fresh water which is disinfected using sodium hypochlorite ('liquid chlorine'), it should retain water in order to maintain the free chlorine which is being dosed into the pool.
- 4.3 Significant work is required in order to retrofit sufficient waterproofing into the pool. Typically, this includes installing a new hydrophilic water stop and a 'bandage' such as Mapei 'Mapeband' along each construction joint. Cracks and joints in the pool shell are often injected using a permanently flexible low viscosity resin such as Tampur 150 however this can only be done whilst retiling the pool.
- 4.4 There are a number of cracks, which are of concern to FMG, and accordingly they are recommended to be investigated in the 'critical works' section below. It is possible that these cracks are due to the reinforcement corroding. The cracks are all located above the water line which indicates that if the steel is corroding then it is likely due to carbonation of the concrete. However, the cracking may also be due to other reasons such as the delamination of the render or moisture ingress into cracks.
- 4.5 The pool is out of level. The main issue associated with a pool being out of level is an un-even distribution of filtered water / soiled water suction. As the suction is located at the deepest section of the pool and the pool is configured with scum gutters only

providing limited surface skimming, this is not of a large concern to FMG. Given the age of the pool the quantity of movement is considered acceptable and will likely remain at its current level going forward (or close to).

#### Destructive investigation recommended

- 4.6 FMG have provided a description of the recommended destructive testing in AppendixB. A quotation to undertake this work was provided to the council on 31 October 2017.The recommended work includes the following;
  - (1) Investigate bulkhead cracking. This involves the removal of 500mm wide section of outer bulkhead tiling and render to investigate the initiating point of the crack. The investigation will determine if concrete is spalling, due to the corrosion of the steel reinforcement, or if the crack is due to another source which is currently unknown. If the pool reinforcement is corroding, causing the concrete to spall, then this has a significant impact on the estimated remaining life of the pool. This will be discussed in more detail later in the report.
  - (2) Investigate two upper bulkhead locations for corrosion of reinforcement [24, 27]. The horizontal crack located near the construction joints in this location is a common occurrence when the reinforcement is corroding.
  - (3) Investigate wall behind damaged tiles in an isolated location. There appear to be previous repairs undertaken at this location however they may relate to the tiles only. As there are no previous records of this, FMG would like to investigate this isolated location to determine if there was spot corrosion located at this point.
  - (4) Pressure test plumbing (optional). The water level was just below the level of the pipes at the initial inspection. Therefore, it is reasonable to suspect that the pipework is leaking. However, it may simply be groundwater entering the pool through the leaking construction joints as FMG witnessed water ingress through the construction joints during the second inspection.

### Critical works

4.7 Whilst FMG was not engaged to assess the plant room, FMG is of the opinion that it is critical that the hydrochloric acid and sodium hypochlorite are separated as per the relative Australian Standards (5m separation required). The acid should also be located within an enclosed bund. Adding partition walls between the acid and chlorine storage

is a potential improvement which could be made to increase the separation of these items.

- 4.8 It is critical that the sharp tile edges (due to cracks and general breakages) are repaired or at least 'smoothed'. As council is well aware, cracked and broken tiles with sharp edges, are a hazard for patrons using the aquatic facility. These injuries range from minor cuts to large cuts which could become infected due to the bacteria in the swimming pool.
- 4.9 If corrosion is found during any of the destructive testing then this will be repaired (within reason) during the destructive testing. FMG recommends that item (2) of the prescribed destructive investigation be undertaken this year prior to the opening the facility. FMG is of the opinion that items (1) and (3) can be undertaken next off season as they are not considered as critical by FMG.
- 4.10 Item (4) is an optional investigation as it is clear to FMG that there are significant leaks occurring in the base of the pool. FMG recommend undertaking this work if the pool structure is found to be sound and re-tiling is to be done. The reason FMG recommend that this is done should re-tiling be considered is that the control joints can be sealed when the re-tiling is undertaken. The control joints are leaking so significantly that additional losses will likely be minimal in comparison.
- 4.11 FMG is of the opinion that there are three possible results from the recommended investigation items (1,2,3).
- 4.12 The first is that the cracking is due to the render/screed delaminating and that the primary structure remains in good condition. If this is the case then FMG would expect to provide an estimated remaining life span in excess of 20 years (provided FMG's repair recommendations are adhered to).
- 4.13 If minor corrosion (isolated to the crack locations) is found then it is expected that FMG would estimate a remaining life expectancy of the facility of approximately 15 years (provided FMG's repair recommendations are adhered to).
- 4.14 If serious corrosion is encountered then FMG would expect to provide a remaining life expectancy of approximately 5-8 years without having to spend ever increasing annual repair costs associated with the regular repairs required.

### Description of works required in order to maintain the facility long term

- 4.15 FMG is of the opinion that the following items should be undertaken (listed in the order of priority);
  - (1) If significant corrosion is encountered during the destructive investigation, then FMG may conclude that the structure has reached the end of its intended life. Whilst repairs can be undertaken to 'extend' the operating functionality of the facility, there will be ever increasing costs associated with annual repairs. In this instance FMG would recommend that investment into a new pool is likely the most cost-effective long term solution.
  - (2) Prior to retiling the pool, it is FMG's recommendation that a plan is put in place to grind/sand any sharp tiles within the pool and the coping beam each year. If the pool is not to be re-tiled within a short period of time (next two years) FMG recommend that new epoxy grout is installed between the small mosaic tiles located on the steps. This is to prevent minor cuts and abrasions on the patrons' feet.
  - (3) Re-tiling of the pool and coping beams. Whilst the pool is being retiled it can also be made to be 'water-tight'. Any additional cracking which is encountered during the re-tiling works can also be repaired using a permanently flexible low viscosity resin such as Tampur 150. Given the height of ground water on the site (evident due to water entering the structure at each control joint) it would be difficult to 'paint' the pool on a regular basis. Therefore, FMG is of the opinion that painting the pool is not a suitable alternative to tiling in this instance. Other methods of lining the pool are also not suitable because of the potential of negative water pressure around the structure.
  - (4) A ceiling should be installed within the plant room. The galvanised steel nail plates are not protected sufficiently to be exposed to the highly corrosive environment created by the presence of acid stored in the plant room. As a result, the lifespan of the trusses will be significantly reduced. The roof space should remain easily accessible and a maintenance plan should be put in place to check the condition of the trusses (in particular the nail plates) every five years.
  - (5) Each time the pool is emptied it is subjected to hydrostatic lift due to relatively high groundwater. Therefore, FMG recommend that hydrostatic valves are installed both in the deep end of the pool and also towards the centre of the pool.

- (6) The stainless-steel items should be maintained using appropriate products. The lane rope anchors and ladder fixings will likely require replacement in the next three years.
- 4.16 Improvements to the pool could also be undertaken such as modifying the pool to include a wet-deck instead of a scum gutter or even simply a shorter hob. This will improve visibility of the pool for life guards or parents supervising children. A renovation system such as the 'Myrtha RenovAction' may also be suitable for this pool.

#### General issues relating to construction of a new pool at the site.

- 4.17 Constructing a new pool on the site is problematic due to the high ground water and the expected geological conditions (poor bearing capacity and difficulty maintaining the walls of an excavation). The high ground water would also make a deep excavation difficult at the subject site. Due to the proximity to the ocean de-watering is also not viable.
- 4.18 However, a new pool shell could easily be constructed inside of the existing pool shell. This is common practice when constructing a new pool on a site with an existing facility.

### Estimate remaining life of the existing pool structure and existing tiling

- 4.19 The remaining expected life expectancy of the structure is heavily dependent on the results of the destructive investigation. This has been discussed within the 'critical works' section of the report.
- 4.20 The tiling has, in the opinion of FMG, failed. Each year it is expected that more tiles will delaminate from both the walls and floor of the structure. There is a large amount of damage to the scum gutter tiles which can only be repaired by replacing the tiles. Whilst it was mentioned to FMG on site that the floor tiles haven't typically required repair, FMG noted a small section of tiles on site during the inspection which had delaminated. There are also no movement joints located throughout the pool. This increases the likelihood that the tiles will delaminate.

4.21 There are issues with tiling this pool due to the high groundwater level around the pool. This will result in a constantly 'damp' pool shell. There are products available which will allow the shell to be tiled effectively however they will result in a premium cost during the renovation works. The 'Myrtha RenovAction' system may reduce the impact of this cost however it should be investigated in more detail prior to implementing such a remediation.

## 5.0 Conclusion

- 5.1 It is expected that only minor corrosion will be encountered during the destructive investigation. As a result, FMG is of the opinion that the pool structure is generally in an acceptable condition with an expected life span ranging from 15 years to 20+ years. However destructive investigations are required to confirm this information. If significant corrosion is encountered then FMG expect that the life expectancy of the pool is between 5 and 8 years.
- 5.2 Assuming that the results of the investigations are positive then the pool still requires significant upgrade and maintenance investment in order to re-tile the structure. The current condition of the tiles is considered by FMG to have already failed. Other lining methods and painting of the pool shell are not considered to be suitable due to various site conditions as discussed in section 4.19 of this report.
- 5.3 The lack of waterproofing at the construction joints is resulting in significant water losses and therefore higher operating costs from the perspective of both the cost of supplying the water and the cost of disinfecting and maintaining chemical balance of the pool water. This can be addressed when the pool is re-tiled. It is not cost effective to address this issue without re-tiling the pool.
- 5.4 Improvements to the pool could also be undertaken in addition to simply re-tiling the pool such as modifying the pool to include a wet-deck instead of a scum gutter. This will improve visibility of the pool for life guards or parents supervising children.



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Appendix A – Photographs



Photograph 1 – Aerial Photograph. Source: NearMap. Capture date: 23 December 2016.



Photograph 2 - Slight corrosion of ladder fixings (north-west corner)



Photograph 3 – Northern control joint, western end. Coping beam tiles have delaminated.



Photograph 4 - North-west control joint. Coping beam tiles have delaminated



Photograph 5 – Concourse drain near northern control joint, western end. Overflowing with sand when flow was reversed due to emptying the pool.



Photograph 6 - North-west control joint. Coping beam tiles have delaminated



Photograph 7 – Crack between the render/tiles and the concourse. Western side of the pool, towards the northern end of the pool.



Photograph 8 – Approximately 45mm of render and tile overhangs the concourse



Photograph 9 – North-west corner of pool. Corner of the pool is relatively acute.



Photograph 10 – Compressible foam between new section of concourse and pool along northern end of pool. Calcium build up evident.



Photograph 11 - Tiles delaminated on northern end of coping beam



Photograph 12 – 'Acute' corner of the pool. Cracking along the centre of coping beam (northern end of pool).



Photograph 13 - Cracked coping tile located near the north-east corner of the pool



Photograph 14 – Crack between the render/tiles and the concourse. North eastern side of the pool



Photograph 15 – Mastic missing from northern construction joint, eastern end.



Photograph 16 – Grout missing from the between the coping beam tiles



Photograph 17 – Mastic is missing from northern control joint, eastern end.



Photograph 18 – General cracking of the tiles around south-east control joint. The coping beam tiles are not discontinuous over the joint. No mastic has been used to allow movement to occur.



Photograph 19 – Mastic missing from southern control joint, eastern end



Photograph 20 – Chipped coping beam tile near southern stairs.



Photograph 21 – General photograph of pool from shallow end (southern end)



Photograph 22 - Chipped coping beam tiles located near the south-east corner



Photograph 23 – Damaged scum gutter tiles and wall tiles above the water line. Northern control joint, western end.



Photograph 24 – Damaged scum gutter tiles [26] and wall tiles above the water line. Horizontal crack below the coping beam tiles (approximately 1.5mm wide [25]). Southern control joint, eastern end.



Photograph 25 – Horizontal crack below the coping beam tiles (approximately 1.5mm wide). Southern control joint, eastern end.



Photograph 26 – Damaged scum gutter tiles and missing mastic. Southern control joint, eastern end.



Photograph 27 – Damaged scum gutter tiles [28] and wall tiles above the water line. Horizontal crack below the coping beam tiles. Southern control joint, western end.



Photograph 28 – Significant damage to the south-east control joint scum gutter tile. Southern control joint, western end.



Photograph 29 – Damage to the wall tiles above and below the water line. Scum gutter tiles are also damaged. Northern control joint, western end



Photograph 30 – Minor damage to tiles around pipe returns.



Photograph 31 – General damage to wall tiles throughout. This photograph is of the eastern wall located towards the north



Photograph 32 – damaged tile to be investigated



Photograph 33 – Damaged scum gutter tile piece being held in place by mastic allowing movement of the damaged tile. Southern control joint, eastern end.



Photograph 34 – Damaged scum gutter tile piece being held in place by mastic allowing movement of the damaged tile. Southern control joint, eastern end.



Photograph 35 – No grout remains between mosaics at the steps



Photograph 36 – Scum gutter tile is continuous over the construction joint (Northern control joint, western end) and has cracked as a result.



Photograph 37 – Evidence of previous repairs around gravity suction



Photograph 38 – General damage to wall tiles



Photograph 39 – Typical photograph of concourse. Possible corrosion of concourse reinforcement.



Photograph 40 – Joint between original and new PVC filtered water return pipes is a possible source of water loss.



Photograph 41 – Corrosion of lane rope anchors



Photograph 42 – Sodium hypochlorite storage located directly against hydrochloric acid [43].



Photograph 43 – Hydrochloric acid is not stored within a bund. Acid is stored directly next to sodium hypochlorite.



Photograph 44 – Water could be seen entering into the pool through both construction joints.



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# Appendix B – Recommended Destructive Investigations



WILLIAMSTOWN SURF LIFE SAVING CLUB - POOL PROJECT:

S37718 - 258126 BY AJH JOB No. .....

Destructive investigation DATE: 9/10/2017 CHECK: SHEET:



#### **INVESTIGATION 1**

INVESTIGATE BULKHEAD CRACKING CAUSE. EXPOSE EITHER START OF CRACK OR REINFORCEMENT. WHICH EVER IS ENCOUNTERED FIRST.

REMOVE A SECTION APPROXIMATLY 500mm WIDE FROM OUTER SIDE OF BULKHEAD FOR INVESTIGATION

#### **INVESTIGATION 2**

INVESTIGATE BULKHEAD CRACKING CAUSE. EXPOSE EITHER START OF CRACK OR REINFORCEMENT, WHICH EVER IS ENCOUNTERED FIRST.

REMOVE A SECTION APPROXIMATLY 250mm WIDE FROM THE TOP OF THE BULKHEAD (ON INSIDE EDGE OF POOL)

**INVESTIGATION 3** 

INVESTIGATE IF TILE DAMAGE HAS A CRACK IN THE CONCRETE BEHIND. REMOVE TILES FOR INVESTIGATION. IF THERE IS A CRACK IN THE CONCRETE CONTACT THIS OFFICE FOR ADDITIONAL INFORMATION

INVESTIGATION 4 (OPTIONAL)

CONDUCT A PRESSURE TEST OF FILTERED WATER RETURN PIPE NETWORK.

CONDUCT A STATIC HEAD TEST OF SOILED WATER RETURN PIPES