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1.0 INTRODUCTION

1.1 Devin Consulting Limited was requested by Abacus to carry out a condition assessment of the swimming pool water treatment system and pool tank at Lordsfield Swimming Club.

1.2 The purpose of the assessment was to advise on the condition and the design appropriateness of the existing installation in accordance with current guidelines and report on remedial works that may be required.

1.3 The inspection of the engineering system was carried out on Monday 31st October 2022. Assistance was kindly provided on-site by Janice Stott and David Lancaster (Lordsfield Swimming Club Plant Operatives).

1.4 The sources of information which form the basis of this report include:

- Visual inspections on site
- Information provided by all parties present on the site inspection
- 'Swimming Pool Water Treatment and Quality Standards for Pools and Spas' as published by the Pool Water Treatment Advisory Group (PWTAG)
- Managing Health and Safety on Swimming Pools, Health and Safety Executive
- BS EN 15288-1 Swimming Pools. Safety Requirements for Design
- BS EN 15288-2 Swimming Pools. Safety Requirements for Operation
- Pool Report – Lordsfield Swimming Club (October 2021).

1.5 The audit does not, for practical reasons, cover every aspect of the engineering systems. Excluded items would typically, but not exclusively, include:

- pool base outlets
- buried/hidden pipework
- pipework internals
- machinery internals
- valve internals
- electrical circuitry.

1.6 The author of this report is:

1.6.1 Stefano Lantrua-Kissack, BEng MSc AMIMechE, Project Engineer at Devin Consulting Limited.

1.6.2 Colin Dougall MEng, AMIMechE, Managing Director of Devin Consulting Limited, Water Engineering Specialists. Colin has over twenty years' experience in the design, construction, operation and maintenance of specialist mechanical engineering systems, including over 200 swimming pool projects, both new and refurbished.

1.7 This report is confidential, personal to the client, non-assignable and not for the benefit of third parties.

2.0 GENERAL DESCRIPTIONS

2.1 The Pool

Lordsfield Swimming Club operate a 23m x 9m (1.00m to 1.5m deep) pool, which is an independent outdoor swimming facility. The pool was installed in approximately 1955-1960.

The facility is used by the community for swimming lessons, lane swimming and other activities. The facility is used for both public and private hire purposes.

The pool is currently operating at reduced opening hours due to the difficulties with water clarity associated with the low system turnover. The operator noted that there has been a number of leaks associated with the pool tank and skimmer boxes. This has led to some associated equipment being decommissioned. The operator stated that leakage at approximately 25mm per day (5.2 m^3) was recorded on site when the pool is fully operational.

The 25m pool tank is finished with a liner (material unknown) that has been applied to all areas of the pool tank.

There is a dedicated pool water treatment system plantroom situated at pool surround level adjacent to the pool surround. Water treatment chemicals are stored and dosed from within the plantroom, the chemicals are separately stored externally to the plantroom.

At the time of the inspection the pool water treatment system was not in operation, so no functional assessment of the equipment could be conducted. Also, the pool water had a significant algae content, therefore a full analysis of the pool tank fittings and the pool tank liner could not be completed.

2.2 Water Treatment Plant

Some of the equipment on site is notably newer than others indicating that a number of elements of the pool water treatment system have been recently replaced.

The treatment principles applied consist of:

- Surface water removal via skimmer boxes
- Water removal via base outlets
- Straining
- Pumping
- Flocculation using poly-aluminium chloride (PAC)
- Filtration on glass media
- Heating of pool water
- Chlorination using calcium hypochlorite
- pH control using sodium bisulphate
- Return of pool water via wall inlets.

3.0 ENGINEERING SYSTEM ASSESSMENTS AND COSTS

3.1 Pool Water Treatment

3.1.1 Key Pool Details

The following information provides the system parameters for the pool to be PWTAG compliant. The pool water treatment system's operational performance will be analysed against the benchmark requirements listed in the table below.

Item	Detail
Year of construction	1955-1960
Pool length and width m	23 x 9
Pool area m^2	207
Pool depth m (site measured)	1 to 1.5
Pool volume m^3	Approx. 259
Design Flow Rate, m^3/hr	131
Bather load	77 *bathers*
Turnover, hours	2

An assessment grade is applied to pool plant/items in the following sections as follows:

A – As new, can be expected to perform adequately for its full normal life.
B – Sound, operationally safe, exhibits only minor deterioration.
C – Operational but requires repair or replacement soon.
D – Risk of a major breakdown or failure/under-designed or inadequate.

The items listed below are currently not a part of the water treatment system so no audit could be undertaken on these items, but consideration into incorporating them into the future design of the pool should be considered.

- Control Panel
- UV system
- Drench shower
- Plant safety interlocks.

3.1.2 Pool water treatment plant capacity

Based on the filter sizes and pipework sizing in the plantroom, and if the pool water treatment system is working at its optimum, the flowrate for the system is estimated at $22m^3$/hr. This is estimated to be six times smaller than that required to achieve PWTAG compliance with the client required PWTAG maximum bather load.

Currently the PWTAG compliant bather load matched to the existing system flow rate is 13.

Recommendation: Increase the capacity of the pool water treatment system to achieve PWTAG compliance with the maximum bather load.

3.1.3 25m pool water treatment plant condition review

Plant/Item	Grade	Assessment notes
Return water inlets	**D**	***Description:*** 2no. (Plastic) return inlets, located at the shallow end wall of the pool tank. ***Comment:*** The inlet fittings appeared to be in satisfactory condition with only light deterioration. Both inlet grilles have been removed in attempt to aid circulation, and now comprise of 50mm apertures. The number and size of inlets is insufficient to satisfy PWTAG treated water distribution and inlet velocity requirements for a full bather load. ***Recommendation:*** Increase the number and size of inlets to satisfy PWTAG treated water distribution and inlet velocity requirements for a full bather load.
Pool outlet fittings	**D**	***Description:*** 2 no. (GRP) grilles located in the deep end of the pool. Note, these were not visible for inspection on the visit due to the level of algae in the pool. ***Comment:*** On review of images provided by the operator, the outlet fittings appear to be relatively new and in satisfactory condition, with only light deterioration. The connecting pipework to the sump appears to be cast iron with a new 2″ uPVC pipe running through the cast iron pipe to the sumps, the precise arrangement of this pipework could not be inspected on site. Refer to the associated comments in the circulation pipework section. ***Recommendation:*** Increase the flow capacity of the outlets and associated pipework to match the maximum bather load flow rate or reduce the bather load to match the maximum flow rate of the current outlets.

Pool hydraulics	**D**	***Description:*** 4no. (Astral Pool) skimmer boxes located in the pool, 2no. situated on the length and 2no. on the deep end wall. ***Comment:*** The skimmer fittings appear to be in a satisfactory condition, with some showing signs of staining and detachment from the installed pool liner. Although it is noted that due to leakage with the associated pipework, 2no. skimmers are currently decommissioned and disconnected from the water treatment system. The most polluted water in a swimming pool occurs at the upper surface of the water body to a depth of 100-150mm. In basic terms the higher the percentage of surface water removal the better the condition of the water condition at the surface of the pool where the swimmers are. The skimmers total water removal rate is estimated at approx. 9 m^3/hr (assuming 1m/s pipe velocity). This is 9% of what is expected for a modern facility at full PWTAG bather load. Skimmer technology is still used in pools today but is not the best way of providing the desired capacity and uniform surface water removal from the pool. This would typically be via deck level transfer channels and an associated balance tank. ***Recommendation:*** Increase the flow capacity of surface water removal from the pool. As a minimum reinstate the disconnected skimmers; for the optimum solution provide a deck level transfer channel system with an associated balance tank system.
Circulation pipework	**D**	***Description:*** The majority of the pipework within the plantroom appears to have been replaced with SCH-40, u-PVC pipes. The filter frontal pipework is assumed to be SCH-40 PVC, although no markings were present to verify this. The main delivery and return pipework from the plantroom to the pool is all backfilled/cast in and is inaccessible. No comment/analysis can be provided on the inaccessible pipework as size, material and condition could not be determined. ***Comment:*** The condition of the plantroom pipework appeared to be satisfactory, although a number of the current pipework sizes are insufficient to satisfy PWTAG suction and delivery pipework velocities for the system requirements detailed in section 3.1.1. ***Recommendation:*** Replace all pipework throughout to achieve system flow rate for full PWTAG bather load.

Pipework support	**D**	***Description:*** There is no pipework support within the plantroom. All accessible pipework is being held by other equipment (filter connections & valves). Or had been supported with bricks/rubble/plastic. ***Comment/Recommendation:*** Adequate and effective pipework support should be provided to all circulation pipework to mitigate the risk of damage during operation.
System valves	**D**	***Description:*** There were a number of manually actuated valves within the plantroom including a 2" multiport valve for the filter frontal and numerous double union ball valves (u-PVC) for the associated suction/delivery pipework. In the drainage sump adjacent to the pool tank, there was a cast iron valve, although this is assumed to be decommissioned. ***Comment:*** The majority of the valves appear to be in good condition. There is minor surface corrosion at joints on some of the older valves which can be addressed manually by the operator. The valves are inadequate for the PWTAG required system flow rate detailed in section 3.1.1. ***Recommendation:*** Replace the valves to match the water treatment system pipework sized for the maximum bather load flow rate.
Circulation pumps & integral strainers	**D**	***Description:*** 1no. Calpeda circulation pump (cast iron, approximately 5.5kW) with steel strainer basket. No performance information could be obtained on-site for the circulation pump. The operator noted that the pump has recently undergone replacement of the impeller and a number of seals on the pump, due to an ongoing leak. It appears that the motor has also been recently replaced/refurbished. The pump is installed above static water level, the manufacturers data suggests that it is self-priming, the operator noted that if the pump has to be restarted, and the pump is manually flooded using a hosepipe on site to prime the pump. ***Comment:*** The pump appeared to be in unsatisfactory condition, with significant surface corrosion and a large amount of residue build up on the pump casing. It would be beneficial to install the pump below static water level to ensure adequate priming and reduce the pressure loss in the system, which will subsequently reduce the electrical load required. If this cannot be achieved, installation of a self-priming pump is advised. ***Recommendation:*** Replace the pump with unit(s) sized for the maximum bather load flow rate.

Variable speed drives	**C**	***Description:*** 1no. Toshiba VF-S11, wall mounted VSD adjacent to the distribution board in the plantroom. ***Comment:*** The VSD appeared to be in satisfactory condition. However, due to the system not being in operation, no analysis of performance could be assessed. Current VSD does not have the capability to operate in a system designed for the maximum bather load. ***Recommendation:*** Provide VSD(s) sized to match a system designed for the maximum bather load.
Electrical cabling	**C**	***Description:*** Electrical cabling and containment was unsatisfactory, a number of electrical cables were run without sufficient/any containment. local isolation switches provided for the pumps adjacent to the control panel; there are a number of components in the plantroom that did not have local isolation of electricity supply. ***Comment:*** Quality and form of cabling and containment varies throughout the installation. Some cabling is tidy and within electrical trays, some in conduit, and other sections are loose and untidy. Some cabling is sharing containment with chemical dosing pipework. ***Recommendation:*** In the short term for the current arrangement – loose and untidy cabling to be corrected. Separate containment should be provided for chemical dosing and electrical cabling. In general the electrical installation and associated containment and support is to be replaced to suit an appropriately sized system.
Make up water system	**C**	***Description:*** Manually operated make up water system installed to the exterior of the plantroom. This comprises of a piece of uPVC pipe with a 100mm air gap to the make-up water pipe. The operator manually connects a hose to the uPVC pipe and tops the pool water up manually. ***Comment:*** Where feasible automatic top up is to be considered, ideally with the water running through the pool water treatment system (heated) prior to filling the pool. ***Recommendation:*** Pipe make up water through the pool water treatment system.

Flocculant dosing system	**B**	***Description:*** 1 no. carboy of Polyaluminium Chloride (PAC) flocculant is installed in the plantroom within a plastic bunded container. The carboy has an installed dosing pump provided by Seko, Kronos-50. At the time of inspection, the flocculant was not connected to the dosing system. ***Comment:*** The exact dosing rate of the flocculant could not be obtained on site. Note that due to the size of the plantroom and small runs of pipework prior to filter delivery, the PWTAG recommended 10 seconds of mixing prior to the media bed did not appear to be achieved. ***Recommendation:*** PAC dosing to be provided for the PWTAG bather load system, with adequate mixing time prior to the filter beds.
Filters	**D**	***Description:*** 2no. 0.76m dia. AKT30 (GRP shallow bed) filters are installed on site. Both filters have filter frontal pipework sized 2". The filters appeared to be in satisfactory condition externally. Due to access restrictions, no comment can be provided on the internal condition of the vessels. ***Comment:*** Shallow bend filtration is not appropriate for swim facilities of this type and usage. The current PWTAG requirements identify that the maximum allowable flow through a filter bed is to be 25 m/hr (medium rate filtration). At this flow rate, the current filters have a total maximum circulation rate of approximately 22.50 m^3/hr. giving a maximum bather load of 13 bathers to meet the current PWTAG guidelines. Foul drainage capacity of the site is to be assessed as this may limit the sizing or replacement filters or necessitate the provision of a backwash attenuation tank. ***Recommendation:*** Replace filters, sized to match a flow rate designed for the maximum bather load. Where possible assess the foul drainage capacity of the site to support the sizing of filters.
Heat Exchanger	**D**	***Description:*** The pool water treatment system pipework is directly connected to 1 no. Certikin MB405N/P gas heater, with an associated pipework bypass arrangement. The boiler is positioned post filtration and prior to chemical dosing & return to the pool. The boiler is situated in the main plantroom with the associated gas supply connections. ***Comment:*** There are significant signs of corrosion on the boiler and it was noted by the operator that it was nearing the end of its operational life. The Certikin technical information for the heat exchanger states a maximum capacity of 108 kW. This would appear to be undersized for the system, though the operator identified that the pool water set temperature of 25°C is maintainable. ***Recommendation:*** Replace the current arrangement with a new boiler/heating system to provide longevity.

Calcium hypochlorite dosing system	**B**	***Description:*** 1 no. 200 litre calcium hypochlorite day tank (mixing at 250g / 20 litres) with bund container (capacity unknown) stored within the main plantroom. The plantroom has no mechanical/natural ventilation, or any dedicated bunded area to ensure separation with the pH control chemical. The louvered sections on the plantroom doors have been covered with Perspex. The dosing pump and mixing motor are mounted on the day tank, conduit is provided for the dosing line to the injection location but there are some exposed areas. ***Comment:*** The plantroom/chemical dosing equipment had some build-up of residue from the calcium hypochlorite, although appeared to be in good condition. The calcium hypochlorite is dosed into a section of pipe on the return to the pool. The injectors of acid and chlorine are located with around 1m pipe separation. Ideally pool water would be boosted to a dedicated calcium hypochlorite store for dosing rather than storage and dosing from the plantroom. ***Recommendation:*** Due to the level of hardness (342 $CaCO_3$ mg/l) identified in the water quality report, it is recommended that Sodium Hypochlorite is used for chlorine disinfection of the water. If calcium hypochlorite is to be used for the disinfection, this may increase the risk of blockages in the system. Necessary preventative measure should be taken to mitigate this. For a new system provide a dedicated chlorine donor room for storage and dosing. For the current arrangement – the full length of the injection dosing line is be protected by conduit.
Sodium Bisulphate dosing system	**B**	***Description:*** 1 no. 200 litre sodium bisulphate day tank, mixing at (1kg:20 litres) within the main plantroom, with GRP bunded container for the day tank. The dosing pump and mixing motor are mounted on the day tank, conduit is provided for the dosing line to the injection location but there are some exposed areas. ***Comment:*** The sodium bisulphate is dosed into the return pipework to the pool, where both the injectors for sodium bisulphate and sodium hypochlorite are located with around 1m separation. Ideally pool water would be boosted to a dedicated sodium bisulphate store for dosing rather than storage and dosing from the plantroom. ***Recommendation:*** For a new system provide a dedicated sodium bisulphate store for storage and dosing. For the current arrangement – the full length of the injection dosing line is be protected by conduit.

Chemicals storage/access/signage /PPE	**B**	***Description:*** The sodium bisulphate is stored within a metal box external to the plantroom on the pool surround, and calcium hypochlorite is stored within an independent chemical store in a shed at the other side of the pool. Access to the sodium hypochlorite is limited and there is no provision of mechanical ventilation in both storage locations. Appropriate signage was provided on the plantroom door and all associated chemical storage locations at the facility. ***Comment:*** Provision of ventilation to the chemical storage and dosing locations (Internal) should be considered. Noted that there were no Material Safety Data Sheets (MSDS) for the stored chemicals. ***Recommendations:*** Provide adequate chemical store ventilation and MSDS for the chemicals.
Chemical controller	**A**	***Description:*** 1 no. Bayrol chemical controller, complete with sample cell wall mounted, measuring free chlorine, pH and Temperature of the pool water. ***Comment:*** Unit appears be in satisfactory condition, although no the unit was not operational at the time of inspection so no comment can be provided on the operational condition. The operator noted that when the circulation pumps tripped the chemicals stopped dosing, although no automatic interlocks for the dosing system with the pool circulation pumps could be demonstrated on site. ***Comment/Recommendations:*** Retain chemical controller and ensure there is provision of an interlock with pool circulation pumps.
General plantroom details	**D**	***Description:*** The plantroom is significantly undersized for the pool water treatment system required for the maximum bather load. The pool is situated at the top of a bank with only access up a constant slope path to the facility. This should be taken into consideration when proposing any refurbishment works. The approximate size of the path is 3.5m. ***Comment:*** The area of the plantroom in close proximity to the pool tank appears to be sinking towards the pool tank, with significant cracks prominent on the walls of the building. Refer to comments in Section 3.2.1. It is recommended that a structural engineer reviews the associated areas for any subsidence. ***Recommendations:*** Provide a plantroom of an appropriate size to accommodate the pool water treatment system required for the maximum bather load. Noted that planning permission has been submitted for a 9m x 4m plantroom, which is currently awaiting approval.

3.2 Pool Tank

At the time of audit, the pool tank was operational/full of water. As such, the pool base outlet sumps and suction pipework underneath the suction outlet grilles could not be inspected. No inspection of the pool tank liner below the static water level (just below the skimmer) could be completed due to the level of algae in the pool, reducing the clarity of the water.

3.2.1 23m pool tank condition review

Plant/Item	Grade	Assessment notes
Alignment/levelness of structure	**D**	Description: There appeared to be some movement of the pool tank structure along the datum down the length of the pool tank. Although no specific defection measurements could be identified. There also appeared to be some level change around the pool tank edge along the coping stones. Comment: Local to the pool water treatment plantroom at the deep end of the pool, there appeared to be deflection of the pool wall towards the tank, aligning with the comments made in section 3.1.3. On site a number of the pool surround tiles had been removed leaving the exposed backfilled area underneath visible, it appears that a large section of the backfilled area had collapsed under the surround and the operator noted that when it was attempted to fill the area, the backfill kept collapsing. This was approximately within 1m from the pool tank edge, where the proposed new plantroom is to be built. No cracking was visible to the structure, but these areas may be covered by the installed pool tank liner. *Recommendation:* Prior to any further works commencing on site, It is recommended that a structural engineer provides an assessment on the construction methodology and structural assessment of the pool tank, pool surround and associated backfilled areas.
Cracking or movement of structure	**D**	

Water tightness of structure	**C**	Description: With reference to the comments identified in section 3.1.3. The operator noted that the level drop recorded in the pool was approximately 25mm per day. This was noted to be associated with the skimmer boxes, but the source of the leak was not found. Comment: No visible signs of leakage or egress were noted on site. Although it was noted that there is no visible interfacing with the pool liner and any fittings. Notable areas of the liner were peeling away from the coping stone and the pool handrails were connected by screws through the liner into the structure. In areas where the handrails had been removed, the holes of the screws remained. *Recommendation:* It is recommended that a water tightness test for the pool tank is completed to assess the current water integrity of the pool tank structure.
Appearance and condition of finishes	**D**	Description: The installed pool liner encapsulates the internal of the pool tank. The liner runs up to just beneath the coping stone of the pool surround, which it then it is then connected with a form of grout or adhesive. The operator noted that the liner has been installed for 20 years. Comment: A number of holes in the liner below static water level were identified on inspection. A number of areas within the pool tank (grout/adhesive) that had disconnected from the pool liner which may be the cause of water egress. The colour of the liner appeared to have deteriorated in most areas of the pool. *Recommendation:* It is recommended that the pool tank liner is replaced.
Access into pool tank	**B**	Description: 3no. stainless steel access ladders, 2no. situated in the shallow end and 1no. situated in the deep end. No pool hoist or stepped access into the pool was observed. It is noted that the operator expressed an interest in the addition of stepped access into the pool tank if remedial works are undertaken to allow for easier access for less ambulant users. *Comments/Recommendation:* Ensuring that the facility is DDA compliant and accessible for less ambulant users should be considered within the redevelopment works at the facility.
General condition of pool surrounds and pool envelope	**D**	Description: The pool surround is constructed of large format concrete slabs, there are coping stones of a different colour around the edge of the pool tank which appear to be in satisfactory condition albeit appearing weathered. *Comment/Recommendation:* It is recommended that the removed pool surround slabs are removed and replaced following remedial works and structural engineer's analysis. It is also recommended that if the pool liner is replaced, sufficient interfacing with the pool surround coping stone is to be provided.

3.3 Additional assessment review comments

3.3.1 The incorporation of a deck level surface water removal should be considered when assessing options for enhancing the circulation in the pool tank. To accommodate a deck level pool surface water removal system a balance tank would need to be incorporated into the pool water treatment system. The balance tank will need to be sized to suit the refurbished pool water treatment system capacity.

3.3.2 There is currently no Ultra-Violet (UV) secondary disinfection installed on the water treatment system. It is recommended that a UV system is provided to uplift the treatment system to be able to breakdown disinfection by-products and deactivate cryptosporidium oocysts.

4.0 Summary & Costs

The current pool water treatment system capacity is estimated to be one-third of that required to achieve PWTAG compliance with the client-required PWTAG maximum bather load. The significance of this far outweighs any requirement for remedial works on the current water treatment system installed.

It is recommended that the water treatment system capacity is increased. The following areas of the pool water treatment system require a significant change in size/capacity to ensure compliance with the current guidelines:

- Filtration equipment
- Circulation pumps
- Surface water removal
- Return water inlets
- Circulation pipework
- Chemical dosing & storage.

The plant is significantly undersized for the current PWTAG requirements, a number of vital pieces of equipment are coming to an end of their useful life and full replacement should be considered. It is to be noted that due to the spatial limitations within the current plantroom and chemical stores, the expansion of the current plantroom or creation of a new plantroom is required.

The operator noted on site that the electrical and water connections are supplied by the school adjacent to the facility. The spare capacity in the local distribution board and capacity of the water supply should be verified prior to the redesign of the pool water treatment system and plantroom builderswork to ensure this meets the requirements.

The movement identified in the pool tank, plantroom, pool surround and associated backfilled areas should be investigated further by a structural engineer. This includes and is not limited to the following:

Pool tank & Pool Surround:

1. Pool structure assessment to determine suitability of the structure for likely works
2. Back fill assessment (slab and pool support)

3. Similar to 1 and 2 above for the pool surround.

Pool Water Treatment System:

1. Structural assessment of the existing pool water treatment plantroom slab
2. Concrete slab for the expansion of the water treatment plantroom
3. Increase in the drainage requirement/capacity for the plantroom
4. Provision of a pump pit (if required)
5. Provision of reinforced concrete slab for the balance tank (if required).

Pool Surround Excavation:

1. Consideration of the requirements associated with the excavation of deep-buried pipework connecting the pool plant to the pool tank
2. Excavation for the balance tank (if required).

Given the age of the pool tank and the potential use of cast iron pipework in other areas then a survey of the pipework should be considered.

Estimated budget costs for the new water treatment plant is **£165,000**.

These values are for the pool water treatment equipment only and do not take into consideration any alterations to the pool tank structure, surface water removal systems or the addition of a balance tank.

