

Stanley Park Lake Revival Lake Engineering Study

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1. Introduction

APEM were commissioned by Blackpool Council to undertake a lake engineering study at Stanley Park Lake, in support of its “Stanley Park Lake Revival” project.

1.1 Stanley Park

Stanley Park Lake sits within Stanley Park, a 260 acre public park that was designed by Thomas Mawson & Sons in 1922 and built in 1926. The park itself is Grade II listed and was recently voted by the public as ‘UK’s Best Park’ at the annual Fields in Trust Awards 2017. The lake is an original feature of the park and has traditionally been used for pleasure boating. Historically sailing took place on the lake as well as pleasure tours provided on the oar propelled ‘Samuel Fletcher’ lifeboat. The park is the largest green space in Blackpool and is well used by both local residents and tourists throughout the year. During the summer months, the range of events can attract thousands of visitors each day to the park.

1.2 Stanley Park Lake vision

A range of ‘shallow water’ watersports such as canoeing and kayaking have been introduced on the lake, but the ability to deliver a wider program, and establish various events and competitions on the park is prohibited by the depth of the water (and dense macrophyte growth during the summer months). The Stanley Park Lake Revival project hopes that desilting the lake would enable activities such as sailing, windsurfing, Stand Up Paddle boards (SUP’s) and open water swimming to be made available to local people on a regular basis as well as providing a stunning venue for local, regional and national competitions.

Blackpool Council therefore have a vision to increase the range of watersport activities available locally whilst restoring Stanley Park lake to its original depth.

1.3 Study requirement

Blackpool Council secured funding to support initial feasibility studies which dependent on their results, would then assist in future funding bids (to the likes of Sport England) to enable the vision to be implemented.

APEM have been commissioned to undertake a lake engineering study “to understand the type and volume of silt in the lake and the most economical way of removing this, that has minimal ecological impact on the lake wildlife and surrounding park”.

1.4 Legal context

Waste is defined as “any substance or material we discard, intend to discard or are required to discard” (Waste Framework Directive (2006/12/EC)). The reuse of potential ‘waste’ soils or similar materials (including dredgings) on a site is governed by environmental legislation

With regards silt deposits within the footprint of a lake, management and movement of silts are generally considered to be ongoing management/maintenance actions which do not constitute waste generation or movement.

When dredgings are deposited on the immediate banks of a lake the silts become a waste material. However, waste exemptions (provided conditions are met) exist for this type of routine management work.

Where 'waste' is reused elsewhere on a site or moved to another site different licensing/permitting controls are generally required - this must be covered by an environmental permit, or an exemption. However, following the CL:AIRE Definition of Waste Development Industry Code of Practice (DoWCoP), and subject to appropriate testing and risk assessment, it is possible to move and re-use materials on the site of production and /or move materials from one site to another as non-waste, provided the material types fall within the scope of the DoWCoP and that the key principles of its re-use are met. This removes the need for an environmental permit, but will normally require the production of a Materials Management Plan (and associated supporting documents). The use of the material would need to be agreed with the regulators and have a defined purpose through the MMP sign-off process.

Field surveys, classifications and interpretations are required to develop appropriate de-silting methods. Data from the field surveys are presented in Sections 3.1 (bathymetry) and 0 (sediment depth). Silts chemistry and classifications are presented in Section 3.3. De-silting methodologies are discussed and presented in Section 3.4

1.5 Project plan

APEM compiled a team that included the two specialist subcontractors SOCOTEC and Ebsford Environmental, to provide laboratory analyses and engineering inputs respectively. A project inception meeting was held on the 2nd May 2019, attended by the Blackpool Council PM (██████████) and other members of the project steering group from the council, as well as the APEM PM (██████████) and the Ebsford PM (██████████). The project plan was agreed at the inception meeting. The key elements of the project plan are:

- **Project inception meeting** – clarify project understandings including site requirements to inform survey works.
- **RAMS:** Risk Assessment and Method Statement prepared and submitted ahead of survey works.
- **Bathymetric survey:** – Estimation of the volume of silt that has accumulated in the lake (Section 2.2 for methods; Section 3.1 for results)
- **Silt sample collection:** Collection of silt samples for chemical analyses (Section 2.7 for methods; Section 3.3 for results).
- **Silt classifications:** Interpretation of chemistry data to inform waste classification and disposal options – see Section 3.3.
- **De-silting methodologies:** Development of a de-silting methodology (Section 3.4).
- **Pricing estimates:** Development of outline costs and program for de-silting based on estimates of silt volume and silt classifications - see Section 3.4 and Appendix VII.
- **Management recommendations:** Management recommendations focusing on minimizing future siltation – see Section 3.6.
- **Tender specification for de-silting phase:** Recommended de-silting works within an outline summary sufficient for letting of tenders for the next project phase – e.g. Appendix VII.

2. Methods

2.1 Site walkover

Figure 1 provides a site location map of Stanley Park lake. The APEM PM and Ebsford PM undertook a site walkover on the 2nd May 2019. An additional walkover was undertaken with the council project steering group on the same day, as part of the project inception meeting.

The entire perimeter of the lake was walked allowing observations to be made related to the current status of the lake. Observations were made of the type and condition of the lake margins, management issues, inflows, outflows, lake use, macrophyte growth etc. An annotated photographic record of notable features observed during the site walkover is provided within Appendix IV.

The walkover observations informed subsequent project phases, including the de-silting methods (Section 3.4) and management recommendations (Section 3.6).



Figure 1 Site location map.

2.2 Bathymetric Survey

The bathymetric survey was required to allow characterisation of the present lake basin bed geometry up to Top Water Level (TWL) and the depth and extent of sediment accumulation at the base of the lake.

The survey zone encompassed the lake as shown in Figure 1. The specific objectives of the bathymetric survey were as follows:

- Hydrographic survey to determine:
 - The bathymetric (depth) profile of the wetted area of the lake
- Depth profiling survey to determine:
 - The soft bed profile (top of sediment bed)
 - The hard bed profile (bottom of sediment bed)
 - The sediment bed profile
 - Water and sediment volumes in the lake

APEM undertook a boat based hydrographic and manual depth ranging survey to determine the bathymetry and sediment depth of the lake.

2.3 Hydrographic survey

The survey was undertaken using one of APEM's small rigid inflatable boat (RIB) survey craft, powered by 6HP outboard, onto which the survey equipment was mounted. The bathymetry and sediment depth data were captured using the following equipment:

- Bathymetry: Xylem M9 bathymetric sensor
- Positioning equipment: Leica GS16 RTK GNSS Rover
- Depth Ranging: Leica GS16 RTK GNSS Rover
- Acquisition Software: Hydrosurveyor and Leica Viva SmartWorx
- Post processing and analysis software: Hydrosurveyor, Surfer and ArcGIS

Ahead of the survey, a survey route plan was drawn up in GIS to ensure that accurate and comprehensive coverage was achieved. The hydrographic survey was based on surveying a systematic 10m x 10m survey grid and one concentric transect around the wetted perimeter of the entire lake (both basins). Additional data was captured as time permitted. The survey route plans were uploaded to the field laptop to allow the skipper to see the survey boats position in real time against the survey plan and follow accordingly. The survey coverage achieved by the hydrographic survey is presented in Figure 2: Note that comprehensive coverage was not possible in the northern half of the lake due to dense macrophyte growth (see appendix IV for images).

The survey and data acquisition were coordinated and subsequently post processed to the following datum's:

- Horizontal datum: Ordnance Survey British National Grid (OSGB1936) based on the ETRS89 to OSTN15 transformation.
- Vertical datum: Ordnance Datum Newlyn (ODN) based on the ETRS89 to OSGM15 transformation.

The hydrographic data were calibrated using a Xylem Castaway conductivity temperature and depth (CTD) profiler. The CTD collected continuous speed of sound (SoS) profiles throughout the water column to provide accurate SoS data. The data were used in post processing to accurately compensate for SoS in determining the bed level in the lake. CTD casts were collected across the lake to determine an average SoS correction factor for the water body. These were duly applied in post processing. CTD cast locations are shown in Figure 2.

Water levels were recorded at the start and end of each survey using the same RTK GNSS survey equipment used for the hydrographic survey, with levels measured relative to Ordnance Datum (see Appendix III). An average water level was calculated using the water level data to determine the survey water level (SWL) for the lake. During data post processing, the hydrographic survey data were reduced to Ordnance Datum (OD) using the SWL data.

Survey control data was collected periodically at four locations throughout the survey using the same RTK GNSS survey equipment. Each control point was measured throughout the survey to provide an RTK data check for the survey data. APEM control data is provided in Appendix III.

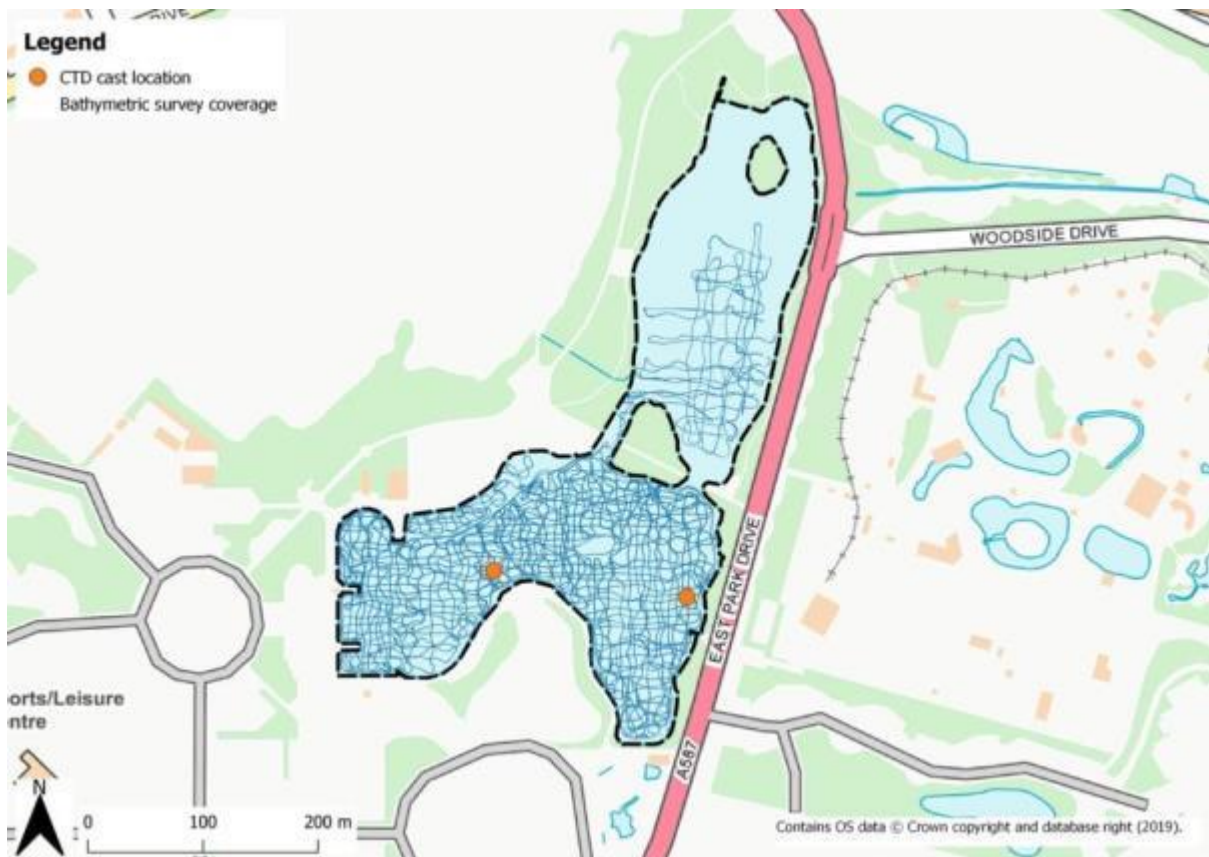


Figure 2 Bathymetric Survey Coverage.

At the time of this survey, the lake was characterised by dense proliferations of macrophyte growth, particularly in the Northern basin (see Appendix IV for images). This density of macrophyte significantly reduced the ability to collect accurate bathymetric data via the M9 and Stratabox hydrographic sensors as intended; the sensors measured the top of the macrophyte growth as the bed level, thus generating an inaccurate representation of the

bathymetry (see Appendix V). As a result, manual ranging survey was utilised to accurately record the soft/hard bed levels within the lake (both basins).

2.4 Depth Profiling survey

Topographic survey was used to capture water level and survey control data. The same RTK GNSS survey equipment was used to measure level data for the soft bed and hard bed levels across the lake and around the lake perimeter.

The levels were recorded using the detail pole with network RTK receiver mounted on top. The ranging pole was used to measure the top of the sediment bed and then driven down until it reached a solid level to record the hard bed level. The difference between the top bed and hard bed level was then calculated to generate a sediment depth. A total of 198 profiling locations were measured for soft bed levels and 605 for hard bed level (803 levels in total). The survey coverage achieved from the depth profiling survey is presented in Figure 3. All level data were recorded directly onto the SmartRover's controller. Upon completion of the survey, the level data were downloaded in XYZ format where:

- X = OS Eastings (m)
- Y = OS Northings (m)
- Z = Elevation (mAOD)



Figure 3 Stanley Park Lake depth profiling survey coverage.

2.5 Silt sample collection

Using the same survey boat, the field team collected 8 (No.) sediment samples from the lake bed using a HTH gravity corer (Figure 4). As part of this study 4 (No.) silt samples were collected from each of the two main lake areas. Silt samples were taken from a range of silt depths (between 0.5m and 1.2m). The grid reference for each sample location is provided in Appendix III with the location of each sampling point presented in Figure 3 and Figure 5. Silt samples were then packaged and submitted under chain of custody procedures via courier (within 24 hours of sampling) to SOCOTEC's UKAS & MCERTs accredited laboratory.



Figure 4 Example sediment core from Stanley Park lake.



Figure 5 Stanley Park Lake sediment sample references.

2.6 Data Processing

Following completion of the field surveys, bathymetric data were processed using Hydrosurveyor software to apply SoS corrections and reduce bed level data to OD. Depth profiling data was downloaded directly from the GS16 smart rover controller. Upon completion of the data processing, the data were exported in XYZ format where:

- X = OS Eastings (m)
- Y = OS Northings (m)
- Z = Elevation (mAOD)

As discussed in Section 2.2, the hydrographic data was discounted from the bathymetric modelling due to the presence of dense macrophyte growth across the lake obscuring the data (example output shown in Appendix V). To generate the bathymetric datasets the survey data were imported into Surfer gridding software to interpolate and generate a continuous grid of data to encompass the survey area. The modelled data were generated at a resolution of 1 m² in grid format and presented in 2D contour model format. The hard bed and sediment depth data followed the same procedure. The final models were exported in GIS and CAD compatible formats and included with this report (see Appendix I).

The gridded data were used to perform volumetric calculations for water up to the measured water level and for the sediment within the lake. A summary of the data generated from the survey is presented in Section 3.

2.7 Silt chemistry assessments

Silt samples (Section 2.5) were submitted to the laboratories of SOCOTEC, Burton-on-Trent for MCerts and UKAS accredited laboratory analyses.

A programme of chemical laboratory testing was scheduled on all of the samples for a range of potential contaminants to allow the materials to be assessed for reuse and waste disposal if required. The scheduled laboratory tests are detailed in Table 1 below, summary results are presented and discussed in Section 3.3 and the laboratory test reports are provided within Appendix VIII.

Table 1: Summary of Chemical Laboratory Testing

Determinand	No. of tests
Metals and semi-metals (boron, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc)	8
Hexavalent chromium	8
Moisture content (for MCerts)	8
Cyanide (free)	8
Phenol Index	8
pH	8
Full TPH CWG to include GRO/BTEX for (nC5 to nC10) plus extractables as aliphatic and aromatic class separation with carbon banding	8
Polycyclic Aromatic Hydrocarbons (16 PAHs)	8
Asbestos analysis Stage 1	8
Asbestos Quantification	1
Polychlorinated Biphenyls (PCBs) (7 congeners)	4
Volatile Organic Compounds (VOCs)	4
Leachate preparation (BS EN 12457-1 Single Stage 2:1, WSLM19)	8
Leachable cyanide (free)	8
Leachable metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc)	8

Results were interpreted to assess the potential risks from any contamination and to inform material re-use and/or disposal options.

2.7.1 Human health risk assessment

A human health risk assessment was undertaken which constitutes a Generic Quantitative Risk Assessment (GQRA) consistent with Environment Agency guidance CLR 11 (EA, 2004)¹. A summary method is presented here with full details available in Appendix VIII.

Human Health Generic Assessment Criteria (GAC) were selected from a range of sources (CL:AIRE C4SL, LQM S4UL and CL:AIRE/EIC/AGS GAC). Given the setting and the potential re-use options within an area of public open space the principal GAC used for screening purposes was the Public Open Space public park (POSpark) GAC, derived using the Environment Agency Contaminated Land Exposure Assessment (CLEA) model (see Appendix VIII for further details).

2.7.2 Controlled waters risk assessment

The assessment of risks to controlled waters follows guidance provided by the Environment Agency (Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination (2006) and DEFRA in the Contaminated Land (England) Regulations 2006 (SI 2006/1380) and consolidated regulations.

As with the human health risk assessment, the controlled waters assessment take into account the receptors that may be at risk from the reuse of the material. This could include underlying groundwater aquifers, or nearby surface waters, or both. The generic assessment criteria (or Target Concentrations) used to assess the potential risks are then be selected based on the receptors of concern.

DEFRA'S Magic Maps (magic.gov.uk) show that the site is located on a Secondary B bedrock aquifer and on a Secondary Undifferentiated Superficial Aquifer. The site is not located within a groundwater vulnerability zone or nitrate vulnerable zone. The site is not situated within a source protection zone or drinking water zone for surface water or groundwater.

The closest surface water receptors are Stanley Park Boating Lake (from which the material will be dredged) and multiple bodies of surface water in Blackpool Zoo and golf course approximately 150-200 m from the site. Stanley Park Boating Lake is not located on a main river; it is 1.24 km upstream of Marton Mere, which is the nearest Water Framework Directive river water body. Marton Mere is a Local Nature Reserve and Site of Special Scientific Interest (SSSI) designated on account of breeding bird populations and the associated open water habitats.

Based on the above information, leachate results were compared with the Environmental Quality Standards (EQS) for fresh waters assessments. It should be noted however, that some of the published freshwater EQS (e.g. for copper, lead, nickel and zinc) are very conservative; they are based on the bioavailable fraction for some of the heavy metals, whilst leachate analysis measures the total dissolved concentration of the metals. The proportion of the dissolved metal that is bioavailable in the aquatic environment is governed

¹ Environment Agency (2014). Guidance CLR 11, Model Procedures for the Management of Land Contamination

by a number of factors, including pH, calcium and dissolved organic carbon (further bioavailability discussions are provided in the discussions Section 3.3.2).

It is also noted that leachate analysis, which is standard practice for risk assessment of all derived 'soils' may be viewed as somewhat of a precautionary assessment in this instance given that the material is already in direct contact with the Stanley Park lake surface water - which is the principal receptor for the purposes of controlled waters. This was considered justified given that dredging works (and the disturbance associated with them) could mobilise any existing contamination (via mixing and partitioning into the water column).

2.7.3 Phytotoxicity Screening Assessment

To confirm whether the dredged material would pose a potential risk to plants and vegetation (i.e. phytotoxic risk), the relevant determinands were screened against thresholds recommended in the Sludge (use in agriculture) Regulations 1989 (SUIAR).

2.7.4 Waste Classification Assessment

The HazWasteOnline toolkit was used to undertake a Hazard Assessment classification. This classification process is in accordance with technical guidance document WM3 (WM3, 2018³). Waste classification results are presented as Section 3.3.4.

2.8 De-silting methodologies

The site understanding (e.g. walkover observations) and the results of the environmental surveys (sediment quantity and quality) were considered alongside the practical de-silting and contracting experience of the project team to develop methodologies for the future de-silting works. Potential and recommended methodologies are presented as Section 3.4 (and Appendix VIII).

3. Results and discussions

3.1 Bathymetry

The hydrographic data products derived from the Stanley Park Lake survey are included in Appendix I. As discussed in Section 1, the dense macrophyte coverage present throughout the majority of the lake resulted in an inaccurate representation of the bathymetry/soft bed profile via SONAR survey with the M9. As a result, manual depth profiling survey was undertaken to accurately represent the bathymetry and hard bed profile of the lake. Whilst every effort was made to ensure accurate recordings of the soft bed level via manual ranging, due to the dense nature of the macrophyte growth it was difficult to determine the true soft bed level in some areas.

The lake soft bed level, hard bed level and volume statistics based at SWL, which was defined as 9.38 mAOD, are provided in Table 1. The survey determined that the minimum soft bed level was 7.33 mAOD (2.05 m below WL) and the average soft bed level was 7.92 mAOD (1.46 m below WL). The volume of the lake based on the soft bed level was calculated as 121.90 ML.

The minimum hard bed level was 6.80 mAOD (3.3 m below WL) and the average hard bed level was 7.73 mAOD (1.65 m below WL). The volume of the lake based on the hard bed level was 137.20

Table 2: Stanley Park Lake bed level and volume statistics (at recorded SWL).

Parameter	Soft Bed	Hard Bed
Maximum bed level (mAOD)	9.38	8.60
Minimum bed level (mAOD)	7.33	6.80
Average bed level (mAOD)	7.92	7.73
Volume (ML)	121.90	137.20

3.2 Sediment depth and volume

A 2D sediment depth contour map is presented in Figure 6. The sediment model generated an average sediment depth of 0.19 m across the lake. The sediment is distributed relatively evenly across the lake bed, with the exception of a few notable 'hot spots'. The maximum depth of sediment was 1.12 m which was observed in a small, deep 'pocket' toward the south west of the lake, in the vicinity of the small jetty. The volume of sediment detected above the hard bed layer was calculated as 15.29 ML which accounted for 11% of the hard bed volume in the reservoir.

Table 3: Stanley Park Lake sediment bed statistics.

Parameter	Unit
Maximum depth (m)	1.12
Minimum depth (m)	0.00
Average depth (m)	0.19
Volume (ML)	15.29

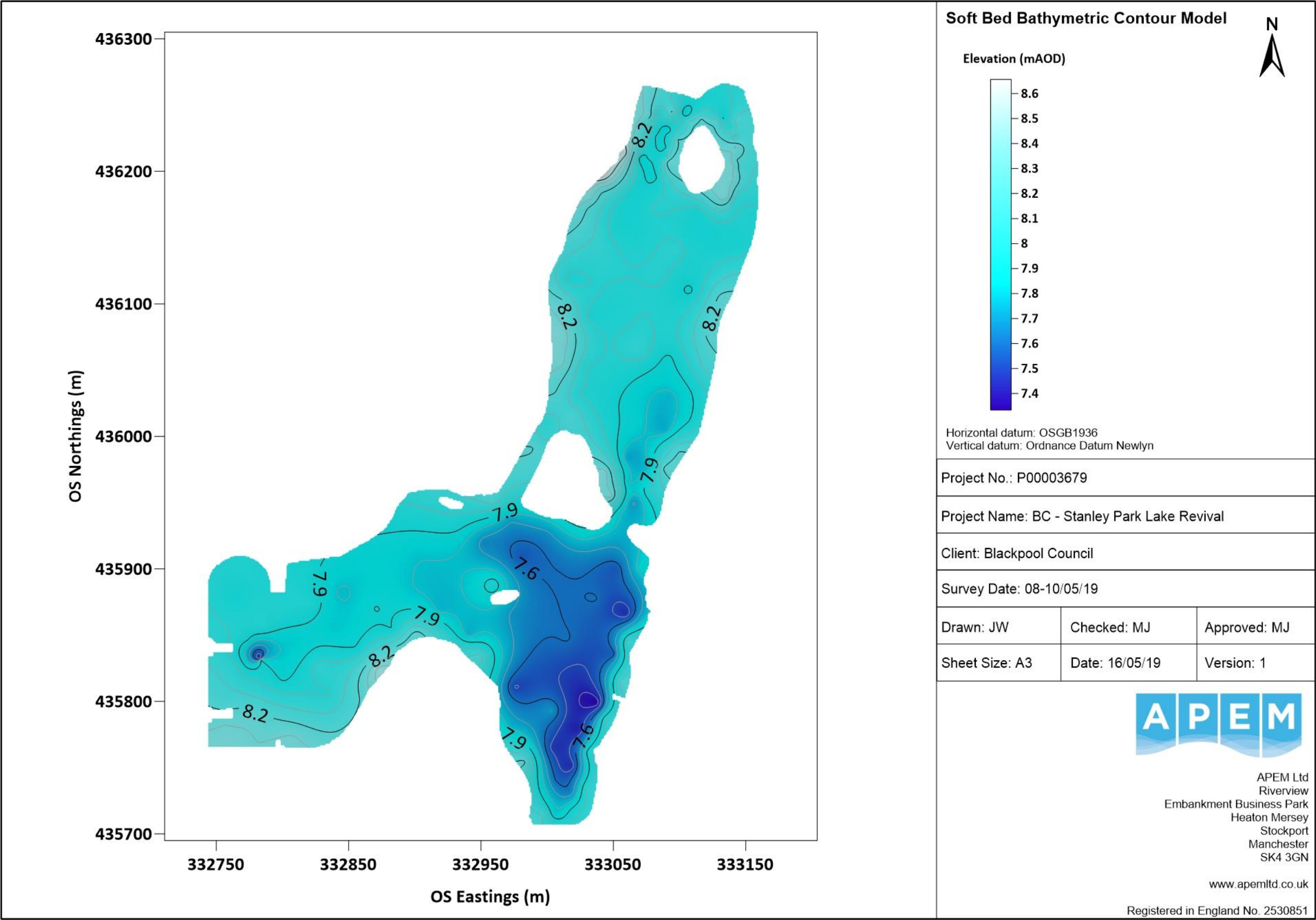


Figure 6 Stanley Park Lake bathymetric contour model



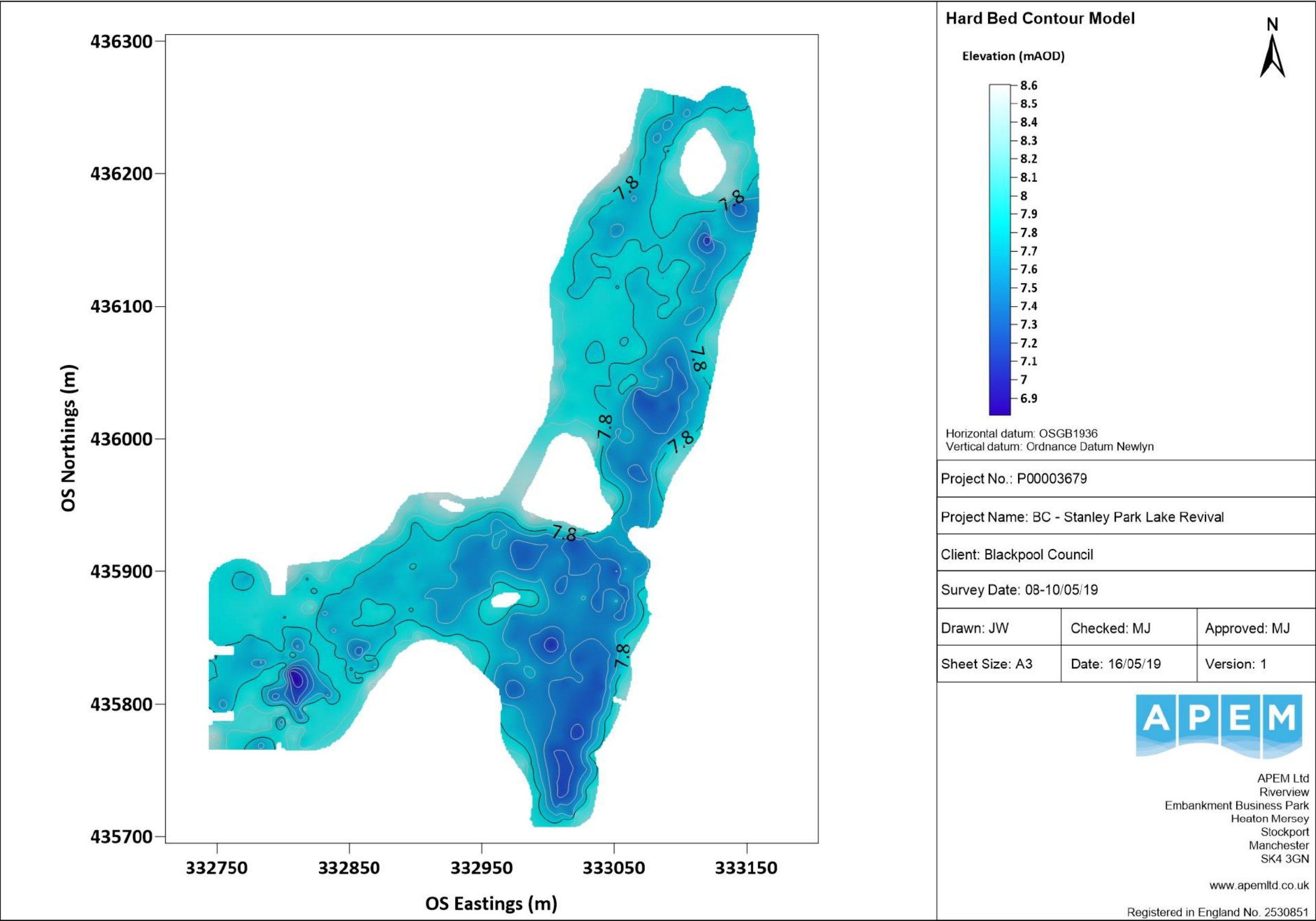


Figure 7 Stanley Park Lake hard bed contour model.

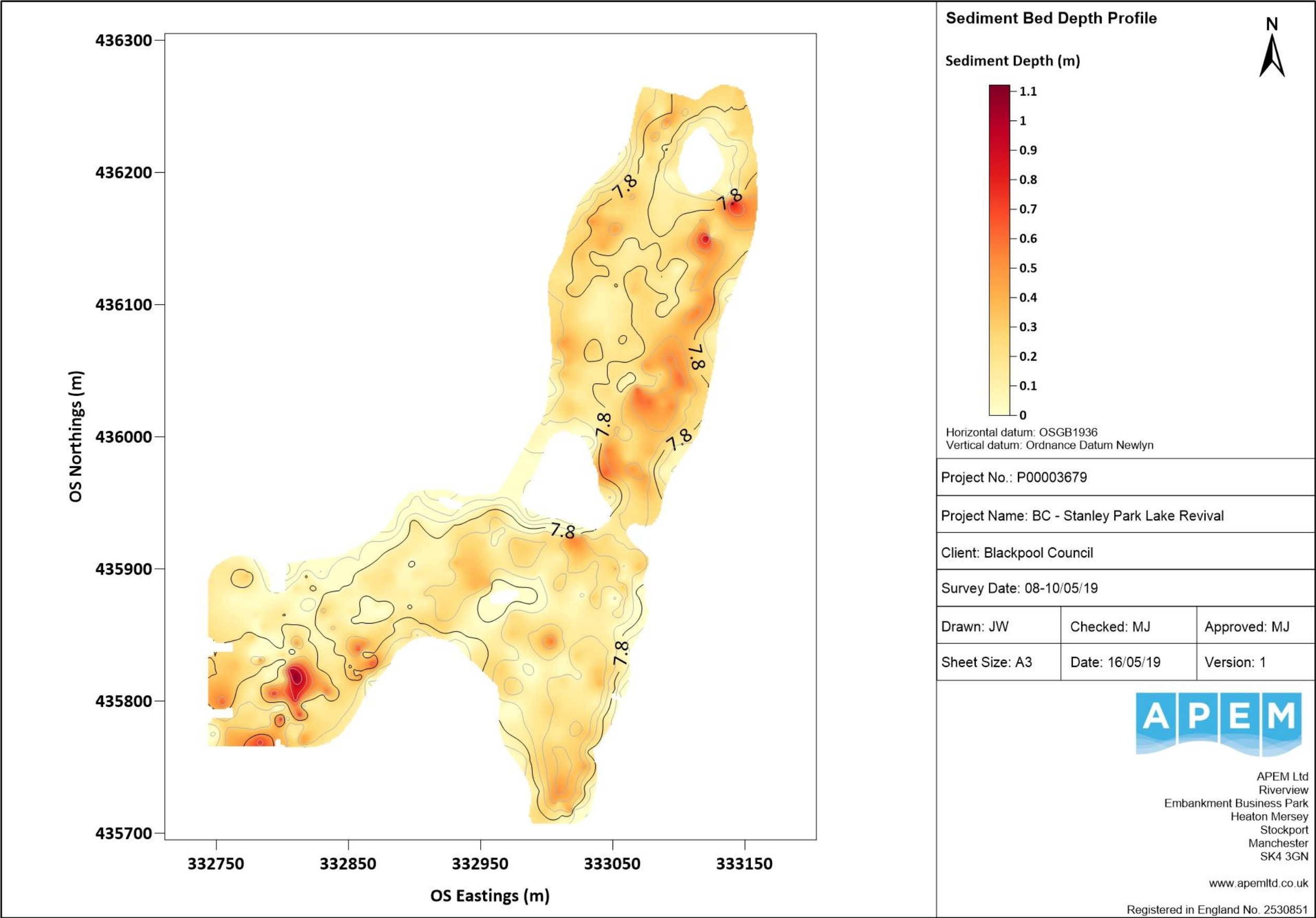


Figure 8 Stanley Park lake sediment depth model.

3.3 Silts chemistry

The silt samples were described as 'Brown Gravel SILT²' (S1, S5 & S7), 'Brown SOIL' (S2) and 'Brown SILT' (S3, S4, S6 & S8).

3.3.1 Human Health Risk Assessment Screening

The maximum recorded concentrations of contaminants in the eight silt samples are compared with the POSpark GAC (adjusted for 1.0% SOM) in Table 2 below.

Table 4: Comparison of Maximum Measured Concentrations with POSpark GAC

Determinand	Maximum Measured Concentration (mg/kg)	Generic Assessment Criterion (GAC) for POS _{park} (mg/kg)	No. of results exceeding GAC (no. of tests in brackets)
Metals & semi- metals			
Arsenic	21.8	170	0 (8)
Boron	3	46000	0 (8)
Cadmium	1.2	532	0 (8)
Chromium III	64.5	33000	0 (8)
Chromium (hexavalent)	<0.1	220	0 (8)
Copper	272.7	44000	0 (8)
Lead	199.3	1300	0 (8)
Mercury ²	0.62	240	0 (8)
Nickel	54.9	3400	0 (8)
Selenium	0.9	1800	0 (8)
Zinc	304.7	170000	0 (8)
Polycyclic Aromatic Hydrocarbons (PAHs)			
Acenaphthene	<0.31	<0.31	0 (8)
Acenaphthylene	<0.31	<0.31	0 (8)
Anthracene	<0.31	<0.31	0 (8)
Benzo(a)anthracene	1.09	1.09	0 (8)
Benzo(a)pyrene	1.41	1.41	0 (8)
Benzo(b)fluoranthene	1.81	1.81	0 (8)
Benzo(g,h,i)perylene	0.98	0.98	0 (8)
Benzo(k)fluoranthene	0.65	370	0 (8)
Chrysene	1.27	93	0 (8)
Dibenzo(a,h)anthracene	0.44	1.1	0 (8)
Fluoranthene	2.32	6300	0 (8)
Fluorene	<0.31	20000	0 (8)

² Major constituent in upper case.

Indeno(1,2,3,c,d)pyrene	1.21	150	0 (8)
Naphthalene	<0.31	1200	0 (8)
Phenanthrene	0.58	6200	0 (8)
Pyrene	2.43	15000	0 (8)
Total Petroleum Hydrocarbons and BTEX			
Aliphatic >C5-C6	<0.787	95000	0 (8)
Aliphatic >C6-C8	<1.574	150000	0 (8)
Aliphatic >C8-C10	<15.75	14000	0 (8)
Aliphatic >C10-C12	<15.75	21000	0 (8)
Aliphatic >C12-C16	<15.75	25000	0 (8)
Aliphatic >C16-C35	506.8	450000	0 (8)
Aromatic >C08-C10	<15.75	7200	0 (8)
Aromatic >C10-C12	16.3	9200	0 (8)
Aromatic >C12-C16	19.75	10000	0 (8)
Aromatic >C16-C21	40.9	7600	0 (8)
Aromatic >C21-C35	341.7	7800	0 (8)
Benzene	<0.0394	90	0 (8)
Toluene	0.189	87000	0 (8)
Ethylbenzene	<0.0394	17000	0 (8)
Xylene-m / p	<0.0787	17000	0 (8)
Xylene-o	<0.0394	17000	0 (8)
Other Compounds			
Asbestos	0.006 %	Presence of Asbestos	1 (8)
Cyanide (total)	<2	47	0 (8)
Phenol (total)	<2	760	0 (8)
Polychlorinated Biphenyls (PCBs)	<0.12824	2.0	0 (4)

Table notes: ¹ C4SL; ² GAC for Inorganic Mercury used.

As shown in Table 4, none of the determinands of concern exceed the GAC for the POSpark scenario, with the exception of the presence of asbestos in one of the samples (i.e. sample 'S1 D 1.00' taken from near the boating jetty in the south basin). Additional asbestos quantification testing was undertaken on this sample to allow further characterisation.

Asbestos is present in this sample in the form of chrysotile free fibres at a concentration of 0.006%. The primary exposure pathway for asbestos is considered to be the inhalation of airborne fibres; note chrysotile is insoluble. Due to the presence of asbestos as free fibres, it is considered likely that the material will be deemed unsuitable for reuse (by regulators) within new surface (i.e. within the top 600 mm) areas of soft landscaping. However, following liaisons and agreement with the key Regulators and Stanley Park stakeholders (who may require further risk assessments), it may be possible to conclude that the soil is suitable for reuse at depth (i.e. > 600 mm) as general fill below suitable clean cover material within areas of soft landscaping and the re-use options developed allow for this requirement.

An asbestos management plan may also need for future works to be undertaken, in accordance with the Control of Asbestos Regulations 2012.

3.3.2 Controlled Waters Risk Assessment Screening

In order to assist in the indicative determination of risks to controlled waters, soil leachate preparation and testing has been carried out on the eight samples collected for the reuse assessment.

The recorded leachate concentrations have been compared to the Environmental Quality Standards (EQS) for freshwaters (Table 5).

Table 5: Comparison of Soil Leachate Concentrations with Target Concentrations (Freshwater EQS)

Determinand	Maximum concentration recorded (mg/l)	Freshwater EQS (mg/l)	Exceedances
Nickel	0.002	0.004	0 (8)
Chromium	0.001	0.0047	0 (8)
Cadmium	<0.0001	0.00009 ¹	8 (8) – due to LOD
Copper	0.03	0.001	2 (8)
Lead	0.012	0.0012	2 (8)
Zinc	0.024	0.0123 ²	2 (8)
Arsenic	0.029	0.05	0 (8)
Mercury	<0.0001	0.00007 ³	8 (8) – due to LOD
Selenium	<0.001	-	-
Cyanide (Free)	0.02	0.001	8 (8) – 7 due to LOD

Table notes: 1 EQS for waters with 51 mg to 100 mg of calcium carbonate per litre of water

2 Annual average EQS value plus ambient background concentrations.

3 MAC-EQS value used in absence of Annual Average EQS value

As shown in Table 5, six determinands appear to exceed the relevant freshwater EQS standards. However, the laboratory limit of detection (LOD) is higher than the relevant EQS for all mercury and cadmium samples and seven of the cyanide samples. Where concentrations of a determinand are lower than the LOD of the laboratory, the result is given as the LOD and therefore, where the LOD is higher than the relevant freshwater EQS, this may cause an apparent exceedance of the EQS that has not been confirmed.

The lowest LODs for mercury and cadmium that are achievable by the testing laboratory, whilst maintaining full UKAS accreditation methods, are marginally greater than the freshwater EQS. Environmental threshold screening analyses often assume a less than value (<) to be 50% or 30% of the LOD. If such an approach were adopted then all mercury and cadmium results would be below EQS. Review of the soil samples finds all results to be below the limit of detection and it is considered unlikely that there is a source of mercury or cadmium present.

There are occasional exceedances of the EQS for copper, lead and zinc (as detailed below), however, the published freshwater EQS are very conservative as they are based on the bioavailable fraction of the heavy metals in the water column, not the dissolved fraction of metal as measured by soil leachate tests.

Copper exceeds the EQS in two of the samples ('S2 D1.00' and 'S3 D 1.00') at a maximum concentration of 0.03 mg/l. The recorded copper concentrations in the corresponding soil samples are 133.3 mg/kg and 272.7 mg/kg respectively, which are not considered to be elevated. Approximations of the corresponding bioavailable copper concentration in water may be made (using indicative values for water pH, Ca concentration etc.) however this was not deemed necessary following review of the concentrations in soils. It is considered unlikely that there is a source of copper contamination present at the site that would pose a risk to controlled waters.

Lead also exceeds the relevant EQS in the same two samples at a maximum concentration of 0.012 mg/l. In the corresponding soil samples, the lead concentration was recorded at a maximum concentration of 179.1 mg/kg which is not considered to be significantly elevated. Approximations of the corresponding bioavailable lead concentration in water may be made (using indicative values for water pH, Ca concentration etc.) however this was not deemed necessary following review of the concentrations in soils. Therefore, it is unlikely that there is a source of lead contamination present at the site that will pose a risk to controlled waters.

Zinc exceeds the relevant EQS in the same two samples as the copper and lead exceedances were recorded, at a maximum concentration of 0.024 mg/l. Within the corresponding soil samples, the maximum recorded concentration of zinc is 304.7 mg/kg (Sample 'S3 D 1.00'). These concentrations are not considered to be elevated. Approximations of the corresponding bioavailable zinc concentration in water may be made (using indicative values for water pH, Ca concentration etc.) however this was not deemed necessary following review of the concentrations in soils. Therefore, it is unlikely that there is a source of zinc contamination present that will pose a risk to controlled waters.

One of the samples exceeds the relevant EQS for cyanide at a concentration equal to the LOD i.e. 0.02 mg/l; all other samples were <LOD. However, as the soil samples all recorded levels of cyanide below the limit of detection (and there is no suspected source of cyanide associated with the lake or catchment), it is considered unlikely that there is a source of cyanide contamination present. Therefore, there is unlikely to be a risk to controlled waters from cyanide.

Based on the above indicative assessment, it is considered unlikely that the silts pose an unacceptable risk to controlled waters if re-used in the manner and locations proposed (Section 3.4). It is noted that the leachate testing has only analysed for a range of common heavy metals and cyanide and has not assessed the potential leaching of organic material in general (e.g BOD, dissolved organic carbon), organic contaminants such as total petroleum hydrocarbon (TPH), and Polycyclic aromatic hydrocarbons (PAHs) and contaminants such as ammonia. Potential short term effects on dissolved oxygen and ammonia concentrations are discussed in Section 3.5. and would be managed via deployment of best practice techniques during dredging works.

3.3.3 Phytotoxicity Assessment

As the limits given in the Sludge (use in agriculture) Regulations 1989 vary according to the pH, the highest values were used as the silt pH were all >7.0.

Table 6: Comparison of Potentially Phytotoxic Determinands with SUIAR Limit Values

	Determinand Concentrations (mg/kg)		
	Copper	Nickel	Zinc
Threshold¹	200	110	450
S1 D 1.00	85.7	29.5	162.6
S2 D 1.00	133.3	39.9	210.5
S3 D 1.00	272.7	54.9	304.7
S4 D 1.20	219.8	43	269
S5 D 1.00	92.5	35.1	149
S6 D 1.00	194.7	38.8	250
S7 D 0.70	100.6	32	164.1
S8 D 0.50	152	28.4	298.4

Table notes: Thresholds selected from Sludge (Use in Agriculture) Regulations 1989 where pH of soil is >7.

As shown in Table 6 above, six of the eight samples meet all of the thresholds with respect to phytotoxic determinands, however, there are two samples S3 D 1.00' and 'S4 D 1.20' where the copper concentrations exceed the relevant limits given in the SUIAR 1989. These are considered modest exceedances and concentrations are still considered to be low and unlikely to be phytotoxic.

3.3.4 Waste classifications

All samples have been assessed as belonging to the '17 05 Soil' List of waste code group in accordance with technical guidance document WM3 *Guidance on the classification and assessment of waste v1.1* (WM3, 2018³).

The HazWasteOnline output sheet for each of the samples, with the exception of sample 'S8 D 0.50', gives an initial waste classification (on an "as received" basis) of non-hazardous waste. Sample 8 ('S8 D 0.50') narrowly exceeded the TPH threshold for hazardous based on the as received sample.

³ WM3 (2018) *Guidance on the classification and assessment of waste v1.1*. Published jointly by Natural Resources Wales / Cyfoeth Naturiol Cymru, the Scottish Environment Protection Agency, the Environment Agency and the Northern Ireland Environment Agency.

Following correction for moisture content all samples including S8 are classified as non-hazardous waste. All HazWasteOnline output sheets are presented in Appendix VIII.

The re-use options proposed under D1 and T5 exemptions, discussed below (Section 3.4), are based on a non-hazardous classification for all samples. However given in-situ consolidation/drying of silts associated with some options, consultations with the key regulators will be necessary to confirm acceptability of specific methods. Should regulators interpret sample 8 results as hazardous, these silts would likely require further characterisation (to have confidence in location and extent of TPH 'hot spots' and this material would be incorporated into the Materials Management Plan re-use route (required for Golf course depressions).

3.3.5 Asbestos waste classification

Asbestos was detected in sample 'S1 D 1.00' in the form of chrysotile free fibres. Subsequent quantification found the concentration of asbestos to be 0.006%. The WM3 guidance defines the threshold for hazardous waste as 0.1% (WM3, 2018³) or if identifiable pieces of asbestos are visible to the naked eye.

As the asbestos present is at a concentration below the hazardous threshold of 0.1 % and was not visible to the naked eye, the material is considered to be non-hazardous with respect to asbestos.

3.3.6 List of Waste Code

Based on the results of the analyses, and the assessment described above (further details provided in Appendix VIII), the predicted List of Waste (LoW) code for all samples is considered to be **'17 05 06 Dredging spoil other than those mentioned in 17 05 05'**, i.e. non-hazardous waste.

3.3.7 Waste Acceptance Criteria

Materials classified as non-hazardous could be disposed of at a non-hazardous waste facility or at an inert landfill subject to meeting inert waste acceptance criteria (WAC) thresholds. No WAC testing has been carried out on these samples to date. Note that given the results of the chemical characterisations, the development of realistic re-use options 'on-site' and the considerable volume of silts present, disposal to landfill options have not been developed; such options would also be prohibitively expensive.

3.3.8 Chemistry conclusions

Analysis and assessment of the Stanley Park silt samples indicated that in general the concentrations of contaminants in the silts are low and are all below relevant POS (park) human health GAC, indicating that the silts are suitable for use from a human health risk point of view. However, one of the samples was found to contain very low concentrations (0.006%) of chrysotile asbestos. It is, therefore, considered that the material represented by this sample will not be suitable for reuse in any areas / locations where it will be placed within 600 mm of the surface. It is recommended that key Regulators and Stakeholders are consulted to confirm an appropriate strategy for those silts containing asbestos, including any requirements for additional sampling to further determine the presence / absence and locations of asbestos.

Based on the assessments carried out, it is considered that the silts are unlikely to pose an unacceptable risk to controlled waters if re-used in the manner and locations proposed.

The phytotoxicity assessment indicates that the silts are unlikely to pose a significant risk of phytotoxic effects due to potentially phytotoxic heavy metals. Two of the samples did have slightly elevated concentrations of copper but the concentrations are still considered to be low and unlikely to be phytotoxic.

The indicative LoW code for the samples is considered to be '17 05 06 Dredging spoil other than those mentioned in 17 05 05', i.e. non-hazardous waste.

3.4 De-silting methodologies

The bathymetric survey (Section 0) defined the overall volume of silt and the average depths of silt in each basin. The following volumes have been calculated using this information:

North Basin: $34,028\text{m}^2$ area x 0.24m average depth = $8,166.7\text{m}^3$ silt (wet) = $5,390\text{m}^3$ silt (dry)

South Basin: $50,881\text{m}^2$ area x 0.14m average depth = $7,123.3\text{m}^3$ silt (wet) = $4,701\text{m}^3$ silt (dry)

As a general rule of thumb, we expect the silt to reduce by 1/3 as it de-waters. This is quite a conservative estimate in that the reduction is usually greater, but using this assumption, there is a total of $15,290\text{m}^3$ of wet silt or $10,091\text{m}^3$ dry silt that would have to be removed to completely empty the lake of silt. There has not been a specific target depth(s) requested and the total figure is therefore treated as a conservative upper limit. Identification of receptors that can accommodate this volume will more than cover the likely amount that will be removed (recognizing also that 100% removal rate is not normally realistic).

In terms of spatial distribution of sediment, there are ~1m pockets of silt to be found in the south-west section of the south basin and along the east bank of the north basin (Figure 8).

Given volumes, data analyses, site specific considerations and via application of professional judgement, several feasible options have been identified for retaining the silt on-site (within Stanley Park) and, where possible, within the footprint of the lake. Options to retain silt are considered preferable in this case – the classification results do not preclude the re-use of silts in this way and such options would avoid extensive costs associated with transportation and disposal (including landfill permitting costs). The identified disposal options are discussed within this report section.

Due to potential lack of practical connectivity between the two basins (low bridges and management considerations i.e. floating barriers between the basins) and the environmental considerations (Section 3.5), the bankside receptors are treated as being limited to receiving silt only from the basin where they are located.

It is important to remember that calculations have been made using estimations of depth and employing satellite imagery, so there will be margin for error; retention volumes are to be treated as estimations.

Specific desilting methodologies associated with the outline options (below) are set out in Appendix VII.

3.4.1 North Basin – East Bank Nicospan

On the East bank of the north basin, we recommend that three half-circle nicospan revetments (Figure 9) are created and back-filled using silt. The banks will also be topped up in this way. In the conservation area a similar revetment could be installed to house the silt there. The total area of these areas would be approximately 2,782m² and these would be filled to an approximate average depth of 0.6m (some areas greater). Once this is backfilled, wetland plugs (native marginal macrophyte species) and/or coir can be used to create large riparian habitat areas. This solution would retain the silt in the footprint of the lake, saving on transport costs, while improving the abundance and diversity of marginal plant species/habitat in the lake. This disposal solution would create habitat improvements that are complementary to the existing management of the north basin.

This on site ‘receptor’ solution would provide a total of 1,669m³ silt retention volume. The nicospan areas could be altered to accommodate more or less silt. It would be at the council’s (and other park stakeholders) discretion as to the amount of water area they would be prepared to lose, although it is suggested that this proposed solution would enhance rather than detract from the existing amenity function of the lake. In the suggested example, the revetments extend approximately 10m into the lake at their widest points. Associated method statements and costs are provided as Appendix VII.



Figure 9: L-Indicative locations of Nicospan ‘half-moons’ (yellow in north basin; pink in the conservation area); R-photograph of current condition.

3.4.2 North Basin – West Bank spot top-up

There are sections of the west bank which are low-lying or eroded (e.g. Figure 10). These areas could be used as bankside receptor areas for de-silted materials, via simple excavator deposit. It would not be possible to deposit a significant volume of silts in this way (limited by relatively small areas), however it would be of aesthetic benefit to build up the banks in these places.

We estimate that ~50m³ of silt could be retained in this way.

It is noted that much of the erosion on the west bank will have been caused by extensive footfall and if specific margin locations are to be retained for access on foot (silt deposits would have to be at least in the short-term fenced off) then it may be preferable to install a cellular grid paver system in these areas (reseeded with native coarse grasses). Should such a system be installed the potential to incorporate dredged silts would be much reduced. Desilting method statements and costs are provided as Appendix VII.



Figure 10: North basin west bank margin erosion.

3.4.3 South Basin – Island (informal)

It is recommended that the island in the center of the south basin is built up as a means of 1) re-accommodating silt in the footprint of the lake, and 2) achieving island margin repairs.

It is suggested that silt can be pushed to the island and an excavator can create a new shape, which can then be planted and/or covered in coir. This would allow the silt to stay within the footprint of the lake and reduce transport costs, while improving the aesthetic and ecological value of the island. We recommend an area of 1,215m² is built up on the island, with average depth of 0.5m throughout the area. When a future planting scheme is developed, consideration should be made to discourage the use of the island by waterfowl (for the wider benefit of water quality); this could be achieved by planting a fringe of emergent reed species for example or alternatively by installing simple waterfowl fencing (e.g. low level wire fencing).

We estimate that 605.7m³ of silt could be retained in this way. The final size of island could be altered to accommodate more or less silt, dependent on the council's (and other park stakeholders) discretion.



Figure 11 Satellite imagery of the south basin island and the approximate size it would increase to (Pink)(left) and picture of the current state of the island (right).

3.4.4 South Basin – Island (Formal)

A hard-engineered solution for the island improvement is to create a formal island edge using plastic piling. An example of this is seen in Figure 12. Advantages of this approach would be a more stable island structure which could be capped with brushwood faggots for a natural finish and/or baffles for boats. It would also be easier to plant and fence off sections of the island after the material has been allowed to dry. There would also be an increased depth of the water immediately surrounding the island compared to the informal option. However, this would inevitably be a more expensive solution and it is likely that contractors would need to test how receptive the bed is to wooden post-driving before confirming this as an option.

We estimate that roughly the same amount of silt can be retained in this way as in the informal option.



Figure 12 Satellite imagery of the south basin island and the approximate size it would increase to (Pink) (left) and picture of a recent example of a post-piled island from Ebsford's Poole Park Project (right).

It is assumed that the options of repair, modification and expansion to the existing island would be preferable to any proposal for an entirely new island, from an aesthetic continuity point of view i.e. keeping as close to the original lake aesthetic as possible.

3.4.5 South Basin – Mooring in-fill

There is a second island that has been constructed formally on the northern boundary of the southern basin, which presents an opportunity for a revetment area. This island is connected to the bank via a dis-used leisure boat mooring area, and the bank also dips into a natural depression/crater. This area encompassing island, mooring area and dipped bank ($1,440\text{m}^2$) could be infilled to reconnect the island to the bank and build up the bankside. A Nicospan barrier may not be an option in this location if the stone apron that lines the bank in large parts of the south basin extends across this area, however it may be possible to build up the area informally, if the stone coping and rotting wooden revetments and fences are removed. An estimated average depth of 0.5m would be deposited here. It is recommended that a D1 waste exemption is registered for this option as it would include bankside spreading.

We estimate that 720m^3 of silt could be retained using this method.

It would be possible to extend the island westward to increase the potential volume of this option, however this would be at the discretion of the council (and other park stakeholders) who may want to retain some of the 'boatyard' area.



Figure 13: Satellite imagery of the location of the boat infill (pink) (left) and the current state of the boat infill area (right).

3.4.6 South Basin – Parkland spread

There is an area of open parkland adjacent to the south basin (with clear road access) that could be used to retain silts. The 'field' is not currently used for a specific amenity use and could be easily scraped to create bunds within which 0.3m depth of silt could be spread. The field is 5,321m² in area and is approximately level, lending itself to this purpose. The silt would initially be dried but then could be blended with sub-soil, capped with top soil and reseeded with amenity grass mix to create a raised grass lawn. Alternatively, the material could be re-capped with subsoil and planted with a native wildflower mix to create a biodiversity increasing wildflower meadow.

This option would require a T5 waste exemption. Even though the field is located in very close proximity, this option would involve increased costs associated with transporting the silt outside the footprint of the lake.

It is estimated that 1,596m³ silt could be retained using this method.



Figure 14 Location of the field relative to the south basin (left) and the current state of the field (right).

3.4.7 North & South Basins – Golf course depressions

There are large depressions or hollows on the golf course that sits to the north west of the lake (council golf course within the boundaries of Stanley Park) that could be used to accommodate large volumes of silt. These areas are currently redundant i.e. they are largely unusable relative to the immediate surrounds and therefore would benefit from landscaping.

The hollows would need to be prepared by creating bunds at the opening of each (to ensure no runoff) then the material could be tipped into the recesses from upslope.

This option would require access agreements with the golf club and significant ground protection to ensure limited damage is done to fairways.

We estimate that a total of 8,000m³ can be retained using this method.

This re-use option is unlikely to qualify for a waste exemption (e.g. the operation will involve more than one plant movement and not qualify for a D1 exemption). It is recommended that the Environment Agency and Local Authority planning and contaminated land officers are consulted to discuss the necessary licensing requirements. On account of the low contamination status of the materials, it may be possible to indirectly deposit the dredgings under exemption (e.g. T5), for example if the finished landscape were developed as a wildflower meadow. This finish could be achieved by covering the dredgings with lower nutrient subsoils (constituting blending) and sowing with wildflower mix. It is recommended that stakeholders and regulators are consulted in order to finalise an appropriate strategy for this receptor site. It is not possible to confirm precisely what would be acceptable to the regulators, as to a certain extent determinations rely on pragmatic decision making.

Should re-use/disposal under a waste exemption not be appropriate, then given the chemical characterisations and waste classifications that have been conducted, it is suggested that works could be completed under an agreed Materials Management Plan (MMP). Both options provide opportunity to deposit the asbestos containing silts at >0.6m depth.

Any requirement for further asbestos (or TPH) characterisation or other validation testing (in support of for example a MMP) would need to be confirmed via consultations with the Environment Agency and Local Authority planning and contaminated land officers. Given the volume of silts proposed to be removed, they are likely to require additional characterization/validation testing.



Figure 15 Photographs of the two golf course recesses/depressions (top) and their locations relative to the lake (bottom).

3.4.8 Summary of options

Table 7 provides a summary of the potential receptor sites discussed above for the Stanley Park silts.

Table 7: Summary of potential receptor site volumes

		South Basin	North Basin
Total silt volume (m3)		4,701	5,390
Receptor	Field (m3)	1,596	0
	Holes (m3)	4,141	4,141
	Boat infill (m3)	720	0
	Nicospan (m3)	0	1,669
	Island – Both options (m3)	608	0
	Bankside top up (m3)		50
	Cut/Fill (m3)	-2,364	-470

The recommended combination of receptors within the footprint of the lake are the Nicospan half-moons (north basin), informally building up the island and infilling the old boatyard (south basin). As a result, there would be a total of 7,094m³ remaining to accommodate outside the footprint of the lake – which could all be deposited in the depressions on the golf course (8,282m³ total capacity). Spreading to the field could accommodate a significant amount of silt (1,596m³), however this is anticipated to be a less palatable option for a public open space (visually in the short term) given the potential for alternatives. The informal island is presented as the initial preference due to the cost differential although the formal option may be slightly preferable for future water sports considerations.

The appropriate size of some receptor areas has been estimated given our understanding of the site. The proposed size of the island receptor area is reasonably modest in order to not impede on the open water landscape character of the lake. If the council/park stakeholders wish to increase the size of the in-lake receptors then less material would have to be deposited to the golf course, meaning less disruption, cost, reinstatement etc.



Figure 16 Overview site plan and legend.

Figure 16 provides an overview site plan which includes consideration for necessary working areas e.g. laydown areas. Appendix VII provides method descriptions (that correspond to Figure 16) associated with each of the receptor options providing a full description of the anticipated works required for each option and the indicative costs. These method statements could - in a redacted/ summary form that does not preclude or disadvantage members of the current project team from bidding for works – be used to define the scope of works for the de-silting project phase.

3.5 Environmental mitigation during dredging

The north island is a Biological Heritage Site (Lancashire County Heritage Site Ref 33NW02) on account of an active Heronry (Grey Herons). It is advised that Blackpool Council biodiversity officers are consulted to arrange in-lake works within the north basin to avoid the heronry nesting period (assumed mid-February to mid-April). De-silting operations would not be expected to have direct adverse effect on the heronry but increased activities have the potential for disturbance. (Tree preparation works have not been proposed on the island.)

The range of silts re-use options do not necessitate drawdown or draining of the lake (and drying the silts in-situ), which is generally considered preferable to minimise disturbance to the amenity use of the park (including angling) and any adverse effects on the ecology of the lake (avoiding loss of benthic invertebrate and fish communities).

The proposed de-silting methods have the potential to adversely affect water quality conditions during works (temporary effect). Temporary deterioration in water quality could affect fish populations.

Fish removal prior to works has been considered, however, this should be avoided where possible and the large surface area of the lake makes this approach problematic. However, the size of the lake and the presence of two discrete basins allow fish the opportunity to take refuge away from the current area of operation. It is therefore recommended that only one area of the lake is worked on at any one time. Silt curtains are sometimes deployed as mitigation against water quality effects, however given the size of the lake, silt curtain deployment around dredging works would be problematic and installation between the basins would cause a barrier to fish movement.

In-situ monitoring of water quality should be undertaken during works, which should focus principally on unionised ammonia (UIA) and dissolved oxygen (DO) concentrations. Temporary elevations of suspended sediment concentration are anticipated, however this is not of principal concern in itself (and is difficult to measure *in-situ*); it is the indirect water quality effects of sediment disturbance, including those on DO and UIA which should be the focus of monitoring effort. Monitoring thresholds (Table 8) should be put in place to protect fish populations / confirm that refuge areas remain acceptable.

Table 8: Suggested thresholds for dissolved oxygen and unionised ammonia monitoring

	One hour	Six hour	24 hours
Dissolved oxygen (mg/l)	3.5	4.5	5.0
Unionised ammonia (mg/l as NH₃-N)	0.175	0.1	0.040

Table notes: Standards based on the UPM fundamental intermittent standards⁴ (one month return period).

Ammonia readings should be taken *in-situ* (using a field test kit) and a physico-chemical multi-parameter probe (including DO in mg/l and % saturation and temperature) deployed from a boat. It is recommended that readings (DO and ammonia) are collected prior to works, then DO readings are taken and recorded each day of dredging operations (three times per day) at a point within the immediate sediment 'cloud' (close to excavations), at a point 30m away from works and also at a point at distance from works in the other basin (representing full refuge area). Equivalent UIA readings are recommended once per day.

Should concentrations drop below the 'one hour' threshold (Table 8) at 30m away from works then monitoring for struggling fish should be put in place. Should evidence of struggling fish be identified, or concentrations at the full refuge area drop below the 'one hour' threshold then all operations should be stopped and conditions allowed to recover and/or mitigation measures put in place. Mitigation measures could include deployment of a surface aerator or dosing with Hydrogen Peroxide (under permit). It would also be appropriate to consider where fish could be moved to if an emergency fish rescue were required (noting that FR2 permissions and fish health checks would be required). No further consideration of fish rescue logistics is undertaken in this report.

⁴

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291496/LIT_7373_b2855a.pdf

It is preferable that schemes ensure that first stage reactive mitigation (usually surface aerators) are on-site to allow rapid deployment; some schemes only arrange such measures when these are a confirmed requirement but this risks effects on ecology and project schedules. Undertaking de-silting works in the late autumn and winter period, when water temperatures are low (and therefore have maximum potential for oxygen saturation) does mitigate to some degree against potential effects. Appendix IX provides indicative prices for hire of a float-mounted 11kW spiral aerator and generator. Particular care should be taken when working in the vicinity of the lake outlet to minimise discharge of waters off-site with elevated suspended sediment concentrations (particularly given the hydraulic connectivity, albeit at distance, with Marton Mere). A silt curtain or semi-permeable membrane could be installed across outlet screens as mitigation if required.

It is recommended that an Ecological Clerk of Works (ECoW) is employed for the duration of the de-silting works to oversee methods, conduct monitoring works (including water quality monitoring) and ensure all elements of the Environmental Management and Monitoring Plan (EMMP) are adhered to. ECoW daily rates tend to be in the region of £400/day.

3.6 Management recommendations

The council does not employ any routine management actions for the Stanley Park lake. Management is generally limited to reactive measures when summer weed growth is excessive e.g. raking and weed cutting. Bankside tree branches were cut approximately 2 years ago, with the exception of the 'conservation area', which is notably more overgrown with overhanging branches and marginal large woody debris.

Excessive in-lake macrophyte growth will be driven by nutrient enriched water quality conditions. The limiting nutrient in most freshwater systems is generally phosphorus. The initial step in the long-term nutrient management of the lake will be removal of the existing sediments, which will be acting as a nutrient store and an annual source of nutrient release (recycling during periods of macrophyte growth and dieback for example).

The sediment volumes estimated by the current bathymetry survey have been compared with those volumes predicted by previous studies, undertaken in 1999 (Casella, 1999⁵). The estimates are very similar which suggests that the rate of sediment deposition, associated with the current operation at least, is minimal. The principal inflows would be expected to be reasonably low in sediment load and the primary source of current sediments will likely be organic matter such as leaf litter.

Management recommendations presented here focus on minimization of future sedimentation and nutrient inputs:

- General management recommendation: The trees in the conservation area would benefit from some management work to open up margins to at least dappled shade. However it is recommended that the heronry island is left in its current state to

⁵ Casella (1999). Stanley Park Lake Sediment Study for Blackpool Borough Council, Ref: DUL4499/V1/MH/PV/05-00.

minimize any disruption to this LNR. It is recommended that tree work is undertaken on the larger perimeter trees (on the lake margins):

- Remove larger branches that are overshadowing the water and the margins;
 - Although the overhanging branches give a somewhat gloomy and overgrown appearance to the conservation area, they are not necessarily having a deleterious affect on the water quality or aquatic communities. However, less intense shade would likely benefit the diversity of marginal macrophyte species in this area. It is recommended that a modest program of branch removal is commissioned i.e. not all branches are removed.
 - It is recommended that the multiple submerged dead branches and tree trunks are removed to minimize oxygen demand. The larger trunks could be retained near the footpath for invertebrate habitat.
- General management recommendation: Linked to the above, there may be potential for some planting of emergent aquatic plants, to facilitate shading or fish refuge in the conservation area, e.g. Amphibious Bistort (*Persicaria amphibia*) or a native waterlily such as the Common White Lily (*Nymphaea Alba*). Note however that all Lilies can spread prolifically and are not recommended initially.
 - Macrophyte control– Prolific macrophyte growth is a characteristic feature of Stanley Park lake in summer months. The proliferations are a combination of duckweeds (particularly prolific in the north, which is likely on account of wind blown accumulations), Water Ferns (*Azolla* genus), unconfirmed submerged pondweeds (possibly of the *Hydrilla* genus) and also filamentous algae (deriving at least initially from the bed).

Measures to prevent proliferation of macrophytes should focus on minimising nutrient inputs (or maximizing water movement and throughput, which is not possible at Stanley Park lake). These are better than reactive measures given potential for rapid proliferation and recurrence. Chemical treatment (herbicides) can be an effective reactive control (for duckweed in particular) but are not generally preferable, particularly in public water features, plus products often need to be applied multiple times and every year if the underlying problem is not addressed. Physical removal of duckweed - raking, netting or skimming – is relatively simple especially when assisted by wind, but this also needs to be repeated frequently. Physical removal of other macrophytes is possible through weed cutting and ripping, but does not address the underlying issues. Any removed material should be disposed of to composting facilities away from the lake. It should not be allowed to break down and rot on the bankings as this would cause nutrient recycling to the lake.

- Sediment control – A leaf litter management programme should be put in place. Leaf litter in established park lakes can contribute considerable nutrient and potential silt materials. Monitoring of wind blown leaf litter should be monitored in the autumn with measures put in place to collect leaves. All removed leaves should be disposed of to composting facilities away from the lake i.e. they should not be allowed to break down and rot on the bankings (and thus allowing nutrients to enter the lake). If hotspots for leaf collection are identified then leaf barriers (e.g. low lying hedge barriers) could be installed to assist leaf collection.
- Water quality inflows – The principal lake inflows derive from land drainage associated with the adjacent golf course. It is likely (assumed) that these sources are nutrient enriched (given maintenance as rich grasslands, application of fertilisers).

The potential for installation of a borehole, to provide a low nutrient water supply, was discounted at the inception meeting.

The two principal inflow input to the lake at the same location (north end) and the existing structure of the channels i.e. discrete, fixed channels (Figure 17) provides opportunity for nutrient capture. These channels could be filled with a matrix (allowing percolation/throughput of water) of a phosphorus removal medium.

- 'Chemical filter medium' materials are generally derived from blast furnace slag (or other similar materials such as argon oxygen decarburization slags, electric arc slags etc.). The use of these materials, although known to be effective, often have waste disposal implications when it is time to remove and replace and the specific P removal rate would need to be monitored.
- A 'Biological filter medium' i.e. a reedbed, would likely be simpler and more appropriate given the locality. Two reedbeds could be installed within the inflow channels and reeds harvested annually (thus creating an annual net removal of nutrient). The rate of P removal may not be as great as a chemical filter but this option would be complementary to the conservation area and could be promoted with information boards etc.



Figure 17 Principal inflow channels

- It is recommended that a programme of annual water quality monitoring is initiated and maintained in Stanley Park lake, in order to inform future management and track the success of any interventions. The suite of monitoring should focus at least on nutrient species and should include low level phosphorus analyses. Ideally a baseline of phosphorus concentrations would be collected prior to dredging works and other nutrient management actions suggested here. Phosphorus exhibits an annual concentration curve i.e. it has an annual cycle of concentration that is specific to each waterbody – dependent on characteristics of recycling and plant uptake. Therefore, monthly nutrient samples are recommended (at least in the first instance) to characterize this cycle.

3.7 Summary next steps

The physical and chemical surveys have determined the volume and the indicative characterisation of the silts in Stanley Park lake. Based on these results suggested de-silting methods and associated costs have been developed.

The next steps are consultations that should be undertaken by Blackpool BC. Consultations should be undertaken with any park stakeholders e.g. friends groups, to ensure information sharing and buy-in. Then consultation with key Regulators is essential, in order to agree and define the licensing and regulatory requirements. This report defines the re-use options as far as is reasonable prior to consultation confirmations.

The results of this report and the proposed routes for re-use require detailed discussions with key regulators; the Local Authority (planning and contaminated land officers) and the Environment Agency. They will be able to define the requirements for:

- Any planning permission requirements;
- Confirmation of re-use routes and acceptability of proposed exemptions.
- Specific requirements under a materials management plan (MMP) approach
 - E.g. requirement for a Design Statement or Remediation strategy
 - E.g. requirement for a re-use risk assessment (beyond the current report)
 - Requirements of MMP under the DowCoP i.e. prior to submission to CL:AIRE.
- Any further silt sampling and characterisation required – given the current indicative results and the known volumes of silt;
 - Any further detailed quantitative risk assessment (DQRA) for asbestos;
 - Details of any validation testing required as part of the works.
- Details of a dredging plan and Construction Environmental Monitoring Plan (CEMP) beyond the method statements already generated.

3.8 Appendix I – APEM Survey Data

Accompanying this report are the following datasets provided in the following formats:

Bathymetric contour data – Provided in CAD compatible DXF format

- P00003679_St Stanley_Park_Bathymetric_Contours.dxf
- P00003679_St Stanley_Park_Bathymetric_Contours.shp

Bathymetric digital terrain model (DTM) – Provided in ASC raster format

- P00003679_St Stanley_Park_Bathymetry_DTM.asc

Hard bed contour data – Provided in CAD compatible DXF format

- P00003679_St Stanley_Park_Hard_Bed_Contours.dxf
- P00003679_St Stanley_Park_Hard_Bed_Contours.shp

Hard bed digital terrain model (DTM) – Provided in ASC raster format

- P00003679_St Stanley_Park_Hard_Bed_DTM.asc

Sediment depth contour data - Provided in CAD compatible DXF format

- P00003679_St Stanley_Park_Sediment_Depth_Contours.dxf
- P00003679_St Stanley_Park_Sediment_Depth_Contours.shp

Sediment depth model (SDM) – Provided in ASC raster format

- P00003679_St Stanley_Park_Sediment_Depth_DTM.asc

All spatial datasets are projected in the following datums:

- Horizontal datum: Ordnance Survey British National Grid (OSGB1936) based on the ETRS89 to OSTN15 transformation.
- Vertical datum: Ordnance Datum Newlyn (ODN) based on the ETRS89 to OSGM15 transformation.
- Sediment depth is presented as depth in metres (m).

3.9 Appendix II – Survey Equipment Specification

Xylem M9 specification.

Specification	Unit
Manufacturer:	Xylem Analytics
Model:	M9
Sensor type:	9 beam (x1 vertical, x8 oblique) bathymetric sensor
Sampling frequency:	x1 vertical @ 0.5MHz, x4 oblique @ 3MHz, x4 oblique @ 1MHz
Depth accuracy:	1% (depth)
Strata penetration:	10 mm
GPS options:	Leica GS16 (see spec below)

Leica GS16 specification.

Specification	Unit
Manufacturer:	Leica
Model:	GS16 (Base and Rover)
Satellite signals tracked	GPS, GLONASS, BeiDou, Galileo, QZSS, SBAS, WAAS, EGNOS, GAGAN, MSAS and L-Band
Horizontal Accuracy (achievable / expected):	8 mm / 15 - 20 mm
Vertical Accuracy (achievable / expected):	15 mm / 20 – 30 mm

3.10 Appendix III – Survey Log and Control Data

Stanley Park Lake hydrographic survey log

Date	Lake	Survey Team	Survey Start Time	Survey End Time	Weather
08/05/19	Stanley Park	██████	10:32	15:57	8/8 cloud, showers
09/05/19	Stanley Park	██████	09:50	15:47	8/8 cloud, showers
10/05/19	Stanley Park	██████	08:45	14:00	8/8 cloud
13/05/19	Stanley Park	██████	08:32	15:48	0/8 cloud, still

Stanley Park Lake control station data

Station	Date	Time	Easting	Northing	Height	1DCQ ⁶	2DCQ ⁷	GDOP ⁸	VDOP ⁹
CTRL1START	08/05/2019	09:57:33	332784.808	435915.611	9.798	0.013	0.011	2.2	1.4
CTRL2START	08/05/2019	09:58:15	332794.206	435912.301	9.751	0.008	0.006	2.1	1.4
CTRL3START	08/05/2019	10:02:39	332728.813	435822.616	10.112	0.01	0.008	1.6	1.1
CTRL4START	08/05/2019	10:03:09	332728.883	435807.871	10.097	0.009	0.007	1.6	1.1
CTRL1END	08/05/2019	15:35:01	332784.778	435915.629	9.771	0.023	0.011	9.7	5.8
CTRL2END	08/05/2019	15:34:46	332794.207	435912.283	9.774	0.014	0.008	3	1.8
CTRL3END	08/05/2019	15:33:10	332728.821	435822.627	10.095	0.01	0.006	2.2	1.3
CTRL4END	08/05/2019	15:32:43	332728.901	435807.872	10.091	0.011	0.007	1.6	1
CTRL1START	09/05/2019	09:22:38	332784.797	435915.623	9.775	0.01	0.006	1.9	1.3
CTRL2START	09/05/2019	09:23:14	332794.178	435912.269	9.762	0.009	0.006	1.8	1.2
CTRL3START	09/05/2019	09:25:02	332728.807	435822.614	10.09	0.009	0.006	1.6	1.1
CTRL4START	09/05/2019	09:25:20	332728.892	435807.876	10.094	0.015	0.01	1.6	1.1
CTRL1END	09/05/2019	14:52:56	332784.778	435915.614	9.790	0.017	0.008	3.1	1.9
CTRL2END	09/05/2019	14:53:13	332794.184	435912.309	9.773	0.021	0.01	3.2	1.9
CTRL3END	09/05/2019	14:54:55	332728.812	435822.62	10.101	0.01	0.006	1.6	1.1
CTRL4END	09/05/2019	14:55:25	332728.904	435807.889	10.089	0.01	0.005	1.5	1
CTRL1START	10/05/2019	08:55:27	332784.801	435915.634	9.6	0.018	0.01	2.5	1.7
CTRL2START	10/05/2019	08:55:43	332794.19	435912.291	9.563	0.012	0.007	2.3	1.5
CTRL3START	10/05/2019	08:57:25	332728.793	435822.612	9.888	0.017	0.011	4.2	2.5
CTRL4START	10/05/2019	08:57:50	332728.901	435807.89	9.888	0.009	0.005	2.1	1.4

⁶ 1DCQ = Vertical coordinate quality (CQ) – Indicates relative accuracy (m)

⁷ 2DCQ = Horizontal coordinate quality (CQ) – Indicates relative accuracy (m)

⁸ GDOP = Geometric dilution of precision – <3 indicates greatest robustness

⁹ VDOP = Vertical dilution of precision – <3 indicates greatest robustness

Stanley Park Lake water level data

Station	Date	Time	Easting	Northing	Height	1DCQ	2DCQ	GDOP	VDOP
WLSTART	08/05/2019	10:05:23	332784.233	435905.569	9.395	0.012	0.009	1.6	1.1
WLEND	08/05/2019	15:30:51	332784.224	435905.578	9.386	0.01	0.006	2	1.2
WLSTART	09/05/2019	09:27:12	332784.25	435905.59	9.379	0.01	0.006	2.2	1.4
WLEND	09/05/2019	14:52:35	332784.238	435905.596	9.178	0.01	0.006	1.7	1.1
WLSTART	10/05/2019	08:59:47	332784.165	435905.506	9.166	0.01	0.006	2.1	1.4

Stanley Park Lake Sediment Sampling Locations

Site	OS Eastings (m)	OS Northings (m)	National Grid Reference
Site 1	332801	435844	SD 32801 35844
Site 2	332931	435905	SD 32931 35905
Site 3	333009	435787	SD 33009 35787
Site 4	333076	435996	SD 33076 35996
Site 5	333042	436087	SD 33042 36087
Site 6	333119	436134	SD 33119 36134
Site 7	333083	436217	SD 33083 36217
Site 8	333139	436240	SD 33139 36240

3.11 Appendix IV – Site photographs

General Site Photos taken at time of bathymetry survey





Dense macrophyte growth inhibiting bathymetric survey and navigation








Annotated walkover photographs



There is a large variety of marginal bank types. Much of the southern basin margins are characterized by (L) sloping concrete marginal aprons or (R) hard edge vertical concrete margins. These provide no potential for marginal macrophytes, however this is consistent with the boating amenity use and the design period (echoes Victorian landscape amenity design focused on open water).



There are multiple locations around the perimeter, most notably in the southern basin hard margins where either (L) concrete margins have eroded/broken, or (R) sections of the perimeter with paving slabs have been vandalized. Repairs to the concrete margins (L) will be very expensive for modest visual gain, however the reinstatement of a

<p>wooden 'running board' would enhance the visual appeal and remove the H&S risk of snagging on the exposed bolts.</p>	
	
<p>'Floating reedbed' panels were originally installed alongside the dividing post and rail fence (dividing the conservation area from the rest of the north basin), however these are now scattered around the lake. Those that are serving as a barrier between the basins should be retained, with others such as that above (I) removed because they are visually unattractive.</p>	
	
<p>Minor inflow on the west bank of the north basin</p>	<p>Same inflow channel looking towards north basin</p>



View looking north from west bank of north basin. Noticeable proliferation of filamentous algae. Also notable (foreground) is where bank material has eroded from behind the timber retaining planks. This is a reasonably simple repair with potential for large positive visual improvement – recommend a cellular grid paver is installed (over a granular subbase) and reseeded with native coarse grasses. The cellular grid will help to prevent future erosion in this area of heavy footfall.

Alternatively this area could be used for a 'spot top-up' receptor area for dredged silts – assuming it were not used so heavily, going forwards, for pedestrian traffic.

Benthic weed – suspected hydrilla genus.



Proliferation of Duckweed at northern end of lake. Surface skimming/netting would be effective given the windblown collection in this area.

Confluence of the two primary inflow channels as they enter the northern end of the lake (looking towards lake).



Brick/stone lined inflow channel (east channel of the two shown confluencing above); photo taken facing north. See recommendations for environmental (water quality driven) improvement suggestions.

Inflow channel (west channel of the two shown confluencing above); photo taken facing ~west. See recommendations for environmental (water quality driven) improvement suggestions.



Access to fishing peg in southern basin (from east bank).

Covered and screened outfall.



The bankside concrete coping flags would benefit from repair in several places. Note broken flag visible on bed. Repairs are possible from the bankside i.e. would not necessitate an in-lake contractor.

Some longer sections of marginal flagging are missing. There is a mix of different materials used (including mix of different concrete flags for instance).

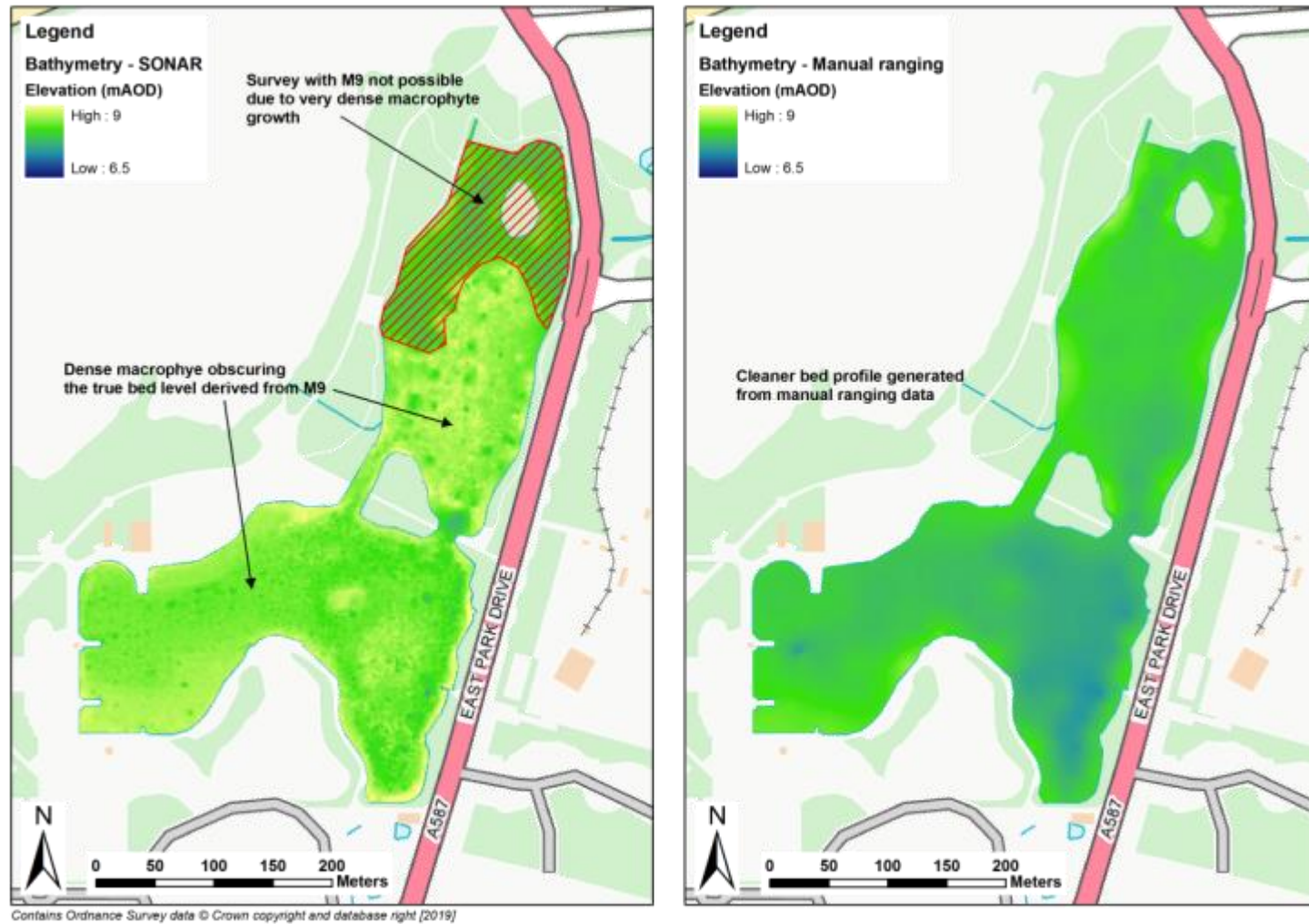


View of the in-lake wooden fence that separates the conservation area from the rest of the north basin. The fence is in poor condition in places however does serve to delineate the area of lake where fishing is prohibited and is regarded by some as a photography opportunity (roosting birds etc). Some posts may need to be removed to gain access by de-silting plant, otherwise it could be retained.

Some tree work is recommended around the margins of the conservation area to a) allow more sunlight and promote diversity of marginal species – note dominance by ivy and nettles above; and b) minimise direct leaf litter potential.

	
<p>Golf course depression (east). This current depression is not currently usable as part of the surrounding course</p>	<p>Golf course depression (west). This current depression is not currently usable as part of the surrounding course; note the club house in the background for scale.</p>

3.12 Appendix V – Data Method Comparison, SONAR vs. Manual Ranging



3.13 Appendix VI – Waste flow chart taken from CECA (2018)

3.14 Appendix VII Method Statements

All prices provided below are provided as though they are standalone projects (with the exception of option 8) including mobilization for equipment etc.

1	Description	Cost (£)	Length	Method & Summary
	Do Nothing	0	n/a	<ul style="list-style-type: none"> • Lake health would be expected to decrease with continued macrophyte proliferation etc. • Shallow waters could pose risk to human health through deep sediments and impediment to watersports
2	Build nicospan revetments on north Basin and backfill		3 weeks	<ul style="list-style-type: none"> • A grandmaster welfare unit would be delivered to the point adjacent (see site plan) to the south basin. • A laydown area and overnight compound for machinery also exists on site (see site plan). Both the welfare area and laydown compound will be secured with Heras fencing. We recommend that the pathway on the east bank of the basin be closed to the public during works, which can be sealed with heras fencing at each end. • Initial tree works would be required from the east bank to ensure that an amphibious excavator can reach the areas where posts need to be driven in. This can be done with a team of 3 workers for 1 week using hand tools (Stihl saws etc.). The brash generated from this can either be stacked on site to create habitat piles or tied in bundles to create brushwood faggots – these can be used at the end of the nicospan process. • The tree works would be required to create an entry point for large plant machinery into the north Basin as well – we would recommend as close to the tarmacked roadway as possible on the west bank but appreciate this may be subject to Tree Preservation Order (TPO) or other conservation orders on the surrounding trees. • A 13t Amphibious excavator would enter the lake at the new entry point with a post knocker attachment • A flat punt would be delivered to site to carry materials (posts, nicospan etc.) to the opposite bank. The punt would then serve as the working platform for a gang of 3 people to install the nicospan with the amphibious excavator. Each 1.65m timber post would be driven in by the machine and guided through the nicospan perforations by the site team at 0.5m intervals. A verdatec layer would also be used and each 1 in 3 posts would have a 1.65m back post to support the line of nicospan. • The nicospan would be installed at a freeboard of 50mm above the AOD of the bank. A second

			<p>amphibious excavator would be brought on site 1 week after start of works with a dredging bucket. A topscape of vegetation would be made on the soft bed of the lake and this material would be deposited on the bank separately to dry off and be disposed of off-site (to council composting facilities). Vegetation should not allowed to rot bankside (to avoid recycling of nutrients). Works should be scheduled in the winter months, following autumn macrophyte die back.</p> <ul style="list-style-type: none"> • Following the vegetation scrape the excavator would immediately begin backfilling the nicospan and bank with the surrounding silt. • One of the excavators would need to remove the wooden barrier between the heronry and rest of the basin for access to be gained for the machine to install nicospan. No provision is currently anticipated for reinstatement of this old barrier. • Once the first excavator has finished installing the nicospan, it can have its bucket changed and contribute to completing the backfilling of silt in the new receptors. At this point on amphibious excavator can also begin the process of topping up low points on the west bank. • Once the receptors have been filled, the brushwood faggots generated from the tree works can be affixed to the top of the nicospan with organic rope to create a natural finish. • We estimate approximately 280 linear m of nicospan would need to be installed to create the revetments explained above. The rate of installation is estimated at 30m/day.
3	Build up informal island in south Basin	3 weeks	<ul style="list-style-type: none"> • The welfare arrangements would be as per the above option. • A 3m silt pusher would be delivered to site on a trailer and sent into the watercourse on the concrete slipway in the south basin. • The silt pusher would use its outboard engine to travel to the island, where it would attach its winch to a well-established tree. There it would motor back out the extent of its winch, lower the front grill to the required depth, and begin pulling back to the island. This bulldozes the silt back to the winching point, where it will accumulate. • After the first week of pushing, an amphibious 13t excavator will be delivered to site and will enter the water in the same place and traverse around the east and south east circumference of the basin to the south of the island. • The excavator will create the new shape of the island and grade the surface to ensure it looks natural and can be matted. Once the shape has taken place, the excavator will then remove the underwater slumped circumference of the island and place the material on the centre. This creates a vertical bank to the island, allowing boats to travel closer without striking silt with the propeller. (This limits the extent of the shallow water surrounding the island although we can expect some more slumping as the island

			settles, however).
			<ul style="list-style-type: none"> To add a more formalised effect to the island and help with the initial establishment of vegetation (which will hold the silt together) we recommend that pre-planted coir matting is installed on the new island shape. This can be done using a team of 2 skilled operatives, who can travel with the equipment to the island in a flat punt with the coir matting. The matting would be unrolled on the new island shape and secured in place using wooden stakes. These operatives will also install anti-predation fencing to ensure these early plants are not eaten by local waterfowl.
4	Build up formal island in south Basin	3 weeks	<ul style="list-style-type: none"> The welfare arrangements would be as per the above option A 3m silt pusher, a flat punt and 13t amphibious excavator would be delivered to site and sent into the watercourse on the concrete slipway in the south basin. The silt pusher would use its outboard engine to travel to the island, where it would attach its winch to a well-established tree. There it would motor back out the extent of its winch, lower the front grill to the required depth, and begin pulling back to the island. This bulldozes the silt back to the winching point, where it will accumulate. Most of the silt will be pushed from the south west of the basin. Concurrently, the amphibious 13t excavator will begin installing the plastic piling, which will have been carried to the island on a flat punt, avoiding the south-west side where silt will be accumulating. The recommended log piles measure 1m x 0.24m and subsist of three connected cylinders through which 1.65m x 0.75m rounded timber posts can be driven to secure the piles in place. Each pile slots into the one adjacent to it. From the bathymetric data, these dimensions would be enough to secure the piles in place at this depth with a reasonable freeboard. Posts are driven into every other cylinder. The excavator will create a trench in the areas where silt has been accumulated to allow the island shape to be completed. The excavator will then change its post-knocker attachment to an excavator bucket and proceed to back fill the new formal shape with silt pushed to close proximity by the silt pusher. To add a more formalised effect to the island, and help with the initial establishment of vegetation, we recommend that pre-planted coir matting is installed. This can be done using a team of 2 skilled operatives, who can travel with the equipment to the island in a flat punt with the coir matting. The matting would be unrolled on the new island shape and secured in place using wooden stakes. These operatives will also install anti-predation fencing to ensure these early plants are not eaten by local waterfowl.
5	Infill section of boatyard and re-connect	3 weeks	<ul style="list-style-type: none"> Welfare would be as above. Heras fencing would be erected around the welfare compound and laydown area, as well as the terrestrial section of the site.

small island to bank		<ul style="list-style-type: none"> Initial tree works would be required to remove the poorly established trees from the small island. This can be done using chainsaws with the wood being placed in the local woodland in habitat piles for small mammals and invertebrates. A terrestrial 13t excavator would be delivered to site using the established access points and be delivered to the site on the north bank of the south basin. The excavator would have a breaker attachment and an excavating bucket. The first job of this excavator would be to remove the timber fencing on the bank inside the works area. This would be disposed of in a skip on site or offered to the local park officials. The stone coping on the lip of the bank would be broken out using the breaker attachment on the 13t excavator, with the waste material disposed of in a skip on site or offered to local park officials. A 3m silt pusher would be delivered to site, which would gain access to the lake and push silt to the site area much in the same way as above, although it may need to winch to one of the trees on bank side (the trees on this small island do not seem sufficiently well-established.) The terrestrial excavator would switch attachments to the excavator bucket, and begin removing the accumulated silt from the lake and casting it on to the bank side, building up the land to a predetermined spec. A 13t amphibious excavator will enter at the slip way and track to the east within the boatyard. The amphibious excavator would initially remove the wooden casing that surrounds the island to be disposed of in a skip on site. The excavator would then relocate the silt that would now have accumulated at the front of the island to fill in the recess behind the island, connecting it to the bank. The amphibious excavator would ensure that a natural shape is given to the island, which would be allowed to dry and settle before remobilising to finish the grading process and seed with an amenity grass mix.
6 Spread silt to field bund adjacent to south Basin	<div style="background-color: black; width: 100px; height: 40px; display: inline-block;"></div> 3 weeks	<ul style="list-style-type: none"> Welfare would be as per the above. Heras fencing would be required around the target field and the route selected for the dumpers to travel. tarmac road way on the south of the south basin should be closed for the duration of the works. To prepare the field bunds, a DN5 bulldozer would be delivered to site via the main access route and dropped off onto the field in question. The bulldozer would first remove the lawn, which would be set aside for once the job had been completed. The topsoil layer would be pushed into 0.5m bunds on the perimeter of the field. A pipe would be installed in the base of the bund closest to the on a downward gradient which would aim to redeliver water into the lake as the material dries. While the field is being prepared, a 3m silt pusher would be delivered and launched to the south basin

			<p>and would begin to push silt to two areas, on either side of the peninsula sticking up from the south of the basin.</p> <ul style="list-style-type: none"> Once the field preparation has been completed the dozer would be off-hired and; an 18t wheeled excavator, 2x 14t rear tipping wheeled dumpers and an 8t tracked excavator would be delivered to the field. The wheeled machinery would serve to protect the concrete path around the lake. The wheeled excavator would begin excavating silt from one of the two stockpiles in the lake, as the silt pusher continues to accumulate to the other. The excavator would deposit into the 14t dumpers, which would work in tandem delivering silt to the field bund via the tarmacked track. The 8t tracked excavator would sit inside the bund redistributing silt to ensure the field is being properly filled from the back and remove any large pieces of debris, to be disposed of in a skip on site. Once the field bund is filled to the 0.5m limit, then all the machinery can be off-hired and the silt allowed to dry for several weeks with the heras fencing around the field staying in place. Once dry, the DN5 dozer will remobilise to blend the silt with the subsoil. We recommend that the topsoil is retained at the perimeter of the field and the subsoil/silt blend is cultivated and seeded by a tractor using a native wildflower seed.
7	Infill Golf Course recesses	5 weeks	<ul style="list-style-type: none"> The welfare arrangements would be as above. Heras fencing would be erected around both golf course recesses and the course should be closed for the duration of the project. Steel trackway should be placed on areas where waterlogging is likely or where the route for any machinery crosses a golf course. Establishing tree works would be required to create two openings on the north basin where a 13t excavator could sit on bank side to extract the silt. Chainsaws and Stihl saws with a team of three would be sufficient. An entrance into the 'conservation area' at the north end of the lake, for the silt pusher would need to be established by removing the wooded barrier. This can be done by a bankside 13t machine reaching as far as possible to create a large enough gap. A DN5 dozer would be delivered to the golf course to begin preparing the recesses for depositing silt. The turf and topsoil would be removed and placed to one side until the holes are filled. The natural entrances of the recesses would be built up into bunds which would tie into the existing high sides of the recesses. The aim would be to deposit at a depth of 2m and 3.5m respectively. Tree works would be required in the largest recess which could be tackled with hand tools and a 2t tracked chipper. The removal of the silt from each lake would be as per the above methodologies; using silt pushers to accumulate silt at locations where a wheeled 13t excavator can deposit into tandem 14t rear-tipping

			<p>wheeled excavators. There would be two gangs doing this, so dredging equipment would be effectively doubled but still retaining the single 8t tracked excavator at the deposition site.</p> <ul style="list-style-type: none"> • The dumpers would have to follow carefully mapped routes to each recess to ensure minimal damage to the grass on the golf course. • When the dumpers are discharging into the recess areas, they would do so from the top of the recess, emptying down into the hole. • Once the desired amount of silt has been removed using this method, all of the machines would be off-hired and the material would be allowed to dry with the heras fencing remaining around the recesses. • After a few weeks, the excavator would return to re-distribute topsoil on to the dried silt. The turf can then be replaced on the sources of the soil, or an amenity grass seed can be used. • The contractor should ensure minimal damage to the rest of the golf course and a great deal of effort and time should be put into necessary re-instatements.
<p>8 De-silting lake with recommended options (see below)</p>		<p>9 weeks</p>	<ul style="list-style-type: none"> • Method as per individual options above.

Further buildability considerations

Susceptibility to Damage and Protective Procedures

The key asset that has potential to be damaged by these works is the lining of the Lake. Onsite investigation during the bathymetry survey found that the bed primarily consisted of gravels, so risk is far smaller than would be if the lake was clay lined. The use of floating and tracked amphibious machinery will vastly limit damage potential to any lining and the silt pushers will be set to a profile height that will be guided by the bathymetric data.

We recommend that measures are taken to mitigate adverse impact on the fish biota in Stanley Park lake during de-silting works as there is potential for dredging activities to lower the dissolved oxygen and raise suspended solids to harmful levels. Mitigation measures are described within Section 3.5 of this report.

Lifting and unloading considerations

It is important to consider early in project planning the lifting and unloading of recommended plant as these can represent construction phase constraints.

To be unloaded via articulated wagon down ramps (no lift plan required):

- 18t Wheeled excavator
- 14t rear-tipping dumpers
- 8t 360 excavator
- DN5 Dozer

To be unloaded via Hiab wagon contract lift:

- 3m silt pusher (lifted directly into water)
- 24' welfare set up (for golf course and full scope options)
- Materials for installing nicospan
- Ground guards for golf course access
- Fuel Bowser

To be brought on trailer and maneuvered into position:

- 13t Amphibious excavator
- Groundhog welfare unit (for all other individual retention options)

To be lifted into lake via Contractor's own lift plan with excavator and leg chains with banksman present:

- Flat Punt

Storage and waste management

Storage of materials should be arranged with the park authority. The most convenient place for laydown of materials is the existing laydown area for the park marked in blue on Figure 16. This compound can be secured relatively easily to allow storage of materials and machinery overnight.

In terms of waste management, skips should be brought on site to take debris and waste generated from de-silting and general works (excluding silts). Wooden waste derived from tree works can be recycled on site in brushwood faggots or habitat piles, both of which infer a benefit to the local biodiversity. Alternatively, wood skips can be brought on site to remove wood waste. It is assumed the

council will have existing recycling routes (e.g. composting, biofuels recycling) for biodegradable materials.

Services potential

No overhead services were identified on site and there are no underground service maps to reference for the site. There are no excavations planned as part of the suggested methods, other than scraping topsoil surfaces in some receptor areas. There is a risk of disturbing (shallow) field drainage systems here, so maps of field drains would be useful in mitigating that risk.

There are some instances of concrete pipes culverting water from the golf course into the north basin. There may have to be plate bearing tests on these to ensure that heavy plant can cross safely. Some of them do lie on the recommended access route for 14t dumpers. The council would be expected to supply all available service details to the contractor, including pipe crossing points, at works ITT phase so precautions can be planned (e.g. laying bog-mats to disperse ground pressure over crossing points and provision of warning trip hazard signs).

Health and safety hazards

The most significant health and safety hazards that the future contractor should provision for are:

- Working around water;
- Working around plant machinery;
- Leptospirosis and Lyme's Disease; and
- Public Interface.

The contractor must be asked to provide a full working around water policy with the correct PPE for working in this environment as well as experience of providing toolbox talks on site during works. These measures should also be taken in regard to working around plant machinery, with machine operatives asked to present their certifications to site management in advance of works to prove competence. Operatives should be issued with Leptospirosis and Lyme's Disease information cards and toolbox talks should be given on site to raise awareness of waterborne diseases. The public and plant interface must also be carefully managed, and segregated zones must be put in place with appropriate signage in advance of and during works all around the park site. In cases where long dumper routes occupy the paths of the park and that area cannot/will not be closed, crossing points should be set up with marshals to allow access for the public.

In all cases the contractor should be asked to provide a RAMS package including their assessment and mitigation of these risks, for approval in advance of works commencing.

3.15 Appendix VIII Laboratory test reports

3.1 Appendix IX Indicative aerator hire prices

Prices are presented here for information purposes, based on recent equivalent equipment quotes and hire period rates for at least 5 weeks. It is assumed that one aerator installed within the refuge basin would be sufficient to mitigate against unacceptable dissolved oxygen concentrations.

Indicative aerator hire prices

Description	Weight	Hire period	Price	
Float-mounted 11kW Spiral Aerator	350kg	At least 5 weeks		
Soft start starter for above	/	As above		
Mooring post	/	/		
Prep and delivery (excluding unloading)	/	/		
Installation	/	/		
De-installation	/	/		
Offhire and collection (excluding loading)	/	/		
Generator	/	/		
Prep and delivery	/	/		
Offhire and collection	/	/		
Fuel	/	/		