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Dear Richard

City Quay Water Feature – Water Quality Testing

As a follow on to the baseline assessment and rehabilitation strategy developed for the City Quay water feature, further water quality testing was recently undertaken. The purpose of this additional testing was to:

1) To determine the chemical water quality status of the borehole water supply water, which was not operational at the time of the initial visit.
2) To determine the water quality status of the spring that emerges from the embankment on the eastern side of the development to determine its potential as a supplementary supply to the water feature.

The site was visited on 4th March 2016 for the purpose of water sample collection. Water was collected in a stainless steel jug from the spring supply on the eastern boundary where it fell from the roofline of the Casemates. It was observed that there was significant development of algal growth on the ground around this area suggesting the water may be potentially nutrient enriched.

A second sample was collected from the borehole water supply located in the south-west corner of the water feature. The borehole was operated for 30 minutes prior to sample collection to purge standing water from the system and provide a more representative sample of the groundwater. It was noted during the initial purge of the system that the water being discharged was highly turbid which is likely to be associated with the recent reinstatement works undertaken on this water supply. After running the borehole for 30 minutes, the turbidity had significantly dropped although some suspended solids were still noted to be present. The borehole sample was collected in a stainless steel jug from the bib tap recently installed on the borehole head-works.

Collected water samples were transferred into bottles supplied by the testing laboratory and placed in a coolbox with icepacks. The samples were collected by courier and delivered to a UKAS accredited laboratory for chemical testing on a standard 10 day turn around.

The results of the analytical testing are presented in Table 1.

Table 1: Results of Water Quality Testing

Determinand	Units	WS1 (Eastern Spring)	WS2 (Borehole Supply)
pH	pH units	7.7	6.9
Electrical Conductivity	µS/cm	395	2100
Chloride	mg/l	20.6	354
Total Hardness (as $CaCO_3$)	mg/l $CaCO_3$	105	216
Total Alkalinity (as $CaCO_3$)	mg/l	260	380
Calcium	mg/l	37.4	39.4
Magnesium	mg/l	2.83	28.7
Suspended Solids	mg/l	52	180
Biochemical Oxygen Demand (BOD)	mg/l	3	2
Total Phosphorus	mg/l	2.1	0.82
Soluble Reactive Phosphorus	mg/l	1.48	0.17
Ammoniacal nitrogen (as N)	mg/l	0.2	0.8
Nitrite	mg/l	0.6	1.0
Nitrate	mg/l	32.6	8.7

Elevated values.

Spring Water Quality

Results of the water quality testing for the spring water sample indicate that the majority of parameters are within the normal range for freshwater. Elevated suspended solids concentrations at 52 mg/l were recorded which may be expected given that the spring is running off an embankment. The nutrient status of the water for phosphorus was found to be highly elevated with total phosphorus recorded at 2.1 mg/l and soluble reactive phosphorus (which is the form readily available for use by algae and aquatic plants) at 1.48mg/l. Under the OECD guidelines, concentrations of total phosphorus greater than 0.1 mg/l are classified as highly nutrient enriched (hypereutrophic). Therefore the use of the spring water is not recommended as an alternative supply to the water feature.

Currently this spring water discharges into a surface drain that runs around the periphery of the access road. It needs to be ensured that this drainage system has no pathways in which excess flows are directed towards the water feature.

Borehole Water Quality

Results from the testing of the water sample collected from the borehole indicated a number of elevated parameters. From these data there appears to be some saline influence on the local groundwater from the tidal River Mersey which is not unexpected given the proximity of the site to the river. It is likely that the degree of saline intrusion into the bed rock will vary with the spring and neap tidal cycles. This saline effect is reflected in the elevated chloride, conductivity and hardness values observed in the borehole water. From the chloride concentration data the estimated salinity value would be 0.64 ppt which is slightly elevated above the upper freshwater threshold limit of 0.5 ppt. Given the elevated salinity some sensitive species of freshwater invertebrates may be prevented from establishing in the lake and the community that develops will tend to be those species that can adapt to very slightly brackish conditions.

Ammoniacal nitrogen was slightly elevated at 0.8mg/l suggesting there may be some local organic or chemical contamination of the groundwater. However, these concentrations should not present any significant toxicity to aquatic life.

Suspended solids were found to be elevated at 180 mg/l although it is expected that further use of the borehole are likely to see these concentrations reduce and that these are likely to be a reflection of recent works undertaken on the borehole.

The borehole water was found to be highly nutrient enriched for phosphorus with a total phosphorus concentration of 0.82 mg/l and a soluble reactive component of 0.17 mg/l. For comparison, water supplies to lakes should ideally have a total phosphorus concentration of less than 0.032mg/l. As phosphorus is the key limiting nutrient for plant growth in freshwater systems (including those that are slightly brackish), the use of the borehole to supply the City Quay water feature will create highly nutrient enriched system that will promote excessive plant growth. In the absence of higher aquatic plants, the loadings of phosphorus will be directed into the development of the phytoplankton algae blooms (green turbid water)as regularly displayed by the water feature. The elevated phosphorus concentrations has implications on the future use of the borehole and the rehabilitation approach for the water feature.

Implications of Findings

The chemical analysis undertaken should be viewed as a 'snap-shot' of the water quality status of both the spring and borehole supply. Both are likely to show temporal variability although groundwater from which the borehole sources its water tend to be more stable in chemical characteristics over longer durations. The main variation in groundwater quality is likely to be in terms of its salinity status associated with the degree of saline intrusion under different tidal conditions.

The spring water given its highly elevated nutrient status is not suitable as a supply to the water feature but may be of use in terms of an irrigation supply for watering landscape areas around the development. However, this should be on areas away from the water feature.

The phosphorus and phosphate concentrations of the borehole were also found to be highly elevated also making it generally unsuitable as a supply to the water feature. In terms of rehabilitation and long-term management of the water feature it is recommended that given the issues with the water supply that its use is kept to a minimum and it is maintained as an emergency supply for top-up only during prolonged dry weather or drought conditions. As such the water level in the lake would be expected to typically drop during the summer months (June, July and August). There are two main issues from reduced water level which are:

1) Increased exposure of marginal butyl lake liner to UV radiation that will reduce its lifespan; and
2) A reduction in visual quality from the water feature having a lower water level and the marginal liner below the coping stones being exposed.

Both of these may be offset by wide scale planting of marginal vegetation around the water feature's margins. A minimum level for the waterbody would need to be set to ensure that the plants are maintained in wet conditions to prevent dieback. This may be achieved through simple changes made to the float switch that operates the borehole pump. Therefore the primary use of the borehole would be to maintain the minimum level to support aquatic marginal plant introductions.

Given that the borehole water is highly nutrient enriched it is not suitable for diluting the existing highly nutrient enriched conditions within the water feature. Therefore consideration should be made to locking up the phosphorus within the lake through a 'Phoslock' application as previous discussed in the rehabilitation report.

If you wish to discuss these findings further then please do not hesitate to contact me.

Regards

Richard Steel
Technical Director Water and Soils