

Committee(s)	Dated: 10 th March 2016
Wanstead Park Working Party	
Subject: Wanstead Park Hydrology Study Sept 2014	Public
Report of: Superintendent of Epping Forest	For Decision

Summary

Wanstead Park is a Grade II * Registered Park and Garden of Special Historic Interest and includes a five lake cascade system that is recognised as London's greatest surviving designed waterscape. Of the five lakes, four, The Shoulder of Mutton Pond, The Heronry Pond, The Perch Pond and The Ornamental Water are administered by the City of London with the fifth, The Basin, administered by Wanstead Sports Ground Limited.

This report summarises the findings of the Wanstead Park Hydrology study (Sept 2014) produced by JBA consulting. The aim of the study was to investigate potential options to restore the lake system so as to minimise the occurrence of significantly lowered lake levels during the summer and autumn and particularly during periods of dry weather.

The study produced hydrological and hydrogeological conceptual models of the cascade system of five lakes. A numerical model was developed to test potential improvement options and a shortlist of proposals to help achieve the desired improvements to the lake system compiled.

Three possible options to follow up the findings of this study have been proposed: A: Do nothing, B: City of London funded inflow improvements while undertaking longer term hydrological assessments and C: Externally funded inflow improvements while undertaking longer term hydrological assessments and the relining of the Heronry Pond.

Confirming how we want to progress the hydrological issues at Wanstead Park is a key requirement in the development of the Conceptual Options Plan for Wanstead Park being developed for later in 2016.

Recommendation(s)

Members are asked to:

- Recommend that Option C be included as an objective within the Wanstead Park Conceptual Options Plan.

Main Report

Background

- Wanstead Park is a Grade II* Park and Garden included on Historic England's register of Parks and Gardens of Special Historic Interest. The Park was declared at risk by English Heritage in 2009 in part due to the condition of its landscape features including the lake cascade.
- This report summarises the Wanstead Park Hydrology Study of September 2014 prepared by JBA Consulting. Based on the report's findings a number of potential development scenarios are outlined for the Wanstead Park Working Group to discuss.
- LDA were engaged in November 2014 to develop a long-term 'Wanstead Park Conceptual Options Plan' to identify and prioritise opportunities for capital investment to conserve and improve Wanstead Park. Confirming how we want to progress the hydrological issues at Wanstead Park is a key requirement in the development of the Conceptual Options Plan for Wanstead Park.
- Wanstead Park is London's greatest surviving designed waterscape. At its greatest extent (circa 1800) there were nine artificial lakes at Wanstead Park. Of the five that exist today four, The Shoulder of Mutton Pond, The Heronry Pond, The Perch Pond and The Ornamental Water are administered by the City of London with the fifth, The Basin, administered by Wanstead Sports Ground Limited. The five lakes form a cascade series, although now water flow between the lakes is much less apparent than when they were created.
- Four of the five lakes (excl. Shoulder of Mutton) are designated as large raised reservoirs retaining over 25,000 m³ of water and fall under the remit of the 1975 Reservoirs Act (as amended by the 2010 Flood and Water Management Act).
- Throughout its history the Wanstead Park lake system has had issues surrounding the supply and retention of water. Much has changed since the lake system was first constructed and, for example, there have been substantial changes to the water catchment area for the lakes as well as problems with the design and structure of the lake system.

Why was the study required?

- Water levels have been artificially maintained by pumping from the River Roding for much of the 20th Century and more recently by abstraction of 294,000 m³ of potable water from the chalk aquifer. The Environment Agency which triennially licences abstraction has indicated that the current levels of abstraction are unsustainable and may reduce substantially by 2020.
- The recommendation to undertake this hydrology study came from a 2011 conservation statement on the hydrology of Wanstead Park produced by Haycock Associates. That study was put together as part of a wider consultation on the future of Wanstead Park and concluded that further information needed to be collected on the hydrological system within the park to better understand the likely capital expenditure required to improve the lake system.
- JBA Consulting was appointed in August 2013 to undertake the follow on hydrology study of the Wanstead Park lake system. The aim of the study was to investigate potential options to restore the lake system so as to minimise the occurrence of significantly lowered lake levels during the summer and autumn and particularly during periods of dry weather.

The Study Methodology

- The study undertook two stages of investigation. The first was a detailed analysis of the hydrological system. This involved a data review and the development of hydrological and hydrogeological conceptual models (Chapter 5) of the lake system.
- The conceptual model was used to inform the development of a numerical groundwater flow model of Wanstead Park (Chapter 6). The objective of the numerical model was to:
 - Provide a qualitative check on the conceptual model and preliminary water balance;
 - Quantify flows between the groundwater system and the surface water system;
 - Make predictions of the future behaviour of the system.
- The second phase of the investigation sought to determine engineering solutions that could be used to restore the lake system. This was undertaken through developing a long list of the options which then went through an appraisal process described in Chapter 7 to develop a short list of those options that were considered to offer the best potential. The short listed options were then tested within the numerical model to determine whether they gave the improvement required.
- Following completion of the main study and the issuing of the main Hydrology report additional information on major utility services impacting the hydrology of

the area were identified. An addendum to the main report presents an appraisal of this new information and makes recommendations for further investigation

Conceptual Modelling Conclusions

- Overall, the numerical modelling suggests that the conceptual model and water balance (for Heronry Pond, Perch Pond and Ornamental Waters) are reasonable. There is however a caution in that there is considerable uncertainty on the model data, especially in terms of water loss to the ground. (See also para 23)
- The water balance produced suggested that over the course of an average year the system appears in balance. This equilibrium is however undesirable as it has to be supported by substantial extraction of water from the Heronry borehole and within a year lake levels can fall a long way below desired levels.
- Heronry Pond, Perch Pond and Ornamental Waters all lose water to the ground. In an average year Heronry Pond shows both the greatest leakage rates and the greatest seasonal variation in leakage, with leakage being greatest in the winter and early spring when water levels in the pond are higher.
- Perch Pond shows the lowest leakage rates and an opposite variation to Heronry: leakage is greatest in the late summer and autumn. This reflects the fact that leakage from Heronry recharges the groundwater within the river terrace sand/gravel deposits that both these water bodies share and which Perch Pond is downslope off. As a consequence when Heronry leaks more, Perch leaks less and vice versa. Modelling suggests that lining Heronry Pond is likely to increase leakage from Perch Pond via this mechanism.

Potential Mitigation Options

- The cascade system of ornamental lakes at Wanstead Park has long suffered from low water levels during dry spells of weather. The two most affected lakes are the Heronry Pond and the Ornamental Water. With an overall aim of ensuring *'that the lakes remain no more than 100mm below the outlets even during a 1 in 10 year drought event'* a shortlist of engineering solutions to achieve this were developed.
- The engineering solutions were grouped under three main themes:
 - Increasing inflow to the ponds:
 - Leakage control
 - Discharge from outlets
- Increasing natural inflows of water through more effective management of existing drainage and increasing flows through improved drainage ranged in cost from £5,000-£50,000 for the Heronry Pond and £5,000 to £15,000 for Ornamental Waters. Increased pumped inflow through abstraction on the Heronry was considered unviable as it was unlikely it would be agreed to by the Environment

Agency without leakage control measures. Increasing inflow options however do not address the leakage problems which may increase over time through further deterioration

- Relining Heronry Pond produces the largest overall decrease in leakage from the lake system and is considered in the report to be the most beneficial improvement to the lake system. It is not a panacea as there is the impact on Perch Pond described above and it does not necessarily improve the Ornamental Water's problems. Three potential techniques for improving the lining of the Heronry Pond were identified:
 - Repair to the existing lining. Costs ranging from £30,000 to £150,000 but with uncertainty existing on being able to identify and repair any or all of the leakage points.
 - Groundwater control through installing a cut off curtain wall around the perimeter of the pond extending down to London Clay. Cost range from £750,000 to £900,000 but requiring considerable tree clearance around the lake though this could be reduced, as could costs, with only a partial curtain on the eastern perimeter.
 - The favoured option was the complete relining the Heronry Pond with two lining options identified, a clay based approach and a synthetic polyethylene liner. The clay liner has the advantage of being able to self-repair following any puncture. How to handle the existing concrete liner impacts on both techniques with costs increasing if the concrete is removed, however, if not removed the final lake depth levels will be reduced by up to 300mm. Costs range from £1,000,000 to £1,400,000 for clay base approaches and £950,000 to £1,370,000 for polyethylene liner options.
- With the reduced leakage following the Heronry Pond repairs the option exists to redirect the existing pumped inflow to Ornamental Waters either via the Perch Pond or directly through a new pipe network. Capital costs for installing a new pipe network were estimated at between £25,000 to £50,000 plus the annual costs of abstracting water.
- The outfall on the Ornamental Waters is close to the inlet from the Perch Pond and there is the potential of water short-circuiting and overtopping into the River Roding. An outfall located further from the inlet could see more of this water being retained in the lake as well as improved water flow. This could help with problems of stagnation and weed growth and would cost between £15,000 to £25,000.
- Any option taken forward would require engineering studies to ensure reservoir flood risks and dam safety are managed and agreed with the Panel Engineer.

Potential Impact of Sewers and Gas Mains on Lake Water Levels

- Following completion of the main study and the issuing of the main Hydrology report, outlined above, additional information on major utility services impacting the hydrology of the area were identified. There is a concern that the service

trenches containing these sewers and gas mains could impact the lake water levels in three ways:

- By intercepting groundwater that would otherwise have supplied the lake;
 - By lowering groundwater levels beneath, or adjacent to, the lake. This may increase the rate of leakage from the lake into the ground;
 - By direct drainage of the lake if the trench/pipe is located on the lake bed.
- The conceptual and numerical models summarised above do not allow for drainage effects related to buried services and associated trenches. Of the five service trenches identified two in particular were identified as a cause for concern: a 1050-1350mm diameter combined sewer which passes close to Ornamental Water and a gas main which passes beneath Ornamental Water, Both were installed in 1974 with the main concerns linked to increased drainage of water away from the lake system arising from possible permeable trench fill and fractures in the sewer..
 - At least both these utilities will need their condition assessed and the conceptual and numerical models reevaluated.

Options

- The water balance for the Wanstead Park lake system overall has been shown to be in equilibrium. Despite this equilibrium there are significant periods when water levels are low. Significant ground water abstraction is also required to maintain this equilibrium without which the water balance is in substantial deficit.

Option A: Do Nothing

- In this we would continue to abstract water to maintain the water balance of the lake system.
- The current abstraction licence is up for review in March 2016 and will be reviewed every three years thereafter. This Hydrology Study was in part required to satisfy the requirements made by the Environment Agency in the Licence renewal process. With London's water resources under increasing pressure our assessment is that having a viable leakage management program will become a necessary requirement of future abstraction applications without which we have a real risk that future abstraction permission will not be forthcoming. Without continued abstraction the lake system would be operating at a considerable water deficit.
- Not discussed in the Hydrology report is the much increased presence of the invasive plant Floating Pennywort (*Hydrocotyle ranunculoides*) in the Perch Pond. Until we successfully control this plant it is not possible to transfer water from the Heronry Pond to the Ornamental Water. Some additional capital investment is likely to be required to allow the transfer of water to the Ornamental Water as otherwise the do nothing approach will not address the water deficit of the Ornamental Water.

Option B: City of London funded inflow improvements while undertaking longer term hydrological assessments

- This option seeks to implement the report's minimal recommendations, such as increasing the inflows to the system at the same time as undertaking the monitoring and investigation works recommended. Activity would be based on using existing City of London resources.
- Measures to improve the natural inflows are a necessary minimum action in any leakage management program and, for example, Heritage England, identify implementing such measures as a matter of urgency.
- The analysis presented in the report is based on limited data. Considerable uncertainty remains with regard to the water balance for the ponds, especially in terms of loss to the ground. In addition, the subsequent identification of the five sewage and gas mains close to the lake system requires further investigation to better describe the impact they may or may not have on the lake system. These investigations are necessary for planning any substantive interventions to improve the lake system and undertaking them will help progress any long term solutions.
- Much of the work required to improve natural inflows and to undertake the hydrological assessments will draw heavily on specialist contractors and consultants to implement. Reliance on the existing resources will mean we have an increasing demand on existing staff and, especially, financial resources to achieve implementation. Both these resources are facing increasing demands introducing a risk towards our ability to either achieve the improvements or at least progress them in a timely way. Ultimately we may well still be faced with the decision on how to progress the more substantive actions recommended in the report.

Option C: Externally funded inflow improvements while undertaking longer term hydrological assessments and the relining of the Heronry Pond

- This option seeks to combine option B with the major leakage improvement recommendation of relining the Heronry Pond.
- The inclusion of the relining of the Heronry Pond opens up the potential of external funding from the Heritage Lottery Fund (HLF) as the likely Heritage project value will be over £100,000. Potentially this could mean that a large part of the Option B works financed by the City of London, when part of a Phase 1 HLF application, could be included as matched funding in any subsequent successful bid for Wanstead Park.
- With Option C there will still be competing claims on operational finances however this would now be against a backdrop where it could lever in additional finance to help address some of the big challenges at Wanstead Park.

Proposal

- It is proposed that Option C be included as an objective within the Wanstead Park Conceptual Options Plan.

Conclusion

- Following an investigation and modelling of the hydrology of Wanstead Park lake system a short list of potential improvements to ensure the lakes remain no more than 100mm below the outlets even in a 1 in 10 year drought event were identified. This report provides a recommendation that as part of potential HLF application for Wanstead Park we seek to include recommendations to reduce leakage from the Heronry Pond and to increase the inflow of water from natural sources.

Background Papers:

Wanstead Park Hydrology Study, Main Report c4.0 and Addendum, September 2014, JBA Consulting

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