LOGAN WATER ALLIANCE

LOGANHOLME WWTP RAS UPGRADE SCOPING STUDY

TASK NUMBER: 90-11-36

JANUARY 2013
## Approval Register

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ABBREVIATIONS

ADWF  Average Dry Weather Flow
RAS  Returned Activated Sludge
WWTP  Wastewater Treatment Plant
SRT  Solids Retention Time
LCC  Logan City Council
LWA  Logan Water Alliance
EP  Equivalent Population
DEHP  Department of Environment and Heritage Protection
TWL  Top Water Level
MCA  Multi Criteria Analysis
EXECUTIVE SUMMARY

Following the completion of Stage 7 upgrade works at the Loganholme Wastewater Treatment Plant (WWTP), operators expressed concern that the existing design capacity of 67 ML/d ADWF (average dry weather flow) could not be met. The *Loganholme Wastewater Treatment Plant Hydraulic Upgrade Planning Report* (LWA, August 2011) highlighted potential constraints in the existing Return Activated Sludge (RAS) system and identified that sludge storage in the clarifiers during peak flows would increasingly occur as the plant approaches its design capacity. It concluded that to avoid sludge storage in the clarifiers from occurring, the RAS capacity would need to be increased from 385 L/s to 822 L/s for RAS plant A and from 870 L/s to 1,238 L/s for RAS plant B.

On this basis, an option assessment was considered necessary to determine the upgrades required at each RAS plant to meet these capacity increases.

During the course of this investigation the *Loganholme WWTP Stage 7 Process Commissioning Report* (LWA, July 2012) identified that the maximum plant capacity can be met if the plant solids retention time (SRT) was reduced to 10 days and sludge storage was allowed to occur in the clarifiers during peak flow events. Whilst gross clarifier failure (loss of sludge blanket) was not likely to occur, there is an increased likelihood that some solids carryover to the disinfection process will occur during these events. This would have serious implications on the disinfection process, as free chlorine would be consumed by the suspended solids, and could result in faecal increased coliform non-compliances in addition to effluent suspended solids non-compliances during peak flow events, particularly as the plant approaches its design capacity.

A preliminary options development workshop was undertaken in March 2012 to identify options to meet the proposed increase in RAS plant capacity. From this workshop, three options for RAS plant A and two options for RAS plant B were carried forward for further investigation.

For RAS plant A, the three options can be summarised as follows:

1. Option A1 - Remediate existing RAS pump station and install new RAS pumps
2. Option A2 - Augment existing gravity pipework and upgrade RAS pump station
3. Option A3 - Install new RAS pumps to augment existing RAS system

For RAS plant B, the two options can be summarised as follows:

1. Option B1 - Remediate existing RAS pump station and install new RAS pumps
2. Option B2 - Augment existing gravity pipework and upgrade RAS pump station

The results of the hydraulic analysis indicate that Options A2 and A3 are not hydraulically feasible, largely due to the insufficient hydraulic drive available to overcome headlosses associated with the DN300 clarifier underflow pipework under maximum flow conditions. This results in the RAS A pump station wet well being drawn down to failure for both options. Upsizing these pipes involves a high level of risk in terms of
constructability, construction risk to the existing plant and health and safety and is not considered feasible. Therefore options A2 and A3 were not taken forward for further analysis.

First principle cost estimates were developed for the remaining options and a multi-criteria assessment (MCA) was undertaken for options to upgrade the RAS B capacity. The cost estimates and results of the MCA are outlined in Table 0-1.

### Table 0-1: Cost estimates and MCA results

<table>
<thead>
<tr>
<th>Asset Description</th>
<th>Option A1 ($1,405,572)</th>
<th>Option B1 ($1,771,136)</th>
<th>Option B2 ($1,744,225)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost relative to lowest cost option</td>
<td>-</td>
<td>$26,911</td>
<td>$0</td>
</tr>
<tr>
<td>Cost relative to lowest cost option (%)</td>
<td>0%</td>
<td>2%</td>
<td>0%</td>
</tr>
<tr>
<td>Financial Ranking</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Total Score (out of 100)</td>
<td>-</td>
<td>91.5</td>
<td>70.1</td>
</tr>
<tr>
<td>MCA Rank</td>
<td>-</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Note:
1. Costs estimated in $2012

Cost estimates revealed that a preferred option for upgrading the RAS B system could not be selected on costs alone, as both options are within +/- 5%. However the MCA showed that Option B1 was the preferred option for the following reasons:

- it provides greater certainty in achieving the required flow rates compared to the gravity driven option (Option B2)
- allows greater flow control of the RAS process through use of pumps and variable speed drives
- it has the same operational philosophy as Option A1; therefore simplifying operator training requirements
- it has the lowest risk for construction impacts on the existing plant

Based on the cost and non-cost assessment of the options, the preferred options for upgrading the existing RAS plants are Options A1 and B1.

The timing of the proposed RAS upgrades is dependent on the following:

- whether or not it is acceptable to reduce plant SRT from 15 to 10 days
- whether or not it is acceptable to store sludge in the clarifiers during peak flow events
- whether or not LCC was prepared to accept the risk for potential increases in effluent suspended solids (SS) and faecal coliform non-conformances with the current discharge licence
At a presentation to LCC Stakeholders on the 5th of December 2012 a consensus was reached that the works are not immediately required for the following reasons:

- only 1 non-compliance of maximum effluent SS has been reported since the completion of Stage 7 upgrades in August 2010. This non-compliance was reported during a peak flow event
- the recorded short-term & long-term 80th%ile effluent SS values are approximately 50% of the allowable licence limits and are unlikely to increase in the short term
- the risk of licence non-compliances due to solids carryover to the disinfection process can be managed in the short term by reducing the plant SRT
- the wasting and biosolids handling processes at Loganholme are currently under investigation by the LWA. Improvements to these processes would help reduce solids storage in the clarifiers
- the Loganholme WWTP licence is currently under review with the Department of Environment and Heritage Protection (DEHP)

It was agreed that the upgrade works should be deferred in the short term and the cost of the proposed upgrades be added to the 2017 capital works program, as detailed in Table 0-2 below.

**Table 0-2: Capital Works for Preferred Options**

<table>
<thead>
<tr>
<th>Capital Works</th>
<th>Total Capacity</th>
<th>Cost ($2012)</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upgrade Loganholme WWTP - RAS A capacity</td>
<td>822 L/s</td>
<td>$1,449,049</td>
<td>2017</td>
</tr>
<tr>
<td>Upgrade Loganholme WWTP - RAS B capacity</td>
<td>1,238 L/s</td>
<td>$1,771,136</td>
<td>2017</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$3,270,185</td>
<td></td>
</tr>
</tbody>
</table>

Based on the outcomes of this study, the Logan Water Alliance recommends that:

1. LCC adopt Options A1 and B1 as the preferred augmentation strategies for increasing the RAS capacity at Loganholme WWTP
2. the proposed works be added to the 2017 capital works program
3. the need for the RAS upgrades be reviewed prior to 2017
4. the clarifier performance be closely monitored during peak flow events, particularly as the plant approaches in design capacity (67 ML/d ADWF)
5. a secondary screens monitoring program be implemented to determine if the RAS screens are still required once the new Loganholme WWTP inlet works have been commissioned
1. INTRODUCTION

The Stage 7 upgrade at Loganholme Wastewater Treatment Plant (WWTP) was completed in 2010 to increase the theoretical effluent treatment capacity to 67 ML/d average dry weather flow (ADWF). This treatment capacity was reviewed in a subsequent planning study – *Loganholme Wastewater Treatment Plant Hydraulic Upgrade Planning Report* (LWA, August 2011) which highlighted potential constraints in the capacity of the existing Return Activated Sludge (RAS) system. In response, the Logan Water Alliance (LWA) commissioned this scoping study to determine the preferred option to upgrade the existing RAS capacity at Loganholme WWTP.

1.1 Objectives

The objective of this study is to identify options to upgrade the RAS system capacity at Loganholme WWTP, and to provide a cost estimate for the preferred option that will inform future upgrades at the WWTP.

1.2 Scope

The scope of this study comprises of:

- a review of previous reports and as-constructed drawings
- meetings with key stakeholders
- a site-based options workshop
- options identification for increasing the capacity of both RAS plant A and RAS plant B
- a hydraulic analysis of identified options
- preparation of first principles cost estimates
- identifying constraints, risks and benefits for each option
- recommendations on the preferred upgrade option for each RAS system

1.3 Business Drivers

The key business driver for the proposed RAS upgrade is compliance. Compliance is required as a result of a legal obligation. In relation to wastewater planning, this typically takes the form of a condition of development approval/licence, or the general environmental duty to prevent or mitigate the risk of environmental harm under the *Environment Protection Act 1994*. Compliance is not limited to these matters and may also include obligations under other Acts including occupational health and safety.

In relation to the Loganholme WWTP it has been identified that the existing plant can theoretically operate at 67 ML/d ADWF assuming a solids retention time (SRT) of 10 days; however this is the absolute limit that the plant can operate at without any reserve margin. This also assumes that solids storage will be allowed to occur in the clarifiers during periods of peak flow. Whilst gross clarifier failure (loss of sludge blanket) is not likely to occur, there is an increased likelihood that some solids carryover to the disinfection process will
occur during these events. This would have serious implications on the disinfection process, as free chlorine would be consumed by the suspended solids, and could result in faecal increased coliform non-compliances in addition to effluent suspended solids non-compliances during peak flow events, particularly as the plant approaches its design capacity.

A secondary business driver for the proposed RAS system upgrade is improvement. There are current issues with the performance of the RAS A pump station that limit the functionality of both the RAS and the WAS processes. Implementation of works to rectify these issues will improve the reliability and performance of the treatment plant and are therefore considered to constitute an improvement.

A tertiary business driver for the proposed RAS system upgrade (in-line with the Loganholme WWTP capacity) is growth. Growth is represented in number of equivalent persons (EP). The current EPs contributing to the Loganholme WWTP has been estimated at 200,000 EP. This is forecast to increase to an estimated 608,345 EP for the ultimate planning horizon (nominally 2061), which represents an average annual growth rate of approximately 3.3%. This projected increase includes the transfer of flows from the areas of North Maclean, Yarrabilba, Greenbank and Logan Village (currently part of the Logan South wastewater network) to the Logan North wastewater network, and subsequently the Loganholme WWTP. The exact timing of the proposed diversions is discussed in detail in the *Logan South Wastewater Servicing Plan* (LWA, February 2012).
2. PLANNING CONTEXT

2.1 Background

The Loganholme WWTP is Logan City Council’s largest wastewater treatment plant. The plant currently operates at approximately 40 ML/d ADWF and has a theoretical design capacity of 67 ML/d ADWF. It is estimated that the capacity of the Loganholme WWTP will need to be increased to 122 ML/d ADWF by the ultimate planning horizon (nominally 2061). This ultimate capacity allows for the diversion of wastewater to the Loganholme WWTP from the future growth areas of North Maclean, Yarrabilba, Greenbank and Logan Village.

2.2 Previous Studies

Previous planning studies that provide background to this report are outlined below.

- *Loganholme Wastewater Treatment Plant Hydraulic Upgrade Planning* (LWA, August 2011). This study examined the hydraulic capacity of individual process elements of Loganholme WWTP to identify capacity constraints and determine if any further system upgrades were required to meet the 67 ML/d ADWF plant design capacity. The existing RAS system was identified as a potential hydraulic constraint to the process.

- *Loganholme WWTP Stage 7 Process Commissioning* (LWA, July 2012). This study examined the limiting processes at Loganholme WWTP that may impact the design capacity of 67 ML/d ADWF. An Evolutionary Operation (EVOP) program was undertaken to refine and test individual process elements to their maximum capacity and determined the following:
  
  o the plant design capacity of 67 ML/d ADWF could be achieved without upgrading the existing RAS capacity if the solids retention time (SRT) was reduced to 10 days and sludge storage was allowed to occur in the clarifiers during peak flow events. However this is the absolute limit that the plant can operate at to meet licence requirements and does not allow any reserve margin.

  o gross clarifier failure may occur for sustained periods of peak flow as a direct result of insufficient RAS capacity, resulting in sludge blanket carryover into the receiving waterway and potential non conformances with the current WWTP licence.
3. ASSUMPTIONS

3.1 Populations, Wastewater Loads and Treatment Plant Staging

Population projections for the Loganholme WWTP have been adopted from the Logan South Wastewater Servicing Plan (LWA, February 2012), and are detailed in Table 3-1 and Figure 3-1. Wastewater loads have been calculated based on the Logan Water Desired Standards of Service (DSS). Figure 3-1 also includes the two future WWTP upgrades (Stage 8 and 9).

Table 3-1: Population projections and wastewater loads for the Loganholme WWTP

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<thead>
<tr>
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<th></th>
<th></th>
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<tbody>
<tr>
<td>Total EP</td>
<td>200,000</td>
<td>261,855</td>
<td>288,669</td>
<td>318,196</td>
<td>342,661</td>
<td>608,345</td>
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<tr>
<td>Total ADWF Load (ML/d)</td>
<td>40.00</td>
<td>52.37</td>
<td>57.73</td>
<td>63.64</td>
<td>68.53</td>
<td>121.67</td>
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Figure 3-1: Projected Loganholme WWTP catchment growth

Figure 3-1 demonstrates that the design WWTP capacity will be exceeded in approximately 2028. The Stage 8 and Stage 9 upgrades are planned to progressively increase the WWTP capacity to a maximum design capacity of 122 ML/d ADWF by the ultimate planning horizon.
3.1.1 RAS system design flowrates

RAS design flowrates for this study were adopted from the *Loganholme Wastewater Treatment Plant Hydraulic Upgrade Planning Report*. These flow rates are based on maintaining a solids retention time (SRT) of 10 days and maintaining RAS system recycle ratios required to prevent solids storage in the clarifiers during peak flow events. These flow rates are outlined in Table 3-2.

Table 3-2: RAS Design flowrates

<table>
<thead>
<tr>
<th>RAS Pump Station</th>
<th>Existing RAS Flow Rate (l/s)</th>
<th>Required RAS Flow Rate (l/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAS A</td>
<td>385</td>
<td>822</td>
</tr>
<tr>
<td>RAS B</td>
<td>870</td>
<td>1,238</td>
</tr>
</tbody>
</table>

3.2 Cost Estimates

The capital cost of infrastructure proposed in this scoping study was calculated using first principle estimates. The following project-owner costs have been added to the base costs for required infrastructure:

- survey 3%
- planning 5%
- design and engineering 5%
- construction supervision 4%
- contract administration and supervision 3%

A contingency of 20% has also been allowed for project risk.

3.3 Qualitative Assessment Criteria

A qualitative assessment of the existing RAS system capacity was developed based on pipe velocity and pump capacity. Table 3-3 identifies the key pipe velocity and pump capacity criteria that were used to assess the hydraulic constraints for the two RAS systems.

Table 3-3: Qualitative assessment criteria of existing RAS systems

<table>
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<tr>
<th>Qualitative Rating</th>
<th>Parameter</th>
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<tr>
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<td>Rising Main Velocity</td>
</tr>
<tr>
<td>No Capacity Constraints</td>
<td>0 – 2.5 m/s</td>
</tr>
<tr>
<td>Nearing Capacity</td>
<td>2.5 – 4.0 m/s</td>
</tr>
<tr>
<td>Capacity Exceeded</td>
<td>&gt; 4.0 m/s</td>
</tr>
</tbody>
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4. KEY LCC STAKEHOLDERS

Table 4-1 summarises the key stakeholders that were consulted at various stages during this study. An options workshop was held at Loganholme WWTP with LCC stakeholders to identify potential options. Regular meetings and site visits were held with LCC plant operations to discuss project progress and to investigate option feasibility, and to present findings of the investigation.

Table 4-1: Consultation with Key LCC Stakeholders

<table>
<thead>
<tr>
<th>Function</th>
<th>Name</th>
<th>Position</th>
<th>Level of Consultation</th>
</tr>
</thead>
</table>
| Logan Water Business - Treatment | Wijay Tilakumara | Program Leader – Treatment                      | • regular meetings to discuss project progress  
  • options identification workshop  
  • presentation for discussion of options and recommendations |
| Logan Water Business - Treatment | Imtiaj Ali            | Treatment Engineer                             | • regular meetings to discuss project progress  
  • options identification workshop  
  • presentation for discussion of options and recommendations |
| Logan Water Business - Treatment | Chitra Liyanage      | Maintenance Engineer                           | • regular meetings to discuss project progress  
  • options identification workshop |
| Logan Water Business - Treatment | Steve Walters       | Treatment Supervisor - Loganholme              | • regular meetings to discuss project progress  
  • options identification workshop  
  • presentation for discussion of options and recommendations |
| Logan Water Business - Treatment | Garry Goodliffe       | Mechanical & Electrical Supervisor             | • regular meetings to discuss project progress  
  • options identification workshop  
  • presentation for discussion of options and recommendations |
5. EXISTING SYSTEM ANALYSIS

5.1 Existing Situation

The following section describes the existing RAS system configurations for the two RAS pump stations (referred to as RAS ‘A’ and RAS ‘B’) and highlights the current hydraulic constraints of each system when required to deliver the maximum RAS flows as identified in section 3.1. Summary tables have been developed to provide a qualitative assessment of each RAS element.

Figure A1 in Appendix A provides an overview of the individual process streams for the RAS ‘A’ and RAS ‘B’ pump stations.

5.2 Existing RAS ‘A’ Pump Station Configuration

A schematic of the existing RAS A system configuration is shown in Figure 5-1.

![Figure 5-1: RAS A system schematic](image)

Flow from the existing clarifiers is conveyed via DN300 clarifier underflow pipework to two sludge boxes. These sludge collection boxes are fitted with adjustable bell mouth outlets and are used to control flow to the RAS pump station. Flows from the sludge boxes are then transferred to mechanical screens via DN450 pipework and then to the RAS pump station wet well via DN600 pipework. The existing RAS station is fitted with dry mounted KSB pumps that operate in a duty/assist/standby arrangement. RAS flows are controlled through the use of variable speed drives. The pumps discharge to OD1 and OD2 via DN375 and DN300 pipework.
5.3 Existing RAS A Hydraulic Constraints

Table 5-1 highlights the areas of the RAS system which are constrained under maximum loading conditions.

**Table 5-1: Qualitative capacity assessment RAS A under maximum loading conditions**

<table>
<thead>
<tr>
<th>Pipework</th>
<th>Pump Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clarifier Pipework</td>
<td>Gravity Mains</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavily constrained – RED</td>
<td>Constrained – ORANGE</td>
</tr>
</tbody>
</table>

The areas of hydraulic constraint identified for the RAS A system are discussed in detail below.

5.3.1 Outlet pipework and gravity mains

The DN300 outlet pipework from the clarifiers to the bellmouth sludge collection boxes is heavily constrained. High velocities and subsequently high headlosses are predicted in this pipework under maximum flow conditions. The adjustable bellmouth arrangement in the sludge collection boxes does not provide a sufficient hydraulic gradient (i.e. driving head due to static height difference) to meet the required 822 L/s flowrate even when fully wound down. The DN450 gravity pipework downstream of the sludge collection boxes is also undersized.

5.3.2 Pump station capacity

The existing KSB pumps are currently flow limited and are undersized for future RAS flow requirements. Cavitation issues prevent the pumps from operating at full speed, and are subsequently flow limited to 385 L/s (43 Hz operating frequency). This flowrate was achieved during system testing with the bellmouths wound down to their lowest height setting and with the WAS pumps not in operation.

The critical level in the existing wet well has been identified as 7.6 mAHD (approx 1.8 m above pump volute and 2.1 m above the centreline of the pump suction pipework. Cavitation is observed in the RAS pumps below this level.

Cavitation of the RAS pump system is attributed to two factors:

- insufficient hydraulic drive for the existing RAS A system, largely associated with the hydraulic limitations of the existing DN300 clarifier underflow pipework to pass forward required flows
- insufficient net positive suction head available (NPSHa) for the existing RAS pumps

5.3.3 Rising main capacity

Analysis of the system resistance curves for the RAS ‘A’ rising main shows that the existing rising main is undersized for future flows, particularly the section of DN300. As a minimum, the DN300 section should be upsized to DN375 to reduce headlosses, as there are no pumps readily available which meet the future operating head requirements using the current rising main configuration.
5.4 Existing RAS ‘B’ Pump Station Configuration

A schematic of the existing RAS B system configuration is shown in Figure 5-2.

![Figure 5-2: RAS B system schematic](image)

Flow from the existing clarifiers is conveyed via DN375 underflow pipework in the outer ring of the flow distribution chamber. Flows from the distribution chamber are then transferred to mechanical screens via twin DN600 pipes and then to the RAS B pump station wet well. The existing RAS station is fitted with two sets of differently sized dry mounted pumps (1 x ABS, 1 x FLYGT). Either pump can be used as a duty pump depending on low flow or high flow conditions. Flow control is provided through the use of variable speed drives fitted to each pump set. The pumps discharge to OD3 and OD4 via separate DN500 rising mains.

5.5 Existing RAS B Hydraulic Constraints

Table 5-2 highlights the areas of the RAS system which are constrained under maximum loading conditions.

<table>
<thead>
<tr>
<th>Table 5-2: Qualitative capacity assessment RAS B under maximum loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipework</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>Clarifier Pipework</td>
</tr>
</tbody>
</table>

Legend:
- OD – Oxidation Ditch
- C – Clarifier
- PS – Pump Station
- DC – Distribution Chamber
- S – Screens

Heavily constrained – RED
Constrained – ORANGE
The areas of hydraulic constraint identified for the RAS B system are discussed in detail below.

5.5.1 Clarifier outlet pipework and gravity mains

The DN375 outlet pipework from the clarifiers to the outer ring of the distribution chamber is heavily constrained. The two parallel DN600 mains that connect the distribution chamber with the screening chamber is also constrained. Hydraulic analysis has estimated a maximum draw-off flow rate from the clarifiers of approximately 770 L/s and therefore requires upsizing to meet future requirements.

5.5.2 Pump station capacity

The RAS pumps draw flow from a screened wet well chamber. The existing pump station has effectively been split into two separate pump stations by installation of a dividing valve to the delivery manifold. Under normal operation each side delivers flow to the oxidation ditches (ODs) independently, however the dividing valve can be opened to modify the flow split back to the ODs.

Analysis of the system resistance curves for RAS B pump station estimates the total pumping capacity at approximately 870 L/s and is therefore undersized for future RAS flow requirements. This is the combined flowrate of the two larger ABS pumps operating in parallel. Combined flowrates of approximately 1000 L/s can be achieved based on duty/assist pumping of both pump sets, however this offers no redundancy for maintenance or shutdown if one pump needs to be taken offline.

5.5.3 Rising main capacity

Velocities of approximately 3 m/s are predicted in the existing DN500 rising mains under maximum flow conditions. Although this is considered as constrained under the identified assessment criteria, it is considered as acceptable for maximum flow conditions as there are pumps readily available which meet the future operating head requirements using the current rising main configuration.
6. OPTION ANALYSIS

An options development workshop was undertaken at the Loganholme WWTP on 13th March 2012 (refer to Appendix B for workshop minutes) to identify feasible options for upgrading both RAS systems.

The identified upgrade options for the RAS A and RAS B systems are detailed in Section 6.1 and 6.2 respectively.

6.1 RAS ‘A’ upgrade options

The upgrade options for the RAS ‘A’ system are based on a maximum design flowrate of 822 L/s. All options identified draw flows from clarifiers 1, 2, 3 and 4 and discharge to ODs 1 and 2 as per the current arrangement.

6.1.1 Option A1 - RemEDIATE existing RAS system and install new RAS pumps

This option increases the existing RAS capacity by undertaking the following:

- connecting new pumps directly to the clarifier underflow pipework. It is proposed to achieve this by removing the adjustable bell mouths currently located in the sludge collection boxes and connecting new pump sets directly to the existing flanged pipework.

- constructing a new RAS/WAS station adjacent to each existing sludge collection box. Each station will consist of two RAS and two WAS pumps, both of which will operate in a duty/stand-by arrangement.

- the proposed pump set that draws flows from clarifiers 1 and 2 will require a new DN375 rising main to be constructed to connect into the outer channel (aerobic zone) of OD1. This is the preferred discharge location from process perspective. The proposed pump set that draws flows from clarifiers 3 and 4 will require a new DN375 rising main to be constructed that will connect to the existing DN375/DN300 RAS A rising main. Flows from clarifiers 3 and 4 will discharge to OD2 only.

- connecting the new WAS pumps to the existing DN225 WAS via the construction of a new DN225 rising main. The WAS system will still discharge to balance storage located outside the sludge building under this option.

- the existing DN450 gravity mains from the sludge collection boxes, screening system, DN600 gravity main to the RAS pump station, WAS system, RAS pump station and the DN300 rising main section will become redundant under this option and will be remediated.

Sub-options were also considered to identify the optimal pump arrangement. Following this assessment, it was concluded a duty/standby arrangement with adjacent WAS pumps would be the preferred pump configuration for this option.

Concept drawings for this option are shown in Figure A-2 to Figure A-4 located in Appendix A.
Assumptions

This option assumes that:

- the existing rising main will be retained for servicing OD2 exclusively
- upsizing the existing rising main along its current alignment between the oxidation ditches poses a significant construction and health and safety risk as it is located in a heavily serviced area and is not considered feasible
- the new DN375 rising main discharging to the outer wall of OD1 will not affect the treatment process
- all new RAS/WAS pumps will be fitted with VSD’s for flow control

6.1.2 Option A2 - Augment existing gravity pipework and upgrade RAS pump station

This option increases the existing RAS capacity by undertaking the following:

- upsizing the existing gravity pipework from the sludge collection boxes to the current RAS pump station size from DN450 and DN600 to DN600 and DN750 respectively and lowering the invert level of pipe entering the existing RAS wet well. Increasing the pipework size between the sludge collection boxes and the existing RAS pump station wet well increases the hydraulic gradient and drives more flow under gravity from the clarifiers to the RAS station wet well
- installing new pumps to meet maximum flow requirement of 822 L/s. These pumps will be installed in a duty/standby arrangement. Analysis identified that the optimal arrangement for this option is to install separate pump sets for discharging to OD1 and OD2 individually. Preliminary examinations have concluded this not feasible under the current arrangement and additional space for the new pumps sets would be required. It is therefore proposed in this option to convert the existing dry well/wet well arrangement to wet well arrangement. This can be achieved by demolishing the centre wall of the well and replacing the existing dry mounted pumps with submersible pumps
- constructing a new DN375 rising main to connect into the outer channel (aerobic zone) of OD1. This is the preferred discharge location from process perspective. The existing rising main configuration will be changed to discharge to OD2 only. This philosophy is similar to that of Option A1.
- the existing DN450 gravity mains from the sludge collection boxes, the screening system and the DN600 mains to the RAS pump station will become redundant under this option and therefore be remediated.

Concept drawings for this option are shown in Figure A-5 to Figure A-6 located in Appendix A.

Assumptions

- the existing rising main will be retained for servicing OD2 exclusively
- a new rising main will connect into the outer wall of OD1
• the new DN375 rising main discharging to the outer wall of OD2 will not affect the treatment process
• the existing dry well can be converted to a wet well and new submersible pumps installed (2 x
duty/standby configuration; 4 pumps total)
• no changes to the existing WAS system will be required
• all new RAS pumps will be fitted with VSD’s for flow control.

6.1.3 Option A3 - Install new RAS pumps to augment existing RAS system

This option increases the existing RAS capacity by undertaking the following:
• removing the bellmouths within the sludge collection boxes. This will increase the hydraulic drive
between the clarifiers and the sludge collection boxes
• constructing a new RAS station adjacent to each existing sludge collection box. Each station will
consist of two RAS pumps which will operate in a duty/stand-by arrangement (as per option A1). The
maximum flows from each new RAS stations will be 219 L/s
• converting the sludge collection boxes to wet wells. The new RAS pump station suction pipework will
draw directly from sludge collection boxes.
• the proposed new pump sets will require a new DN375 rising main to be constructed and will
discharge into the outer channel (aerobic zone) of OD1. This is the preferred discharge location from
process perspective. The existing RAS station will continue to operate at its maximum flowrate (385
L/s) and continue to utilise the DN375/DN300 RAS A rising main, however it will be reconfigured to
discharge to OD2 only.

Concept drawings for this option are shown in Figure A-7 to Figure A-9 located in Appendix A.

Assumptions
• the existing RAS pump station can return a maximum flowrate of 385 L/s to the ODs
• the existing sludge collection boxes are of sufficient size to prevent drawdown during peak flows
• the new RAS pump sets will convey flows to OD1 only
• all RAS pumps will be fitted with VSD’s for flow control
• WAS pumping can be maintained from the existing RAS pump station wet well

6.2 RAS ‘B’ upgrade options

The upgrade options for the RAS ‘B’ system are based on a maximum design flowrate of 1,238 L/s. All
options identified draw flows from clarifiers 5, 6, 7 and 8 and discharge to ODs 3 and 4 as per the current
arrangement.
6.2.1 Option B1 - RemEDIATE existing RAS system and install new RAS pumps

This option increases the existing RAS capacity by undertaking the following:

- connecting new pumps directly to the clarifier underflow pipework. It is proposed to achieve this by cutting-in a Tee to each clarifier outflow pipe. This will feed the new RAS/WAS pump suction manifold for each RAS station.
- constructing two new RAS/WAS stations adjacent to the existing flow distribution chamber. Each station will consist of two RAS and two WAS pumps, both of which will operate in a duty/stand-by arrangement.
- reconfiguring one of the existing DN600 gravity pipes between the flow distribution chamber and the RAS B screening chamber as a DN600 rising main and connecting to the existing DN500 rising mains. It is proposed that the RAS pumps that draw flows from clarifiers 5 and 7 will discharge to OD4 and the RAS pumps that draw flows from clarifiers 6 and 8 will discharge to OD3.
- connecting the new WAS pumps to the existing DN225 WAS via the construction of a new DN225 rising main. The WAS system will still discharge to balance storage located outside the sludge building under this option.
- the existing outer ring of the clarifier flow distribution chamber, the parallel DN600 gravity pipework, existing RAS B screening chamber and the existing RAS B and WAS B pump stations will become redundant under this option and therefore will be remediated.

Concept drawings for this option are shown in Figure A-10 to Figure A-11 located in Appendix A.

Assumptions

- the existing gravity mains between the flow distribution chamber and the RAS B screening chamber can be converted to a rising main.
- the existing clarifier underflow pipework is fit for use as suction pipework for the new RAS and WAS pump sets.
- the pump stations can be constructed in the space available between the clarifier underflow pipework and the distribution chamber.
- all RAS pumps will be fitted with VSD’s for flow control.

6.2.2 Option B2 - AugMENT existing gravity pipework and upgrade RAS pump station

This option increases the existing RAS capacity by undertaking the following:

- interconnecting the clarifier underflow pipework prior to the flow distribution chamber, upsizing one of the parallel DN600 gravity pipes to DN750, diverting existing DN600 and connecting the proposed DN750 pipes to a new DN3600 RAS wet well at an increased depth.
• install new RAS pump sets to the existing RAS B dry well. These pumps will operate in a duty/stand-by arrangement and discharge to the existing DN500 RAS B rising mains. It is proposed to maintain the current discharge arrangement where one pump set discharges to OD3 and the other discharges to OD4. Whilst the existing rising mains are considered as constrained under the identified assessment criteria, they are considered acceptable for future use as there are pumps available which meet the future operating head requirements under maximum flow conditions.

• construction of new WAS wet wells to allow full submergence of the existing WAS pump suction pipework under maximum flow conditions

• the existing outer ring of the clarifier flow distribution chamber and the existing RAS B screening chamber will become redundant under this option and therefore will be remediated

Concept drawings for this option are shown in Figure A-12 to Figure A-13 located in Appendix A.

Assumptions

• the existing pump suction and discharge manifolds can be modified within the existing dry well to accommodate new pumps

• the connectivity between the new wet wells and the existing RAS B / WAS B stations is feasible

• all RAS pumps will be fitted with VSD’s for flow control

6.3 Options not considered for investigation

The following options were discussed at the options workshop held in March 2012 but were not considered as feasible solutions for augmenting the RAS systems:

• **Upsizing the clarifier underflow pipework**: The existing clarifier underflow pipework has been identified as a major hydraulic constraint for both the RAS A and RAS B systems. The upsizing of these pipes, whilst considered as technically possible, would involve an extremely high degree of risk in terms of constructability, construction risk to existing plant and health and safety. On this basis this option was not considered for further investigation.

• **Install pumps to augment existing RAS B system**: Whilst this option is feasible and has been discussed for RAS A (Option A3) it is not feasible for the RAS ‘B’ system due to the hydraulic limitations of the existing clarifier distribution structure.
7. OPTIONS EVALUATION

The RAS system upgrade options were hydraulically analysed to determine the feasibility of the upgrade strategy prior to further investigation. The results of the hydraulic analysis are discussed in Section 7.1. The hydraulically feasible options were then taken forward and assessed against cost and non cost criteria. Benefits/opportunities and risks were also identified for each option as part of the non-cost assessment, and are discussed in Section 7.2. First principles cost estimates were developed for each of the options under investigation and are discussed in Section 7.3.

7.1 Hydraulic Analysis

The results of the hydraulic analysis are summarised below in Table 7-1.

Table 7-1: Results of Hydraulic Analysis

<table>
<thead>
<tr>
<th>Option</th>
<th>Pipework</th>
<th>Pump Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Clarifier Pipework</td>
<td>Gravity Mains</td>
</tr>
<tr>
<td>A2</td>
<td>Clarifier Pipework</td>
<td>Gravity Mains</td>
</tr>
<tr>
<td>A3</td>
<td>Clarifier Pipework</td>
<td>Gravity Mains</td>
</tr>
<tr>
<td>B1</td>
<td>Clarifier Pipework</td>
<td>Gravity Mains</td>
</tr>
<tr>
<td>B2</td>
<td>Clarifier Pipework</td>
<td>Gravity Mains</td>
</tr>
</tbody>
</table>

Heavily constrained – RED
Constrained – ORANGE
Not constrained – GREEN

Detailed hydraulic analysis of all options can be found in Appendix C.

The results of the hydraulic analysis indicate that Options A2 and A3 are not hydraulically feasible. This is solely due to insufficient hydraulic drive available to overcome high headlosses associated with the DN300 clarifier underflow pipework under maximum flow conditions. This results in the converted sludge collection boxes and RAS A wet well being drawn down to failure for both options.

The DN300 clarifier underflow pipework is sufficiently sized for Option A1 as the net positive suction head (NPSH) of the proposed new RAS pumps is able to overcome the high headlosses associated with this pipework. The velocity in the underflow pipework would be approximately 3 m/s.

As discussed in Section 6.3 upsizing these pipes involves a high level of risk in terms of constructability, construction risk and health and safety and is not considered viable.

Therefore Options A1, B1 and B2 were taken forward for further analysis.
7.2 Risks and Benefits/Opportunities

This section outlines the risks and benefits/opportunities identified for all of the hydraulically feasible options identified for upsizing the RAS A and RAS B system capacity.

7.2.1 Option A1

The following benefits/opportunities have been identified for Option A1:

<table>
<thead>
<tr>
<th>Benefits/Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>- removes limitations of gravity-driven flow to the existing RAS pump station</td>
</tr>
<tr>
<td>- removes problems associated with pump cavitation of RAS pumps (pumps currently limited to 43 Hz to avoid cavitation)</td>
</tr>
<tr>
<td>- removes problems associated with the inability to run RAS and WAS at same time (draws down wet well)</td>
</tr>
<tr>
<td>- avoids augmentation of existing rising mains in a heavily congested service corridor</td>
</tr>
<tr>
<td>- VSDs fitted to new RAS stations allow controlled draw off from the clarifiers and controlled delivery to OD1 and OD2</td>
</tr>
<tr>
<td>- new RAS pump station simple to operate</td>
</tr>
<tr>
<td>- ability to configure rising mains to serve either OD through the use of actuated valves</td>
</tr>
<tr>
<td>- minimises construction impacts on existing plant</td>
</tr>
</tbody>
</table>

The following risks have been identified for Option A1:

<table>
<thead>
<tr>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>- space constraints around the existing sludge collection boxes, clarifiers and pipework poses a construction risk</td>
</tr>
<tr>
<td>- screened RAS flows prior to return to OD1 and OD2 removed (existing screens become redundant)</td>
</tr>
<tr>
<td>- suction manifold design is critical to ensure no cavitation issues are introduced as a result of shared RAS/WAS manifold</td>
</tr>
</tbody>
</table>

The Loganholme WWTP Stage 7 Process Commissioning Report identified that plant A can operate for short periods with two clarifiers offline under existing loads. It is uncertain at present if this statement is still true for future loads, particularly during wet weather events. However the construction of Option A1 can be staged so that only two clarifiers are taken offline at any time. The construction impacts on the existing plant...
are further minimised with this option as only minor modification works would be required to sludge collection boxes to commission the new RAS stations.

The construction of the new rising main and pump stations between the clarifiers and sludge collection boxes is space constrained and poses a construction risk in terms of damage to existing plant and pipework. This can be managed by surveying and potholing the proposed footprint and pipe alignments during the detailed design phase.

Logan Water Treatment Plant operations staff have expressed concerns that the removal of the RAS screen is a risk to the treatment process. Unscreened solids carryover from the clarifiers have previously resulted in blockages of the RAS A pumps. Whilst this is recognized as a potential problem, the proposed construction of the new inlet works complete with improved screening to the plant will provide increased levels of protection to downstream plant processes. It is recommended that a secondary screens monitoring program be implemented to determine if the RAS screens are still required (refer to section 7.6 of this report).

### 7.2.2 Option B1

The following benefits/opportunities have been identified for Option B1:

<table>
<thead>
<tr>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>• removes limitations of gravity-driven flow to the existing RAS pump station</td>
</tr>
<tr>
<td>• existing infrastructure is reused where possible</td>
</tr>
<tr>
<td>• VSDs fitted to new RAS stations allow controlled draw off from the clarifiers and controlled delivery to OD3 and OD4</td>
</tr>
<tr>
<td>• new RAS pump station simple to operate</td>
</tr>
<tr>
<td>• ability to configure rising mains to serve either OD through the use of actuated valves</td>
</tr>
</tbody>
</table>

The following risks have been identified for Option B1:

<table>
<thead>
<tr>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• space constraints around the existing flow distribution chambers, clarifiers and pipework poses a construction risk</td>
</tr>
<tr>
<td>• screened RAS flows prior to return to OD3 and OD4 removed (existing screens become redundant)</td>
</tr>
<tr>
<td>• additional costs incurred if the existing gravity mains cannot be converted to rising mains</td>
</tr>
</tbody>
</table>

The Loganholme WWTP Stage 7 Process Commissioning Report identified that plant B can operate for short periods with two clarifiers off line under existing loads; however it is uncertain if this is still true for future
loads, particularly during wet weather events. However the construction of Option B1 can be staged such that no more than two clarifiers are taken off line at any time. The construction impacts on the existing plant are minimised as each clarifier pair can be isolated via existing penstocks fitted to all inlet and outlet mains at the flow distribution chamber and the installation of temporary plugs where penstocks are not fitted.

The construction of the pump stations and rising main between the clarifiers and flow distribution chamber is space constrained and poses a construction risk in terms of damage to existing plant and pipework. This can be managed by surveying and potholing the proposed footprint during the detailed design phase.

As per Option A1 this option proposed the removal of the RAS screening process. The construction of the new inlet works complete with improved screening to the plant will provide increased levels of protection to downstream plant processes. It is recommended that a secondary screens monitoring program be implemented to determine if the RAS screens are still required (refer to section 7.6 of this report).

The new pump station arrangement assumes that the existing DN600 gravity mains from the flow distribution chamber to the RAS B screening chamber can be converted to rising mains. A condition assessment of the existing pipe will be necessary to determine the feasibility of pressurising this gravity pipe. Potential slip lining of the existing mains, or outright replacement of these mains, may be necessary as a result of the condition assessment. There is a risk that additional costs for the replacement or rehabilitation of these assets may be incurred if the suitability for reuse of these mains are identified as ‘poor’.

7.2.3 Option B2

The following benefits/opportunities have been identified for Option B2:

<table>
<thead>
<tr>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>• existing infrastructure is reused where possible</td>
</tr>
<tr>
<td>• VSDs fitted to new RAS stations allow controlled draw off from the clarifiers and controlled delivery to OD3 and OD4</td>
</tr>
<tr>
<td>• ability to configure rising mains to serve either OD through the use of actuated valves</td>
</tr>
</tbody>
</table>

The following risks have been identified for Option B2:

<table>
<thead>
<tr>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• screened RAS flows prior to return to OD3 and OD4 removed (existing screens become redundant)</td>
</tr>
<tr>
<td>• risk of cost escalation if structural works required to retrofit existing pump station</td>
</tr>
<tr>
<td>• higher headlosses than estimated may result in additional works to meet future RAS flows</td>
</tr>
</tbody>
</table>

As with Option B1, plant B can operate for short periods with two clarifiers off line under existing loads; however it is uncertain if this is still true for future loads, particularly during wet weather events. However
Option B2 can be staged such that no more than two clarifiers are taken off line at any time. The construction impacts on the existing plant are minimised as each clarifier pair can be isolated via existing penstocks fitted to all inlet and outlet mains at the flow distribution chamber and the installation of temporary plugs where penstocks are not fitted.

To increase flows under gravity to the existing RAS pump station in this option one of the gravity mains downstream of the distribution chamber will need to be increased from DN600 to DN750. There is risk that headlosses have been underestimated and may additionally require the second DN600 to be upsized. The cost of this upsize has not been included in the cost estimate.

A pump upsize is required in this option. A complete refit of the internal pump station pipework will be necessary to accommodate the new pumps. It has been assumed that internal refit can be accommodated in the existing pump station; however there is a risk that this may not be possible and that structural works may be required to accommodate the new pump arrangement.

### 7.3 Cost Assessment

A summary of the capital costs of each option is provided in Table 7-2. The costs are shown in 2012 dollars. Detailed cost estimated for all options are located in Appendix D.

#### Table 7-2: Summary of Option Costs

<table>
<thead>
<tr>
<th>Asset Description</th>
<th>Option A1</th>
<th>Option B1</th>
<th>Option B2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ranking</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Mains</td>
<td>$325,851</td>
<td>$287,653</td>
<td>$366,122</td>
</tr>
<tr>
<td>Wastewater pump stations</td>
<td>$381,988</td>
<td>$634,623</td>
<td>$511,552</td>
</tr>
<tr>
<td>Electrical/pump station controls</td>
<td>$250,000</td>
<td>$220,000</td>
<td>$330,000</td>
</tr>
<tr>
<td>Miscellaneous works (1)</td>
<td>$112,910</td>
<td>$122,821</td>
<td>$38,197</td>
</tr>
<tr>
<td>Sub Total</td>
<td>$1,003,980</td>
<td>$1,265,097</td>
<td>$1,245,875</td>
</tr>
<tr>
<td>On-cost and contingency</td>
<td>$401,592</td>
<td>$506,039</td>
<td>$498,350</td>
</tr>
<tr>
<td>Total</td>
<td>$1,405,572</td>
<td>$1,771,136</td>
<td>$1,744,225</td>
</tr>
<tr>
<td>Cost relative to lowest cost option</td>
<td>$0</td>
<td>$26,911</td>
<td>$0</td>
</tr>
<tr>
<td>Cost relative to lowest cost option (%)</td>
<td>0%</td>
<td>2%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Notes:
1. Includes cut-in works, ancillary items and decommissioning costs. Cost estimates for new pump dry wells include $100,000 cost for gantry crane system for pump maintenance and removal.
2. 20% on-cost and 20% contingency applied

Table 7-2 shows that Option B2 was found to be the lowest cost option for the RAS B capacity upgrade. Option B2 was approximately 2% cheaper than that of Option B1.
7.4 Non-cost assessment

A Multi-Criteria Assessment (MCA) was undertaken to evaluate the non-cost considerations for each of the RAS B upgrade options. Logan Water Treatment Plant operators were consulted during the non-cost assessment to gauge the expected operator-related issues with the identified options.

The results of the MCA are summarised in Table 7-3. The MCA framework and the rationale used to develop each of the criteria are detailed in Appendix E.

**Table 7-3: MCA for RAS B system upgrade options**

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>WEIGHTING (%)</th>
<th>OPTION B1</th>
<th>OPTION B2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical</td>
<td>90</td>
<td>81.9</td>
<td>65.7</td>
</tr>
<tr>
<td>Environmental</td>
<td>10</td>
<td>9.6</td>
<td>4.4</td>
</tr>
<tr>
<td><strong>Total Score (out of 100)</strong></td>
<td></td>
<td>91.5</td>
<td>70.1</td>
</tr>
<tr>
<td>MCA Rank</td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

7.4.1 RAS ‘B’ MCA outcomes

Option B1 scored considerably higher than the alternative options as it provides the following benefits:

- it provides greater certainty in achieving the required flow rates compared to the gravity driven option (Option B2)
- allows greater flow control of the RAS process through use of pumps and variable speed drives
- it has the same operational philosophy as Option A1; therefore simplifying operator training requirements
- it has the lowest risk for construction impacts on the existing plant

Additionally Option B2 involves some risk surrounding potential upsizing of the second DN600 gravity main and potential retrofit of the existing station that could affect the overall cost of this option.

7.5 Preferred upgrade option

Cost and non-cost considerations have been taken into account when selecting the preferred option for each RAS system upgrade.

Option A1 was considered the only feasible option identified for the upgrade of the RAS A system and is therefore adopted as the preferred RAS A upgrade option.

Option B1 was selected as the preferred option for RAS B system. Whilst it was not the lowest cost option, it provides greater certainty in achieving the required RAS flowrates and involves the lowest risk for construction impacts on the existing plant.
The preferred options for each pump station and costs associated for the implementation of the options are outlined in Table 7-4.

**Table 7-4: Preferred options**

<table>
<thead>
<tr>
<th>Pump Station</th>
<th>Preferred Option</th>
<th>Cost Estimate ($2012)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAS A</td>
<td>Option A1</td>
<td>$1,499,049</td>
</tr>
<tr>
<td>RAS B</td>
<td>Option B1</td>
<td>$1,771,136</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$3,270,185</td>
</tr>
</tbody>
</table>

### 7.6 Secondary Screens Monitoring Program

It has been identified that a monitoring program should be implemented in order to determine if secondary screening prior to RAS return is still required once the new inlet works have been commissioned.

It is envisaged that this monitoring program would consist of:

- a visual inspection of the secondary screens prior to construction of the new inlet works. The weight/volume of screenings per day from the secondary screens would provide a base case for comparison
- a visual inspection of the secondary screens once the new inlet works have been commissioned. The weight/volume of screenings per day from the secondary screens could then be compared to the base case. The results could be used to determine if the secondary screens are still required.

Samples should be taken over various flow conditions (i.e. dry days and wet weather) and should also account for seasonal variations (summer/winter).

If it was found that the secondary screens were still required after the commissioning of the new inlet works then the following could be considered as potential solutions with regard to RAS blockages:

- fit the new RAS pumps with non clog impellers; or
- install macerator/grinder pumps to the new RAS stations

The use of non clog impellers or macerator/grinder pumps would however need to be further examined in the detailed design phase to verify their suitability for this application.
8. TIMING OF THE PROPOSED WORKS

The Loganholme WWTP currently operates at a solids retention time (SRT) of approximately 15 days. The Loganholme WWTP Stage 7 Process commissioning report identified that the plant design capacity of 67 ML/d ADWF could be achieved by reducing the SRT to approximately 10 days and allowing sludge to be stored in the clarifiers during peak flow events, however this is the absolute limit that the plant can operate at to meet licence requirements.

8.1 Sludge storage in clarifiers

The Loganholme Wastewater Treatment Plant Hydraulic Upgrade Planning report identified that the RAS system would need to be upgraded immediately under the current operating arrangements (SRT of 15 days) in order to ensure that no sludge storage occurred in the clarifiers during peak flow events. This is demonstrated in Table 8-1 below.

Table 8-1: Plant capacity estimation

<table>
<thead>
<tr>
<th>Clarifiers</th>
<th>Units</th>
<th>Current Operation @ 40ML/d ADWF (SRT 15 Days)</th>
<th>Future Operation @ 67 ML/d ADWF (SRT 10 Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No sludge storage</td>
<td>With sludge storage</td>
</tr>
<tr>
<td></td>
<td>OD 1/2</td>
<td>OD 3/4</td>
<td>OD 1/2</td>
</tr>
<tr>
<td>Existing RAS capacity</td>
<td>ML/d</td>
<td>31</td>
<td>35</td>
</tr>
<tr>
<td>Required RAS capacity</td>
<td>ML/d</td>
<td>40</td>
<td>72</td>
</tr>
<tr>
<td>Total RAS Capacity</td>
<td>ML/d</td>
<td>71</td>
<td>107</td>
</tr>
<tr>
<td>Estimated ADWF WWTP Capacity</td>
<td>ML/d</td>
<td>35</td>
<td>51</td>
</tr>
<tr>
<td>Year Upgrade required</td>
<td>Year</td>
<td>2012</td>
<td>2019</td>
</tr>
</tbody>
</table>

However if sludge storage was allowed to occur in the clarifiers during peak flow conditions then the RAS capacity upgrade is not required until 2019. Effluent suspended solids (SS) may increase as a result of the reduced mixed liquor suspended solids (MLSS) concentrations in the ODs but gross solids loss should not occur during peak flows. However beyond 2019 gross clarifier failure (loss of sludge blanket) would be expected to regularly occur during peak flows.

Reducing the treatment plant SRT from 15 days to 10 days defers the requirement for the RAS upgrades. Solids accumulation in the clarifiers would not be expected to occur until 2017. The plant could potentially
operate at its design capacity without upgrading the RAS systems if sludge storage was allowed to occur in the clarifiers; however this is the absolute limit that the plant can operate at to meet licence requirements.

It should be noted that whilst gross clarifier failure is not likely to occur until beyond 2019, some solids carryover from the clarifiers to the disinfection process may occur during sustained peak flows. This would have serious implications on the disinfection process, as free chlorine would be consumed by the suspended solids, and could result in faecal coliform in addition to SS non-compliances during peak flow events.

8.2 Existing plant performance – Effluent Suspended Solids

The release quality characteristics for effluent SS at Loganholme WWTP are given below in Table 8-2.

Table 8-2: Loganholme WWTP release quality characteristics for effluent SS

<table>
<thead>
<tr>
<th>Quality Characteristic</th>
<th>80th percentile (short term)</th>
<th>80th percentile (long term)</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspended Solids (mg/L)</td>
<td>15</td>
<td>10</td>
<td>30</td>
</tr>
</tbody>
</table>

Figure 8-1 shows the performance of the Loganholme WWTP with regard to effluent SS since October 2009.

![Figure 8-1: Monitored effluent SS performance](image-url)
Examination of the WWTP data from the last 3 years shows:

- 6 non-compliances of maximum effluent SS limits have been recorded since October 2009
- some non-compliances for short-term and long-term 80th%ile effluent SS limits were recorded in 2009 and 2010

The Stage 7 process commissioning was completed in August 2010. WWTP data since this time shows:

- 1 non-compliance of maximum effluent SS
- 0 non-compliances for short-term and long-term 80th%ile effluent SS limits
- effluent SS maximums occurred during peak storm events
- the only non-compliance that occurred in the last 2 years was during a bypass event, which has no limit for effluent SS (only requires fine screening & degritting)
- recorded short-term & long-term 80th%ile effluent SS values are approximately 50% of the allowable licence limits

This suggests that the Stage 7 plant upgrade has improved the overall effluent SS quality, subsequently reducing the amount of non-compliances observed at Loganholme WWTP.

It is likely that the existing clarifier performance (measured by effluent SS) will not change in the short term given that:

- the clarifiers have enough capacity to store sludge during peak flows until the year 2019 under the current operating regime (SRT 15 days)
- current short term and long term 80th percentile effluent SS values are consistently half the licence limits since the commissioning of Stage 7 at Loganholme WWTP

8.3 Implications of not undertaking the RAS upgrades

It has been shown in sections 8.1 and 8.2 that it is possible to defer the RAS upgrades indefinitely if the plant SRT is reduced to 10 days and if sludge storage in the clarifiers is allowed during peak flow events. It has also been identified that there is an increased risk of faecal coliform and effluent SS non-conformances with the WWTP licence if the RAS upgrades are not undertaken, particularly as the plant approaches its design capacity.

The Department of Environment and Heritage Protection (DEHP) has the capacity to penalise a Water Authority for reported non-conformances against a WWTP discharge licence. These penalties, in the form of fines, can range from $416,500 under the Environmental Protection Act to $5 million under the Environmental Protection Biodiversity Conservation Act. Fines can be issued for each reported licence non-conformance. The severity of fines is highly dependent on what reasonable and practical steps a Water Authority has taken to reduce the risk of non-conformances.
8.4 Agreed timing of the proposed works

It has been identified that the works may not be required if sludge storage is allowed to occur in the clarifiers during peak events and the SRT at the WWTP was reduced to 10 days. At a presentation to LCC Stakeholders on the 5th of December 2012 a consensus was reached that the works are not immediately required for the following reasons:

- only 1 non-compliance of maximum effluent SS has been reported since the completion of Stage 7 upgrades in August 2010. This non-compliance was reported during a peak flow event with the bypass in operation.
- the recorded short-term & long-term 80th%ile effluent SS values are approximately 50% of the allowable licence limits
- the risk of licence non-compliances due to solids carryover to the disinfection process can be managed in the short term by reducing the plant SRT from 15 to 10 days
- the wasting and biosolids handling processes at Loganholme are currently under investigation by the LWA. Improvements to these processes would help reduce solids storage in the clarifiers
- the Loganholme WWTP licence is currently under review with DEHP

It was identified that the upgrade works should be added to the 2017 capital works program and the need for the works reassessed prior to this date.

8.5 Capital works implications

The proposed upgrade works are not currently included in the Logan Water Capital Works program. Therefore the works, as identified in Table 8-3, will need to be added to the capital works program.

Table 8-3: Capital works for preferred options

<table>
<thead>
<tr>
<th>Capital Works</th>
<th>Total Capacity</th>
<th>Total Cost ($2012)</th>
<th>Year Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upgrade Stage 7 Loganholme WWTP - RAS A capacity</td>
<td>822 L/s</td>
<td>$1,449,049</td>
<td>2017</td>
</tr>
<tr>
<td>Upgrade Stage 7 Loganholme WWTP - RAS B capacity</td>
<td>1,238 L/s</td>
<td>$1,771,136</td>
<td>2017</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>$3,270,185</strong></td>
<td></td>
</tr>
</tbody>
</table>
9. CONCLUSIONS

The following conclusions are drawn from this study:

- the Loganholme WWTP plant design capacity of 67 ML/d ADWF can be theoretically achieved at a Solids Retention Time (SRT) of approximately 10 days without upgrading the RAS capacity, however this is the absolute limit that the plant can operate at and assumes that solids storage will be allowed to occur in the clarifiers during periods of peak flow.

- there is an increased risk of faecal coliform non-compliances in addition to effluent SS non-compliances during peak flow events if the RAS systems are not upgraded, particularly as the plant approaches its design capacity.

- there are current hydraulic constraints that prevents the RAS A pumps from operating at their full capacity. In addition to this, the WAS A pumps cannot be operated in conjunction with the RAS A pumps during peak flows. This is attributed to insufficient hydraulic capacity of the clarifier underflow pipework and insufficient net positive suction head of the existing RAS pumps.

- any upgrades to the existing RAS systems will require at least two clarifiers to be taken off-line to facilitate connection of the new works. Recent studies have determined that the plant can operate satisfactorily with two clarifiers off line under existing loads; however it is uncertain at present if this is true for future loads, particularly during wet weather events.

- Option analysis was undertaken to determine the preferred option for each pump station based on assessment of cost and non-cost criteria. Option A1 was selected as the preferred option to upgrade RAS A pump station and Option B1 was selected as the preferred option to upgrade RAS B pump station. In both cases the preferred option to increase RAS capacity involved constructing new RAS pump stations that draw directly off the existing clarifier underflow pipework rather than augmenting existing infrastructure to increase hydraulic drive (flow capacity under gravity) through the process. This is largely because:
  - it provides greater certainty in achieving the required flow rates compared to the gravity driven option (Option B2)
  - allows greater flow control of the RAS process through use of pumps and variable speed drives
  - both options have similar operational philosophies; therefore simplifying operator training requirements
  - it has the lowest risk for construction impacts on the existing plant.
10. **RECOMMENDATIONS**

Based on the outcomes of this study, the Logan Water Alliance recommends that:

1. LCC adopt Options A1 and B1 as the preferred augmentation strategies for increasing the RAS capacity at Loganholme WWTP
2. the proposed works be added to the 2017 capital works program
3. the need for the RAS upgrades be reviewed prior to 2017
4. the clarifier performance be closely monitored during peak flow events, particularly as the plant approaches its design capacity (67 ML/d ADWF)
5. a secondary screens monitoring program be implemented to determine if the RAS screens are still required once the new Loganholme WWTP inlet works have been commissioned
11. REFERENCES

Task 90-10-99 - Loganholme Wastewater Treatment Plant Hydraulic Upgrade Planning (LWA, August 2011)

Task 90-11-19 - Logan South Wastewater Servicing Plan (LWA, February 2012)

Task 90-11-42 - Loganholme WWTP Stage 7 Process Commissioning (LWA, July 2012)
Appendix A  Figures
FIGURE A-2

**RAS UPGRADE SCOPING STUDY**

**OPTION A1**

**DIVERSION OF EXISTING RAS PUMP STATION**

- **NEW RAS PUMPS INSTALLED ON CLARIFIER DRAW-OFF PIPEWORK**
- **NEW RAS RISING MAINS**
- **NEW RISING MAIN DISCHARGE INTO OXIDATION DITCH 1 (OD1)**
- **CONNECT TO EXISTING WAS RISING MAIN**
- **CONNECT TO EXISTING WAS LINE**
- **NEW RAS DELIVERY LINE**

Legend:
- MIXED LIQUOR:
- RAS LINE:
- CLARIFIED EFFLUENT:
- RAS DELIVERY LINE:
- WAS LINE:
NEW PUMP STATION AND SLAB/DRY WELL

SECTION A-A

FROM CLARIFIERS

DRAWING NOTES
- DRAWING NOT TO SCALE
- PUMP CONFIGURATIONS SHOWN ARE CONCEPTUAL AND DO NOT NECESSARILY REPRESENT FINAL PUMP ARRANGEMENT

TO OXIDATION DITCHES

TO SLUDGE DEWATERING

RAS DUTY
RAS STANDBY

WAS DUTY
WAS STANDBY

FROM CLARIFIERS

RAS

DUTY

WAS

DUTY

NEW PUMP STATION AND SLAB/DRY WELL

FROM CLARIFIERS

RAS

STANDBY

WAS

STANDBY

FIGURE A-3

Page 2 of 8

RAS UPGRADE SCOPING STUDY

OPTION A1 - DETAIL A
PUMP STATION CONCEPT

Legend

Revised
Nov 7, 2012

FIGURE NO.
FIGURE A-3
NEW PUMPS INSTALLED IN DRY WELL

SUCTION PIPEWORK INSTALLED ONTO EXISTING FLANGED PIPEWORK

SLUDGE COLLECTION BOX

FROM CLARIFIERS

TO OXIDATION DITCHES

ADJUSTABLE BELLMOUTHS REMOVED

DRAWING NOTES
- DRAWING NOT TO SCALE
- PUMP CONFIGURATIONS SHOWN ARE CONCEPTUAL AND DO NOT NECESSARILY REPRESENT FINAL PUMP ARRANGEMENT

TWL 9.23

FSL

NEW PUMPS INSTALLED IN DRY WELL
NEW DN375 MAIN FROM RAS PUMP STATION TO OXIDATION DITCH

CONVERT PUMP STATION TO WET WELL ARRANGEMENT AND INSTALL NEW SUBMERSIBLE PUMPS

NEW DN750 MAIN FROM MANHOLE 'A' TO RAS PUMP STATION

NEW DN1800 MANHOLE 'A'

LAY DN600 MAINS FROM EXISTING SLUDGE COLLECTION BOXES TO MANHOLE 'A'

NEW DN375 MAIN FROM RAS PUMP STATION TO OXIDATION DITCH

ABANDON EXISTING SCREENING CHAMBER

REMOVE BELLMOUTHS IN EXISTING SLUDGE COLLECTION BOXES

LAY DN600 MAINS FROM MANHOLE 'A' TO RAS PUMP STATION

NEW DN750 MAIN FROM RAS PUMP STATION TO OXIDATION DITCH

NEW DN375 MAIN FROM RAS PUMP STATION TO OXIDATION DITCH

DN600

DN750

DN375
ESTIMATED TWL AT MAXIMUM RAS FLOW (822 L/s), submergence ~ 600mm

EXISTING GRAVITY MAINS AND SCREENING CHAMBER ABANDONED

NEW DN600 AND DN750 GRAVITY MAINS

ESTIMATED TWL AT MAXIMUM RAS FLOW (822 L/s), submergence ~ 600mm
RAS UPGRADE SCOPING STUDY

PROJECT

LOGAN WATER ALLIANCE

REVISED

NOV 7, 2012

FIGURE NO.

FIGURE A-7

PAGE

6 of 8

DRAWING TITLE

OPTION A3

DIVERSION OF EXISTING RAS PUMP STATION

LEGEND

MIXED LIQUOR
RAS LINE
CLARIFIED EFFLUENT
RAS DELIVERY LINE

WAS LINE
TO OXIDATION DITCHES

NEW PUMP STATION DRY WELL

SECTION A-A

FROM CLARIFIERS

RAS DUTY

RAS STANDBY

INSTALL RAS SUCTION PIPEWORK IN SLUDGE COLLECTION BOXES

EXISTING BELLMOUTH OUTLETS REMOVED

FROM CLARIFIERS

DRAWING NOTES
- DRAWING NOT TO SCALE
- PUMP CONFIGURATIONS SHOWN ARE CONCEPTUAL AND DO NOT NECESSARILY REPRESENT FINAL PUMP ARRANGEMENT
NEW PUMPS INSTALLED IN DRY WELL

SUCTION PIPEWORK INSTALLED INTO SLUDGE COLLECTION BOX

TO OXIDATION DITCHES

SLUDGE COLLECTION BOX

FROM CLARIFIERS

FSL

--- DRAWING NOTES ---
- DRAWING NOT TO SCALE
- PUMP CONFIGURATIONS SHOWN ARE CONCEPTUAL AND DO NOT NECESSARILY REPRESENT FINAL PUMP ARRANGEMENT
- TWL BASED ON MAXIMUM FLOWS FROM CLARIFIERS (410 L/s total)
- WATER LEVELS ARE THEORETICAL ESTIMATES BASED ON ESTIMATED HEAD LOSSES

NEW PUMPS INSTALLED IN DRY WELL

SUCTION PIPEWORK INSTALLED INTO SLUDGE COLLECTION BOX

TO OXIDATION DITCHES

SLUDGE COLLECTION BOX

FROM CLARIFIERS

FSL

--- DRAWING NOTES ---
- DRAWING NOT TO SCALE
- PUMP CONFIGURATIONS SHOWN ARE CONCEPTUAL AND DO NOT NECESSARILY REPRESENT FINAL PUMP ARRANGEMENT
- TWL BASED ON MAXIMUM FLOWS FROM CLARIFIERS (410 L/s total)
- WATER LEVELS ARE THEORETICAL ESTIMATES BASED ON ESTIMATED HEAD LOSSES

Approx. 650mm submergence depth available at max flow.
RISING MAINS RECONFIGURED

TO OXIDATION DITCH 4

TO OXIDATION DITCH 3

RAS B PUMP STATION TO BE DECOMMISSIONED

EXISTING WAS PUMPS DECOMMISSIONED

NEW RAS AND WAS PUMPS INSTALLED

REFER DETAIL A

RECOMMISSION EXISTING WAS LINE

EXISTING WAS LINE

MIXED LIQUOR

RAS LINE

CLARIFIED EFFLUENT

WAS LINE

SUCTION LINE

RAS DELIVERY LINE
RAS UPGRADE SCOPING STUDY

GENERAL ARRANGEMENT DETAIL – OPTION B1

Legend
- MIXED LIQUOR
- SUCTION LINE
- RAS LINE
- CLARIFIED EFFLUENT
- WAS LINE

DISTRIBUTION CHAMBER

PROPOSED DUTY/ASSIST PUMP SET (PLUS STANDBY) CONNECTED TO RAS RETURN LINES FROM CLARIFIERS

CONNECTS TO EXISTING WAS LINE
CONSTRUCT NEW RAS SUCTION WELL – REFER DETAIL A

INSTALL DN600 CONNECTIONS TO RAS RETURN LINES (BYPASS EXISTING DISTRIBUTION CHAMBER)
CONSTRUCT NEW RAS SUCTION WELL

RAS PIPEWORK TO BE DIVERTED TO NEW SUCTION WELL

CONNECT TO EXISTING WAS SUCTION WELL

DIVERT GRAVITY MAINS INTO NEW RAS SUCTION WELL

UPGRADE EXISTING RAS PUMPS

MODIFY EXISTING WAS SUCTION WELL

EXISTING RAS SCREENING/SUCTION WELL TO BE DECOMMISSIONED

CONSTRUCT NEW RAS SUCTION WELL

RAS PIPEWORK TO BE DIVERTED TO NEW SUCTION WELL

CONNECT TO EXISTING WAS SUCTION WELL

EXISTING RAS SCREENING/SUCTION WELL TO BE DECOMMISSIONED

CONNECT TO EXISTING WAS SUCTION WELL

MODIFY EXISTING WAS SUCTION WELL

Divert Gravity Mains into New RAS Suction Well

Upgrade Existing RAS Pumps
Appendix B  Option Workshop Meeting Minutes
# MEETING MINUTES

**MEETING:** RAS Upgrade Scoping Study – Concept development Workshop  
**MEETING NUMBER:** 1  
**DATE:** 13/03/2012  
**START TIME:** 10:35 am  
**END TIME:** 1:10 pm  
**LOCATION:** Loganholme WWTP  
**CHAIRMAN:** Liliana Castro

## ATTENDEES

<table>
<thead>
<tr>
<th>NAME (Present = YES)</th>
<th>ABBR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ian Cameron</td>
<td>IC</td>
</tr>
<tr>
<td>Simon Hawkes</td>
<td>SH</td>
</tr>
<tr>
<td>Kevin Killalea</td>
<td>KK</td>
</tr>
<tr>
<td>Ken Hartley</td>
<td>KH</td>
</tr>
<tr>
<td>Chitra Liyanage</td>
<td>CL</td>
</tr>
<tr>
<td>Colin Salem</td>
<td>CS</td>
</tr>
<tr>
<td>Simon Rasmussen</td>
<td>SR</td>
</tr>
<tr>
<td>Liliana Castro</td>
<td>LC</td>
</tr>
<tr>
<td>David Kent</td>
<td>DK</td>
</tr>
<tr>
<td>Paul Campbell-Cowie</td>
<td>PCC</td>
</tr>
<tr>
<td>Stephen Walters</td>
<td>SW</td>
</tr>
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</table>

## APOLOGIES/CC:

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<tbody>
<tr>
<td>Phil Selmes</td>
<td>PS</td>
</tr>
<tr>
<td>Gary Goodliffe</td>
<td>GG</td>
</tr>
<tr>
<td>Scott Francis</td>
<td>SF</td>
</tr>
</tbody>
</table>
### MINUTES

<table>
<thead>
<tr>
<th>NUMBER:</th>
<th>ITEM:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>LC: Introduction and explanation of workshop objective – Develop 2-3 conceptual options for upgrading RAS system and provide cost estimate for preferred option to upgrade.</td>
</tr>
</tbody>
</table>
| 2.     | Query re: screening requirement at RAS  
RAS screens initially installed due to underperformance of screening at inlet works. RAS screens were retro fitted (around same time as construction of Clarifier 5 & 6).  
**Question:** With new inlet works to be constructed, is screening of RAS return flows required?  
The screens are to be retained until the new inlet works are complete and screening improvements are experienced throughout the plant. It is assumed that the new inlet works will reduce the screenings passed forward. If this is observed then the RAS screens could be removed, however it is preferable that the RAS screens be retained if possible. |
| 3.     | **Question:** Any issues with floc breakup due to high pumping velocities?  
KH: There is no issue with floc break-up as particles will reflocculate through the plant |
| 4.     | Query: Current pump type for RAS process  
Current RAS pumps are confirmed as normal centrifugal wastewater type pumps. There is no requirement for positive displacement pumps. |
| 5.     | **Constraints of existing RAS systems**  
RAS Plant A –  
- Pipework – DN300 pipework under clarifiers C1-C4, DN450 pipework to inlet to screens are a hydraulic limitation to flow out of clarifiers  
- Bellmouths in sludge collection boxes – limitation to maximum draw off capacity from clarifiers (currently estimated at approximately max. 125 L/s per clarifier, 500 L/s total)  
- Pumps – Existing pumps cavitate at flows over 385 L/s – maximum frequency of VFD set at 43Hz for the pump station to limit flow. The existing pumps are operating at the far end of pump curve. If existing rising main is retained high velocities will be experienced for future flows.  
- Wet well – the size of the wet well is limitation to pumping – the WAS and RAS pumps currently draw off the same wet well. The WAS cannot pump beyond a set flow rate or else it... |
impacts minimum flows required by RAS pumps.

RAS Plant B –

Pipework – DN375 pipework under clarifiers and parallel DN600 mains between distribution chamber and RAS screening/wet well is undersized and is a limitation to maximum draw-off capacity from clarifiers (estimated at approximately max.175 L/s per clarifier, 700 L/s total)

Pumps – currently limited to maximum combined pump flow of 350-400 L/s per pump set. PCC commented that the reason for limiting the pump rate is unknown.

BRAINSTORMING:

RAS A – Clarifiers to Bell Mouth Pits

The first suggestion was to remove the bellmouths in the bell mouth pits in order to increase the driving head (and therefore draw-off flow rate from the clarifiers)

KH: there is a process requirement to balance draw-off flows equally between clarifiers

This would require control valves which could be adjusted remotely via SCADA

Option 1 – Installation of pumps to RAS draw off pipework and bypass existing RAS A

This option proposed installing pumps to the clarifier RAS draw off pipework. Pump suction could be fitted directly to the flange within the bellmouth chamber, following removal of the bellmouths or clarifier draw off pipework before the bellmouth pit. If pumps are fitted to the clarifier draw off lines then the bellmouth pits will become redundant and could be decommissioned. New delivery (rising main) lines from each new pump set could pump directly to the oxidation ditches, but more likely connect back into the existing rising mains to reduce additional pipework. Due to the high velocities the system resistance curve will be dominated by friction head and likely be unsuitable for VSD flow control over a large flow range (post meeting comment).

There are variants to this option:

Option 1A: Connect 1 duty + 1 standby pump per Clarifier (8 pumps in total)

This is the ideal solution for RAS A. It involves.

- Removal of bell mouths in bell mouth pits
- Connect additional suction pipework to the flange within the bellmouth chamber and run pipe to new duty/standby pump installation for each clarifier

Option 1B: Connect 1 duty + common standby pump per Clarifier (6 pumps in total)

This solution involves:
7. **Removal of bell mouths in bell mouth pits**
   - Connect additional suction pipework to the flanges within the bellmouth chamber and run pipe to new installation of duty/duty/common standby for each pair of clarifiers

While it was agreed that Option 1B was feasible, it was noted that this would require complex valving in order to maintain an even flow split between the clarifiers, and the additional system design and operational complexity would outweigh the benefits of this option (KISS principle). It was agreed a simple solution would be preferred to a complex solution.

It was also noted that this configuration would make the existing pump station and RAS screening process redundant.

Pumps would require VFD’s in order to operate over a flow range from 0.5ADWF to PWWF.

<table>
<thead>
<tr>
<th>OPTION 2: Investigate increasing flows to the existing pump well</th>
</tr>
</thead>
<tbody>
<tr>
<td>This option proposed undertaking works to increase the flow capacity to the existing wet well by:</td>
</tr>
<tr>
<td>- Removal of bell mouths in bell mouth pits</td>
</tr>
<tr>
<td>- Increasing the hydraulic capacity from the bell mouth pits to the existing wet well (augment with additional conduits or replace existing with larger main)</td>
</tr>
<tr>
<td>- Upsizing the existing pumps to meet the proposed 822 L/s</td>
</tr>
<tr>
<td>- Knocking out the centre wall of the existing RAS pump station in order to provide a greater wet well capacity and alleviate issues with operating WAS pumps and RAS pumps simultaneously</td>
</tr>
</tbody>
</table>

It was also noted that this configuration retains the existing pump station and RAS screening process, however the additional flows could bypass screens depending on the new pipework configuration.

<table>
<thead>
<tr>
<th>OPTION 3: Install pumps in bellmouth pits and retain existing RAS A</th>
</tr>
</thead>
<tbody>
<tr>
<td>This option proposed to retain the existing screen chamber and pumping station and supplement the existing draw off capacity from the clarifiers by installing pumps in the bellmouth pit. This involves:</td>
</tr>
<tr>
<td>- Removal of bell mouths in bell mouth pits</td>
</tr>
<tr>
<td>- Installation of pumps in the bellmouth pit (which will act as a new wet well) and pipework to discharge directly to the oxidation ditches. Pumps controls could be set to start as the sludge draw off becomes restricted by the existing system hydraulics.</td>
</tr>
</tbody>
</table>

It was also noted that this configuration retains the existing pump station and RAS screening process, however the additional flows would pump straight to the oxidation ditches and therefore would not be screened.
OPTION 4: Mount submersible pump directly in clarifier sludge hopper

This option proposed mounting pumps to the moving bridge scrapers in order to increase the draw-off capacity from the clarifiers. This option was dismissed as too complex for the following reasons:

- It is limited to the pipework connection requirements i.e. fixed pipework would require a flexible rotating coupling in order to connect to rotating pipework
- Pipework fixed to the rotating scraper bridge would require an external discharge channel around the clarifiers. There is insufficient clearance around the clarifiers to achieve this.

RAS B –

Option 1: Install pumps clarifier/RAS flow distribution chamber

This option was the same proposed as Option 1 for RAS plant A. It is considered that 2 pumps per clarifier in a duty/standby arrangement is preferred.

Variants of this option include:

- Pumping straight to Oxidation Ditches. Return flows would not be screened and existing RAS B station would be decommissioned
- Pumping to existing RAS B screening chamber. Allows for the existing screens to be maintained but will require the existing RAS pumps to be upsized to meet the proposed 1238 L/s.
- Pumping to existing RAS B wet well, decommission existing screens and upsize existing RAS pumps to 1238 L/s.

Option 2: Increase the hydraulic capacity from the clarifiers (construct new deeper wet well), upsize the existing pump station

This option proposed connecting into the existing clarifier draw-off pipework and laying new sections of pipework to a new deeper wet well in order to:

- Increase the driving head available from the clarifiers to meet the required draw-off flowrate
- This will maintain use of the existing RAS plant; 2 existing small pumps will need to be upsized. Existing larger pumps will need to be assessed to determine suitability for reuse. NPSH requirements will need to be considered, as a greater suction lift will be required with a deeper wet well.
- the existing clarifier/RAS flow distribution chambers will be decommissioned

Option 3: Increase draw-off capacity from the existing clarifiers
Another option suggested in order to increase the draw off capacity of the existing wet well involved laying new outlet pipes from the existing sludge hoppers in the clarifiers.

2 means of achieving this were discussed:

- Underboring from the edge of each clarifier using a trenchless technology (HDD, auger boring, etc)
- Saw-cutting a slot out of the floor of the existing tanks

**Underboring:**

This was considered a high cost, high complexity option. KK indicated that a launching pit approx. 3m by 6m (nom. 3-4m deep) would be required for each underbore. Therefore the size of the launching pit would likely be a constraint.

**Saw-cutting:**

This option was considered undesirable due to the unknown implication of disturbing the structural integrity of the clarifiers. This was also considered to be high risk. The issue of resealing the tank was identified as a risk.

It was agreed that these methods were more complex and carried a higher degree of risk than a pumped solution for increasing the draw-off capacity from the clarifiers. High level costing for the underbores could be sought from drilling contractors who have performed work previously for the Alliance. Structural engineers could also be consulted to better gauge the risk of saw-cutting into the floor of the clarifiers.

12. Construction sequencing. All options require consideration for construction sequencing. This should be undertaken as part of the Multi criteria assessment for the options to help determine the preferred solution to progress to costing.
Appendix C  Hydraulic Analysis
### Loganholme WWTP

#### Logonholme WWTW

**Unknown Information approximated in Red**

**RAS flow into PS**

<table>
<thead>
<tr>
<th>Location</th>
<th>Inlet to RAS 'A' Pump Station</th>
<th>Sludge Box to New MH A</th>
<th>New MH A Losses</th>
<th>New MH A to Main Pump Station</th>
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<td><strong>Area</strong> (m²)</td>
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<td><strong>R Flow</strong> (l/s)</td>
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<td><strong>Velocity</strong> (m/s)</td>
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- **TWL In Clarifier 2**: 7.82
- **9.575**: 7.87
- **7.87**: 9.575
- **TWL is based on no water leaving the system on overflow**
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Assumptions:
- Lengths scaled from drawing "B1 -8215 C"
- TWL in Clarifiers: 45 deg bend 0.30
- Entry 0.50
- Exit 1.00
- TWL In sludge box 9.23
- Losses through parallel DN600 GRP
- DN450 Hobas Class 5000, OD = 478 wall = 10
- DN600 GRP

Notes/Comments:
- This is based on no water leaving the system on overflow
- 30 404.4 404.4
- 0.6
- 0.28 0.149
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<th>Head Loss</th>
<th>Head</th>
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<th>Reynolds</th>
<th>Friction</th>
<th>Minor</th>
<th>Total</th>
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Notes:
- Assumptions: Lengths scaled from drawing. 61 - 615 m.
- Note on gate or plug plate may require raising headwell calculation.

Considers modifying and lowering the invert levels of the DN600 gravity mains entering the existing screening chamber. Based on values assumed this will require deepening of the WAS suction well, suction pipework and confirmation of the Vogelsang rotary lobe NPSHr is met.
### Loganholme WWTP

#### CLARIFIERS 5-8

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<th>Operation</th>
<th>RAS flow into PS</th>
<th>33 107 ML/d</th>
<th>382</th>
<th>1238</th>
<th>L/s</th>
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#### Inlet to RAS "B" Pump Station

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<th>Losses through underflow pipe to dist. Chamber</th>
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<th>0.54</th>
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<tbody>
<tr>
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<td>Length</td>
<td>Losses through parallel DN600 GRP + new DN750</td>
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<td>0.14</td>
<td>0.17</td>
<td>0.19</td>
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#### Notes/Comments

- TWL in Clarifiers
- TWL is based on no water leaving the system on overflow
- Considers upsizing one of the DN600 gravity mains to DN750 so that the existing screening chamber can be maintained and construction of a new RAS suction well avoided. Based on toughness value = 1.5mm is used the TWL in the suction well of the WAS pumps will be only 0.15m. — the water require deemntency of the WAS suction and also, suction pipework and confirmation the ungawing capacity i.e. NPSH is not exceeded.

---

**Assumptions**

- New Pump On Level in Screening chamber/pump suction well
- Available water depth in WAS suction well = 8.8m
- Wet well depth = 4m

---

**Reserve for future development**

- 25% of effective area
- 50% of effective area
- 75% of effective area
Appendix D  Cost Estimates
<table>
<thead>
<tr>
<th>Item Description</th>
<th>Option A1</th>
<th>Option A2</th>
<th>Option A3</th>
<th>Option B1</th>
<th>Option B2</th>
<th>Remarks</th>
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<td>AT O C Costs</td>
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Appendix E  Multi Criteria Assessment
### Technical/Operation/Risk

**Sub Criteria:**
- Security / redundancy / reliability / flexibility:
  - Flexibility of the network. Contingency so that the network can continue to operate during failure of any element of the network without spills to the environment occurring. Ability to provide an ongoing satisfactory level of service, with the minimum possible interruptions or reductions in levels of service below the accepted threshold value. Ability to expand the network and be able to react to changing patterns of growth.

- Construction risk:
  - Potential impact on existing plant from construction methods i.e. damage to plant during construction

- Operability and maintainability:
  - Ability for operators and employees to operate and maintain the infrastructure system in the most effective manner. Includes improved control and monitoring mechanisms, reduction in system complexity and unknowns and reduction in personnel hours required to operate and maintain the system.

- Constructability:
  - Density of development in construction areas, poor soils, deep excavations, river crossings, Major Road and rail crossings etc.

**Weighting:** 90%

### Environmental

**Sub Criteria:**
- Greenhouse gas emission and energy consumption:
  - Greenhouse gas generation

- Construction impact on environment:
  - Impact on environment during construction; eg ASS, contaminated land, cultural heritage

- Operation impact on environment:
  - Potential for spills/overflows from pump stations, surcharging of gravity mains, pipe breaks/bursts etc. Better redundancy etc will minimise this. Flood impacts. Visual amenity.

**Weighting:** 10%

### Scoring System:

**Qualitative:**
- 0 - 1: Number of important deficiencies
- 2 - 4: Significant number of deficiencies but may have merit
- 5 - 6: Merits outweigh the deficiencies. Deficiencies can be managed
- 7 - 8: Considerable merit. Few deficiencies, which can be managed
- 9 - 10: No or few deficiencies. Deficiencies can be designed out.

**Marginal, Fair, Good, Strong, Very Strong**
## MCA RESULTS

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<th>ASSESSMENT CRITERIA</th>
<th>ASSESSMENT CRITERIA WEIGHTING</th>
<th>SUB CRITERIA</th>
<th>SUB CRITERIA WEIGHTING</th>
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<th>OPTION B2</th>
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SUMMARY

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