DEVELOPMENT SERVICES
31 JUL 2008
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1 INTRODUCTION

1.1 Background

Matthew Homes commissioned JBA Consulting in March 2008 to undertake preliminary calculations for sizing foul and surface water storage structures for a proposed residential development off Leicester Road, Hinckley (NGR SP43944701). The development will cover approximately 0.4ha of land and will consist of 10 domestic dwellings. The land is currently occupied by two residential houses which will be demolished and replaced by the proposed development. Leicester Road is located to the immediate south of the development area and contains a combined sewer which would be a convenient disposal point for flows arising from the new development. The existing development already discharges foul and surface water to this sewer. In order for new connections to be acceptable to Severn Trent Water (STW), who have responsibility for the combined sewer, the peak discharge into the combined sewer would have to be the same both before and after development. Increasing the number of houses from two to ten will increase the peak discharge rate of both foul and surface water flows, thus attenuation in the form of storage is the recommended solution for maintaining the existing peak flow rates. Onsite infiltration of surface water has been ruled out as a ground investigation showed that conditions are not suitable for soakaways. Also, there is no convenient watercourse located nearby. Disposal of surface water to the sewer system is therefore the only viable option at this particular site.

A further issue requiring consideration is that the proposed development is at a lower elevation than Leicester Road, the location of the combined sewer. A pumping station will therefore be required, in conjunction with a storage system, in order to transfer foul and surface water flows from the new development to the combined sewer.

A meeting was held on 25 April 2008 between Richard Roebuck of JBA Consulting, Carl Harrison and Andrew Tait of STW, and Jason Cooper of Matthew Homes. Given the small size of the site and density of the proposed development, there is insufficient space to design a pumping station to the requirements of the Sewers for Adoption manual. STW stated that they could not adopt a system under these circumstances and that any pumping station and storage systems would have to be privately owned and maintained. They did however offer advice regarding the location, arrangement and types of pumping stations and storage systems that would be feasible for this site, and this information was taken into account during the writing of this report.

Finally, STW stated that, for a private system, their main concern would be the peak discharge rate at the point of connection to the public sewer system. It needs to be demonstrated that the pre-development peak flow rate into the combined sewer system in Leicester Road can be maintained for the post-development condition. Demonstrating how this can be achieved using a combination of underground storage and controlled pumping is the main purpose of this report.

2 PROPOSED SOLUTION

2.1 Underground Storage Systems and Package Pumping Station

This section presents the main results and recommendations. Further details of the calculations conducted are given in appendix 1. Note that this report is a preliminary investigation into the feasibility of using underground storage systems and a pumping station to maintain the existing peak flow rate into the combined sewer system. It does not provide detailed information regarding, for example, the locations of surface and foul conveyance pipes and associated levels. It is assumed that these will be determined during the detailed design stage.

The proposed solution is to drain all surface water to an underground storage tank (large pipe), sized to contain the runoff arising from the critical 1 in 30 year storm event. Foul drainage infrastructure is to include additional storage within the system in order to ensure sewage flooding does not occur at the pumping station during plant or power failure, as per Sewers for Adoption guidance. The outflow from both the surface water and foul systems is to be to a wet well containing a small package pumping station designed to maintain a discharge no greater than the existing peak flow rate into the combined sewer system. A rising main will connect the pumping station to the existing combined sewer system in Leicester Road. Table 2-1 details the relevant characteristics of the existing site whilst Table 2-2 summarises the key components of the proposed drainage solution. Figure 2-1 is a plan view of the proposed development showing possible locations for the surface and foul water storage systems as well as the pumping station. This demonstrates the feasibility of locating the required infrastructure within the new development. Finally, Figure 2-2 is a long section of the proposed wet well, foul storage and surface water storage, and shows how the various structures can be arranged in terms of relative levels.

Table 2-1: Summary of existing site characteristics

Component	Comments	Value
Number of houses	Detached properties	2
Impermeable area	Positively drained impermeable areas, consisting of roofs and hard standing areas	304m^2
Peak surface water runoff	Used rational method, assumed peak rainfall intensity of 50mm/hr	4.2 litres/second
Peak foul flow	Estimated using method given in Sewers for Adoption, 6th ed.	0.1 litres/second
Peak flow to combined sewer system	Combined peak flow for existing surface and foul water	4.3 litres/second

Table 2-2: Summary of proposed solution

Component	Comments	Value
Number of houses	Mostly detached properties	10
Impermeable area	Positively drained impermeable areas, consisting of roofs, driveways and highway	2096m^2
Underground surface water storage tank (modelled as an oversized pipe)	Size of tank required to store surface runoff from critical 1 in 30 year storm (inc. climate change allowance) with pumped outflow of 4.2 litres/second	62m^3 capacity, which could be obtained using a pipe 2m in diameter with a length of 19.7m
Foul water storage (pipe storage assumed)	Size of pipe required to store foul flow in case of pumping station failure, as recommended by Sewers for Adoption, 6th ed.	1.6m^3 capacity, which could be obtained using a pipe 0.7m in diameter with a length of 4.2m
Package pumping station	To be located in a wet well with inflows from surface and foul systems	Max. pumping capacity to be 4.3 litres/second

Figure 2-1: Suggested locations for storage systems and pumping station

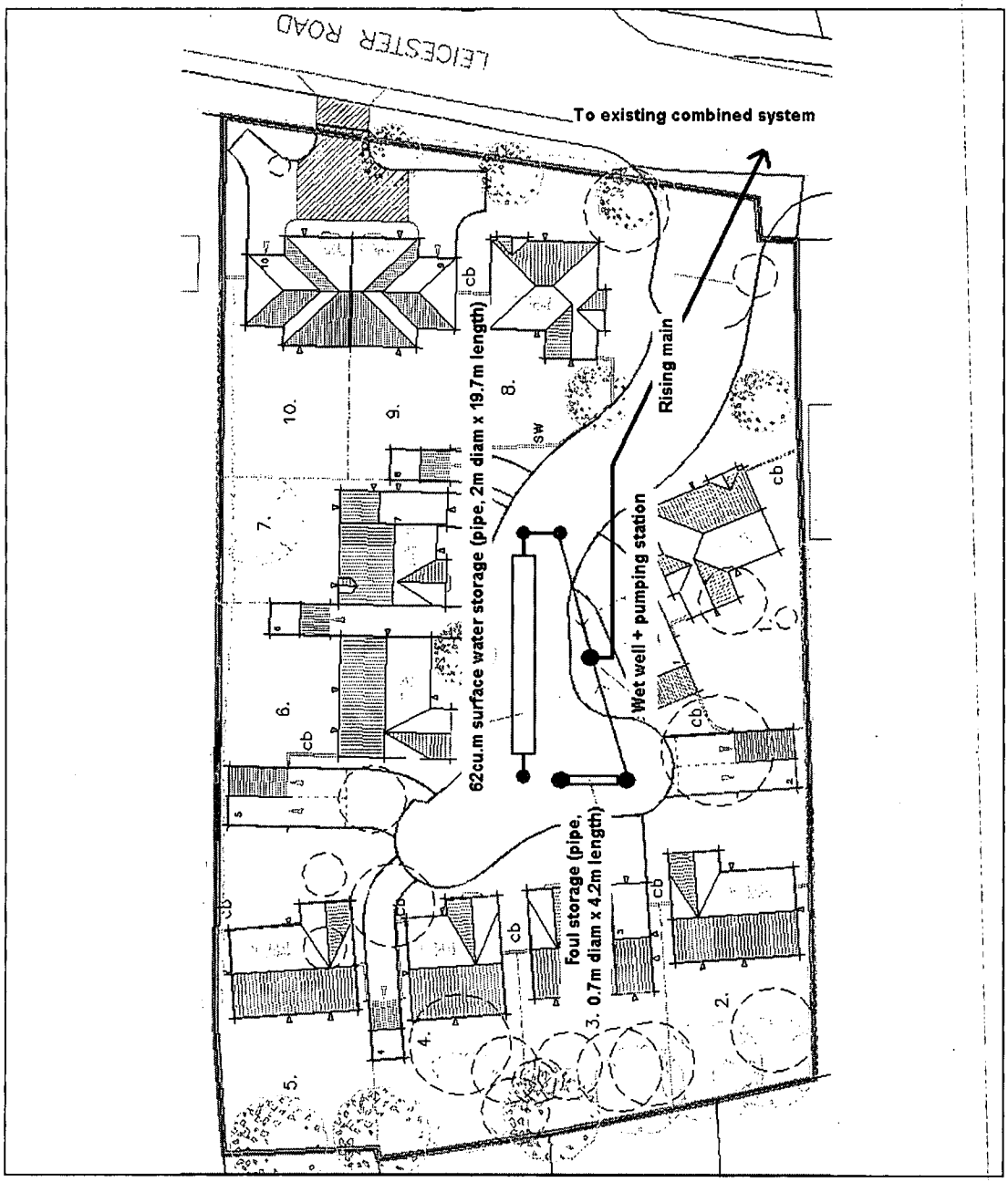
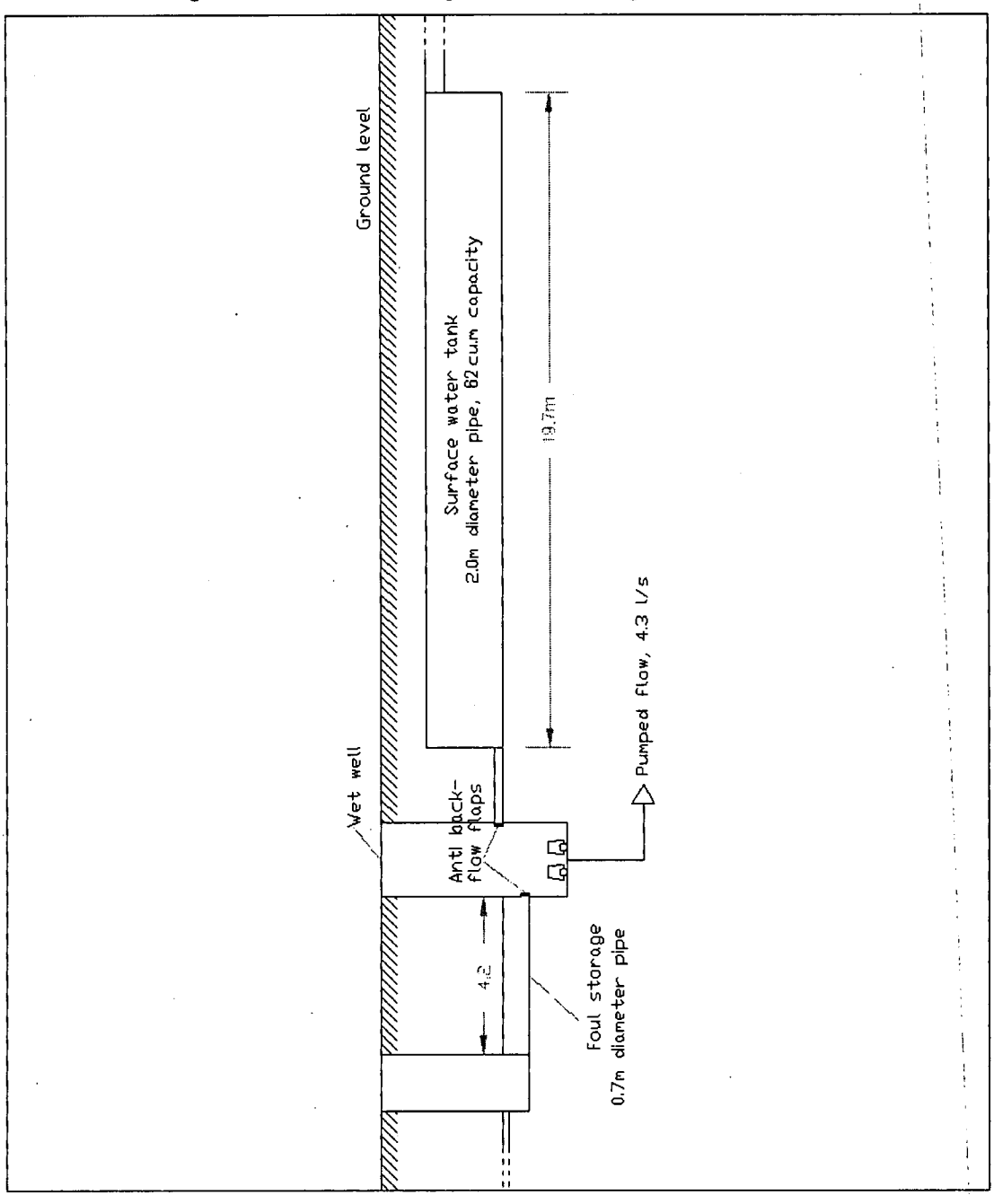


Figure 2-2: Schematic long section of storage structures and wet well



2.2 Other Comments

This report has investigated the feasibility of using foul and surface water storage systems in conjunction with a pumping station at the proposed residential development. The report at this stage therefore does not include detailed design information. However, the following points should be considered during any further design work:

- If the drainage system remains private, the relevant Highways Authority may refuse to adopt the development access road. The implications of this require consideration.
- A maintenance schedule for the pumping station, including plans to cater for pump failure, would need to be in place.
- The surface water system needs to be designed for exceedance. This report calculated the size of storage system needed to contain the 1 in 30 year critical storm event, plus climate change allowance. A more detailed design would also need to consider what happens during events with longer return periods. For example, a 100 year storm plus climate change. Overland flow routes and possible above ground temporary flood areas may require identification.
- A short gravity sewer is likely to be required to connect the rising main to the public sewer system. This was not indicated on Figure 2-1 but it is assumed that this will be part of the final design solution.

3 APPENDIX B - CALCULATIONS

3.1 Estimating peak flow rates for existing site

3.1.1 Foul Water

Foul water peak flow was estimated using the methodology recommended by the Sewers for Adoption manual, 6th edition. This states that design flows for gravity sewers on residential developments should be 4000 litres/dwelling/24 hours. In terms of litres per second, this equates to 0.046 l/s/dwelling. For two dwellings the combined peak foul flow is therefore ≈ 0.1 litres per second.

Additional storage volume was calculated as per Sewers for Adoption 6th edition methodology, section 2.17.7. As a minimum, storage should equate to 160 litres/dwelling for residential developments. As there are 10 proposed dwellings this therefore gives a storage volume of 1,600 litres. This could be contained within a pipe 0.7m in diameter and 4.2m in length.

3.1.2 Surface water

Peak surface water flow was estimated using the rational method and assuming that permeable areas have 0% runoff and impermeable areas have 100% runoff. The rational method formula is given below.

$Q = 2.78CiA$

Where: Q = peak flow rate (litres/second)

C = runoff coefficient (assumed 1 in this case)

i = rainfall intensity (mm/hr)

A = impermeable area (ha)

The time to concentration will be short given the small size of the site. In order to avoid the use of unrealistically high rainfall intensities (due to the short time to concentration) a peak rainfall intensity of 50mm/hr was assumed. The extent of positively drained impermeable area was measured from AutoCAD drawings supplied by the client and was found to be 304m^2. Inputting the above data into the rational method formula therefore gives:

Q = 2.78 x 1.0 x 50mm/hr x 0.0304 = 4.2 litres per second.

The total peak flow rate into the combined sewer for the existing site is equal to the peak foul flow rate plus the peak surface water flow rate. From the above calculations it can be seen that this equates to 0.1 + 4.2 = 4.3 litres per second.

3.2 Derivation of design storms

Design storms were derived using a spreadsheet based on the Wallingford Procedure. Relevant parameters are given below (M5-60min and M5-2day data derived from Wallingford Procedure maps):

- Region: England, Midlands.
- Design rainfall return period = 30 years.

- M5-60min depth = 20mm.
- Ratio of M5-60min to M5-2day, r, = 0.4.

A 30 year return period was selected as this is the design standard given in the Sewers for Adoption manual. A number of design storms in the range of 5 to 720 minutes were derived. Rainfall profiles were adjusted for climate change by increasing the intensities by 30% as per PPS25 recommendations. These were then used as the hydrological inputs in a computer package called Erwin, a software package written specifically for modelling sustainable drainage systems. The positively drained impermeable area of the new development was measured from AutoCAD drawings supplied by the client and was found to be 2096m^2.

The storage tank was modelled as an oversized pipe. The required capacity was determined by routing the flows generated by the impermeable areas into the pipe and adjusting the size until there was sufficient capacity to hold surface runoff from all the design storm events, minus a constant outflow of 4.2 litres per second (pumped outflow). The results from the analysis are presented in Table 3-1.

Table 3-1: Design rainfall events and surface water storage requirements

Event duration, D (mins)	Intensity, i (mm/hr)	+30% climate change allowance (mm/hr)	Rainfall in time D (mm)	Storage required (m^3)
5	129.0	167.7	14.0	28
10	95.0	123.5	20.6	40
15	76.0	98.8	24.7	48
20	64.0	83.2	27.7	52
30	50.0	65	32.5	58
60	31.0	40.3	40.3	62
120	18.6	24.18	48.4	56
180	13.7	17.81	53.4	44
240	11.0	14.3	57.2	30
360	8.0	10.4	62.4	20
720	4.7	6.11	73.3	0
Required storage calculated based on inflows minus constant pumped outflow of 4.2 litres/second				

From Table 3-1 it can be seen that the critical storm in relation to the volume of storage needed is the 60min event, requiring a storage capacity of 62m^3, assuming a constant pumped outflow rate of 4.2 litres per second. 62m^3 of storage can be provided in an oversized pipe 2m in diameter and 19.7m in length. (Note that the dimensions of the pipe may be varied as long as the overall storage capacity is maintained).