Appendix 2

Drainage Strategy
Revision Status

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<th>Description</th>
<th>Author</th>
<th>Checked</th>
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A  Site location plan
B  Plan of the existing drainage systems
C  Plan showing existing flows from the catchment and from the site
D  Plan of the proposed surface water drainage systems post development,
   SUDS choice and elements of SUDS train
E  Plan showing the proposed flows from the site post development
F  Calculation of the existing capacities within the receiving systems
G  Spreadsheet calculations of flow hydrographs using FEH catchment data
H  WinDes calculations for proposed storage areas
I  EA indicative flood mapping
1. INTRODUCTION

1.1. Richard Jackson Limited have been instructed by Meridian Strategic Land Ltd to develop a surface water drainage strategy for a proposed development of approximately 1500 dwellings at Land North of Witney, Oxfordshire.

1.2. The site is bounded by Hailey Road (B4022) to the west, New Yatt Road and the A4095 Woodstock Road to the east. To the south lies the conurbation of Witney along Vanner Road and Eastfield Road and partly to the north, Downhill Lane. The centre of the site is located near the Ordnance Survey coordinate location of 436150E, 211590N.

1.3. The site covers 55.24 Ha (136.5 acres) that currently is used as farmland. Topographical levels on site are in between approximately 100m AOD and 85m AOD with higher ground to the north and land falling towards Witney Town. A site location plan is shown in Appendix A, Figure 100.

1.4. The objective of this report is to ascertain how the risk of flooding and surface water management can be controlled to reduce the effects of existing & future potential surface water runoff from the development site. An indication of the flooding in Witney is shown on the Environment Agency map in Appendix I.

1.5. Also the report aims to investigate whether the proposal of approximately 1500 dwellings north of Witney can provide an opportunity to reduce the fluvial flood risk in Witney from the two sources, the Hailey Road Drain and the Madley Brook.

1.6. In July 2007 a fluvial flooding event caused 240 properties to flood. Fluvial flooding from both the Hailey Road drain and Madley Brook resulted in 75 flooded properties, as reported by the Environment Agency and District Council. The Environment Agency (EA) has reviewed the 2007 flooding event and published their findings within the Witney Flood Review in 2008. In order to reduce the future flood risk in Witney one of the options that were suggested by the EA was to provide future flood storage north of Witney and in particular north of Eastfield Road.
2. **EXISTING SITUATION**

2.1. The British Geological Survey mapping shows mudstone and limestone bedrock geology in the area of the site which indicates that using surface water infiltration techniques is not an option for draining the site.

2.2. Both watercourses, the Hailey Road Drain and the Madley Brook, are tributaries of the River Windrush. The watercourse that runs through the site from North to South is referred to as the Hailey Road Drain in this report.

2.3. The topography of the site suggests that the farmland west of Middlefield Farm drains to the open watercourse called the Hailey Road Drain. The site areas east of Middlefield Farm are expected to drain to the Madley Brook. Hence this report refers to Part A, the bigger part (45.343 ha) in the west and Part B the smaller part (9.897 ha) in the east of the site.

2.4. The Hailey Road Drain culvert starts north of the dwellings at Eastfield Road and runs south to joins the River Windrush at the centre of Witney.

2.5. A plan, 43163-C-002, of the existing drainage system is shown in Appendix B. The existing flows from the site are shown on drawing 43163-C-003 in Appendix C.

**Part A (West Area of Site)**

2.6. The capacity of the inlet to the Hailey Road culvert has been assessed to be 1.60 m³/s as a 900 mm diameter pipe at 1/154 gradient. Details of the calculations are shown in Appendix F.

2.7. The total upstream catchment at the inlet (north of Eastfield Road at grid reference 435950 211100) has an area of 3.19 km². Existing flows from the catchment have been calculated using FEH data (FEH-CDROM 3) and the Revitalised FSR/FEH rainfall runoff method (Spreadsheet application version 1.4).
### Table 3.1 Peak flows from the upstream Hailey Road Drain catchment when site stays undeveloped, for Part A.

<table>
<thead>
<tr>
<th>Return period</th>
<th>Peak flow</th>
<th>Peak flow incl. climate change (20%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m³/s</td>
<td>m³/s</td>
</tr>
<tr>
<td>1</td>
<td>0.43</td>
<td>0.52</td>
</tr>
<tr>
<td>30</td>
<td>1.52</td>
<td>1.83</td>
</tr>
<tr>
<td>100</td>
<td>1.96</td>
<td>2.36</td>
</tr>
<tr>
<td>1000</td>
<td>3.41</td>
<td>4.1</td>
</tr>
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</table>

2.8. The impact of the 2007 event shows the necessity for flood water storage areas upstream of Eastfield Road. This is clear when comparing the peak catchment flows during a 1 in 100 year event (2.36 m³/s) with the culvert capacity (1.60 m³/s), as there is insufficient capacity in the sewerage system. According to our calculations the inlet of this culvert has a capacity that is less than the total catchment peak flows in a 1 in 30 year event including climate change, therefore an attenuation proposal needs to be implemented.

### Part B (East Area of Site)

2.9. As a potential outfall location, the existing capacity of the 375mm diameter Thames Water sewer in Woodstock Road, adjacent to the lowest point of Part B, has been calculated as shown in Appendix F. The capacity of this sewer has been calculated based on information from the Thames Water sewer record. Areas that might currently drain to this sewer have been considered as 82.2 l/s. The approximate remaining capacity of this surface water sewer at manhole 7802 is 145.8 l/s based upon a 375mm diameter pipe at a gradient of 1/77.

2.10. The flows from the undeveloped site areas east of Middlefield Farm (Part B only) have been calculated using the IH124 method in the Microdrainage WinDes source control tool. Climate change for increased flows was factored in as recommended by Planning Policy Statement 25 – Development and Flood Risk.
<table>
<thead>
<tr>
<th>Return period</th>
<th>Undeveloped Greenfield runoff</th>
<th>Undeveloped Greenfield runoff incl. climate change (20%)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>l/s</td>
<td>l/s</td>
</tr>
<tr>
<td>1</td>
<td>86.5</td>
<td>103.8</td>
</tr>
<tr>
<td>30</td>
<td>191.7</td>
<td>230.04</td>
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<tr>
<td>100</td>
<td>233.1</td>
<td>279.72</td>
</tr>
<tr>
<td>1000</td>
<td>318.1</td>
<td>381.72</td>
</tr>
</tbody>
</table>

Table 3.4 Greenfield runoff rates for undeveloped site with and without climate change

3. PROPOSED SURFACE WATER DRAINAGE STRATEGY

3.1. The proposed surface water strategy for the sites development needs to address several key issues;

- Potential risk of flooding on site;
- Discharge from the site and;
- A reduction in the risk of flooding downstream of the development

3.2. To address these issues, as highlighted in chapter 2, there are significant restrictions to the capacity of the existing pipe network and thus the water discharging into the systems needs to be reduced. To complete this, attenuation features will need to be implemented to store water within the development site and alleviate downstream sewer systems which are acting over capacity. A solution to the issues is outlined in Appendix D and drawing 43163-C-004.

3.3. The proposed surface water drainage system on site may serve 1500 dwellings. Areas along the Hailey Road Drain could be used as public open space and incorporate flood storage areas in order to drastically reduce fluvial flooding in Witney downstream of the site.

3.4. Due to ground conditions the use of infiltration techniques to dispose of surface water is unlikely to work on the site and instead surface water will be attenuated at source, through a series of cascading ponds or lagoons.
3.5. To reduce peak flows at source a combination of SUDS (sustainable urban drainage systems) is proposed. Source control elements have been proposed to form a SUDS train. When calculating SUDS the impact of climate change has been considered in our proposal.

3.6. On private areas surface water will be attenuated permeable paving which provides storage without considering infiltration. This type of permeable paving is classified as Type C within Ciria report 697. Alternatively other subsurface storage elements like tanks or oversized pipes can be chosen for attenuating flows on every residential unit.

3.7. Flows from private areas should be restricted to future Greenfield runoff rates. The resulting flows will either be discharged to a system that runs next to the road or underneath the road. Currently Thames Water accepts flows in their system up to the 1 in 30 year event to be drained. Future arrangements under the Flood and Water Management Act may favour and allow flows from private property to discharge in road parallel ditches that also drain the road. Such systems are expected to be adopted by the SUDS approval body (SAB) as defined by the Flood and Water Management Act, which is a future legal act that is likely to come into force in 2012.

3.8. We also propose that rainwater harvesting be utilized as part of a sustainable drainage system. Rainwater harvesting is the process of collecting rain that falls directly onto roofs such that it can be re-used for non potable uses around the home (flushing toilets, washing machines, car washing, irrigation etc). For systems where the collected run-off is to be used for toilet flushing etc. it is likely that the water would be pumped from the storage tank installed on the grounds of the property. The simplest form of rainwater harvesting involves the collection of run-off from a roof via a water butt situated at the bottom of a down pipe, for irrigation usage.

3.9. It is proposed to use green roofs where practical, which will help to reduce the run off from the site.

3.10. Flows from the Thames Water surface water sewer and/or Highway drains will be directed to the Hailey Road Drain. These flows will be attenuated by a number of bunded storage areas as shown in Appendix D.

3.11. It is likely that new private surface water sewers will have to meet Thames Water's adoption criteria. The Flood and Water Management Act may have been introduced at the time this proposal is submitted for planning approval and any SUDS will require approval from the SUDS Approval Body (SAB).
Part A (West Area of Site)

3.12. Areas along the Hailey Road Drain could be used as public open space and incorporate flood storage areas in order to drastically reduce fluvial flooding in Witney downstream of the site. For Part A of the site a total storage area of 60,000m² (6.0 ha) will be required as indicated in Appendix H. This total storage area could be split up into 6 storage areas as shown in Appendix D and calculated in Appendix G. A summary of the calculations is shown in the table below. A drawing indicating the likely proposed flow from the development is shown in Appendix E and drawing 43163-C-005.

<table>
<thead>
<tr>
<th>Return period</th>
<th>Peak inflow from catchment including the proposed site with 20% climate change allowance</th>
<th>Proposed controlled peak outflow post development</th>
<th>Depth of water in storage area</th>
<th>Resulting stored volume of water</th>
</tr>
</thead>
<tbody>
<tr>
<td>m³/s</td>
<td>m³/s</td>
<td>m</td>
<td>m³</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.592</td>
<td>0.067</td>
<td>0.243</td>
<td>14,566</td>
</tr>
<tr>
<td>30</td>
<td>2.151</td>
<td>0.347</td>
<td>0.633</td>
<td>38,033</td>
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<td>100</td>
<td>2.781</td>
<td>0.475</td>
<td>0.778</td>
<td>46,705</td>
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<td>1000</td>
<td>4.850</td>
<td>0.813</td>
<td>1.303</td>
<td>78,239</td>
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</table>

Table 3.3 Calculated storage volumes and controlled outflow rates post development for Part A.

3.13. Each of the 6 storage areas will work as a pond during times of flooding and will have freeboard of 0.5m which results in a bunding height of 1.3m. Under normal conditions the storage areas will serve as public open space (POS). Each bunded area will store a maximum volume of approximately 13,040m³ of flood water at the peak of the 1 in 1000 year flooding event.

Part B (East Area of Site)

3.14. In order to achieve a 55% reduction of peak flow due to the capacity of the receiving sewerage system during the 1 in 100 year event including climate change (from Part B) a storage volume of 2,335m³ will be required. This can be achieved by bunding an area with a size of 5,500m² as indicate by the calculations in Appendix G and shown by the plan of the proposed surface water drainage strategy in Appendix D.
3.15. The flows from the undeveloped site areas east of Middlefield Farm have been calculated using the IH124 method under the Microdrainage WinDes source control tool.

<table>
<thead>
<tr>
<th>Return period</th>
<th>Post development Proposed peak discharge rate (climate change considered)</th>
<th>Depth of water in storage area</th>
<th>Resulting stored volume of water</th>
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<tbody>
<tr>
<td>1</td>
<td>l/s</td>
<td>m</td>
<td>m$^3$</td>
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<tr>
<td>27.9</td>
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<td>0.178</td>
<td>979</td>
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<tr>
<td>30</td>
<td>l/s</td>
<td>m</td>
<td>m$^3$</td>
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<tr>
<td>86.3</td>
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<td>0.338</td>
<td>1,861</td>
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<td>100</td>
<td>l/s</td>
<td>m</td>
<td>m$^3$</td>
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<td>123.9</td>
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<td>0.425</td>
<td>2,335</td>
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<tr>
<td>1000</td>
<td>l/s</td>
<td>m</td>
<td>m$^3$</td>
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<tr>
<td>207.3</td>
<td></td>
<td>0.686</td>
<td>3,775</td>
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Table 3.4 Calculated storage volumes and controlled outflow rates post development

3.16. This proposal allows the site to drain with an attenuated flow into the existing sewer system within the existing calculated spare capacity.

4. CONCLUSIONS

4.1. This report shows that the proposed storage area with a total area of 65,500m$^2$ along the Hailey Road Drain and northwest of Woodstock Road, located within the POS would result in a huge reduction of peak flows and hence flood risk from the Hailey Road Drain and Madley Brook.

4.2. As shown in Table 4-1 the proposed storage areas can reduce the peak flows from the site by approximately 80% to the Hailey Road culvert and by 55% to the Thames Water surface water sewer and eventually to the Madley Brook during a 1 in 100 year event including climate change. When calculating the proposed total storage area on site we have used 50% of the site’s area as being impermeable. This high value resembles the failure of the proposed SUDS system and allows for spare volume within the total storage area.
4.3. Sustainable urban drainage systems have been incorporated in the proposal. Flows can be controlled at source but also in central storage areas along the Hailey Road Drain. Hence a sustainable solution for the surface water drainage can be achieved.

4.4. It is to be noted that the design and calculations proposed for the site are made on some assumptions regarding the outfall sewers at Hailey Road Drain and the Thames Water surface water sewer south of Part B of the site at Woodstock Road. It is possible that a detailed look at the hydraulics of the two receiving systems south of the development site could result in a reduction of storage volume needed on site and a better use of available capacity in the sewerage of the proposed development.

4.5. The overall conclusion suggests, that by reducing the surface water runoff from the development to the capacity of the drainage available, the site could deliver a sustainable and calculated reduction in flood risk from the site and benefit the conurbation downstream.
5. LIMITATIONS

5.1. This report has been produced for the sole use of Meridian Strategic Land Ltd for a proposed residential development. Its contents should not be relied upon by others without the written authority of Richard Jackson Limited. If any authorized third party makes use of this report, they do so at their own risk and Richard Jackson limited owes them no duty of care or skill.

5.2. All information provided by others is taken in good faith as being accurate, but Richard Jackson Limited cannot, and does not, accept any liability for the detailed accuracy, errors or omissions in such information.

5.3. The flood and Water Management Act 2010 will change the adoption criteria for SuDS in the future. This report does not reflect this change as the details are not yet known and legislation is due to come into force in 2012.
APPENDIX
APPENDIX A

Site location plan
APPENDIX B

Plan of the existing drainage systems
APPENDIX C

Plan showing existing flows from the catchment and from the site
Part A

Hailey Road Drain catchment runoff:
Q1+CC = 0.52 m³/s
Q30+CC = 1.83 m³/s
Q100+CC = 2.35 m³/s
Q1000+CC = 4.1 m³/s

Approximate capacity of Hailey Road Drain culvert entrance: 1.6 m³/s

Part B

Greenfield runoff from Part B:
Q1+CC = 103.8 l/s
Q30+CC = 230.04 l/s
Q100+CC = 279.72 l/s
Q1000+CC = 381.6 l/s

Approximate current discharge to manhole 7802: 41.1 l/s

Approximate capacity of the Thames Water sewer at manhole 7802: 228 l/s
APPENDIX D

Plan of the proposed drainage systems post development, SUDS choice and elements of the SUDS train
Hailey Road drain with proposed cascading storage areas in POS

Storage area with proposed connection to Manhole 7802 of the Thames Water sewer system

Beginning of Hailey Road culvert. Downstream system to be investigated

Connection to Thames Water surface water sewer at manhole 7802

Key:
- Open watercourse
- Existing culvert
- Existing inlet
- Existing Thames Water surface water system
- Existing Thames Water foul water system
- Storage areas within public open space
- Earth bunding for storage areas
- Area containing 1500 dwellings; area drained by elements of SUDS as shown in Appendix D.
- Public open space (need ground modelling to accommodate flood storage volumes)