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University of York
Heslington East Campus

SURFACE WATER MANAGEMENT PLAN

('SUDS' STRATEGY)

February 2008

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REPORT CONTROL SHEET

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REVIEWED AND APPROVED BY: Ed Connon

REVISION SCHEDULE

Rev. No.	Description of Amendment	Prepared By	Approved By	Date

1 INTRODUCTION

1.1 The Commission

W A Fairhurst & Partners (Fairhurst) was commissioned by The University of York to prepare a Surface Water Management Plan (or 'SuDS' Strategy) for the proposed Heslington East Campus Development. The Surface Water Management Plan would develop strategic proposals for the disposal of surface water runoff from the new Campus incorporating Sustainable Drainage Systems (SuDS).

SuDS allow surface water runoff from urban areas to be managed in a manner sympathetic to the natural environment. Watercourse pollution and downstream flooding effects commonly associated with new development are avoided and opportunities are created for new wildlife habitats and the enhancement of recreational and amenity areas.

The Heslington East Campus provides an ideal opportunity to promote the use of SuDS within the master-planning process allowing the integration of natural habitats, SuDS, ecology and landscape. A substantial lake and wetland area, providing a landscape focal point, will also perform important treatment and flow attenuation functions as part of a SuDS 'Management Train' approach described later in this report.

1.2 Planning Conditions

Condition 19 of the Planning Permission granted by the Secretary of State in a letter dated 27th June 2007 states that:

"Development shall not begin until an assessment has been carried out into the potential for disposing of surface water by means of a sustainable drainage scheme, in accordance with the principles of sustainable drainage systems set out in national planning policy statements, and the results of that assessment have been provided to the Local Planning Authority. The assessment shall take into account the design storm period and intensity; methods to delay and control the surface water discharged from the site; and, measures to prevent pollution of the receiving groundwater and/or surface waters."

Condition 19 further requires the submission of drainage proposals before the development commences:

"Surface water drainage works shall be carried out in accordance with details that have been submitted to and approved in writing by the Local Planning Authority before the development commences. Those details shall include a programme for implementing the works. Where, in the light of the assessment the Local Planning Authority conclude that a sustainable drainage scheme should be implemented, details of the works shall specify:

i) a management and maintenance plan, for the lifetime of the development, which shall include the arrangements for adoption by any public authority or statutory undertaker or any other arrangements to secure the operation of the scheme throughout its lifetime; and

ii) the responsibilities of each party, for implementation of the sustainable drainage scheme, together with a timetable for that implementation.

There shall be no piped discharge of surface water from the development prior to the completion of the approved sustainable drainage scheme."

This Surface Water Management Plan (or SuDS Strategy) has been prepared for consideration by the City of York Council. It has been developed in line with the Environment Agency's Policy on Sustainable Drainage Systems (Policy No. EAS/0102/1/3) and CIRIA Report C697, 'The SuDS Manual'.

1.3 Site Location and Baseline Conditions

Heslington East is located 4km south east of York City Centre and to the east of the existing University Campus (Figure 1.1). The site lies within the catchment area of the Ouse and Derwent Internal Drainage Board (Figure 1.2).

The primary function of the Internal Drainage Board is to collect surface water that falls both on agricultural land and built up areas within its boundary and to convey it through a system of drainage channels and pumping stations into the principal watercourses controlled by the Environment Agency.

The 116 hectare development site is presently drained by an extensive system of tile drains and land drainage ditches (Figure 1.3). Drainage ditches generally run east to west and north to south from Kimberlow Hill in the north east corner of the site to the lower ground along the southern boundary before discharging into the Germany Beck and Tilmire Drain drainage channels (and then to Stilling Fleet Beck) and ultimately to the River Ouse (a principal watercourse controlled by the Environment Agency).

Two existing Yorkshire Water surface water sewers (900mm and 600mm diameter) run from the Badger Hill housing estate to the north and discharge run-off from roofs, footpaths, highways and vehicle parking areas into the land drainage ditch system within the site.

An emergency overflow from a Yorkshire Water foul pumping station presently connects to the 900mm surface water sewer. This connection represents a potential source of contamination and could affect water quality downstream.

A third 225mm diameter surface water sewer serving housing to the north-east of Heslington Village also discharges to a farm ditch within the application site. These farm ditches drain to Germany Beck and ultimately to the River Ouse.

The Environment Agency's General Quality Assessment (GQA) Scheme classifies the River Ouse as a Grade 'B' or 'Good Quality' watercourse. A Grade "B" watercourse maintains ecosystems at or close to 'natural' status and the Ouse is therefore considered to be of moderate to high sensitivity. Both Germany Beck and Tilmire Drain are unclassified watercourses. However, as they discharge into the River Ouse, they can be classified as equally sensitive – i.e. moderate to high.

1.4 The Proposed Development

At present the 116 hectare Site is under arable cultivation characterised by large open fields with land drainage ditches and occasional hedgerows and hedgerow trees. The general topography slopes down from Kimberlow Hill in the north towards Low Lane on the southern site boundary.

The core of the new campus will include academic buildings, student housing, and community facilities occupying an area of some 65 hectares. The surrounding green space provision will include a lake and wetland area extending over 10.4 hectares. The lake and wetlands will form an integral part of the Sustainable Surface Water Drainage Scheme for Heslington East as well as providing a valuable visual and ecological amenity.

The Development Masterplan (Figure 1.4) divides the site into a number of development zones within which development of Heslington East will be phased over a 15 to 20 year period. These development zones will be bounded by a service road to the north, a central boulevard and green vistas, and a movement spine and feature lake to the south.

The development zones are associated with specific groups of activities as follows:

- Cluster 1 will comprise a mix of academic and residential buildings with associated social space including the departments of Computer Science, Electronics, and Theatre, Film and Television.
- These will be followed by two other academic clusters with a similar mix of academic, residential and social space.
- In addition to the academic clusters there will be a range of stand alone facilities including a conference centre, student centre, and various sporting facilities

Initial development will be focused around the Central Boulevard, and will then progress east and west to occupy the area of land between the lake and Kimberlow Hill. It is currently envisaged that landscaping provision (including the lake) will be largely completed by year 2012 in tandem with the first period of academic development.

The majority of the development site is currently under arable cultivation. Since surface water run-off from landscaped areas within the development is likely to contain a relatively high residual concentration of nutrients resulting from the long-term application of soil conditioners and fertilisers, pre-treatment measures may be required to avoid water quality problems in the lake.

For that reason drainage from landscaped areas, as well as potentially contaminated runoff from roofs, roads, car parks, and other hard surfaces will be routed through a series of SuDS facilities designed to treat and attenuate surface water runoff before discharging into the downstream watercourses.

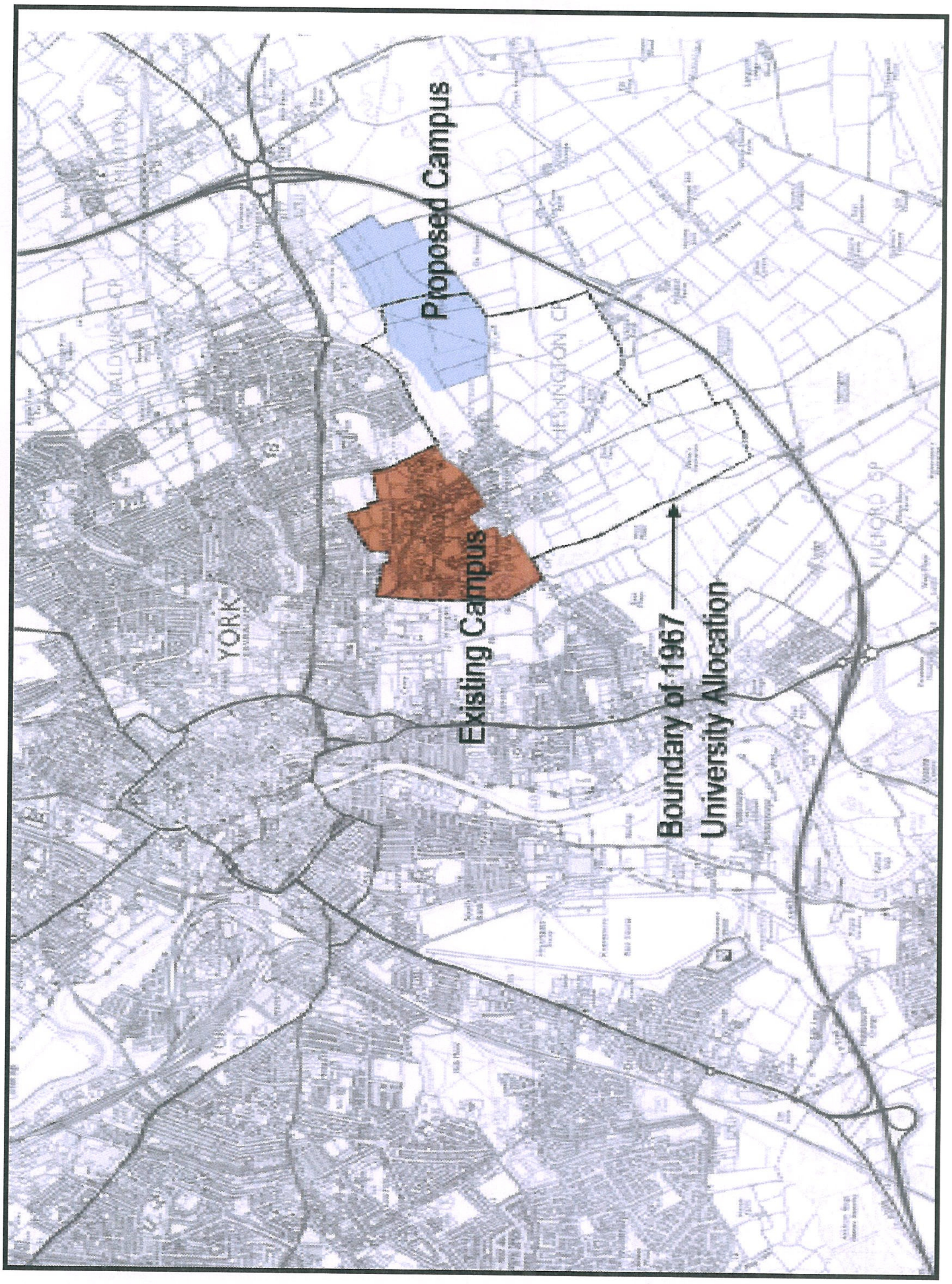


Figure 1.1 – Development Location Plan

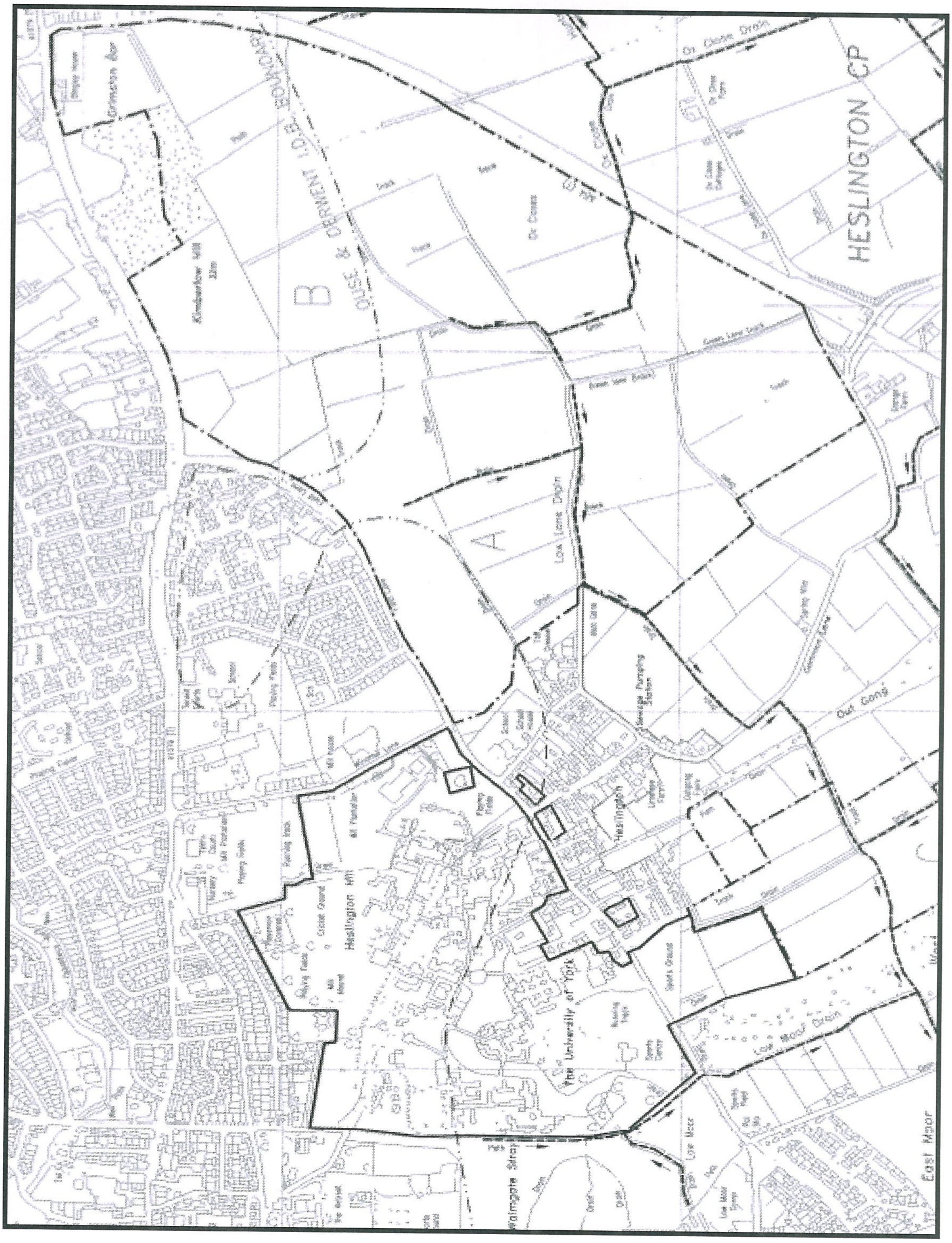


Figure 1.2 – Internal Drainage Board Boundaries

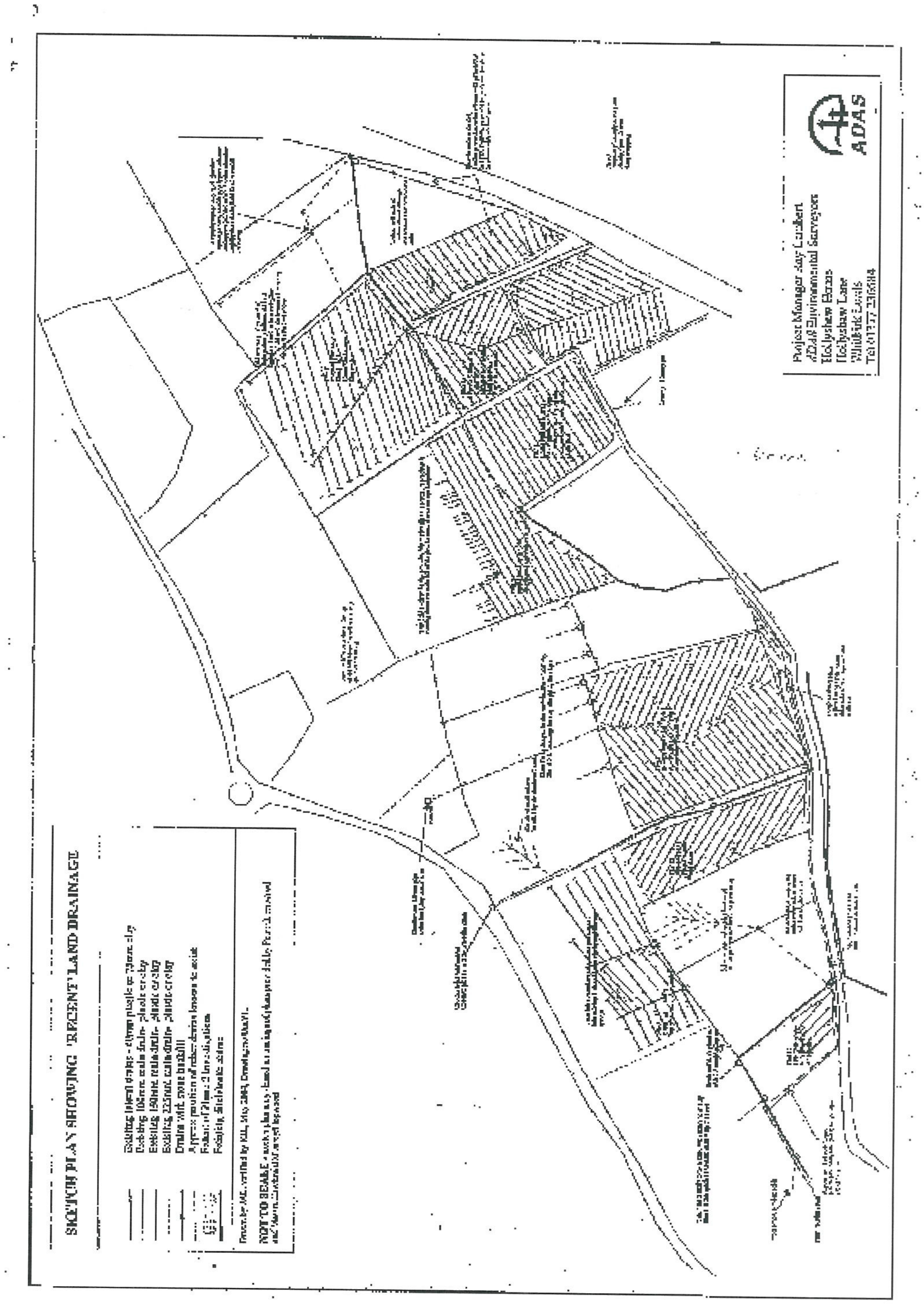


Figure 1.3 – Land Drainage Plan

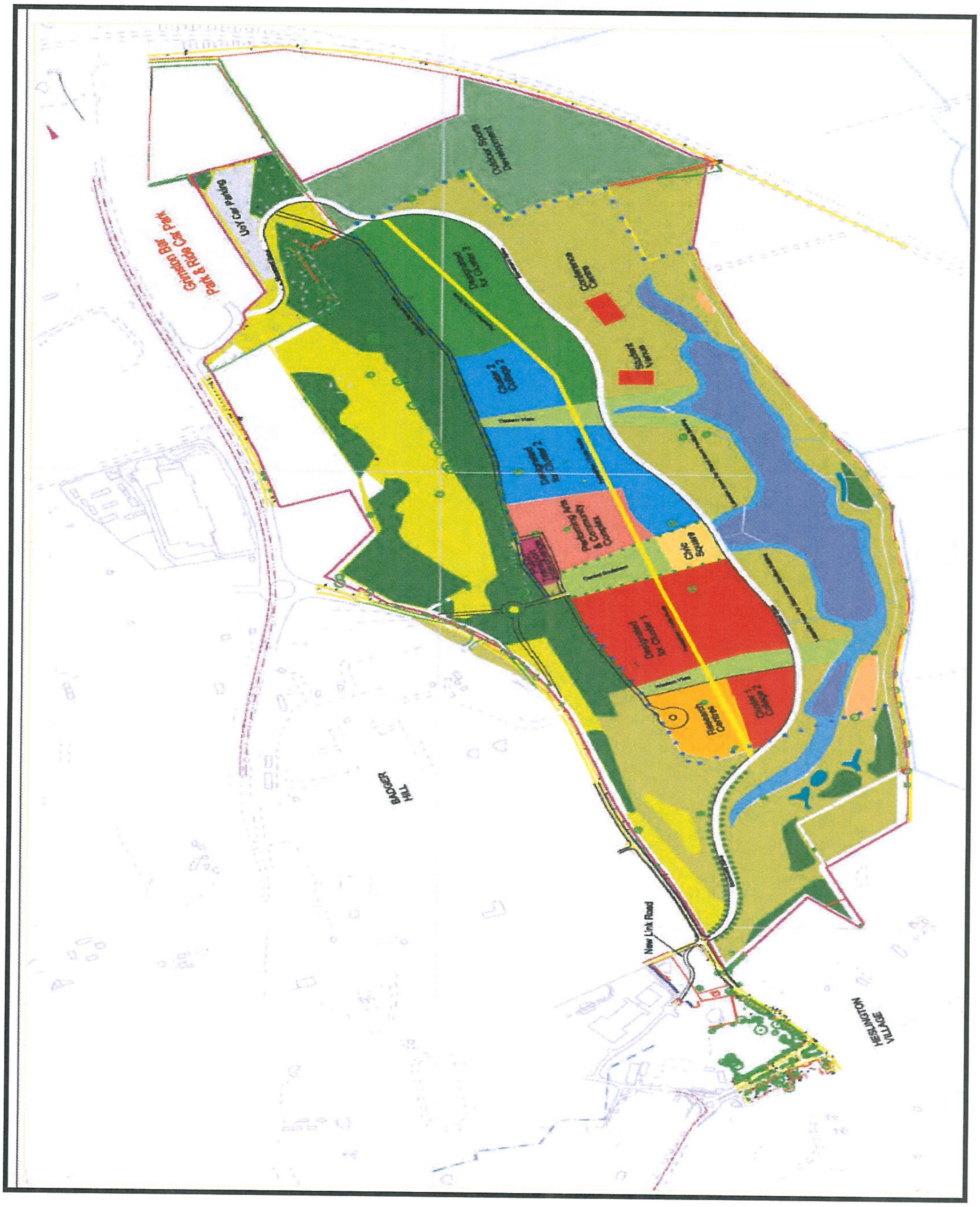


Figure 1.4 – Development Masterplan

2 SUSTAINABLE URBAN DRAINAGE (SUDS)

2.1 Background to Sustainable Drainage

Contaminated surface water run-off from new development can have a serious detrimental affect on the water environment in terms of chemical and ecological status. Conventional drainage systems are widely accepted as major contributors to pollution in watercourses and an increased risk of flooding. A sustainable approach will thus be adopted in the design of Heslington East's surface water disposal systems.

SuDS is an umbrella term for a number of approaches to urban drainage, comprising new, more sustainable methods for the management of water resources in urban areas. The philosophy of SuDS is to mimic the undeveloped natural surface water drainage regime and to treat run-off from development to remove pollutants. The adoption of a SuDS strategy provides the combined benefits of water quality and quantity control, as well as increased amenity value see Figure 2.1).

It is generally accepted that the implementation of a SuDS approach provides several benefits including:

- reduced peak flows (flood risk downstream)
- improved water quality (by removing pollutants)
- improved amenity (provides public open spaces and wildlife habitat)

SuDS provide a flexible design approach and individual techniques are used to reinforce the natural drainage pattern, namely:

- Prevention – the use of good site design and housekeeping measures to prevent run-off and pollution
- Source Control – control run-off at source, i.e. pervious pavements, soakaways
- Site Control – manage run-off from individual sites providing flow attenuation and treatment
- Regional Control – manage run-off from several sites providing attenuation and treatment

2.2 SuDS Design Philosophy

The following design philosophy is proposed for Heslington East:

- Maintain natural drainage paths and hydrology
- Control and attenuate development runoff peak flow rates
- Use the 'Management Train' approach to treat contamination as near as possible to source

- Provide regional treatment (i.e. lake & wetlands) for biological and physical treatment of the contaminated water together with creation of a diverse habitats
- Use of 'soft engineering' techniques to limit visual impact
- Attenuate upstream of regional controls
- Limit impermeable fraction of development areas
- Provide overland flood routes and convergence within regional facilities for extreme events (minimising risk to development & infrastructure)
- Create buffer strips of shrubs and grasses next to SuDS features

The Strategic Surface Water Drainage System proposed for Heslington East (as shown on drawing number 70072/SK007 in Appendix A) will incorporate many of the key elements set out in the published standards and, in particular, guidance documents such as CIRIA Report C697, the SuDS Manual.

2.3 SuDS 'Management Train'

The surface water 'Management Train' approach (i.e. source, site and regional controls) will be central to the SuDS strategy (see Figure 2.2). The main objective is treatment and control of runoff as near to the source as possible protecting downstream habitats and further enhancing the amenity value of regional features.

Surface Water Management Train

Treatment Level	SUD Technique
Management and Prevention	Good Housekeeping Water management and re-use
Source Control	Swales Filter drains & filter strips Porous/permeable surface Water butts
Site Controls	Below ground storage/attenuation Detention Basins
Regional Controls	Retention Ponds Detention Basins

Development density at Heslington East will be limited to 23% of the proposed development area with substantial areas set aside for designated open space including woodlands, tree-lined avenues, green wedges, and landscaped open water features.

Source controls, including the use of pervious pavements, will be utilised to slow surface water run-off and increasing the efficiency of treatment systems. Pre-treatment facilities such as oil interceptors will be incorporated in higher risk areas to safeguard against the accidental pollution of surface and ground waters.

Swales (grass lined natural drainage channels) and filter drains (stone filled ditches) will be used to attenuate and treat surface water runoff that may be contaminated.

Site controls designed to further manage surface water runoff will be located at strategic points throughout the drainage system in order to balance and treat flows and thus maximise the treatment potential of the lake and associated wetlands.

2.4 Source & Site Controls

Appropriate selection and design of the upstream systems (source and site controls) will ensure that water quality within the lake is protected and capable of supporting wildlife habitats. Wetland areas incorporating reed beds will also be included to pre-treat runoff from landscaped areas with a view to reducing the nutrients associated with historic agricultural land-use.

The strategic drainage system will include pre-treatment for landscape areas outside the main development area as well as arterial channels designed to convey runoff from the development to the lake. Three primary channels will occupy the two 'green vistas' and the central boulevard providing a drainage outlet for individual development zones as well as roads, car parks, footpaths and cycle ways.

The choice and extent of SuDS techniques employed within individual development areas will be influenced by spatial planning requirements, including building layout and accessibility. The Indicative Strategic Surface Water Drainage Plan (Drawing No. 70072/SK007) shows how the various elements of the SuDS 'Management Train' will interface including possible discharge points for each development area.

The schedule of sub-catchment areas shown on the 'SuDS' Strategy Plan (also included in Appendix B) suggests 'target' discharge rates for each development area (including roads and landscaping). These 'target' rates are based on a global 'greenfield' discharge rate of 1.4l/s/ha (see Section 3.4 on Flow Control below). The control and partial attenuation of runoff from individual drainage areas with sustainable drainage systems designed to accommodate a 1 in 30 year design storm will reduce the potential for storm surges and channel erosion downstream.

2.5 Drainage Channels and 'Swales'

Extensive use will be made of open drainage channels or 'swales' throughout the Heslington East Campus both to store and convey runoff and to remove pollutants. Guidance on various types of 'wet' and 'dry' swales is contained in CIRIA Report C697, the SuDS Manual (also see Appendix C).

The selection of swale types for each specific location will be influenced by several factors such as local landscape character (i.e. semi-urban or landscape setting), ease of access for routine maintenance (e.g. grass-cutting), and intended primary function (i.e. conveyance only or conveyance and treatment).

In practice, various swale types will be incorporated within each of the Heslington East development area providing a range of habitats for flora and fauna and adding to the bio-diversity potential of the site. Drainage channels and swales, designed to convey runoff from the development areas to the lake, will also provide safe overland flood routes for more extreme rainfall events.

2.6 Regional Control (Lake & Wetlands)

The lake and wetlands are key elements of the development proposals and also form an integral part of the surface water management system. Attenuated and partially treated surface water runoff from the development site will be discharged through the lake into the existing off-site drainage system.

Outlet controls combined with appropriate attenuation storage designed to accommodate a 1 in 100 year design storm will limit off-site discharges to a global 'Greenfield' discharge rate of 1.4l/s/ha. Biological treatment capacity and natural filtration systems designed to remove pollutants will ensure protection of downstream water quality.

The lake and other SuDS features will not only perform water quality and quantity management functions but will also contribute significantly to local ecology and biodiversity through the creation of open water, wetland and marsh habitats. The lake and the ecologically diverse wetlands will link the existing network of drains and watercourses downstream from the development site with the retained and new ditches and landscaped areas within the site itself.

2.7 Land Drainage Diversions

Whilst new drainage systems will be installed to cater for runoff from the development, measures will be required to maintain the integrity of existing drainage systems both during construction and, to a lesser extent, following completion of construction.

Where encountered, existing subsoil drains will be reinstated. However, due to the nature of the development and because much of the underground pipework is aged its reliability may be questionable in the longer term. New subsoil drains will therefore be installed to serve all landscaped areas within the development.

These will be connected to retained sections of the existing open channel drainage system and new drainage channels.

As shown on Figure 2.3, Drain 1, which takes flow from the 600mm and 900mm diameter Yorkshire Water sewers from the Badger Hill housing estate, will be re-routed around the western edge of the development area into the proposed lake via a pre-treatment wetland.

The emergency overflow from the upstream foul pumping station will be removed and emergency storage provided. This will remove the risk of foul water contaminating the lake. In the longer term flows in the Germany Beck will be maintained by flows from the lake but during construction of the lake Drain 1 will be diverted into Drain 2.

Drain 3 enters the site from the west collecting surface water originating from a housing estate and school playing fields and joins Drain 2. Drain 3 will be diverted to discharge into the lake via a pre-treatment wetland.

Drains 4 and 5 flow from the north-east corner of the development site discharging into the Tilmire Drain below Low Lane. Drain 4 will be re-routed around the eastern edge of the development area into the proposed lake. Drain 5 will be abandoned as it lies entirely within the footprint of the proposed development.

During the construction of the lake Drain 4 will be temporarily diverted around the development area to join Drain 5, thus maintaining existing flows within Tilmire Drain.

Figure 2.1 - Water Quantity, Quality and Amenity/Biodiversity Objectives

Quantity Objectives
The following design principles will be adopted to control the effects of urbanisation on the receiving watercourses (Germany Beck and Ox Close / Hunts / Tilmire Drains) and hence mitigate against flood risk downstream:

- Attenuation of development run-off rates to the natural "Greenfield" condition up to the 1 in 100 year critical rainfall event
- Check design for exceedance and establish safe overland flood routes for events greater than the 1 in 100 year critical rainfall event

Quality Objectives
The following design principles will be adopted to protect downstream watercourses from point source, diffuse and accidental contamination:

- Provide treatment based on the SuDS Manual (CIRIA C697)
- Incorporate recognised sustainable drainage techniques to protect downstream watercourses from point source, diffuse and accidental contamination

Amenity / Biodiversity Objectives
The following design principles will be adopted to integrate the drainage scheme with the overall habitat, environmental, and landscape strategies:

- Provide permanent SuDS features and landscaped buffer zones
- Establish 'green corridors' linking principal SuDS features
- Plan footpath and cycle routes to encourage safe public access

Figure 2.2 - Schematic of SuDS Management Train

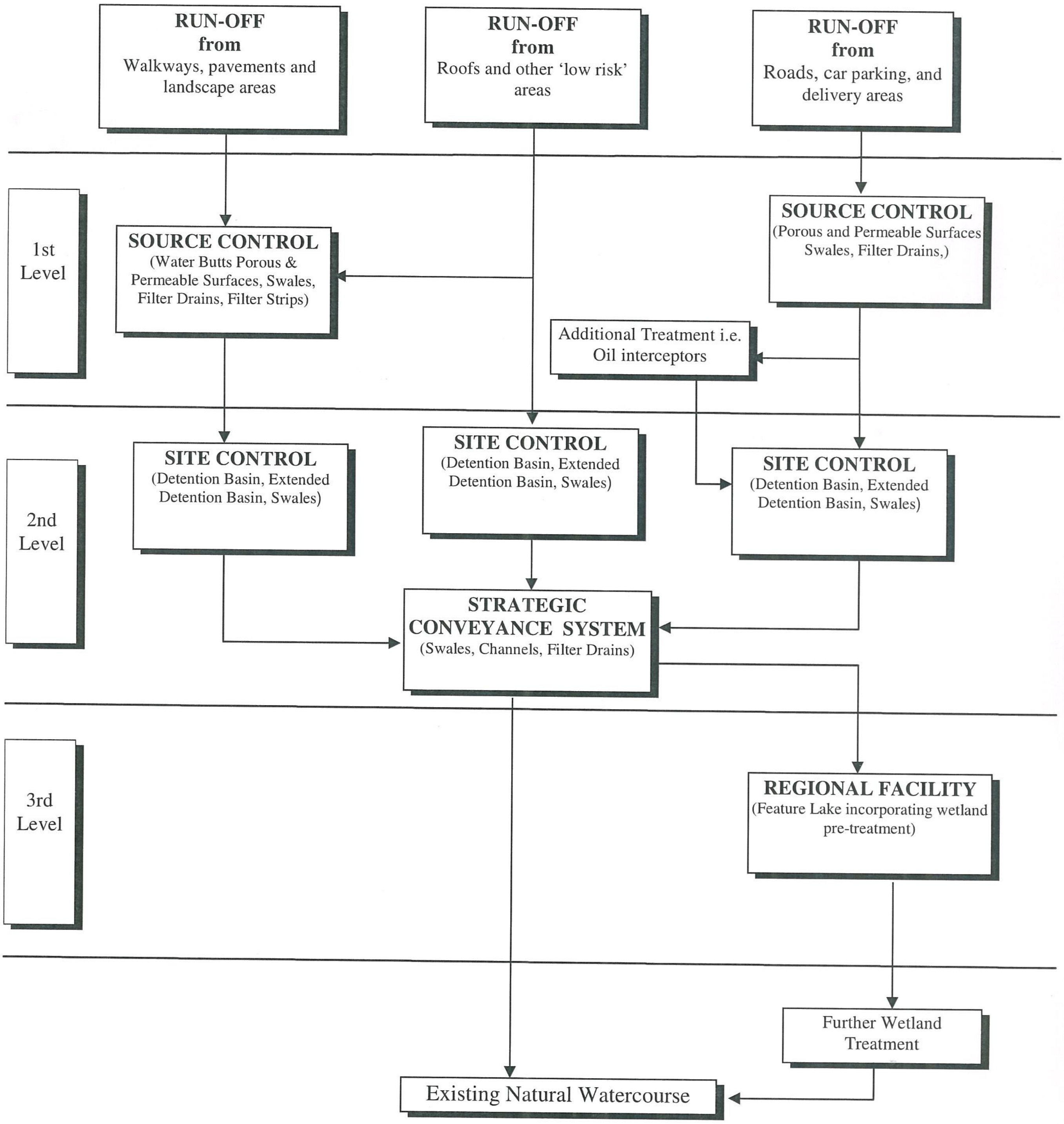
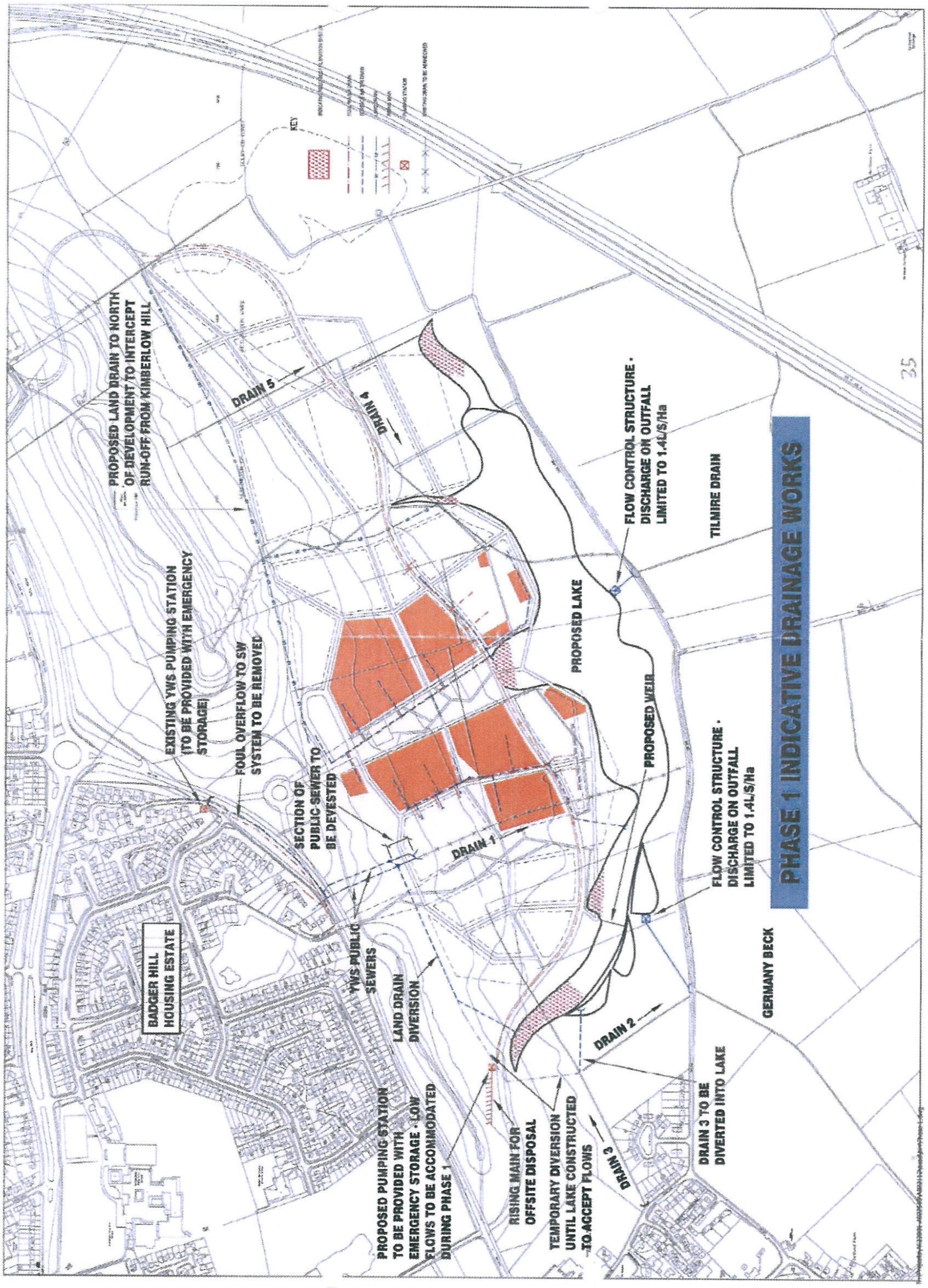


Figure 2.3 - Diversion of Land Drains and Sewers



3 THE LAKE

3.1 Design Philosophy

The 10.4 hectare lake and wetland area occupies the southern section of the application site as shown on the Development Masterplan (see Figure 1.4). The lake will consist of a permanent water body maintained at a minimum 'design' water level of 10.15mAOD with 'freeboard' capacity for storm attenuation.

The primary surface water management function of the lake is to provide flow balancing and flood storage to compensate for accelerated run-off from roofs, roads, and other hard surfaces within the proposed development. The lake and associated wetlands will also capture and treat contaminated surface water runoff prior to discharge into the existing Germany Beck and Tilmire Drain watercourses downstream.

Surface water runoff from the development site alone may be insufficient to maintain stable conditions. Lower rainfall during summer months translates into a potential lowering of water levels even after completion of all development although the lake would normally return to its 'design' water level of 10.15mAOD as a result of higher rainfall through autumn and winter.

In order to maintain the 'design' water level throughout the year and during periods of extended drought a new borehole will abstract groundwater from the Sherwood Sandstone major aquifer during periods of low rainfall. This will also serve to maintain base flows in the Germany Beck and Tilmire Drain watercourses downstream thus avoiding adverse ecological impacts during extended periods of low flow which could otherwise be experienced due to the storage effects of the lake.

3.2 Water Depth

The main body of the lake will be constructed to provide a maximum water depth of between 1.5 and 2.5m in order to discourage the growth of submerged vegetation.

Shallow margins with a water depth of up to 0.5m will be planted with emergent reed type species and other aquatic vegetation to provide wildlife habitats and enhanced potential for the natural treatment of pollutants. Partially treated and attenuated surface water runoff from the development area will be routed through the shallow planted margins and perimeter wetland areas.

Minimum 'normal' operating water levels in the lake will be maintained by a fixed weir structure at the lake outlet. During dryer summer months a 'top-up' supply of abstracted groundwater will be used to maintain the normal operating water level of 10.15mAOD.

Following heavy rainfall, water levels in the lake could rise by up to 200mm (10.35mAOD) providing sufficient flood storage volume to maintain a constant discharge rate (see Flow Schematic in Figure 3.1 and Section on 'Flow Control' below).

3.3 Nutrient Control

Excess algal growth could be experienced within the lake if the inflow is high in nutrients originating from the previous agricultural land-use. This will be controlled by pre-treating runoff from landscaped areas in specially designed reed bed and constructed wetland zones located immediately upstream of the lake.

A satisfactory reduction in nitrate and phosphate concentrations can be achieved through a combination of low through-flow rates and selected plant species and planting mediums. Soil and ground water analysis is being carried out to assist with the development of detailed design proposals.

Water quality within the lake will be continuously monitored and a pumped recirculation system (the control centre will be located near the lake outlet) will assist in achieving a constant minimum through-flow and also in providing the option of additional wetland / reed bed treatment.

3.4 Flow Control

Outflows from the lake into the Germany Beck and Tilmire Drain will be controlled to avoid any increase in flood risk and channel erosion downstream.

Consultations with the Ouse & Derwent Internal Drainage Board have established that surface water discharge from Heslington East should be restricted to a maximum discharge rate of 1.4l/s/ha (based on the total contributing catchment area of the two principal watercourses at the development site boundary).

Flow control will be achieved using conventional fixed weir structures designed for ease of maintenance and to resist fouling. Outflow rates from the lake will be monitored enabling the control of the abstraction borehole supply during periods of low inflow.

During storm events the lake level will rise. Inflows in excess of 1.4l/s/ha will mobilise the design flood storage up to a 1 in 100 year design storm event. After the peak of the storm event has passed inflows will reduce to the point that they will be exceeded by outflow and the lake level will gradually return to normal water level.

3.5 Lake Construction

The lake will be formed by excavating below existing ground levels to the required formation depths whilst ground levels along the perimeter of the site will remain largely unaltered. A geo-synthetic or remoulded clay liner will avoid unacceptable water losses through seepage and help to maintain a constant water level within the lake.

Initial filling of the lake will be achieved over a period of up to 12 months using a combination of surface water runoff from the development area, and water abstracted under licence from the underlying Sherwood Sandstone aquifer.

During a phased construction of the lake, base flows in the downstream watercourses will be maintained and measures incorporated to ensure downstream water quality is fully protected.

The lake and associated wetland areas will be the subject of a separate 'reserved matters' planning application. This will include details of the inlet and outlet structures, perimeter drainage, existing drainage channel diversions, and detailed planting proposals,

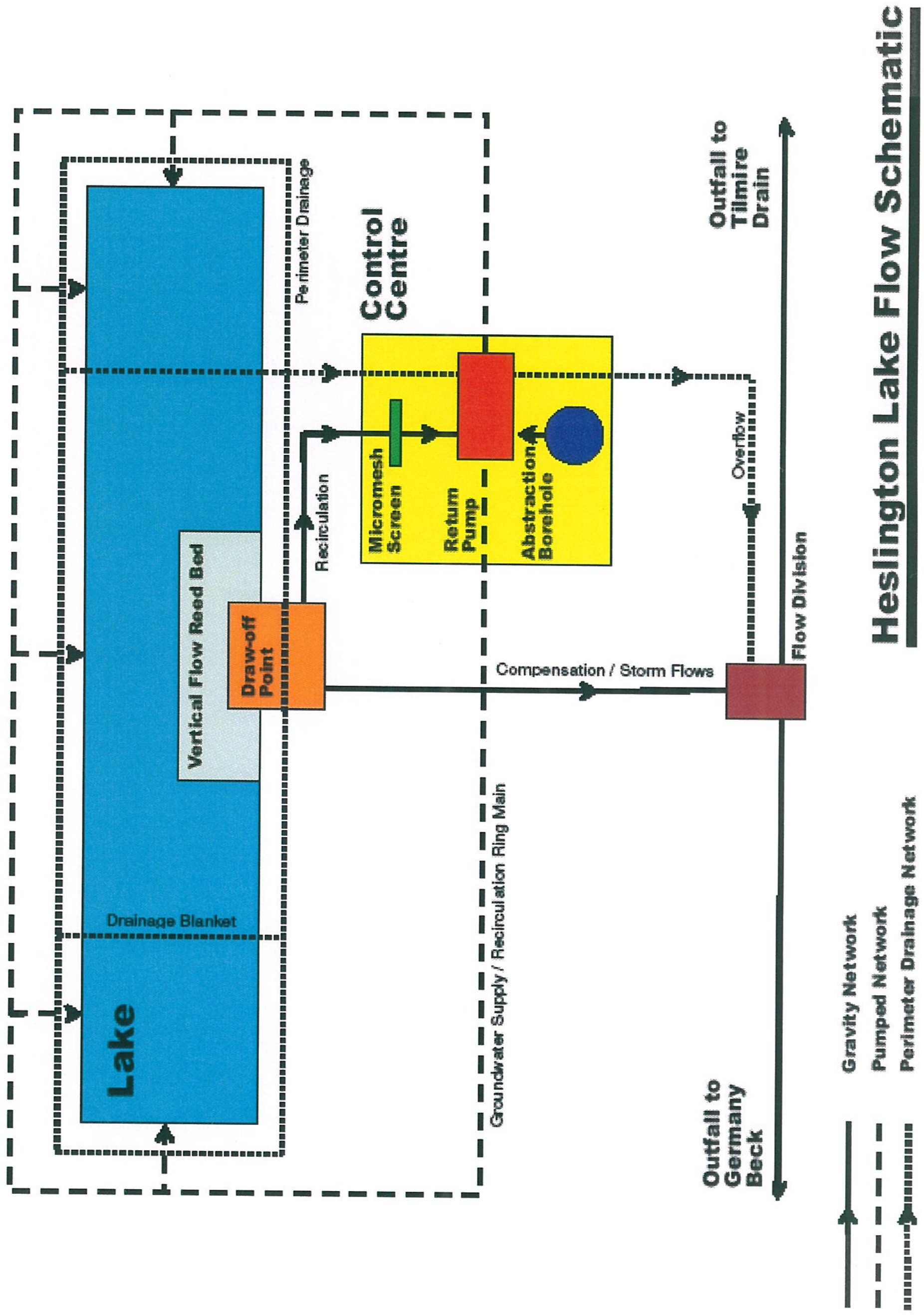


Figure 3.1 – Lake Flow Schematic

4 IMPLEMENTATION STRATEGY

4.1 Construction Programme

The construction of the strategic surface water drainage system with regional facilities to serve the Heslington East Campus is programmed for completion within the first phase of development.

The regional facilities (lake and associated wetlands) will be particularly vulnerable to damage from construction runoff and appropriate measures will be taken to minimise the pollutant loading from entering the strategic system (see Section 4.2 below).

Soil stripping operations should ideally be programmed during dry summer weather. Filter drains and porous surfaces are particularly vulnerable to blockage from heavy silt laden runoff from construction activities. Temporary silt lagoons and traps will be provided upstream of strategic drainage system to intercept runoff.

Further discussions are taking place with the Internal Drainage Board (and the Environment Agency) to ensure that adequate information is available for compliance and requisite approvals under the Land Drainage Act and Local Byelaws.

4.2 Protection of Water Resources during Construction

Construction activities can create potential risks to watercourse contamination. The following safeguards are identified within the 'Construction Site Management Plan'.

a) Deliveries - Special care is to be taken during deliveries, especially when fuels and hazardous materials are being handled. All deliveries are to be supervised by a responsible person so that storage tank levels are checked before delivery to prevent overfilling and that the product is delivered to the correct tank. Contingency plans are to be agreed and suitable materials available to deal with any incident that occurs. All employees are to be briefed on the actions that are required in the event of a spillage.

b) Storage - Many of the materials used in construction operations, such as oil, chemicals, cement, lime, cleaning materials and paint have the potential to cause serious pollution. All fuel, oil and chemical storage must be sited on an impervious base within a bund and secured. The base and bund walls must be impermeable to the material stored and of an adequate capacity. Leaking or empty oil drums must be removed from the site immediately and disposed of via a licensed waste disposal contractor. The contents of any tank are to be clearly marked on the tank, and a notice displayed requiring that valves and trigger guns be locked when not in use.

c) Security - All valves and trigger guns are to be protected from vandalism and unauthorised interference and turned off and securely locked when not in use. Any tanks or drums are to be stored in a secure container or compound, which is to be kept locked when not in use. Bowsers should be stored within site security compounds when not in use.

d) Silt - Water containing silt will not be pumped directly into the lake or surface water drains. Silty water can arise from excavations, exposed ground, stockpiles, plant and wheel washing.

i) *Excavations* - Measures are to be taken to prevent water from entering excavations. This could be by the use of cut-off ditches to prevent entry of surface water and well point dewatering or cut-off walls for ground water. The means of dewatering excavations in the event there is ingress is to be agreed in advance.

ii) *Spoil heaps* - Spoil heaps will be located and configured in a way that will reduce the risk of contamination of drainage ditches.

iii) *Plant and wheel washing* - Wheel washes and plant washing facilities are to be securely constructed with no overflow and the effluent should be contained for proper treatment and disposal. Recycling of water is to be included within the design.

iv) *Site roads* - These are to be kept free from dust and mud deposits. In dry weather dust suppression measures may be required.

v) *Dealing with silty water* - Adequate provision for dealing with silty water is to be agreed in advance. Any planned discharges off the site will require prior approval with the appropriate authorities. Suitable treatment may be required, including the use of a settlement lagoon or tank or grassed areas.

e) Refueling - The risk of spilling of fuel is at its greatest during the refueling of plant. Mobile plant is to be refueled in a designated area, preferably on an impermeable surface away from any drains or watercourses. A spill kit is to be available in this location. Hoses and valves are to be checked regularly for signs of wear and turned off and securely locked when not in use. Diesel pumps and similar equipment are to be placed on drip trays to collect minor spillages. These should be checked regularly and any accumulated oil removed for disposal.

f) Concrete - Concrete is highly alkaline and corrosive and can have a serious impact on watercourses. It is essential to take particular care with all works involving concrete and cement. Suitable provision is to be made for the washing out of concrete mixing plant or ready mix concrete vehicles so that washings do not flow into any drain or watercourse.

In the event of a spillage on site, the material must be contained (using an absorbent material such as sand or soil or commercially available booms). In the event of a significant occurrence the Environment Agency is to be notified immediately.

4.3 Planting Regime

The construction programme for the SuDS facilities should allow rapid planting and seeding at the most appropriate season. The strategic system and regional treatment facilities will be constructed to coincide with the initial phase of development, providing time for marginal and aquatic planting to become established before maximum flow rates are achieved.

The SuDS features will use a combination of planting and natural regeneration to establish vegetation cover, with a review of the communities at 5 year intervals.

Further information on the planned management and maintenance of SuDS facilities as part of a site wide landscape management strategy is contained in the 'Landscape Management Plan' and Section 5 of this report.

5 MAINTENANCE AND MANAGEMENT

5.1 Introduction

SuDS facilities require regular and planned maintenance and monitoring to ensure operational effectiveness. The following paragraphs outline the issues that affect maintenance of the SuDS features to be constructed as part of the strategic surface water drainage system for the Heslington East Campus Development.

5.2 Construction and Aftercare

To maximise the value of the SuDS facilities for both wildlife and amenity, some fine-tuning during the establishment and operational period will be required.

The following three phased approach will be adopted:

- Construction, planting and seeding in Year 1
- Fine-tuning of physical structure and operation, and establishment of vegetation in Years 2-3
- Strategic review of ecology and landscape aspects at 5-year intervals to develop enhancement proposals

Construction

During planting it is be important to avoid polluting the SuDS systems. The creation of low-maintenance landscapes will minimise areas that require the application of fertilisers, herbicides and pesticides, further helping to reduce water pollution.

The design and specification for the SuDS facilities will closely describe the species required on site and the consequences of introduction of unwanted species. Contract documentation will also require contractors to remove any non-native aquatic plants, and should allow for the removal of undesirable species of any origin.

The SuDS facilities constructed as part of the strategic system will be operational prior to the construction of the identified development areas upstream. Greater care will therefore need to be taken during the construction of the development sites upstream to ensure that the surface runoff from the sites will not harm the completed SuDS facilities.

Fine-Tuning

A post-completion review and enhancement will be required to audit the system. This will provide the opportunity to fine-tune the design through further, small-scale activities. During the first few years of operation and establishment of vegetation, the opportunity should be taken to adjust where necessary any minor elements of the design.

Strategic Review
Regular monitoring and review of the quality of the SuDS facilities should follow construction. An aftercare period of 5 to 10 years is required for the establishment of complex semi-natural systems.

As Heslington East will contain a number and variety of features, established over several years, it will be appropriate to review them at intervals of around 5 years to assess the strengths and weaknesses of the SuDS facilities, in ecological, landscape and engineering terms. A strategy can then be developed to extend successful practices or techniques, and to increase diversity or promote extension of a particular habitat or outcome.

Periodic plant and invertebrate sampling at key points throughout the drainage system will provide an auditable record of water quality allowing an assessment of pollution levels.

5.3 Aquatic Management

Current nature conservation guidelines for water management recommend a minimal approach to intervention, allowing the lake and associated wetlands to develop and to mature naturally, and creating new water-bodies nearby where open water is required. Such an approach links well with the management of SuDS features, where costs need to be minimised and wildlife benefits maximised.

Management and control of wildfowl and fish stocks should be continued in the longer term since overpopulation by wildfowl and fish can have a seriously detrimental effect on the water quality and appearance of a water bodies.

SuDS features will be designed to have a greater capacity than would be required in the short term so that siltation and infilling with vegetation can occur without reducing drainage and flow balancing capacity below acceptable levels.

5.4 Managing Sediment

In line with the objectives to minimise management input, the distribution and accumulation of sediment needs to be considered from the outset. It is a common misconception that the silt accumulation in water bodies is undesirable and that management and maintenance regimes should seek to reverse this process.

The gradual and controlled accumulation of silt will reduce the area of open water promoting the development of marginal and wetland habitats. Such areas have a very high value in their own right, are better at improving water quality through sedimentation and nutrient capture, and can support a greater range of species than deep water. Such natural processes should be incorporated into the design and management of the system as a whole, promoting bio-diversity.

Particular consideration of silt retention will be needed during the construction phases of both the strategic surface water system and the development areas upstream when earth moving operations can result in high silt loadings in runoff. Additional settlement pools are likely to be required to address this, and these can be designed to be retained, without excavation, as shallow pools or marsh in the long-term.

Excessive loss of flow balancing capacity in the longer term will be achieved by routing upstream drainage through grass swales to help reduce sediment load.

5.5 Managing Wildlife and Vegetation

The rapid establishment of a diverse range of plant species is an important element of this strategic surface water drainage strategy. Vegetation plays a key role in the effective operation of SuDS facilities, filtering water and removing nutrients. The early establishment of marginal vegetation will also help to increase the visual appeal of water bodies, reduce inappropriate uses and enhance safety.

Excessive and unbalanced populations of fish and waterfowl in water bodies can result in poor aquatic plant communities through fish feeding and disturbance. Such water bodies are typically higher in nutrients, more turbid and more prone to algal blooms. Managing waterfowl numbers and resisting the introduction of fish will help to maintain good water quality.

The wetland and grassland around the margins of water bodies are also an important component of the system. They act as a buffer, protecting the ponds from polluted runoff, filtering inflowing water and removing silt and nutrients. Creation of small pools of open water in this draw-down zone can be of benefit for a range of species and should be considered, on a minor scale when ponds are well established. Amphibians can breed in such isolated pools safe from fish predation.

5.6 General Maintenance Issues

SuDS facilities will be designed to minimise routine management and maintenance requirements. The use of low-fertility substrates will help to minimise grass cutting whilst increasing the chances of flower-rich communities developing. Basic maintenance to ensure the continued operational efficiency of the treatment systems will be necessary. As with conventional surface water systems the facilities should be checked annually and after each extreme storm event. Accumulated debris should be removed, vegetation maintained and settled solids removed periodically. The key factors will be to remove litter and weeds to promote a well-cared for appearance.

It is anticipated that a review and amendment of the maintenance regime will be required following a period of monitoring. Similarly the level of maintenance will change with time as development expands, construction activity slows, and various facilities become established. Regular inspection and monitoring of the maintenance programme is recommended to enable amendments to be made and to plan future actions.

Maintenance activities will comprise two main elements, routine maintenance and planned remedial works. Site specific maintenance requirements will be determined as the site is commissioned and after a period of operation. The required frequency of silt removal from the regional facilities will be substantially reduced by the introduction of upstream source controls.

6 WATER SAFETY CONSIDERATIONS

6.1 Open Water Safety

Safety will form a key design parameter for all sustainable drainage facilities. The Royal Society for the Prevention of Accidents (RoSPA) has identified a chain of events which can lead to accidents in water bodies. These are:

- Ignorance, disregard or misjudgment of danger
- Unrestricted access to hazards
- Absence of adequate supervision
- Inability to save oneself

All these elements should be considered in a strategy to render the SuDS features as safe as practicable. Education is a key step and will be promoted through initiatives throughout the University and at local schools and community centres.

Design will reduce the accessibility of areas with potential for accidents. Small, shallow water bodies with gently sloping margins, and densely planted edges will provide few opportunities for unsupervised access.

SuDS avoid many of the safety risks of traditional drainage engineering, for example those associated with enclosed culverts.

6.2 Safety Risk Assessment

The safety issues of SUDS in Heslington East will be reviewed and safety measures identified and incorporated in the design. Water will always be an attraction, particularly to young children. Public education and awareness of the facilities is therefore seen as an important factor in prevention of accidents.

The measures identified will reflect the conclusions of a risk assessment and general advice from RoSPA. Ultimately, safety is the responsibility of all parties and the choice of measures taken will depend on the risk attitude willing to be adopted and duty of care by the parties responsible.

The main conclusions of previous assessments are as follows:

- Potential hazards associated with open water within an urban or semi-urban setting can be reduced by careful design

- Access to water bodies should be controlled

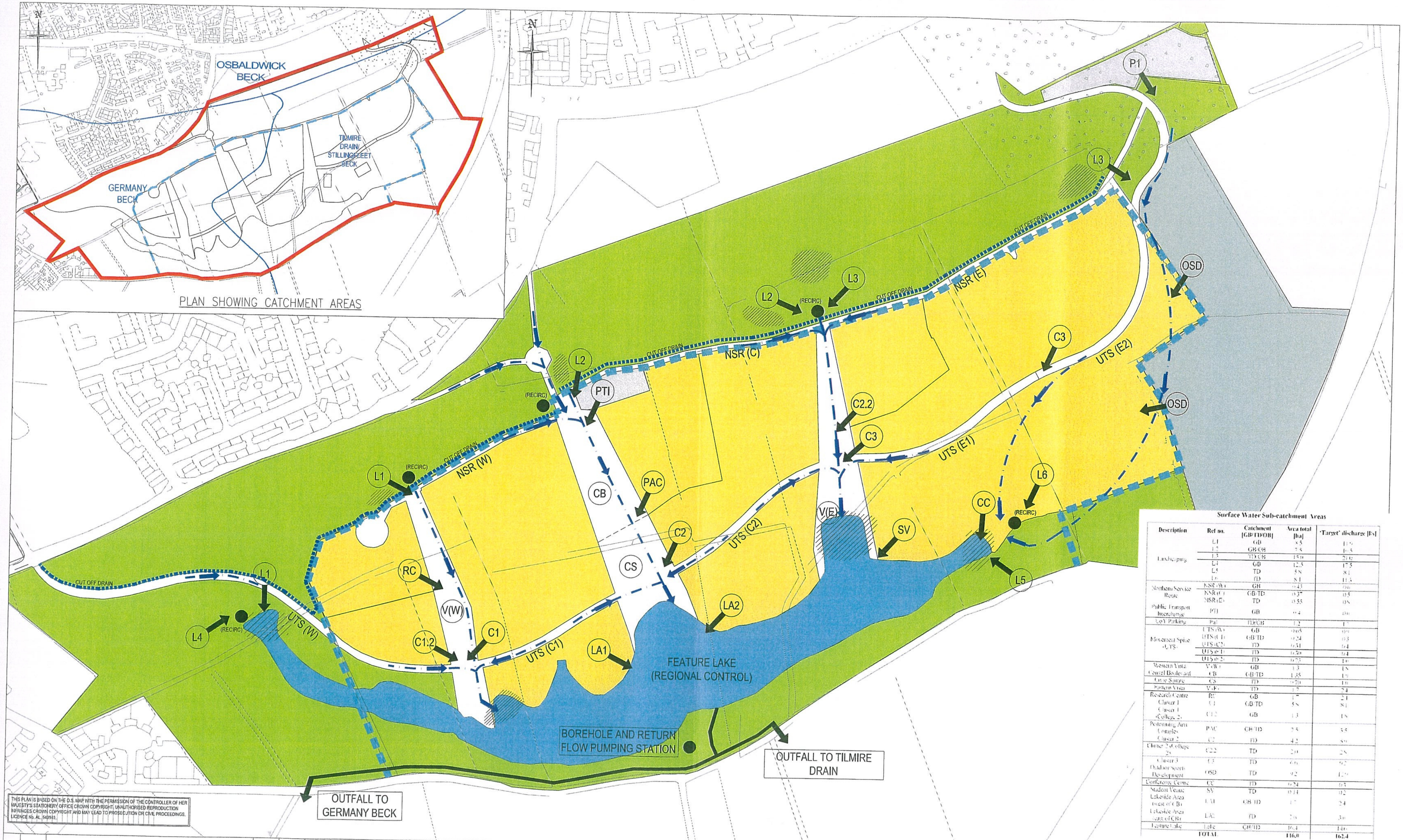
- Physical barriers comprising inhospitable planting and dense aquatic planting in shallow margins will deter public access to open water

- Gradual side slopes combined with shallow margins will avoid sudden changes in footing below water level
- Routine maintenance programmes should be established
- Public awareness of water quality and the potential hazards associated with open water should be raised locally

The provision of safety notices and rescue equipment has been considered in depth during previous audits. Following advice from RoSPA it has been concluded that whilst their selective use at designated access or viewing points can be beneficial, vandalism may result in such measures being counter-productive to public safety.

APPENDIX A: STRATEGIC SURFACE WATER DRAINAGE PLAN

Drawing no. 70072/SK007 - Heslington East Campus Development
Indicative Strategic Surface Water Drainage Plan



THIS PLAN IS BASED ON THE O.S. MAP WITH THE PERMISSION OF THE CONTROLLER OF HER MAJESTY'S STATIONERY OFFICE CROWN COPYRIGHT, UNAUTHORISED REPRODUCTION INFRINGES CROWN COPYRIGHT AND MAY LEAD TO PROSECUTION OR CIVIL PROCEEDINGS. LICENCE No. AL 542943.

Surface Water Sub-catchment Areas

Description	Ref no.	Catchment [GB/TD/OB]	Area total [ha]	'Target' discharge [l/s]
Landscaping	L1	GB	8.5	11.9
	L2	GB/OB	7.5	10.5
	L3	TD/OB	15.0	21.0
	L4	GB	12.5	17.5
	L5	TD	5.8	8.1
	L6	TD	8.1	11.3
Northern Service Route	NSR (W)	GB	0.43	0.6
	NSR (C)	GB/TD	0.37	0.5
	NSR (E)	TD	0.55	0.8
Public Transport Interchange	PTI	GB	0.4	0.6
UoY Parking	Pal	TD/GB	1.2	1.7
Movement Spine (UTS)	UTS (W)	GB	0.65	0.9
	UTS (C1)	GB/TD	0.24	0.3
	UTS (C2)	TD	0.31	0.4
	UTS (E1)	TD	0.30	0.4
	UTS (E2)	TD	0.73	1.0
Western Vista	V(W)	GB	1.3	1.8
Central Boulevard	CB	GB/TD	1.35	1.9
Civic Square	CS	TD	0.70	1.0
Eastern Vista	V(E)	TD	1.7	2.4
Research Centre	RC	GB	1.7	2.1
Cluster 1	C1	GB/TD	5.8	8.1
Cluster 1 (College 2)	C1.2	GB	1.3	1.8
Performing Arts Complex	PAC	GB/TD	2.5	3.5
Cluster 2	C2	TD	4.2	5.9
Cluster 2 (College 2)	C2.2	TD	2.0	2.8
Cluster 3	C3	TD	6.6	9.2
Outdoor Sports Development	OSD	TD	9.2	12.9
Conference Centre	CC	TD	0.24	0.3
Student Venue	SV	TD	0.14	0.2
Lakeside Area (west of CB)	LA1	GB/TD	1.7	2.4
Lakeside Area (east of CB)	LA2	TD	2.6	3.6
Feature Lake	Lake	GB/TD	10.4	14.6
	TOTAL		116.0	162.4

Legend: GB – Germany Beck, TD – Tilmire Drain, OB – Osbaldwick Beck

LEGEND:

- INDICATES LANDSCAPED AREA
- INDICATES DEVELOPED AREA
- INDICATES TRANSPORT/CAR PARK AREA
- INDICATES WATER FEATURE
- INDICATES PRE-TREATMENT FOR LANDSCAPE DRAINAGE
- ALLOCATION BOUNDARY
- DRAINAGE CHANNEL/SWALE

Rev.	Date	Description	Drawn	Checked	Approved
A	31/03/08	Updated masterplan and lake boundary	AW	ML	EC

Client: THE UNIVERSITY of York

Project Title: HESLINGTON EAST EXPANSION

Drawing Title: INDICATIVE STRATEGIC SURFACE WATER DRAINAGE PLAN, (SUDS STRATEGY)

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APPENDIX B: PRE-DEVELOPMENT RUNOFF RATES

Calculation of pre-development runoff rate is difficult to quantify accurately given the number of variables involved. The 'Greenfield' runoff rate determines the extent of attenuation required and is affected by the amount of depression storage, existing drainage system, natural and artificial constrictions, gradient of the site, type of land use, soil type and antecedent conditions. However, a number of empirical methods are available which have been used to assess the Greenfield runoff of the catchments (see Table B1 below).

Table B.1

Method	Formula
Poots and Cochrane	$Q_{BAR} = 0.0136\ (AREA)^{0.866}(RSMD)^{1.413}\cdot(SOIL)^{1.521}$
FSSR No6 Institute of Hydrology	$Q_{BAR} = 0.00066\ (AREA)^{0.92}(SAAR)^{1.22}(SOIL)^{2.0}$
Report No124, Institute of Hydrology	$Q_{BAR} = 0.00108(AREA)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$

Consultations with the Ouse & Derwent Internal Drainage Board and the Environment Agency have established that the allowable rate of surface water runoff from the new development should not exceed an equivalent 'Greenfield' rate of 1.4l/s/ha. The empirical methods described above together with the results of an ongoing flow monitoring study will be used to verify this figure prior to completion of detailed drainage and lake designs.

In the absence of a complex hydrological model capable of being updated as development proceeds, a conservative approach involves the proportional distribution of the allowable discharge rate for the entire catchment over the individual development areas. This method is recommended for its simplicity reflecting the empirical method of analysis and providing a better method to monitor and control development proposals.

Discharge rates for each drainage sub-catchment within the Heslington East site have been calculated using the global allowance of 1.4l/s/ha. This rate has then been divided between each development area in the calculation of 'target' discharge rates. The choice of SuDS techniques will be influenced by spatial planning requirements, including building layout and accessibility. However, the control and partial attenuation of runoff from development areas will reduce the potential for storm surges and erosion downstream.

The following table (Table B2) shows the calculated 'target' discharge rates for the major catchments within the Heslington East Campus Development.

Table B.2 - Surface Water Sub-catchment Areas

Description	Ref no.	Catchment [GB/TD/OB]	Area total [ha]	'Target' discharge [l/s]
Landscaping	L1	GB	8.5	11.9
	L2	GB/OB	7.5	10.5
	L3	TD/OB	15.0	21.0
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	NSR (C)	GB/TD	0.37	0.5
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Public Transport Interchange	PTI	GB	0.4	0.6
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	UTS (C1)	GB/TD	0.24	0.3
	UTS (C2)	TD	0.31	0.4
	UTS (E1)	TD	0.30	0.4
	UTS (E2)	TD	0.73	1.0
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Central Boulevard	CB	GB/TD	1.35	1.9
Civic Square	CS	TD	0.70	1.0
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Cluster 2	C2	TD	4.2	5.9
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Outdoor Sports Development	OSD	TD	9.2	12.9
Conference Centre	CC	TD	0.24	0.3
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Feature Lake	Lake	GB/TD	10.4	14.6
TOTAL			**116.0**	**162.4**

Legend: GB – Germany Beck, TD – Tilmire Drain, OB – Osbaldwick Beck

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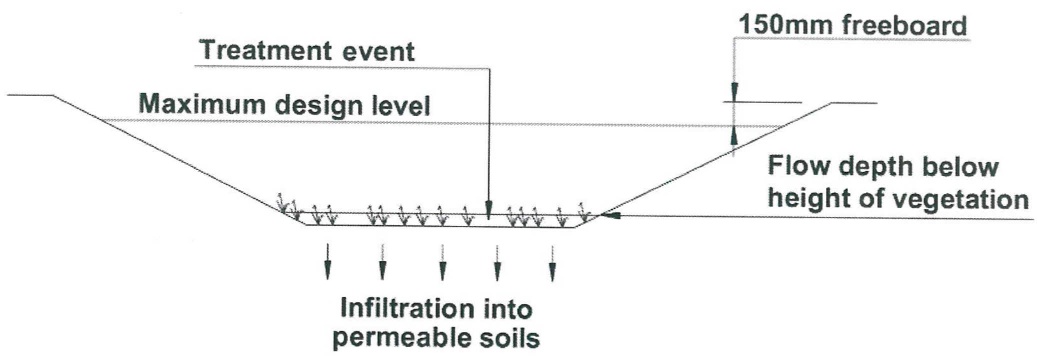
APPENDIX C: SWALES – GENERAL DESCRIPTION

Swales are shallow channels designed to store and/or convey runoff and remove pollutants. They may be used as conveyance structures to pass the runoff to the next stage of the treatment train and can be designed to promote infiltration where soil and groundwater conditions allow.

The swale channel is broad and shallow and covered by dense vegetation, usually grass, to slow down flows and trap particulate pollutants. A swale can have check dams or berms installed across the flow path, to promote settling and infiltration. There are three main types of swale, each with different surface water management capability.

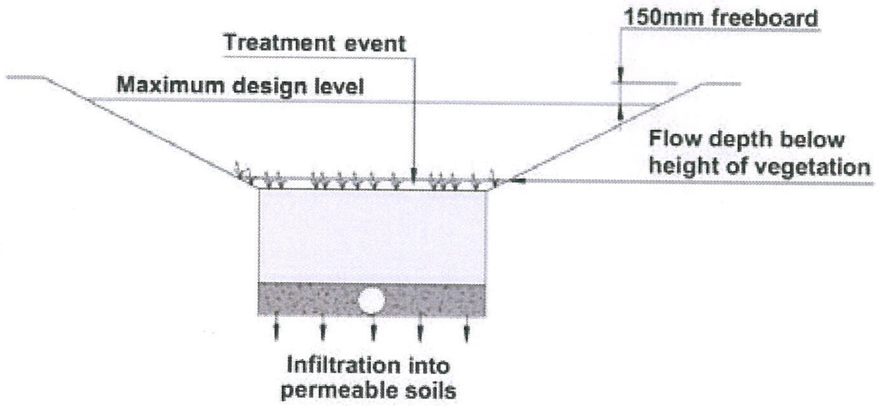
1. Standard conveyance swale

Conveyance swales are broad, shallow vegetated channels. These are particularly effective ways of directing and conveying runoff from the drained area to another stage of the surface water management train. They can be designed for vegetative filtration or detention, depending on the level of flow constraint and ponding depths appropriate at the site.



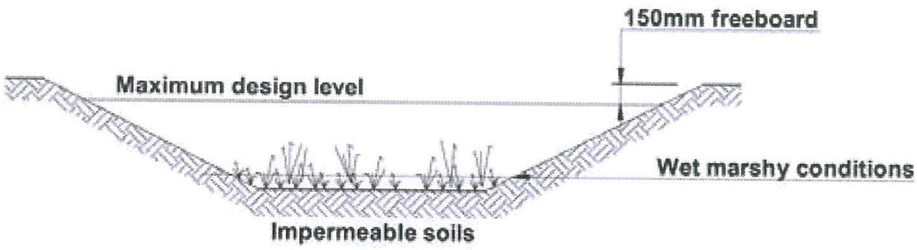
2. Dry swale

The dry swale is a vegetated conveyance channel, designed to include a filter bed of prepared soil that overlays an under-drain system. This provides additional treatment and conveyance capacity beneath the base of the swale. As they remain dry most of the time, they do not become boggy during wet weather. In some locations, such as pollution hotspots, dry swales may require lining to prevent infiltration.



3. Wet swale

This system is equivalent to the conveyance swale, but designed to encourage wet and marshy conditions in the base to enhance treatment processes. This can be achieved using liners or, where underlying soils are poorly drained (or water tables are high), in combination with shallow gradients.



Regular inspection and maintenance is important for the effective operation of swales as designed. Adequate access must be provided to all swale areas for inspection and maintenance, including for appropriate equipment and vehicles.

Sediments excavated from swales that receive runoff from residential or standard road and roof areas are generally not toxic or hazardous material and can be safely disposed of by landfilling. Many of the specific maintenance activities for swales can be undertaken as part of a general landscaping contract and, therefore, if landscape management is already required at site, should have marginal cost implications.