



King's Lynn and West Norfolk Settlements Surface Water Management Plan

Stage 1 Report

November 2010
Norfolk County Council Client Task Group

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Norfolk County Council Client Task Group

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Executive Summary

This report concerns Stage 1 of the King's Lynn and West Norfolk Settlements Surface Water Management Plan (SWMP). The aim of a SWMP is to understand and resolve complex and high risk surface water flooding problems in urbanised areas. A SWMP brings together key local partners, with responsibility for surface water and drainage in their areas, to collaborate to investigate the causes of surface water flooding and agree the most cost effective way of managing surface water flood risk. The principal output from a SWMP study is an action plan outlining the preferred surface water management strategy and identifying the actions timescales and responsibility of each partner.

The project is being led by a Client Task Group (CTG) who, through Norfolk County Council, are steering the delivery of the work. The CTG is composed of the following organisations: Borough Council of King's Lynn and West Norfolk, Anglian Water, Environment Agency, Norfolk County Council and representatives from the local Internal Drainage Boards (IDBs).

The King's Lynn and West Norfolk Settlements SWMP is being undertaken in two Stages. Stage 1 (Inception) covers the Phase 1 (Preparation) part of the DEFRA defined process, and Stage 2 covers Phases 2, 3 and 4 of the DEFRA process (see Section 1.2.3 for details). This report is in regard to Stage 1 only.

Stage 1 of the King's Lynn and West Norfolk Settlements SWMP has achieved the following:

- Identified the level of assessment at which the SWMP study will be carried out, (see Section 1.2.4). It will be at an intermediate level, with detailed assessments undertaken in specific areas vulnerable to surface water flooding where funding allows;
- Established a partnership and clarified the roles of responsibilities of each partner, (see Sections 2.1 and 2.2);
- Established an engagement plan to define the method and timing of stakeholder engagement in Stage 2, (see Section 2.4);
- Set the overall objectives for the King's Lynn and West Norfolk Settlements SWMP, (see Section 2.5);
- Collated and mapped all available data for the SWMP, identified missing data and presented the data in a format which will aid Stage 2 of the SWMP, (see Chapter 3);
- Identified areas more vulnerable to surface water flooding from existing data, (see Section 3.10); and

- Determined the approach for Stage 2 (Phases 2, 3 & 4) of the King's Lynn and West Norfolk Settlements SWMP, (see Chapter 4).

The key deliverables from Stage 1 are:

- A report (this report), including a list of contacts, tables of available data (plans, reports, GIS and spreadsheet data), gap analysis, maps of available data and a preliminary estimate of surface water flood risk; and
- DVDs providing all data collated during Stage 1 for use in Stage 2.

The final technical reports and final action plan produced under this study will be available under the Freedom of Information Act (FOI) at the end of the study. However, working draft versions of documents and the raw data provided to the study by participating organisations will not be available under the FOI Act from Norfolk County Council. Any requests for the underlying information would need to be made directly with the participating organisations.

1. Introduction

1.1 Background

The aim of a Surface Water Management Plan (SWMP) is to understand and resolve complex and high risk surface water flooding problems in urban areas. A SWMP brings together key local partners, with responsibility for surface water and drainage in their areas, to collaborate to investigate the causes of surface water flooding and agree the most cost effective way of managing surface water flood risk¹. The principal output from a SWMP study is an action plan outlining the preferred surface water management strategy, and identifying the actions timescales and responsibility of each partner.

Surface water flooding in urban areas due to the current finite capacity of conventional drainage systems, is a particular area of concern. This has been highlighted in the UK Government's strategy for flood and coastal erosion risk management, Making Space for Water (MSfW) 2004. It is recognised that the urban drainage system is complex, including the funding arrangements, with different organisations holding separate responsibilities in relation to urban drainage. Strategic and integrated approaches to surface water drainage are essential under the challenges of housing growth and climate change.

In 2007 DEFRA instigated a series of 15 Integrated Urban Drainage (IUD) pilot studies to examine various aspects of Integrated Urban Drainage Management (IUDM). These studies investigated partnership development, data sharing issues, surface water modelling approaches and surface water flooding mitigation options.

Following on from these pilot studies and the flooding events of summer 2007, DEFRA published the Future Water Strategy, which sets out its intention to use SWMPs to develop IUDM approaches in England. In the Pitt Review of the summer 2007 floods, Sir Michael Pitt recommended that SWMPs be adopted where surface water flood risk is high, and in response to this the Government outlined the intention for local authorities to take a leadership role in local flood risk management in partnership with other stakeholders.

The Norfolk Flood Partnership (led by Norfolk County Council) decided a Surface Water Management Plan for King's Lynn and selected West Norfolk Settlements was required as a priority. This decision was based on the susceptibility of King's Lynn and the selected West Norfolk settlements to surface water flooding, and the large scale proposed growth in the Borough, particularly in King's Lynn (refer to Section 3.6 for further information).

The project is being led by a Client Task Group (CTG) who, through Norfolk County Council, are steering the delivery of the work. The CTG is composed of the following organisations: Borough Council of King's Lynn and West Norfolk, Anglian Water, Environment Agency, Norfolk County Council and representatives from the local Internal Drainage Boards (IDBs).

Specific SWMP guidance has been compiled by DEFRA using lessons learnt from the IUD pilot studies. The latest version was published in March 2010, and is known as the Surface Water Management Plan Technical Guidance. It is not intended for the SWMP to replace existing practices such as those outlined in

¹ Defra (2010), Surface Water Management Plan Technical Guidance.

Sewerage Risk Management (SRM)² for improvements to water company sewerage systems, or the DEFRA Project Appraisal Guidance (PAG) for prioritising flood risk investment. Rather, it is to be used alongside these other approaches to provide a simplified, overarching framework to allow organisations to develop a shared understanding of the most suitable solutions to surface water flooding problems.

Six first edition SWMPs have been undertaken. The main lessons learnt were presented at the British Water, Surface Water Management Sustainability Challenge conference, on 9th February 2010 in Solihull. These can be summarised as:

- Follow guidance broadly but tailor for local needs;
- Agree early on how to engage with and benefit from the local community;
- Scope the project first before setting the overall programme, costs and outputs;
- Don't be overambitious at the start – select one or two high risk locations for solution development;
- Keep modelling simple, but do include infrastructure and features that could be part of the solution. Do not turn SWMPs into a modelling exercise but focus any modelling required on priority areas;
- Verify LiDAR DTM data and model flood predictions on the ground;
- Develop a strategy for the long term – early actions and changes over 50 – 100 year period; and
- Don't worry about current regulatory and funding arrangements. SWMP can outline a hierarchy of mitigation options from low to high cost and then the funding available will influence what is implemented.

The updated DEFRA guidance published in March 2010 has taken account of these lessons as well as introducing advice on identifying the level of assessment required for a specific SWMP. Three levels of assessment have been identified (strategic, intermediate and detailed) to encourage the level of assessment to be appropriate to the scale of SWMP being undertaken.

The King's Lynn and West Norfolk Settlements SWMP is being undertaken in two Stages. Stage 1 (Inception) covers the Phase 1 (Preparation) part of the DEFRA defined process, and Stage 2 covers Phases 2, 3 and 4 of the DEFRA process. This report is in regard to Stage 1 only.

The aim of Stage 1 of the SWMP has been to undertake Phase 1 of the SWMP process for King's Lynn and the selected West Norfolk Settlements, as discussed in more detail in Section 1.2.4. It is a scoping exercise that seeks to establish what the intended outcomes are for the areas being considered, what data are available, and how the data can be used to achieve the outcomes, or in the case the data is inadequate, what the expected or reasonable outcomes could be.

The final technical reports and final action plan produced under this study will be available under the Freedom of Information (FOI) Act at the end of the study. However, working draft versions of documents and the raw data provided to the study by participating organisations will not be available under the FOI Act from Norfolk County Council. Any requests for the underlying information would need to be made directly with the participating organisations.

² Water Research Council. 2010. [_____](#)

1.2 Overview of the SWMP Process

1.2.1 Definition of a SWMP

The overall aim of a SWMP is to understand and resolve complex and high risk surface water flooding problems in urban areas. A SWMP brings together key local partners, with responsibility for surface water and drainage in their areas, to collaborate to investigate the causes of surface water flooding and agree the most cost effective way of managing surface water flood risk. The definition of surface water flooding in this context is given in Box 1.

Box 1 Definition of Surface Water Flooding under the SWMP guidance (2010)

In the context of SWMPs, surface water flooding includes the following:

- Pluvial flooding; flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (surface runoff) before it enters the underground drainage network or watercourse, or cannot enter because the network is full to capacity;
- Groundwater flooding; where groundwater is defined as all water which is below the surface of the ground and in contact with the ground or subsoil;
- Sewer flooding; flooding which occurs when the capacity of the underground systems is exceeded due to heavy rainfall, resulting in flooding inside and outside of buildings. Normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters;
- Flooding from urban watercourses; flooding from small open-channel and culverted urban watercourses which receive most of their flow from inside the urban area and perform an urban drainage function; and
- Overland flows from the urban/rural fringe entering the built-up area, including overland flows from groundwater springs.

The DEFRA guidance states that decisions that are taken regarding surface water flooding should be evidence based, future proofed and inclusive of stakeholder views. The main focus of SWMPs should be on the existing developed urban area. It also states that SWMPs can identify proposed new development which can help to reduce surface water flood risk to the existing urban area through a Flood Risk Assessment. The SWMP can inform the content of the Flood Risk Assessment and help to provide co-ordination between developers for measures such as sustainable drainage systems. However, SWMPs should consider only how the new growth outside the urban area affects the urban area itself. On site surface water issues will be dealt with by the new developers themselves through a Water Cycle Study (WCS), and where there is surface water flood risk, through a Flood Risk Assessment. SWMPs can also provide a framework for the management of urban water quality, and detailed mapping of areas prone to surface water flood risk will be useful in terms of future spatial planning.

1.2.2 Links with other data and plans

SWMPs are part of a wider process of strategic planning between local government, the Environment Agency, and Water and Sewage Companies (WaSCs). The Environment Agency encourages the use of WCSs and Strategies to address water related issues in planning, and SWMPs are part of this process. They use information from studies covering wider water related issues and geographical areas such as Catchment Flood Management Plans (CFMPs) and Level 1 and 2 Strategic Flood Risk Assessments

(SFRA), and apply this to smaller priority areas to undertake detailed assessments and suggest mitigation solutions. The findings will inform decisions on mitigation actions to be applied, investment in capital infrastructure and maintenance, the location and design of new developments and emergency plans.

Locally, a Strategic Flood Risk Assessment³ (SFRA) was completed in 2005. This report was then updated by Faber Maunsell⁴ in 2008 to take advantage of advances in hydraulic modelling techniques as well as take into account Planning Policy Statement 25: Development and Flood Risk (PPS25). Finally in 2010, an annex of the SFRA was produced by Entec⁵ to help inform the appropriate siting of development within the borough.

The SFRA is complemented by the Water Cycle Study completed in 2009, which has addressed the wider issues of water supply, water quality, sewerage and infrastructure.

1.2.3 Key elements of a SWMP

The principal stages of a SWMP according to the DEFRA guidance 2010 are:

- Phase 1 – Preparation;
- Phase 2 – Risk Assessment;
- Phase 3 – Options; and
- Phase 4 – Implementation and Review.

These phases are illustrated in Figure 1.1.

The recent guidance from DEFRA, March 2010, requires the level of assessment at which a SWMP study should be carried out to be identified during Phase 1, the preparation phase. Three levels of assessment have been identified as shown in Table 1.1.

³ Bullen Consultants. 2005. King's Lynn and West Norfolk Strategic Flood Report Assessment.

⁴ Faber Maunsell. 2008. King's Lynn and West Norfolk Strategic Flood Report Assessment (2007/2008 revision).

⁵ Entec. 2010. King's Lynn and West Norfolk Strategic Flood Report Assessment Annex to Level 1.

Figure 1.1: Phases of a SWMP according to the DEFRA Technical Guidance, March 2010.

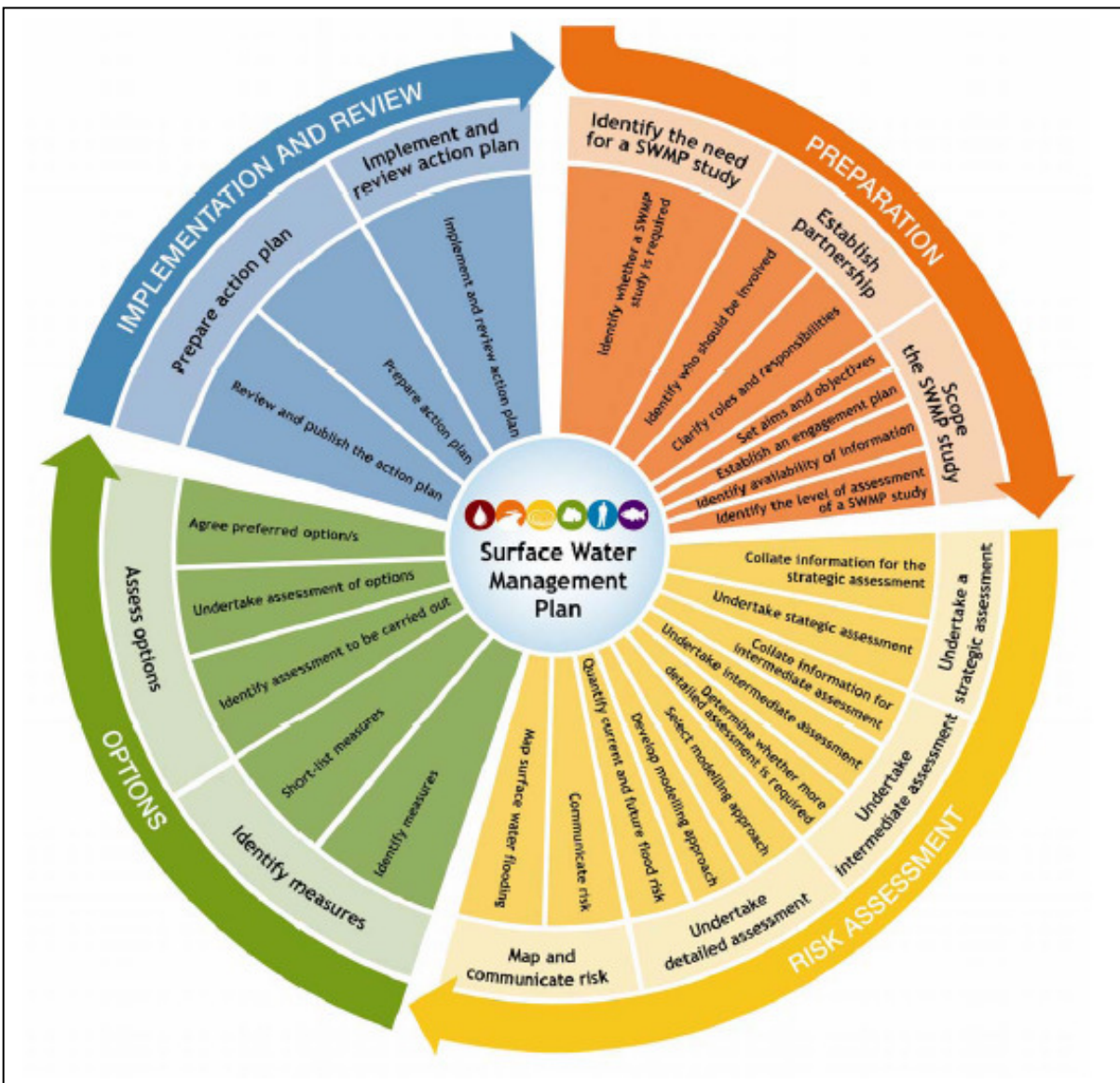


Table 1.1: Levels of assessment in a SWMP study

Level of analysis	Appropriate scale and examples	Outputs	When might this approach be adopted
<p>Strategic assessment (1st level of risk assessment creating a base for further work).</p>	<p>County or large conurbation (e.g. Greater London)</p>	<p>Broad understanding of locations which are more vulnerable to surface water flooding</p> <p>Prioritised list for further assessment</p> <p>Provide outline maps for spatial and emergency planning</p>	<p>Where there is limited current understanding of areas vulnerable to surface water flooding</p> <p>OR</p> <p>Where the local authority wants to develop a prioritised list of locations for further assessment</p>
<p>Intermediate assessment (2nd level of risk assessment including homing in on priority areas)</p>	<p>Large town or city (e.g. Warrington, Leeds)</p> <p>OR</p> <p>Borough (e.g. London Borough of Richmond & Kingston)</p>	<p>Identify flood hotspots which might require further analysis through detailed assessment</p> <p>Identification of immediate mitigation measures which can be implemented</p> <p>Outputs should be used to inform spatial and emergency planning</p>	<p>To enhance understanding of local surface water flooding issues</p> <p>OR</p> <p>To identify flood hotspots which require a detailed assessment</p>
<p>Detailed assessment (3rd level or assessment helping to understand the detailed causes and impacts of flooding. At this level solutions can be designed.</p>	<p>Small town</p> <p>OR</p> <p>Known flood hotspots (from SFRAs, recent flood incidents, local knowledge etc)</p>	<p>Detailed assessment of the causes and consequences of flooding, which can be used to understand the flooding and to test mitigation measures (this is done through modelling of surface and sub surface drainage systems).</p>	<p>Where the locations at higher risk of surface water flooding are already known (e.g. through recent flood incidents or level 2 SFRA)</p> <p>OR</p> <p>Where intermediate assessment identifies the need for the detailed assessment.</p>

Source: DEFRA SWMP guidance 2010

In the first phase, the preparation phase, the level at which the assessment will be carried out will be decided, a partnership of relevant organisations established along with the roles and responsibilities of each partner organisation, and the broad objectives set. Data is collated, analysed and mapped and specific areas more vulnerable to surface water flooding will be identified for further detailed assessment in later phases. An engagement plan is defined to consider which stakeholders will be consulted in the further phases, and the intended method to be used. Finally, the approach to the risk assessment and options approach to be undertaken in Stage 2 will be broadly defined.

In the second phase, the risk assessment phase, an intermediate assessment is undertaken followed by a more detailed assessment of priority areas based upon the likelihood and consequence of surface water flooding. Quick win mitigation measures and immediate actions will be identified and results will be mapped and communicated to professional stakeholders and the public.

In the third phase, the options phase, a range of mitigation options will be identified and short-listed for further analysis. Cost-benefit analysis will be used to select the most appropriate local solutions and these will be taken forward to form the SWMP action plan in Phase 4, including a strategy for new development.

The final phase, Phase 4, is concerned with preparing an action plan to guide the implementation of the suggested mitigation measures. According to the DEFRA SWMP guidance, the action plan is expected to cover some or all of the following:

- Capital and maintenance actions and programmes of work for each partner/stakeholder;
- Advice and information to local authority planners;
- Advice and information to local resilience forums and emergency planners;
- A programme of further work or follow up actions;
- A reference to when the plan will be reviewed and updated and how implementation will be monitored; and
- A list of any other flood risk management measures being undertaken in the plan area to achieve objectives of European legislation (such as the Water Framework Directive or Habitats Directive).

The need to undertake a Strategic Environmental Assessment (SEA), an Appropriate Assessment (required by the Habitats Directive), or an Article 4.7 (WFD) assessment should be established by Local Authorities.

Much of the detailed technical information should form supplementary documents, but the plan would benefit from a short summary of the risk assessment and maps to provide a context for the action plan.

Plans should normally be reviewed every six years as a minimum in line with the requirements of the Floods Directive, but the following circumstances may trigger a review and/or an update of the action plan in the interim or in some cases annually:

- Occurrence of a flooding incident;
- Additional data or modelling results becoming available;
- Outcome of investment decision by partners is different to the preferred option; and
- Additional development or other changes in the catchment which affect the surface water flood risk.

A summary of tasks involved in Stage 2 (Phases 2 to 4), is shown in Table 1.2.

Table 1.2: Key elements identified for the King's Lynn and West Norfolk Settlements SWMP

SWMP Stage	SWMP Phase	Chapters	Tasks	
Stage 1	Phase 1 - Preparation	Identify the need for a SWMP study	Identify whether a SWMP study is required	
			Identify which organisations should be involved	
		Establish the partnership	Clarify roles and responsibilities of the partnership	
			Scope the SWMP study	Set the aims and objectives (SMART ⁶)
			Establish an engagement plan	
		Collate information	Identify the availability of information	
			Identify the level of assessment at which the SWMP study will be carried out	
			Collate and analyse information	
			Map information	
			Identify areas more vulnerable to surface water flooding	
Strategic assessment	Select a draft approach to Phases 2 and 3, risk assessment and options appraisal			
	Select approach	Select a draft approach to Phases 2 and 3, risk assessment and options appraisal		
Stage 2	Phase 2 – Risk Assessment	Intermediate assessment	Understand flood risk using historic data, existing model outputs or deriving new information using simple techniques if necessary	
			Produce a prioritised list of locations based upon the likelihood and consequence of surface water flooding for further detailed assessment	
			Identify mitigation measures on basis of evidence to date including quick wins and immediate actions	
		Detailed assessment for priority areas	Scope requirements for the detailed assessment of priority areas	
			Select an approach for the detailed assessment	
			Undertake assessment (if modelling including verification and calibration)	
			Quantify annualised average damages for current and future time horizons (including an assessment of where proposed new development can help reduce surface water flood risk)	
		Map and Communicate risk	Map outputs from the assessment of surface water flooding (taking into account requirements of Flood Risk Regulations)	
			Communicate risk to professional stakeholders	
			Communicate risk to the public	
Phase 3 - Options	Identification of mitigation measures	Identify a range of measures and options to mitigate surface water flooding		
		Short-list the measures and options for further analysis and discard options considered unfeasible		
	Assessment	Assess short-listed options using an appropriate method such as cost-benefit analysis		
		Agree the preferred option to be taken forward to the SWMP action plan		
Phase 4 – Implementation and Review	Prepare action plan	Prepare the SWMP action plan		
		Review and publish the action plan		
	Implement and review the action plan	Implement and review the action plan.		

Source: Adapted from the DEFRA SWMP Technical Guidance, March 2010.

6 SMART objectives - Specific, Measurable, Achievable, Relevant and Timely

1.2.4 Specific Aims and Objectives of Stage 1 of the King's Lynn and West Norfolk Settlements SWMP

This report concerns Stage 1 of the King's Lynn and West Norfolk Settlements SWMP only. The aim has been to undertake Phase 1 of the SWMP process for King's Lynn and the selected West Norfolk Settlements according to an intermediate to detailed level of analysis as defined above. It was a scoping exercise that seeks to establish what the intended outcomes are for the area being considered, what data are available, and how the data can be used to achieve the outcomes, or in the case the data is inadequate, what the expected or reasonable outcomes could be.

The specific objectives of Stage 1 are to:

- Identify the level of assessment at which the SWMP study will be carried out;
- Establish a partnership and clarify the roles of responsibilities of each partner;
- Collate all available data for the SWMP, identify missing data and present the data in a format which will aid Stage 2 of the SWMP;
- Set the overall objectives for the King's Lynn and West Norfolk Settlements SWMP;
- Establish an engagement plan to define the method and timing of stakeholder engagement in Stage 2;
- Map the information;
- Identify areas more vulnerable to surface water flooding from existing data; and
- Determine the approach for Stage 2 (Phases 2, 3 & 4) of the SWMP.

The key deliverables from Stage 1 are:

- A Stage 1 report (this report) including:
 - A list of contacts,
 - Tables of available data (plans, reports, GIS and spreadsheet data),
 - Identification of data gaps, and
 - Maps of available data and a preliminary estimate of surface water flood risk; and
- All data collated in Stage 1 provided on DVDs for use in Stage 2.

2. Partnership Establishment

2.1 Partner Organisations

The King's Lynn and West Norfolk Settlements SWMP is being led by the CTG who, through Norfolk County Council as the lead partner, is steering the delivery of the work. The CTG is composed of the following organisations that make up the Partnership: Norfolk County Council, Borough Council of King's Lynn and West Norfolk, Environment Agency, Anglian Water, and the Middle Level Commissioners on behalf of the Water Management Alliance and the Downham Group of IDBs. A contacts list for representatives of each of the partner organisations involved in the King's Lynn and West Norfolk Settlements SWMP can be seen in Appendix E.

2.2 Roles and Responsibilities

The roles and responsibilities of each partner and stakeholder are defined in the DEFRA guidance, and can be seen in Sections 2.2.1 and 2.2.2. These were presented to the partners at the King's Lynn and West Norfolk Settlement SWMP progress meeting on 8th October 2010.

2.2.1 Roles and Responsibilities of the Partnership

Table 2.1: Roles and Responsibilities of the King's Lynn and West Norfolk Settlements SWMP Partnership

Partners	SWMP Partner	Role and Responsibilities
Upper Tier Local Authorities	Norfolk County Council	<p>Role</p> <ul style="list-style-type: none"> - A lead partner for the SWMP to secure implementation of the SWMP. - Ensure the objectives are set and met. - Ensure a partnership approach is adopted and the Partnership is established. - Develop the SWMP strategy. - Data and information provider for the SWMP. <p>Responsible for sharing information about or making available:</p> <ul style="list-style-type: none"> - Land-use planning and urban development. - Highways drainage including sustainable urban drainage systems in their control. (<i>Highways Agency for major routes</i>). - Ordinary watercourses in their control. - Urban green space. - Strategic Flood Risk Assessment of the area. - Reported flooding incidents. - Costs and practicalities of re-engineering streets and green space as flow routes or storage. - Operations and maintenance regimes. - Property values and damage due to flooding.
Second Tier Local Authorities	Borough Council for King's Lynn and West Norfolk	<p>Role</p> <ul style="list-style-type: none"> - A lead partner for the SWMP. - Role as planning authority. - Data and information provider for the SWMP.

Partners	SWMP Partner	Role and Responsibilities
		<p>Responsible for sharing information about or making available:</p> <ul style="list-style-type: none"> - Land-use planning and urban development. - Highways drainage including sustainable urban drainage systems in their control. (<i>Highways Agency for major routes</i>). - Ordinary watercourses in their control. - Urban green space. - Strategic Flood Risk Assessment of the area. - Reported flooding incidents. - Costs and practicalities of re-engineering streets and green space as flow routes or storage. - Operations and maintenance regimes. - Property values and damage due to flooding.
<p>Environment Agency</p>	<p>Environment Agency – Anglian Region</p>	<p>Role</p> <ul style="list-style-type: none"> - Essential partner for the SWMP. - Operational role with responsibility for main river and coastal flooding, river defences, river structures, development control and water quality. - National strategic overview for all sources of flooding. - Support SWMP through provision of tools, guidance and advice. - Data and information provider for the SWMP. <p>Responsible for sharing information about or making available:</p> <ul style="list-style-type: none"> - River flows, levels and flooding. - River flow models. - Catchment flood management plans (CFMP). - Reported flooding incidents. - Digital elevation data (e.g. LIDAR) - Interactions between rivers or the sea and drainage systems. - Operation and maintenance regimes. - Long term investment plans.
<p>Water and Sewage Company</p>	<p>Anglian Water</p>	<p>Role</p> <ul style="list-style-type: none"> - Essential partner for the SWMP. - Responsible for public sewerage services within the SWMP area and the reduction of sewer flooding. - Data and information provider for the SWMP. <p>Responsible for sharing information about or making available:</p> <ul style="list-style-type: none"> - Sewer network capacity and performance. - Reported flooding incidents. - Sewer network models. - Costs and practicalities of sewer rehabilitation. - Drainage Area Plans (DAPs) and Sewerage Management Plans. - Long term investment plans. - Sustainable drainage systems in their control.

Partners	SWMP Partner	Role and Responsibilities
Internal Drainage Boards (and groupings thereof)	Middle Level Commissioners on behalf of the Water Management Alliance and the Downham Group of IDBs.	<p>Role</p> <ul style="list-style-type: none"> - Essential partner for the SWMP. <p>Responsible for sharing information about or making available:</p> <ul style="list-style-type: none"> - River / drain flows, levels and flooding. - River / drain flow models. - Data on pumping stations and flow control structures. - History of flooding incidents.

2.2.2 Roles and Responsibilities of Key Stakeholders

Table 2.2 identifies the key stakeholders to be consulted in Stage 2 of the King's Lynn and West Norfolk Settlements SWMP. The Town and Parish Councils have been consulted by Norfolk County Council during Stage 1, however due to time constraints, their input will inform Stage 2 of the SWMP process.

Table 2.2: Roles and Responsibilities of the King's Lynn and West Norfolk Key Stakeholders

Stakeholders	SWMP Stakeholders	Role and Responsibilities
Town and Parish Council's	Hunstanton Town Heacham Parish Snettisham Parish Dersingham Parish Burnham Market Parish North Creake Parish South Creake Parish West Rudham Parish East Rudham Parish Terrington St Clements Parish West Winch Parish Gayton Parish Downham Market Town Wimbotsham Parish Shouldham Parish Southery Parish Feltwell Parish	<p>Role</p> <ul style="list-style-type: none"> - Stakeholder for the SWMP, particularly where responsible for improvement to/maintenance of open channels or culverted watercourses which are essential for surface water drainage. <p>Responsible for sharing information about or making available:</p> <ul style="list-style-type: none"> - Flooding incidents.
Riparian Owners	Individual owners to be identified in Stage 2	<p>Role</p> <ul style="list-style-type: none"> - Potential Partner or stakeholder for the SWMP if responsible for improvement to/maintenance of open channels or culverted watercourses which are essential for surface water drainage. <p>Responsible for sharing information about or making available:</p> <ul style="list-style-type: none"> - Flooding incidents.

Stakeholders	SWMP Stakeholders	Role and Responsibilities
Householders, businesses and landowners (the community)	Individuals within areas identified to be at risk from surface water flooding. Will be contacted in Stage 2.	<p>Role</p> <ul style="list-style-type: none"> - Potential Partner or stakeholder for the SWMP. - A valuable source of information about historical flood occurrences and preferences for flow exceedance routes and/or storage. - Can also be involved in the development of solutions. <p>No specific responsibilities.</p>
Developers	To be identified	<p>Role</p> <ul style="list-style-type: none"> - Potential Partner or stakeholder for the SWMP, especially where large areas of new development are planned and there are opportunities for a strategic approach to surface water management. <p>No specific responsibilities, but sharing information about development proposals as early as possible can help to ensure surface water issues are integrated into the SWMP.</p>
Highways Agency		<p>Role</p> <ul style="list-style-type: none"> - Potential Partner or key stakeholder for the SWMP where main or trunk roads form a key part of the drainage or flood risk. <p>No specific responsibilities.</p>

2.3 Treatment of Sensitive Information from Partner Organisations

This section of the Stage 1 report constitutes a brief Memorandum of Understanding (MOU) between the partner organisations regarding data sharing of sensitive information from partner organisations relating to flooding of individual properties, especially concerning the Freedom of Information (FOI) Act and how this information is presented to the public.

Concern was raised that some flood information required for the study may be sensitive, especially relating to surface water flooding of individual properties. Additionally, individual organisations are not permitted to release information regarding flooding which can identify individual properties. Therefore, some historic flooding information has been provided and collated on a postcode basis.

The final technical reports and final action plan produced under this study will be available under the Freedom of Information (FOI) Act at the end of the study. However, working draft versions of documents and the raw data provided to the study by participating organisations will not be available under the FOI Act from Norfolk County Council. Any requests for the underlying information would need to be made directly with the participating organisations.

2.4 Engagement Plan

An engagement plan is required to set out how to engage with all stakeholders throughout the SWMP process. Stakeholder engagement is not foreseen to be necessary until Stage 2, but the engagement plan should be established as soon as possible in the project. This involves:

- Clarifying what should be achieved through stakeholder engagement;
- Identifying the stakeholders that should be consulted and why;
- Identifying the level of engagement the partnership would like from the stakeholders and at what stages of the process stakeholder engagement will occur; and
- Identifying which partner will take the lead for stakeholder engagement.

Table 2.3 summarises the above points for each identified stakeholder. Stakeholder engagement with the public is more complex and is discussed in Section 2.4.1.

Table 2.3: Engagement Plan Summary

Stakeholder	Reason for being consulted	Level of engagement necessary	Stage involvement required	Lead partner liaison with stakeholder
Town and Parish Council's	<p>May be responsible for maintenance of ordinary watercourses and associated assets.</p> <p>May hold anecdotal information on historic surface water flooding.</p>	<p>Understand which assets, drains and watercourses they are responsible for.</p> <p>For those in priority areas discuss:</p> <ul style="list-style-type: none"> - role of ordinary watercourses and drains in surface water flooding events; - maintenance undertaken; and - possible improvements that could be made to the operation of the watercourse. <p>Find out if they have any information on historic surface water flood events and the possible causes.</p> <p>Agree their role and responsibilities for the King's Lynn and West Norfolk Settlements SWMP.</p>	Intermediate assessment	Norfolk County Council
Riparian Owners	Own and are responsible for maintenance of ordinary watercourses on their property.	<p>For ordinary watercourses in the identified priority areas, discuss:</p> <ul style="list-style-type: none"> - role of ordinary watercourses in surface water flooding events; - maintenance undertaken by the owner; and - possible improvements that could be made to the operation of the watercourse. <p>Agree their role and responsibilities for the King's Lynn and West Norfolk Settlements SWMP.</p>	Intermediate assessment	Borough Council for King's Lynn and West Norfolk
Internal Drainage Boards	They are responsible for drainage and water level management service in their designated areas, by working closely with Local Authorities, the Environment Agency and may therefore provide useful information in priority areas.	<p>Understand which assets, drains and watercourses they are responsible for.</p> <p>For those in priority areas discuss:</p> <ul style="list-style-type: none"> - role of ordinary watercourses and drains in surface water flooding events. - maintenance undertaken. - possible improvements that could be made to the operation of the watercourse. <p>Find out if they have any information on historic surface water flood events and the possible causes.</p> <p>Agree their role and responsibilities for the King's Lynn and West Norfolk Settlements SWMP.</p>	Intermediate assessment	Norfolk County Council

Stakeholder	Reason for being consulted	Level of engagement necessary	Stage involvement required	Lead partner liaison with stakeholder
Highways Agency	Responsible for main and trunk roads within the SWMP study area.	Discussions to understand the operation and maintenance of the highway drainage within the study area and how this affects surface water flooding. Agree their role and responsibilities for the King's Lynn and West Norfolk Settlements SWMP.	Intermediate assessment	Norfolk County Council
Network Rail	Responsible for the railway lines and associated drainage within the SWMP study area.	Discussions to understand the operation and maintenance of the railway drainage within the study area and how this affects surface water flooding. Agree their role and responsibilities for the King's Lynn and West Norfolk Settlements SWMP.	Intermediate assessment	Norfolk County Council
Householders / General public	May hold anecdotal information on historic surface water flooding. May exacerbate surface water flooding if roof drainage is directed into sewer system. Are the victims of surface water flooding.	Discussed in more detail in Section 2.4.1	Detailed assessment	Borough Council for King's Lynn and West Norfolk
Businesses	May hold anecdotal information on historic surface water flooding. May exacerbate surface water flooding if roof drainage is directed into sewer system. Are the victims of surface water flooding.	To be determined	Detailed assessment	Borough Council for King's Lynn and West Norfolk
Developers	Are responsible for installing drainage systems in new development to meet requirements of PPS25. Will be required to carry out suggested actions specified in the SWMP action plan for new developments.	To be determined	Detailed assessment	Borough Council for King's Lynn and West Norfolk

2.4.1 Public Consultation – Potential Approach

Stakeholder consultation is a requirement of the SWMP process, including consultation with the public. It is suggested that only those people in the priority areas identified as vulnerable to surface water flooding are consulted, to ensure they understand and buy-in to the process, and that the consultation is not hijacked by vocal residents from unaffected areas, diluting the value of the study and potentially delaying the output.

We envisage that awareness of the issues will be raised and engagement sought with those likely to be directly affected by the outputs of the study. It will be important to manage public expectation from the study by clarifying the scope of the King's Lynn and West Norfolk Settlements SWMP with the public, especially ensuring that the definition of surface water flooding in this context is made very clear to ensure it is understood. Historic evidence of surface water flooding from those living in the identified priority surface water flood risk areas will be sought, along with their opinions on the potential causes of the surface water flooding.

Raising public awareness will be undertaken locally, as flooding is a very personal issue for those affected. Arrangements will be put in place to speak to affected individuals at a time and place which is relevant to them when they are at home and in their local community.

Mechanisms that may be considered include a campaign which aims to target those affected and encourage them to become involved in the process and find out more. It is suggested that wherever possible, involvement is restricted to those who live in affected areas.

There are a number of mechanisms to achieve this, but to ensure effort is as closely targeted to the affected areas as possible, the following mechanisms may be considered:

- Leaflet drops to households in the affected area including an information pack and questionnaire related to their experience of flooding; and
- Set up a small website containing an on-line version of the questionnaire, which people can use to record their experiences of flooding. This method has successfully been used by the Environment Agency in the past. If an online format was chosen, it is recommended to use a password system to ensure that the survey is not completed by those living outside the risk areas.

If it is decided that a consultation questionnaire is required, it should be carried out as early as possible in Stage 2 to allow time for the results to be incorporated into the rest of the study. Sufficient budget and time must be made available for the analysis of the results.

When the final, approved SWMP action plan of chosen mitigation measures is to be issued, press releases and information packs should be provided to the major news titles. This can explain the process undertaken, especially the consultation with those living in the areas, and manage any unfounded concerns that the article might otherwise have raised.

2.5 Objectives of the King's Lynn and West Norfolk Settlements SWMP

SMART (Specific, Measurable, Achievable, Relevant and Timely) objectives should be set for the whole of a SWMP. These should be relevant to the local situation. Suggested objectives were discussed with the Partners at the King's Lynn and West Norfolk Settlements SWMP progress meeting on 8th October 2010 and the following list was agreed:

1. To openly share information, to improve the management of surface water flooding in King's Lynn and the West Norfolk Settlements;
2. To engage with all identified stakeholders and implement the agreed engagement plan;
3. To map all known surface water flood risk and engage the community and stakeholders to share this knowledge;
4. To identify and prioritise effective, achievable and cost-beneficial measures to mitigate surface water flood risk;
5. To develop an implementation plan showing how partners and stakeholders will work together to implement the solutions; and
6. To periodically review the plan and monitor the effectiveness of the chosen solutions.

3. Data Collation

All incoming documents received during Stage 1 are listed in the Incoming Documents Register in Appendix B. A confidence score has been assigned to each dataset as described below, although no detailed checking has been undertaken on the data received due to time limitations. Responsibility for the quality of the data remains with the issuing organisations, as was agreed at the inception meeting with the CTG.

Confidence score	Description
1	From a professional organisation, likely to be reliable and accurate
2	From a professional organisation, but having known issues
3	Recorded information from the public, requires analysis

3.1 Study Area

3.1.1 General

This study focuses upon King's Lynn and 16 other settlements within the administrative boundary of the Borough Council for King's Lynn and West Norfolk. The settlements included within the SWMP are listed in Table 3.1. For convenience, these have been sub-divided into five geographic groups.

Table 3.1: Settlement Groupings

Group 1	Group 2	Group 3	Group 4	Group 5
Hunstanton	Burnham Market	Terrington St.Clement	Shouldham	Southery
Heacham	North Creake	King's Lynn	Wimbotsham	Feltwell
Snettisham	South Creake	Gayton	Downham Market	
Dersingham	East Rudham			
	West Rudham			

The Borough of King's Lynn and West Norfolk is located in the East of England, adjacent to The Wash. The upper tier local authority in this region is Norfolk County Council. The study area for the SWMP was discussed by the Partnership at the inception meeting on 27th July 2010 and confirmed at the progress meeting on 8th October 2010. The defined study areas for the King's Lynn and West Norfolk Settlements SWMP can be seen in Map A.01.

The second tier local authority in this region is the Borough Council for King's Lynn and West Norfolk. There are also a number of Town and Parish Council's within the study areas, as shown in Map A.01.

3.1.2 Topography

Topographic information for the study area has been received in the form of LiDAR data from the Environment Agency Geomatics Department at 1m and 2m resolution, as shown in Map A.06 and A.07 respectively. 1m resolution data appear only to be available for the larger settlements within the region as

well as those which are at risk of tidal flooding. There is therefore no coverage of Burnham Market, North Creake, South Creake, East and West Rudham, Gayton and Shouldham. However, 2m resolution data is available for the majority of the study areas with the exception of Gayton and the western fringes of Downham Market and Hunstanton.

3.1.3 Hydrology

There are several principal watercourses in the King's Lynn and West Norfolk Settlements SWMP area; these are listed in Table 3.2 and shown in Map A.02. The most important of these watercourses is the River Great Ouse which has a substantial catchment and is heavily embanked as it flows northward through the region to outfall to The Wash via King's Lynn.

Table 3.2: Principal Watercourses

Watercourse	Closest SWMP Settlement
River Hun	Hunstanton
River Heacham	Heacham
River Ingol	Snettisham
River Burn	Burnham Market, North Creake, South Creake
River Tat	East Rudham
Babingley Brook	King's Lynn
River Nar	King's Lynn
River Great Ouse (Tidal)	King's Lynn, Downham Market
Relief Channel	King's Lynn, Downham Market
Ely Ouse	Southery
Cut-Off Drain	Feltwell

3.1.4 Geology

The bedrock and superficial geology underlying the SWMP study areas is shown in Maps A.14 and A.15 respectively; Table 3.3 summarises this information for the SWMP settlements.

The bedrock geology of the Borough is primarily split between clay and chalk, with large areas of Kimmeridge Clay in the west and the Upper Chalk Formation in the east. Intermediate areas primarily comprise alluvium, sand and gravel. The nature of the underlying geology affects the potential for groundwater flooding as well as the surface water drainage mechanisms and possible mitigation actions. Chalk sub-strata, indicating the presence of groundwater, can be linked to a heightened risk of groundwater flooding but also enables the use of infiltrating sustainable drainage (SuDS) features to reduce runoff volumes from urban areas. Conversely, clay substrata inhibits the use of infiltrating SuDS features but also indicates a lower risk of groundwater flooding due to the inherent absence of large bodies of groundwater.

Source protection zones (SPZs) should be considered when applying mitigation measures, such as SuDS, which have the potential to contaminate the underlying aquifer if this is not considered adequately in the design. Generally, it will not be acceptable to use infiltrating SuDS in an SPZ 1 if the drainage catchment comprises trafficked surfaces or other areas with a high risk of contamination. SPZs within the SWMP defined study areas, as well as licensed abstraction points are shown in Map A.13.

Information with regard to the superficial geology underlying the SWMP study areas is less complete than the bedrock geology. No information is available for the majority of SWMP study areas with the remainder being primarily split between Alluvium and Glacial Till, including Peat under Southery.

Table 3.3: Bedrock and Superficial Geology

SWMP Settlement	Primary Bedrock Geology	Primary Superficial Geology
Hunstanton	Upper and Middle Chalk Formation	Largely unknown, small areas of Till
Heacham	Snettisham Clay Formation	Largely unknown, small areas of Till
Snettisham	Dersingham Formation (Sandstone)	Unknown
Dersingham	Dersingham Formation (Sandstone)	Unknown
Burnham Market	Upper Chalk Formation	River Terrace Deposits (Undifferentiated)
North Creake	Upper Chalk Formation	Till and Glacial Sand & Gravel
South Creake	Upper Chalk Formation	Glacial Sand & Gravel
East Rudham	Upper Chalk Formation	Unknown
West Rudham	Upper Chalk Formation	Unknown
Terrington St.Clement	Kimmeridge Clay Formation	Alluvium
King's Lynn	Kimmeridge Clay Formation and Sandringham Sand Formation	Alluvium, Till, Glacial Sand & Gravel, and Peat
Gayton	Lower Chalk Formation and Gault Formation (Clay)	Unknown
Shouldham	Gault Formation (Clay)	Unknown
Wimbotsham	Sandringham Sand Formation and Carston Formation	Largely unknown, small areas of River Terrace Deposits (Undifferentiated)
Downham Market	Sandringham Sand Formation and Carston Formation	Largely unknown, small areas of Till
Southery	Sandringham Sand Formation	Largely unknown, with an area of Peat
Feltwell	Lower Chalk Formation	Unknown

3.1.5 Fluvial and Tidal Flood Risk

Although SWMPs do not consider fluvial and tidal flooding from main rivers to be a source of surface water flooding where the majority of flow is derived from outside the urban catchment, it is useful for this study to have a broad understanding of the fluvial and tidal flood risk posed to the SWMP areas.

The Environment Agency flood map is indicative of flooding from rivers (fluvial flooding) or the sea (tidal flooding), this flood map and the location of flood defences can be seen in Map A.03.

The varied topography of the Borough greatly influences the nature of flood risk which is present throughout the SWMP areas. Flood risk in the majority of the SWMP area is dominated by tidal influences, primarily due to the low-lying nature of the south and east of the Borough but also due to the vulnerability of coastal settlements to tidal surges from the North Sea. The flood zones for extreme events extend a significant distance from the coast and tidal River Great Ouse. However, fluvial flood risk is of equal importance given that the Borough is located at the downstream end of the River Great Ouse, a major watercourse draining a catchment of approximately 690km².

Historically, a network of flood defences has been constructed to reduce flood risk within the Borough, and large drainage features are used to manage discharge during flood events. Whilst managing flood risk over large areas of the Borough as shown in Map A.03, this flood defence infrastructure does increase the residual risk of flooding in these areas due to the possibility of its failure. There are two primary modes of defence failure; overtopping and breach. The latter is commonly far more destructive than the former and has been the focus of numerous modelling exercises within the Borough, refer to the SFRA for further information.

The residual risk of failure is exacerbated by the fact that a number of the principal watercourses within the Borough are embanked and thus have water levels which are commonly above the surrounding topography. Surface water drainage within many catchments is dependant upon the work of the Internal Drainage Boards, some of which rely on pumping stations to raise runoff into the embanked watercourses.

Please refer to the SFRA for further information with regard to fluvial and tidal flood risk within the Borough of King's Lynn and West Norfolk.

3.1.5.1 Impact of Climate Change

Using the predictions made by the UK Climate Impacts Programme (UKCIP), the Norfolk Climate Change Strategy⁷ commissioned by the Norfolk Local Government Association states that in general, by the 2080s, Norfolk is likely to experience:

- A rise in annual average temperatures of 1 to 5°C;
- Hotter, drier summers;
- Wetter winters;
- Sea level rise of up to 0.88m; and
- More extreme events (heat waves, gales, storms, tidal surges and intense rainfall).

Given that large areas of the Borough are reliant upon flood defence infrastructure, the predicted impacts of anticipated climate change are of key importance, specifically with regard to the increase in sea level. The Draft Great Ouse Catchment Flood Management Plan (CFMP) expects a significant increase in the number of properties at risk of flooding in the future as indicated in Table 3.4.

Table 3.4: Current and future fluvial and tidal flood risk for King's Lynn town

Factor	Properties Flooded	
	Present	Future (2110)
1 in 100-year Fluvial Event	102	918
1 in 200-year Tidal Event	0	3,574

Source: Draft Great Ouse CFMP

The Draft Great Ouse CFMP states that the preferred policy for managing flood risk within the lower reaches of the River Great Ouse is to maintain the existing level of flood risk into the future. Given the significant predicted impact of anticipated climate change, the CFMP highlights the need to undertake a

⁷ Norfolk Local Government Association. Tomorrow's Norfolk, Today's Challenge: A Climate Change Strategy for Norfolk.

strategic review of the existing flood defences in order to enable investigations into the possibility of improving the standard of protection currently afforded by the defences.

The SFRA produced flood extent maps which take account of anticipated climate change to the year 2115. These maps assume that the existing fluvial and tidal defences are maintained in their present state and predict a substantial increase in flood risk across the Borough as a result of climate change. The SFRA notes that over the next hundred years, a much larger area of the Borough will be within Flood Zone 3.

In terms of surface water flooding, Table B.2 of PPS25 suggests that by 2080, peak rainfall intensity and peak river flow will both increase by 20%. This will put additional pressure on existing surface water drainage infrastructure. From field drains to sewers and pumping stations, more intense rainfall events will undoubtedly lead to an increase in surface water flood risk. In addition, wetter winters will influence groundwater regimes and may also lead to an increased occurrence of groundwater flooding.

The additional flood risk brought about by climate change highlights the importance of locating development away from the most vulnerable areas, improving the resilience of buildings and infrastructure, and especially the need to appropriately assess the potential for developments to increase flood risk elsewhere.

3.1.6 Internal Drainage Boards

An Internal Drainage Board is an operating authority in areas of special drainage need in England and Wales. They have powers to undertake work to secure clean water drainage and water level management within drainage districts. The area of an IDB is not determined by county or district boundaries, but by water catchment areas. Their responsibilities include the maintenance of rivers, drainage channels, ordinary watercourses, pumping stations and other critical infrastructure, facilitating drainage of new developments, the ecological conservation and enhancement of watercourses, monitoring and advising on planning applications and making sure that any development is carried out in line with legislation (PPS 25). IDBs are not responsible for watercourses designated as main rivers within their drainage districts; the supervision of these watercourses is undertaken by the Environment Agency.

There are three groups of IDBs operating in the Borough; these are the Middle Level Commissioners, the Downham Group of IDBs, and the Water Management Alliance. Within these three groups, the IDBs which have drainage districts in the SWMP defined study areas are listed in Table 3.5. These IDBs are SWMP partners as defined in Table 2.1. The IDB catchments can be seen in Map A.05.

The Water Management Alliance states its aims as:

- To reduce the flood risk to people, property, infrastructure and the natural environment by providing and maintaining technically, environmentally and economically sustainable flood defences within our hydraulic catchment areas;
- Provide a one-stop flood risk, drainage and water level management service in our areas, by working closely with Local Authorities, the Environment Agency and other stakeholders;
- Enable and facilitate land use for residential, commercial, recreational and environmental purposes by guiding and regulating activities; and
- Nurture, enhance and maintain the natural habitats, which exist in and alongside watercourses.

Table 3.5: Internal Drainage Boards within the SWMP study areas

SWMP Settlement	IDB Name	IDB Group
Hunstanton	King's Lynn / Norfolk Rivers	Water Management Alliance
Heacham	King's Lynn	Water Management Alliance
Snettisham	King's Lynn	Water Management Alliance
Dersingham	King's Lynn	Water Management Alliance
Burnham Market	Norfolk Rivers	Water Management Alliance
Gayton	King's Lynn	Water Management Alliance
King's Lynn	King's Lynn	Water Management Alliance
Terrington St.Clement	King's Lynn	Water Management Alliance
West Winch and South King's Lynn	East of Ouse, Polver and Nar	Downham Group
Shouldham	East of Ouse, Polver and Nar	Downham Group
Wimbotsham	Stoke Ferry	Downham Group
Downham Market	Stoke Ferry	Downham Group
Southery	Southery and District	Downham Group
Feltwell	Southery and District	Downham Group

Note: The Water Management Alliance and Downham Group of IDBs are represented in the CTG by the Middle Level Commissioners.

3.1.7 Pollution Incidents

Information on historic pollution incidents that have occurred within the King's Lynn and West Norfolk Settlements SWMP study areas were received from the Environment Agency and are shown in Map A.10. The locations of water quality monitoring locations are also shown on this map.

3.2 Historic Pluvial or Capacity Surface Water Flooding

3.2.1 Information from Norfolk Fire and Rescue Service

Information from Norfolk Fire and Rescue Service regarding historic surface water flooding is presented in Appendix D.2. The likely source of flooding has not been recorded, so these are not necessarily only surface water flood events. Flooding events were identified where two or more incidents of water removal had been recorded on the same date. This results in four readily identifiable flooding events occurring between 2001 and 2009; identified in Table 3.6 and shown in Map A.08 by postcode locations. These events may require further analysis in Stage 2.

The most significant event of those recorded seems to be the event of July 2004 with seven recorded incidents reported in Downham Market.

Table 3.6: Significant reported flood events between 2001 – 2009 from recorded incidents by Norfolk Fire and Rescue Service

Event	Data Set	Locale
30-31 July 2002	Norfolk Fire and Rescue	King's Lynn
8 July 2004	Norfolk Fire and Rescue	Downham Market
2-6 June 2007	Norfolk Fire and Rescue / Environment Agency	Widespread
7 September 2008	Norfolk Fire and Rescue	Downham Market

3.2.2 Information from the Norfolk Resilience Forum

The Norfolk Resilience Forum holds a Community Risk Register which presents information on significant hazardous events within the County. From this list, references to flooding in the defined study area for the SWMP as well as those in the remainder of the County are listed in Table 3.7. Whilst not directly related to surface water flooding, these events may have had the potential to cause such flooding, for example via tide-locking or flood-locking.

Table 3.7: Recorded flooding events in Norfolk from the Norfolk Resilience Forum Community Risk Register

Historical Evidence	Area Affected
11 September 1968 – Low pressure and thunderstorms led to 4.75" rainfall in 24 hours. From Diss to Gorleston underwater, every road out of Norwich except A11 flooded, railway bridge washed away, widespread property flooding.	South Norfolk, Norwich
11 January 1978 - Tidal surge. Wells reached 4.91m, high onshore northerly winds, considerable overtopping. Surge tide 156 properties flooded, 1,300ha of agricultural land flooded. 1.8m in excess of predicted levels.	King's Lynn
27-28 April 1981 - 126mm rainfall recorded over 3 days at High Kelling.	Broadland
20-21 February 1993 - Tidal surge. Wells reached 4.36m, waves 20ft high pounded Lowestoft, over 400 people evacuated from the Gorleston area. Excess of £500,000 of damage repair costs, 42 defended and a further 97 undefended properties mainly in Broadland were flooded up to 1 metre deep.	Broadland
11 October – 15 October 1993 – Low pressure, double normal monthly rainfall. 75.2mm recorded at Norwich in 48 hours (monthly total usually 46.5mm).	Norwich
01 September 1994 – 3 months rainfall fell in Ditchingham, near Bngay (150mm fell in a matter of hours). 50 roads underwater, also Diss, Norwich and Hempsall properties and shops affected.	South Norfolk
November 2007 - A combination of high tide and North Sea Surge resulted in a 1 in 40 event at Great Yarmouth and a tide level of 2.826m AODN. This led to the Broadland system becoming tide locked and causing flooding to a limited number of vulnerable properties (mainly boatyards) in Acle, Brundall, Reedham and on the Waveney Valley	Broadland

Source: Norfolk Resilience Forum Community Risk Register August 2010.

3.2.3 Information from the Local Climate Impacts Profile (LCIP) for Norfolk

The Norfolk LCLIP was commissioned by the Norfolk Climate Change Task Group to better understand their exposure to weather and climate. The project explored the impacts of severe weather in Norfolk between 2001 and 2008. It found that Norfolk has been affected by at least 40 significant weather events during that time, of which the most frequent are heavy rain and localised flooding. One of the aims of project outputs is the creation of a spreadsheet of significant weather events identified through media articles and their impacts.

3.2.4 Information from the Environment Agency

Surface water flooding mapping has been undertaken by the Environment Agency and has been provided to Local Authorities to be used in association with Emergency Planning roles. This data is a simplistic way of depicting locations where water could collect if no method of dispersal were in place. The 'direct rainfall' method was used for a rainfall event with a 0.5% probability and does not depict any river based flooding. The modelling results are not freely available and are not able to be published by individual Authorities owing to licence restrictions, and therefore the actual results cannot be shown in this report, but analysis from the data can be shown and is discussed in Section 3.10.

Information recorded by the Environment Agency regarding historic surface water flooding incidents is presented in Appendix D.3 and shown in Map A.08 by post code location.

3.3 Historic Sewer Flooding

3.3.1 Information from Anglian Water

Information relating to Anglian Water's assets has been released to Mott MacDonald only for use on the King's Lynn and West Norfolk Settlements SWMP under a confidentiality agreement and therefore the raw data has not been reproduced in this report. If another consultant is involved in Stage 2 they will need to sign another copy of the confidentiality agreement.

The historic flooding information received from Anglian Water comprises edited listings of locations currently at risk of flooding and annual lists of flooding incidents. Most of these are foul sewer related, as opposed to surface water, unless there are comments to suggest otherwise. However, the reason for foul flooding is predominantly due to the ingress of surface waters to foul sewers during rainfall.

3.3.2 Information from Documentation

The King's Lynn and West Norfolk Water Cycle Study (WCS), carried out by Entec in December 2009, highlighted that capacity issues exist within the sewer system in the Borough, indicating potential sewer flood risk. The report notes that there have been numerous instances of flooding as a result of blockages or pumping station failures. However, improvements to the network are ongoing, as indicated by the drop in recorded instances of flooding from 323 in 2007 to only 52 in 2008. The WCS suggested new development

may exacerbate sewer flooding and therefore sufficient capacity within the existing systems should be ensured and SuDS used to limit discharge into the system.

3.4 Underground Surface Water Drainage Assets

3.4.1 Highways Drainage

Norfolk County Council is the highway authority for the region. Therefore Norfolk County Council is responsible for highways drainage within the Borough of King's Lynn and West Norfolk.

Unfortunately Norfolk County Council highway drainage records are incomplete. They do not currently have any significant information in CAD or GIS format. However, fragmented GIS records do exist indicating the location of surface features such as ditches, kerbs and gullies. The spatial availability of this data is shown in Map A.04. Efforts are currently underway to expand this database of available information held for highway drainage development since 1974. Other records may be held in either paper or microfiche form, and in the last couple of years on AutoCAD, but they are not geo-referenced. No specific information was provided regarding which records are available.

A highway surface drainage lifecycle management plan was received from Norfolk County Council and can be seen in Appendix F. Highway assets that Norfolk County Council manages include:

- Highway gullies;
- Kerb offlets;
- Associated pipework;
- Soakaways;
- Catchpits;
- Grips and backdrains; and
- Outfalls.

The management of each of these asset types are discussed individually in the management plan along with maintenance activities.

3.4.2 Ordinary Watercourses

The operation and maintenance of ordinary watercourses is generally the responsibility of the riparian landowners whose property includes the watercourses. As part of Stage 2, it will be necessary to establish who is responsible for the ordinary watercourses within the SWMP study areas. A map of watercourses in the study areas can be seen in Map A.02.

3.5 Sewer System Assets

Anglian Water is the water and sewerage service provider for the study area of the SWMP.

Information relating to Anglian Water assets has been released to Mott MacDonald only for use on the King's Lynn and West Norfolk Settlements SWMP under a confidentiality agreement, and therefore the detailed information provided has not been reproduced in this report. If another consultant is involved in Stage 2 they will need to sign another copy of the confidentiality agreement.

Asset information received from Anglian Water comprises the following:

- A GIS dataset of consented overflows and discharges.
- Digital data providing location and attribute details of the sewerage system. The location and type of sewers within the study area can be seen in Map A.11. This shows the locations of combined, surface and foul sewers. For this study it is useful to know the distribution of surface and combined sewers and this information will be especially helpful if integrated modelling is undertaken at the detailed analysis stage. Map A.11 shows that combined sewer systems, historically the most susceptible to surcharging, only exist in the King's Lynn urban area; the remainder of the SWMP settlements possess separated foul and surface water sewers.

No sewer modelling data has been received. Anglian Water is currently willing to run the sewer models for scenarios that may assist the King's Lynn and West Norfolk Settlements SWMP, but is not prepared to hand over the models for others to use on the SWMP.

3.6 Potential Development within the King's Lynn and West Norfolk Settlements SWMP Area

In order to meet the needs of the region's growing population, the recently withdrawn East of England Plan stipulated minimum regional housing targets for the period 2006 to 2021. Over this period, it was envisaged that a minimum of 402,540 dwellings would be required in the East of England, of which 9,460 were to be located in the Borough of King's Lynn and West Norfolk. The Plan also identified King's Lynn as a 'key centre for development and change', indicating that the concentration of development at this location would make best use of existing infrastructure and the potential for improvements or extensions to it. As a key centre for development and change, the Plan recommended that the Local Development Documents for King's Lynn should make provision for 12,000 dwellings and 5,000 jobs. Moreover, the town has also been designated separately as a Growth Point.

Using the East of England Plan as a starting point, the emerging Core Strategy (which will remain) calculates that 15,840 new dwellings will be required across the Borough over the period 2001 to 2025. Contributing towards this figure, there have been 5,846 completions to the end of March 2009 and a further 3,616 dwellings have received planning permission but have not yet been constructed. Therefore, sites will need to be located to accommodate the construction of 6,378 additional dwellings before 2025. To this end, a Site Specific Allocations and Policies Development Plan Document is currently being compiled by the Borough Council of King's Lynn and West Norfolk. This document is due to be completed in early 2011; until which point the Core Strategy gives an indication of proposed strategic development within the Borough but only identifies areas in King's Lynn, Downham Market and Hunstanton (refer to Map A.12).

Table 3.8 below shows the potential strategic allocation of the housing development required by the Core Strategy. The final locations and numbers are subject to the findings of the Site Specific Allocations and

Policies Development Plan Document. It is anticipated that the final allocations will be available to inform later stages of the SWMP.

Table 3.8: Potential strategic location of housing in the King's Lynn and West Norfolk area

Settlement	Potential Housing Provision Target	New Sites required to meet Target
King's Lynn	7,000	4,600
Downham Market	2,700	350
Hunstanton	560	200
Key Rural Service Centres , including: Burnham Market; Dersingham; East Rudham; Feltwell; Gayton; Heacham; Snettisham; and Terrington St. Clement.	2,800	600
Rural Villages , including: Shouldham; Southery; and Wimbotsham.	1,260	195

Source: Adapted from King's Lynn and West Norfolk Core Strategy – Proposed Submission Document.

3.7 Usability of the Data

The data received for use in this study has been taken at face value. No detailed quality checks have been undertaken on data received due to time limitations. Responsibility for the quality of the data remains with the issuing organisations as was agreed at the inception meeting with the Client Task Group (CTG).

Issues relating to sharing data have been documented in Section 2.3.

3.8 Gap Analysis

A list of required data for the King's Lynn and West Norfolk Settlements SWMP along with information explaining what has been received to date is presented in Appendix B.

The significant areas of unavailable data are:

- Highway drainage records from Norfolk County Council. Fragmented GIS data of surface drainage features has been made available, discussed in Section 3.4.1, but no quantitative data has been received;
- Historic records of surface water flooding from Norfolk County Council, the Borough Council of King's Lynn and West Norfolk and the IDBs;
- GIS data from the Water Management Alliance regarding the boundaries and assets of the King's Lynn and Norfolk Rivers IDBs; and
- Sewer model and results from Anglian Water. Anglian Water is currently willing to run the sewer models for scenarios that may assist the SWMP but are not prepared to hand over the models for use by others on the project. Further discussion may be required with Anglian Water regarding this issue if integrated modelling is to be undertaken in Stage 2.

3.9 Mapping and Spatial Analysis

The information contained within this report has been presented spatially in GIS format where possible and can be seen in the maps in Appendix A. Some initial analysis and discussion regarding this data is provided in the relevant sections of this document and will require further detailed analysis within Stage 2 of the King's Lynn and West Norfolk Settlements SWMP.

3.10 Identified Areas Vulnerable to Surface Water Flooding

Areas at most risk of surface water flooding have been identified from analysis of the following information:

- Environment Agency surface water flood maps; and
- Records of anecdotal flooding to households and businesses from Norfolk Fire and Rescue Service, the Environment Agency and the WCS.

There are a number of identified locations at present, displayed in Map A.09. Further analysis of these areas is required in Stage 2 to identify the likelihood and consequence of surface water flooding in each of these areas and to identify any "quick win" mitigation measures that could be applied. The location and number of identified areas may change in Stage 2. Where funding allows, it is proposed that a small number of these areas, with the highest likelihood and most severe consequences of surface water flooding, are selected within Stage 2 for more detailed assessment. This could perhaps involve integrated sewer/ surface water modelling. This is discussed further in Section 4.

4. Suggested Approach for Phases 2 and 3

Stage 2 of the King's Lynn and West Norfolk Settlements SWMP will cover Phases 2 and 3 of the DEFRA SWMP phases. Phase 2 is the Risk Assessment and Phase 3 considers the mitigation options. A detailed breakdown of tasks involved is discussed in Section 1.2.2 and also repeated here in Section 4.1.

4.1 Risk Assessment (Phase 2) and Options Appraisal (Phase 3)

In the risk assessment phase (Phase 2), an intermediate assessment will be carried out, followed by a more detailed assessment for areas identified as being particularly vulnerable to surface water flooding.

The intermediate assessment will use information supplied from the data collation undertaken during Phase 1. The historic data collected will be analysed in more detail, and existing results from the Environment Agency surface water flooding model will be analysed in further detail. A preliminary assessment has been undertaken in Phase 1 to assess the areas at greatest risk of surface water flooding using collated information, but further analysis will be needed in Stage 2 to assess the likelihood and consequence of flooding in these areas. This will be achieved by undertaking assessments of each area individually through site visits and discussions with people who have been affected by flooding in these areas in the past. Additionally, discussions will be undertaken with drainage engineers from local councils and Anglian Water, responsible for assets within the areas of concern. Following this, immediate mitigation measures shall be identified including any "quick wins". The next step will be to undertake the detailed assessment for a small number of priority areas. For this, a modelling approach may be required if sufficient data exists in the area to warrant modelling. Modelling will only be undertaken if it is deemed the most effective way to use the available funds to achieve the required understanding of flood mechanisms, rather than using other investigative methods. Any modelling undertaken is likely to involve integrated urban drainage modelling. Results will be mapped and communicated to professional stakeholders and the public, in line with the engagement plan discussed in Section 2.4.

The options phase (Phase 3) considers a range of mitigation options that will be identified and short-listed for further analysis. Cost-benefit analysis will be used to select the most appropriate local solutions, and where funding allows, these will be taken forward to form the SWMP action plan in Phase 4.

A detailed breakdown of tasks involved is shown in Table 4.1.

Table 4.1: Detailed elements of the Risk Assessment and Options Appraisal

PHASE 2 – RISK ASSESSMENT	
Chapters	Tasks
Intermediate assessment	Understand flood risk using historic data, existing model outputs or deriving new information using simple techniques if necessary
	Produce a prioritised list of locations based upon the likelihood and consequence of surface water flooding for further detailed assessment
	Identify mitigation measures on the basis of evidence to date, including quick wins and immediate actions
	Scope requirements for the detailed assessment of priority areas
Detailed assessment for priority areas	Select an approach for the detailed assessment, integrated modelling or other investigative methods
	Undertake investigations (if modelling including verification and calibration).
	Quantify annualised average damages for current and future time horizons (including an assessment of where proposed new development can help reduce surface water flood risk)
Map and Communicate risk	Map outputs from the assessment of surface water flooding (taking into account requirements of Flood Risk Regulations)
	Communicate risk to professional stakeholders
	Communicate risk to the public
PHASE 3 – OPTIONS	
Chapters	Tasks
Identification of mitigation measures	Identify a range of measures and options to mitigate surface water flooding
	Short-list the measures and options for further analysis and discard options considered unfeasible
Assessment	Assess short-listed options using an appropriate method such as cost-benefit analysis
	Agree the preferred option to be taken forward to the SWMP action plan

4.2 Suggested Modelling Approach for Detailed Assessment

Detailed assessment will be undertaken for the identified priority areas. Each priority area will be ranked according to the likelihood and consequence of predicted surface water flooding. The number of priority areas to be modelled will depend on their size, location throughout the study area, and the availability of data within those areas to inform the modelling. This will be assessed at the end of the intermediate assessment, but it is likely to involve a small number of priority areas. If it is agreed that modelling is the most appropriate use of funds to achieve the required understanding of flooding in these selected areas, the modelling approach is likely to be focused on building an integrated drainage and surface water model for the identified area for a number of return period events (various rainfall intensities and durations). This will allow the sewers, watercourses and overland flow interactions to be represented in an integrated manner. Where funding allows, models will be constructed initially with high level data. These will then be refined, with more detail incorporated for the priority areas. Current Anglian Water sewer models have been constructed using Infoworks CS software, and 2m resolution LiDAR data is available for the majority of the study areas.

Anglian Water is currently willing to run the sewer models for scenarios that may assist the King's Lynn and West Norfolk Settlements SWMP but are not prepared to hand over the models for use by others on the SWMP. If integrated modelling is to be undertaken, this approach will need to be discussed in more detail with Anglian Water as it may make the integrated modelling more difficult.

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Glossary

CFMP	Catchment Flood Management Plan
CTG	Client Task Group
IUD	Integrated Urban Drainage
IUDM	Integrated Urban Drainage Management
LiDAR	Light Detection and Ranging
MSfW	Making Space for Water
SMART	Specific, Measurable, Achievable, Relevant, Timely
SRM	Sewerage Risk Management
SWMP	Surface Water Management Plan
WaSCs	Water and Sewage Companies