

Central Lincolnshire Water Cycle Study - Detailed Strategy



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Table of Contents

Non-Technical Summary.....	1
Introduction	1
Future Growth & Development.....	1
Review of the Water Cycle	2
Lincoln Policy Area.....	2
West Lindsey.....	4
North Kesteven	5
Conclusions.....	6
Strategy.....	7
1 Introduction	11
1.1 Background	11
1.2 Stakeholders.....	12
1.3 Detailed WCS	13
1.4 Report Format	14
1.5 Strategy Development	15
2 Development Planning.....	17
2.1 Future Growth.....	17
2.2 Completions and Commitments.....	18
2.3 Planning Policy	19
2.4 Identifying Areas for Growth	19
2.5 Levels of Growth.....	21
2.6 Employment Land.....	25
2.7 Potential for Change	26
3 Water Resources & Supply	29
3.1 Introduction.....	29
3.2 Water Resources & the Environment Agency.....	29
3.3 Water Resources & Anglian Water Services	30
3.4 Water Resources Status.....	32
3.5 Water Supply	35
3.6 Conclusions	36
3.7 Additional Demand Management.....	36
4 Foul Water Sewerage.....	39
4.1 Introduction.....	39
4.2 Sewerage Capacity in the LPA	39
4.3 Sewerage Capacity outside the LPA	47
4.4 Combined Sewer Overflows	48
5 Sewage Treatment	51
5.1 Sewage Treatment in the LPA	51
5.2 Sewage Treatment outside the LPA	55
5.3 Water Quality	56
5.4 Expansion of Canwick STW & Flood Risk	58
6 Surface Water Drainage.....	61
6.1 Introduction.....	61
6.2 Existing Situation	61
6.3 The Lincoln Integrated Urban Drainage Pilot.....	61
6.4 Surface Water Flooding	63
6.5 Design Standards	65
6.6 Surface Water Sewers & New Development	65
6.7 Sustainable Drainage Systems.....	67
6.8 SUDS & Future Development.....	69

7	Fluvial & Groundwater Flood Risk.....	72
7.1	Introduction.....	72
7.2	Fluvial Flood Risk	72
7.3	Groundwater Flooding	81
7.4	Conclusions	81
8	The Environment.....	85
8.1	Introduction.....	85
8.2	Environmentally Designated Sites	85
8.3	Conclusions	90
8.4	Environmental Enhancement.....	92
9	RAG Summary for the Water Cycle	95
9.1	The Lincoln Policy Area	95
9.2	West Lindsey	97
9.3	North Kesteven.....	98
10	Delivering the Targets of the Regional Plan for the LPA.....	101
10.1	Sustainable Urban Extensions.....	101
10.2	SHLAA Sites	101
10.3	Development Scenarios.....	101
11	Infrastructure Requirements	107
11.1	Lincoln Policy Area	107
11.2	West Lindsey	110
11.3	North Kesteven.....	111
11.4	Challenges to be Overcome in Providing Water Services Infrastructure	111
11.5	Approaches to Overcoming the Challenges	112
12	Masterplanning the Sustainable Urban Extensions.....	115
12.1	Introduction.....	115
12.2	Code for Sustainable Homes.....	115
12.3	Water Neutrality	115
12.4	Water Sensitive Cities.....	116
13	Conclusions & Strategy.....	119
13.1	Conclusions	119
13.2	Strategy	119
14	Guidance for Developers.....	124
14.1	Introduction.....	124
14.2	Contact Points	124
14.3	Items of The Water Cycle To Be Considered	124
14.4	Reference Documents	126
	Abbreviations.....	127
	References	129
	List of Appendices	
	Appendix A: Residual Risks & Assumptions.....	131
	Appendix B: West Lindsey & North Kesteven Housing Data	134
	Appendix C: Water Quality Joint Position Statement.....	139
	Appendix D: Implementation of the Flood Risk Regulations	141
	Appendix E: Lincolnshire Wildlife Trust Sites.....	150

List of Tables

Table 2.1: Future Housing Provision in the Central Lincolnshire HMA	18
Table 2.2: SUE Housing Scenarios	20
Table 2.3: Growth in the Lincoln Policy Area	22
Table 2.4: Significant Growth in West Lindsey outside the Lincoln Policy Area*	23
Table 2.5: Growth in North Kesteven outside the Lincoln Policy Area	24
Table 3.1: CAMS resource availability status categories	30
Table 3.2: Forecast deficit in Water Resources across the LPA	33
Table 3.3: Selected Water Resources Schemes	34
Table 3.4: Forecast deficit in Water Resources in West Lindsey	34
Table 3.5: Selected Water Resources Schemes	34
Table 3.6: Forecast deficit in Water Resources in North Kesteven	35
Table 3.7: Selected Water Resources Schemes	35
Table 3.8: Water Resources RAG Status	35
Table 3.9: North Kesteven Water Supply RAG Status	36
Table 4.1: RAG status of SHLAA Maps	40
Table 4.2: Constraints Associated with the NEQ Engineering Options	44
Table 4.3: LPA Sewerage RAG Status	46
Table 4.4: West Lindsey Sewerage RAG Status	47
Table 4.5: North Kesteven Sewerage RAG Status	47
Table 5.1: STW RAG Status in the LPA	51
Table 5.2: Sustainability Factors Affecting STWs	53
Table 5.3: West Lindsey STW RAG Status	55
Table 5.4: North Kesteven STW RAG Status	55
Table 5.5: Comparison of WFD and River Ecosystem Targets	56
Table 5.6: Comparison of existing discharge consents and what is required to achieve WFD 'good' status	57
Table 5.7: Phosphorus Consents	58
Table 5.8: Impact of Growth on Consents Required to meet the WFD	58
Table 6.1: SUDS & the SUEs	69
Table 7.1: LPA Flood Risk RAG Status	82
Table 7.2: West Lindsey Flood Risk RAG Status	83
Table 7.3: North Kesteven Flood Risk RAG Status	83
Table 8.1: Sites of Environmental Importance within or adjoining the LPA	86
Table 8.2: Sites of Environmental Importance within or adjoining the wider West Lindsey area	87
Table 8.3: Sites of Environmental Importance within or adjoining the wider North Kesteven area	89
Table 8.4: LPA Environmental RAG Status	90
Table 8.5: West Lindsey Environmental RAG Status	91
Table 8.6: North Kesteven Environmental RAG Status	91
Table 9.1: Summary of RAG Status for the SUEs	95
Table 9.2: Summary of RAG Status for the SHLAA Sites in the LPA	96
Table 9.3: Summary of RAG Status for West Lindsey	97
Table 9.4: Summary of RAG Status for North Kesteven	98
Table 10.1: Phasing of Development on the SUEs	101
Table 10.2: Phasing for the SUEs restricted to the 2026 Planning Horizon	101
Table 10.3: Scenario 1 – to test the numbers deliverable in the PUA	102
Table 10.4: Scenario 2 – to test the numbers deliverable in the PUA	103
Table 10.5: Scenario 3 – to test the numbers deliverable in the PUA	103
Table 10.6: Scenario 4 – to test the numbers deliverable in the LPA	105
Table 11.1: Timetable of Water Infrastructure Required in Lincoln to Deliver Growth on SUEs	108
Table 12.1: Development's Relationship with Water	117
Table 12.2: Annual Rainfall Comparisons	117

List of Figures

Figure 1.1: City of Lincoln, West Lindsey & North Kesteven Districts	12
Figure 1.2: The Water Cycle	15

Figure 2.1: Lincoln Policy Area & Principal Urban Area.....	18
Figure 2.2: Lincoln's Proposed Sustainable Urban Extensions	20
Figure 2.3: Location of Potential Development within the Lincoln Policy Area.....	23
Figure 2.4: Location of Potential Development in North Kesteven outside the Lincoln Policy Area.....	24
Figure 2.5: Potential Housing Growth in the Housing Market Area between 2006 and 2026	25
Figure 2.6: Employment Land within Lincoln	26
Figure 3.1: Areas of Relative Water.....	29
Figure 3.2: AWS Water Resource Zones.....	31
Figure 3.3: AWS Planning Zones.....	33
Figure 4.1: City of Lincoln SHLAA Maps incorporated into Sewer Model	40
Figure 4.2: City of Lincoln SHLAA Maps RAG Status.....	41
Figure 4.3: NEQ & Canwick STW	42
Figure 4.4: The Additional Area (red) which could be diverted via the NEQ	43
Figure 4.5: Foul Sewerage Network Affected by the WGC.....	45
Figure 4.6: North Kesteven Sewage RAG Status	48
Figure 4.7: CSOs in Lincoln.....	49
Figure 5.1: Catchment Area Served by Canwick STW	52
Figure 6.1: Pluvial Flood Data Collated as part of the LIUD	62
Figure 6.2: Combined Sewers in Central Lincoln with respect to SHLAA sites.....	66
Figure 7.1: Historic Fluvial Flooding in Lincoln	73
Figure 7.2: The Environment Agency's Flood Zones in the PUA	74
Figure 7.3: The Environment Agency's Flood Zones in West Lindsey.....	77
Figure 7.4: The Environment Agency's Flood Zones in North Kesteven.....	78
Figure 7.5: IDB Districts.....	80
Figure 7.6: Groundwater Flooding – Sleaford 1977	81
Figure 8.1: Environmental Sites within the LPA.....	86
Figure 8.2: Environmental Sites in the vicinity of Market Rasen, West Lindsey.....	88
Figure 8.3: Environmental Sites in the vicinity of Sleaford, North Kesteven	89
Figure 8.4: Sites to be incorporated into the Sub Regional Country Park.....	92
Figure 10.1: Scenario 1 falls short of the Regional Plan Target for the PUA	102
Figure 10.2: Scenario 2 exceeds the RSS Target for the PUA	103
Figure 10.3: Scenario 3 Exceeds the RSS Target for the PUA.....	104
Figure 10.4: Scenario 4 Exceeds the Regional Target for the LPA	105
Figure 11.1: The Area of North Lincoln that could be re-routed via the NEQ.....	107
Figure 11.2: Timeline of Water Infrastructure Requirement to Serve Development on SUEs.....	109
Figure 11.3: Timeline of Water Infrastructure Requirements for Caistor, Market Rasen and Middle Rasen, West Lindsey	110
Figure 11.4: Timeline of Water Infrastructure Requirements for Sleaford.....	111
Figure 12.1: Water Balances & Urban Areas.....	116

Non-Technical Summary

Introduction

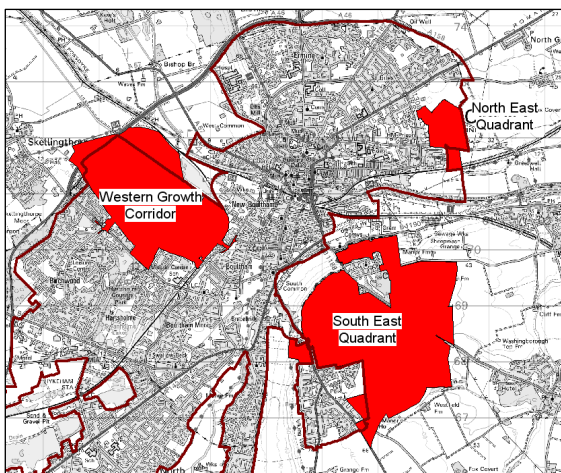
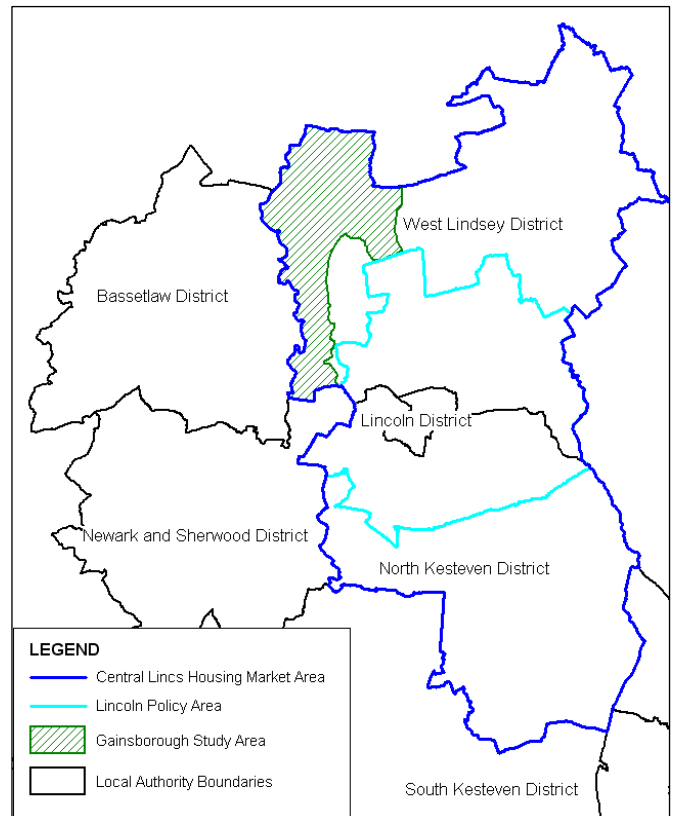
Two Water Cycle Studies (WCS) have been undertaken for the Central Lincolnshire Housing Market Area; one covers Gainsborough and surrounding villages in West Lindsey (the Gainsborough WCS) and this 'Central Lincolnshire WCS'; covers the rest of West Lindsey, the City of Lincoln and North Kesteven. This WCS has been broken down into three regions; the Lincoln Policy Area (LPA), West Lindsey outside the LPA excluding Gainsborough, and North Kesteven outside the LPA.

Future Growth & Development

The City of Lincoln Council, West Lindsey DC, North Kesteven DC and Lincolnshire County Council have recently decided to undertake a Joint Core Strategy covering the Central Lincolnshire Housing Market Area. A Central Lincolnshire Joint Strategic Planning Committee came into effect from 12th October 2009 and a Local Development Scheme has been submitted (awaiting approval) timetabling and outlining the documents that will be produced jointly. The Core Strategy will be the first key document produced under the new arrangements.

A Joint Planning Unit is currently being established to deliver the joint LDF work. In light of these changes to the planning structure, the site allocations document is not expected to be delivered until summer 2013.

Therefore information concerning potential future development has been considered across the study area and in the case of the LPA an assessment has been undertaken to see if the potential housing could meet the targets set out in the Regional Spatial Strategy for the East Midlands within the constraints of the water cycle. The focus of the study has been three Sustainable Urban Extensions (SUEs) to Lincoln; the Western Growth Corridor (WGC), the North East Quadrant (NEQ) and South East Quadrant (SEQ) which are intended to provide the majority of growth in and around Lincoln.



There is significant uncertainty concerning the number of houses that will be delivered on each of the SUEs and the phasing of their potential development means that they may not achieve the targets of the Regional Plan on their own. Consequently additional housing data has been reviewed that could be needed to achieve the growth targets. This data comprised the sites identified within the Strategic Housing Land Availability Assessment (SHLAA) for Lincoln and North Kesteven. In the case of West Lindsey the Growth Point Programme of Development and historic rates of development were used to identify areas of growth.

There is considerable uncertainty as to whether or not the SHLAA sites will be developed. This uncertainty has limited the level of analysis that it has been possible to undertake. Hence recommendations have been made that will require review as the planning situation evolves over the coming years.

Review of the Water Cycle

The development data available has been reviewed against six parameters associated with the water cycle using a Red Amber Green (RAG) methodology. The six parameters considered were;

- water resources,
- water supply,
- sewerage,
- sewage treatment,
- flood risk, and
- the environment.

The RAG classification broadly denotes development as;

- Red if there are funding, planning or environmental constraints identified to providing the infrastructure necessary to meet the proposed development,
- Amber if there are funding, planning or environmental constraints identified to providing the infrastructure necessary to meet the proposed development, but measures have been identified which are sustainable and deliverable,
- Green if there are no identified funding, planning or environmental constraints to providing the infrastructure necessary to meet the proposed development.

It is concluded that sewerage, sewage treatment and flood risk are the three parameters of the water cycle that present the most significant constraints to future development in the study area. Of these three factors, sewerage is considered to be the primary constraint. Many sewer systems do not have the capacity to accept additional flows without exacerbating existing, or causing new problems. In the case of sewage treatment, whilst there is spare capacity at many Sewage Treatment Works (STWs) across the study area there is insufficient capacity to accommodate all of the potential growth and it would be advisable to avoid growth at certain STWs (because of environmental impacts).

Given the uncertainty over whether or not the development considered will come forward in the planning process, it is suggested that to avoid premature, wasteful investment in water services infrastructure, development ought to be targeted to make use of spare capacities which currently exist within the foul sewerage systems and STWs. As the picture of future development becomes clearer over the coming years it will be possible to more accurately define what specific investment is required to meet the needs of the growing population.

There is a relatively high level of inherent (or mitigated) risk associated with flooding throughout the study area with many urban areas being located in close proximity to watercourses. Consequently many potential development sites fall within Environment Agency Flood Zones 2 and 3 (PPS25, Table D1).

Lincoln Policy Area

The Regional Plan sets targets of 25,170 new houses within the LPA between 2006 and 2026, of which 19,800 ought to be within or adjacent to the Principal Urban Area (PUA). The PUA comprises the built up areas of Lincoln City, North Hykeham, Bracebridge Heath and Waddington. In order to be able to serve these levels of growth it will be necessary for Anglian Water Services (AWS) to invest in a new water treatment works in AMP5 (2010-15) and upgrade Canwick STW in AMP6 (2015-20). The other water infrastructure requirements will be dependent on what and when, development actually occurs (this is applicable to not only the LPA but the entire study area).

North East Quadrant

The NEQ is expected to provide up to 2,000 homes. In order to sustainably develop this site it will be necessary for AWS to provide a new trunk sewer from the site with a direct connection to Canwick STW. The site is unable to connect into the existing sewer network since additional foul flows would exacerbate an existing problem in the foul and combined sewer system. The new connection would bypass the existing problem and provide opportunities for improvements to the overall system. AWS would also need to connect the site into the water supply network.

The footprint of the NEQ falls within the Flood Zone of Greetwell Beck, it will therefore be necessary for the Environment Agency to approve an appropriate Flood Risk Assessment for the site and the Lincoln Drainage Group to ensure that surface water

drainage from the site is adequately managed. It is anticipated that all of these works will be required within the next five year AMP period.

The NEQ also falls across Greetwell Quarry; a designated SSSI. As such it will be essential to ensure that the designated features of the quarry are not adversely affected by the development.

South East Quadrant

The SEQ is considered to be the most favourable of the three SUEs by AWS. The location is such that it would require new water supply and sewerage infrastructure thereby not impacting on the existing networks. The SEQ has a small fluvial flood risk therefore surface water drainage would be the primary concern which ought to be informed through consultation with the Lincoln Drainage Group. Strategic balancing ponds may be appropriate. The need for water infrastructure is dependent on when development starts however this is not expected until AMP6 (2015-20).

Western Growth Corridor

The WGC is perhaps the most contentious of the three proposed SUEs. It has the benefits that it will not adversely impact upon the water supply or foul sewerage networks (as demonstrated through hydraulic modelling) and not require major new trunk mains but be able to exploit existing mains serving south west Lincoln. The footprint of the WGC comes into contact with a number of environmental sites and whilst it therefore has the potential to adversely affect these sites it also has a high potential to bring about benefits and improvements not only for those sites but for the wider area in the form of the proposed Sub Regional Country Park.

The constraint applicable to the WGC is that much of the area is in Flood Zones 2 and 3 and is low lying. Consequently if sequential and exception testing under PPS25 deems that areas of the site within Flood Zone 3 are to be developed it will be essential for appropriate flood management infrastructure to be put in place.

SHLAA Sites

Across North Lincoln, within the PUA, sewerage represents a significant constraint to development and all SHLAA sites have been classified Red. This is because the entire area drains to Canwick STW via one river crossing at Stamp End where there is an existing flood problem that additional development would exacerbate. This barrier could be overcome; the NEQ would have a direct connection to Canwick STW thereby providing a second river crossing. This would present an opportunity to re-route parts of North Lincoln via the NEQ thereby bypassing the problem at Stamp End.

Many other SHLAA sites across the study area have been classified Amber however, without more certainty concerning whether or not the development will go ahead it has not been possible to identify what investment would be required to bring these sites forward.

Development in Skellingthorpe, Cherry Willingham and Langworth has been classified as Red for foul sewerage whilst development in Faldingworth has been classified Red for sewage treatment.

Meeting the Targets of the Regional Plan

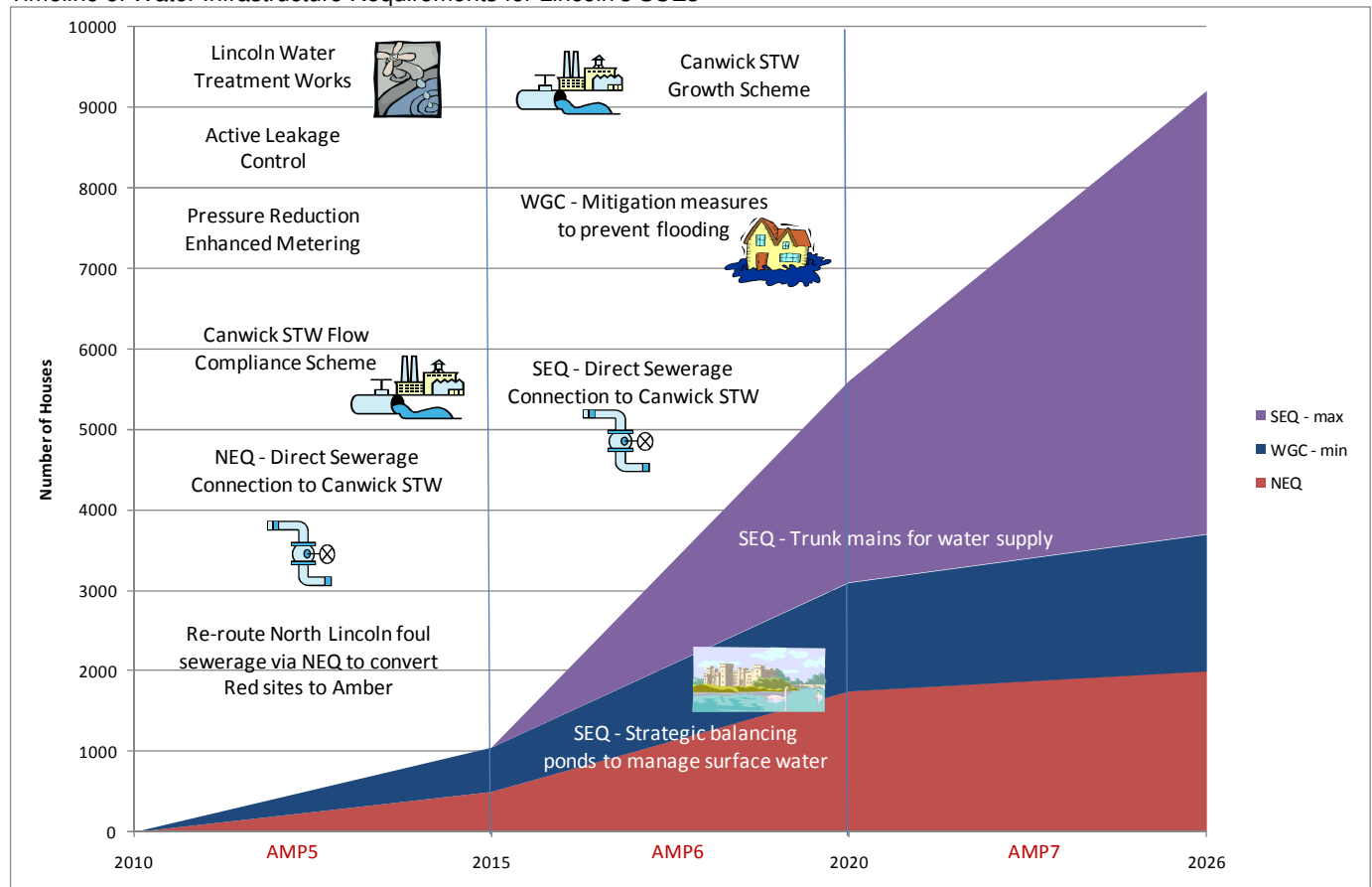
Section 10 of the WCS considers the potential to meet the growth targets for the LPA set out in the Regional Plan with regard to the RAG classification. Sewerage was deemed to be the most significant constraint and therefore the sewerage RAG status was used to identify preferred sites.

It is concluded that developing the SUEs alone would not provide sufficient numbers to meet the Regional Plan targets for either the PUA or the LPA. Including all of the SHLAA sites which have been designated Green for sewerage, the NEQ and realising maximum numbers on the WGC and SEQ would meet the requirements. However, if maximum numbers are not realised on both SUEs it will be necessary to develop some of the SHLAA sites which have been classified Amber, and AWS will need to identify what infrastructure is required and invest in the foul sewerage system as and when these sites come forward.

It is also concluded that if maximum development numbers are not realised on either the WGC (5,000) or the SEQ (10,000) then utilising all of the Amber SHLAA sites would not provide enough houses to meet the targets and some sites that have been classified as Red would also need to be developed.

The figure below illustrates a timeline of infrastructure requirements for Lincoln's three SUEs.

Timeline of Water Infrastructure Requirements for Lincoln's SUEs



West Lindsey

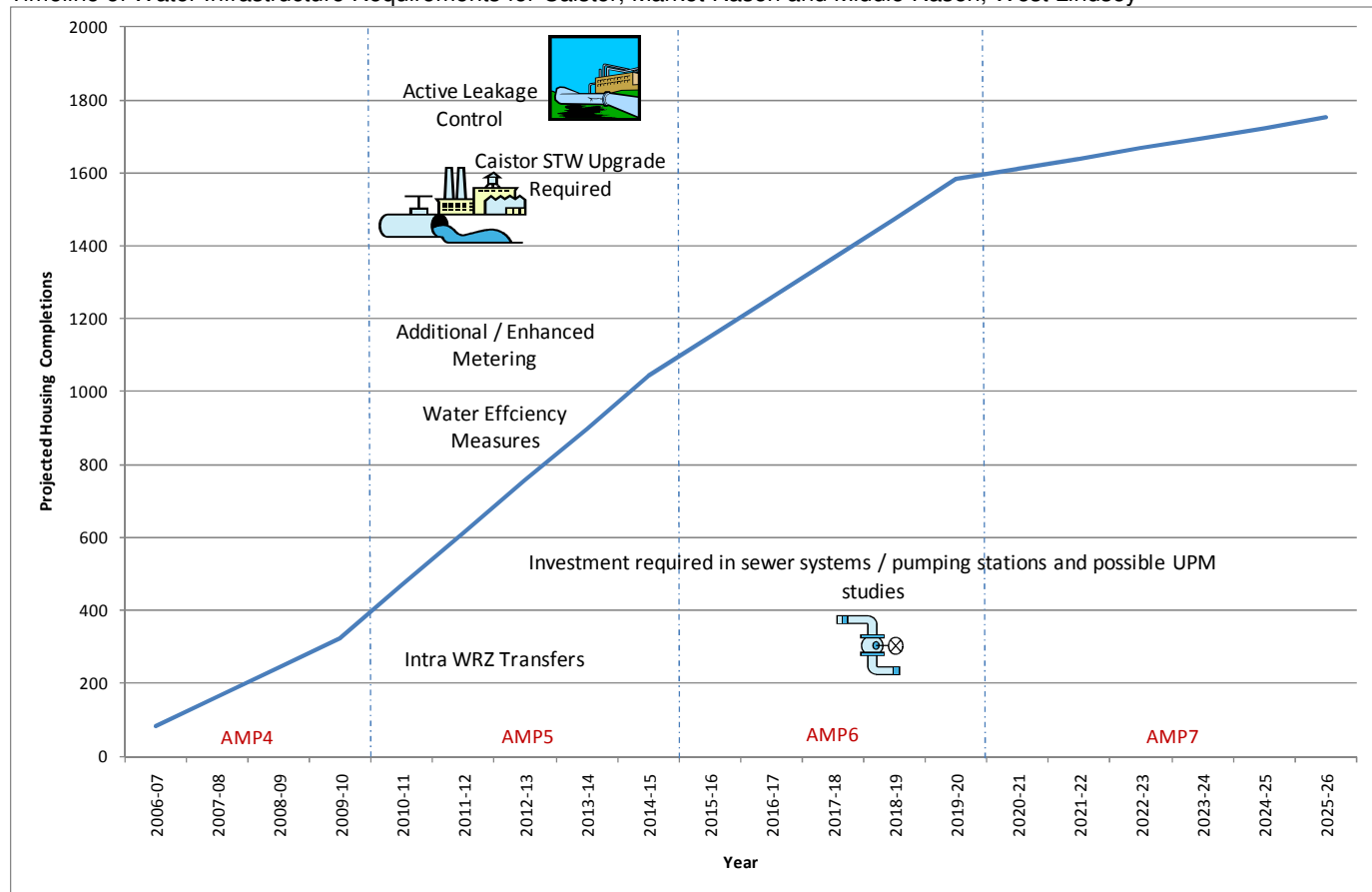
Within West Lindsey, outside the LPA and excluding Gainsborough, significant development is only expected in two towns; Caistor and Market Rasen although due to its close proximity Middle Rasen has also been included in the analysis.

With regard to wastewater infrastructure the forecast growth in Middle Rasen is within existing capacities and therefore would not require investment, unless the forecast growth occurred in Market Rasen first. AWS have indicated that for both Caistor and Market Rasen investment would be required in the sewerage system, when this investment would be required would depend on growth rates and spatial distribution of development.

Caistor presents a problem in terms of the timing of development. Whilst the water cycle parameters for water and wastewater are Amber, indicating investment is required, that investment is needed immediately. AWS have indicated that there is no spare capacity at the local STW and the development phasing profile suggests that 64 houses could have been built between 2006 and 2010, and 180 are planned for the 2010-2015 period. It would therefore appear necessary to upgrade the wastewater infrastructure immediately to be able to serve this development. However it is likely that there could be a delay to any upgrades in light of AWS not having any upgrades planned. It will be necessary for West Lindsey DC to liaise with AWS concerning future development in Caistor and Market Rasen.

A timeline of potential infrastructure requirements for the West Lindsey villages of Caistor, Market Rasen and Middle Rasen is presented in the figure below.

Timeline of Water Infrastructure Requirements for Caistor, Market Rasen and Middle Rasen, West Lindsey



North Kesteven

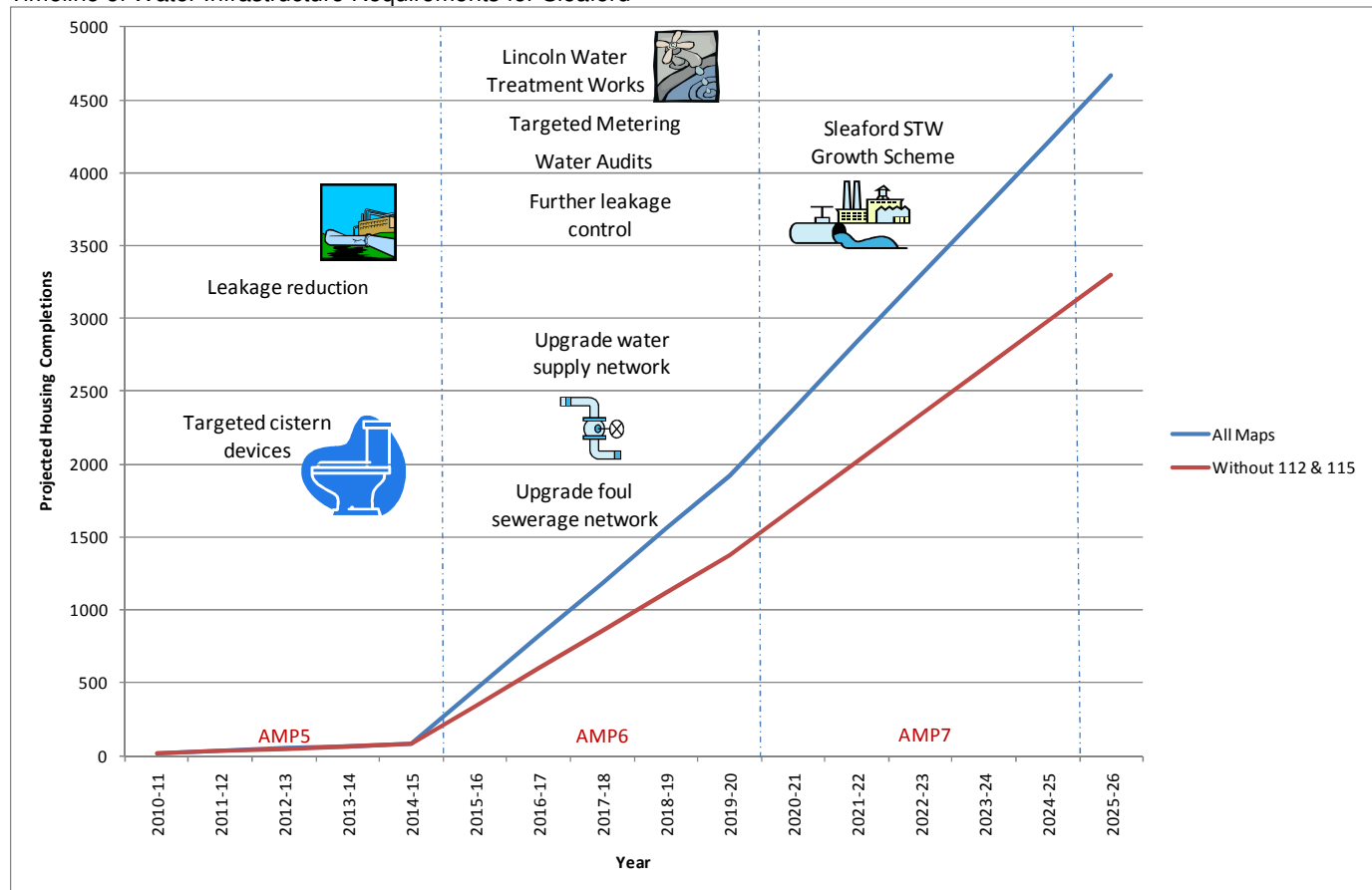
Given the current planning information available, sewerage presents a barrier to further growth in Walcott, Billinghay, Ruskington and parts of Sleaford. In terms of sewerage treatment it is worth noting that whilst the STWs serving North Kesteven may struggle to serve all of the SHLAA sites, they do have capacity to accept some growth.

Sleaford

The SHLAA data identifies potential sites for 4,744 houses in and around Sleaford. With regard to sewerage, SHLAA sites to the south west of Sleaford have been classified as Red and unable to accommodate additional flows. If these sites were to be excluded, the number of potential houses in Sleaford reduces to 3,376. The Sleaford STW that would serve these sites has been classified as Amber on account of not being able to accommodate all of the SHLAA sites. The STW does have spare capacity to accommodate approximately 3,500-4,000 additional houses. Therefore, the most sustainable means of developing Sleaford would appear to be to avoid developing those sites to the south west of Sleaford. Whilst this would require investment in the sewerage network and water supply network by AWS to serve these developments, the STW would not require upgrading.

A timeline of potential infrastructure requirements for Sleaford is presented on the basis that SHLAA sites to the south west (maps 112 and 115) are not developed but all of the other SHLAA sites do come forward.

Timeline of Water Infrastructure Requirements for Sleaford



In the case of Ruskington, the SHLAA identifies potential to site 817 houses but the foul sewerage network has been deemed incapable of accommodating any additional flows and classified as Red. However, the Anwick STW which serves Ruskington, has spare capacity for an additional 5,500-6,000 houses before an upgrade would be required. Therefore if significant development were to be planned in the future, in the form of a SUE for the Sleaford / Leasingham / Ruskington area, it would be advantageous for it to be sited to use the spare capacity that exists at Anwick STW.

Conclusions

The following bullet points are offered to bring out the pertinent conclusions of the Central Lincolnshire WCS;

- The targets set out in the Regional Plan will not be achieved through the SUEs alone.
- Factors such as the current economic climate mean that future development across the study area is highly uncertain. Unpredictable build rates and uncertainty over which SHLAA sites may come forward, is further complicated by the current status of the Local Development Framework. Therefore the overall strategy needs to be both flexible and robust to change.
- The SEQ is considered to be the most sustainable of the three SUEs, followed by the NEQ then the WGC. The WGC is the only SUE with a significant issue, namely the flood risk associated with the site.
- There are significant constraints within the existing foul and combined sewerage network which represents the primary constraint in terms of the water cycle to developing the SHLAA sites.
- In order to meet the Regional Plan targets it will be necessary for AWS to invest in the foul sewerage system to release some Amber SHLAA sites and maximum numbers will have to be realised on either the WGC or the SEQ.
- If both the WGC and the SEQ only achieve minimum build numbers not only would all of the Amber SHLAA sites be required but some Red sites would also be needed.

- The NEQ presents an opportunity to alleviate the constraints on the foul and combined sewerage system in North Lincoln which has been classified as Red.
- Additional water resources are required to service the Regional Plan target figures and some new water supply trunk mains will be needed to serve the NEQ and SEQ.
- Investment will be required at STWs in order to cater for the Regional Plan targets. AWS plan to invest for major growth at Canwick STW and recommend that growth in other catchments be limited to that which can be accepted within the existing capacities of the receiving STWs.
- Potential growth does not preclude compliance with the WFD however there are outstanding issues concerning phosphorous that the Environment Agency need to assess along with water companies as part of their ongoing WFD related work.
- There are no areas where sites with environmental designations would be adversely affected by growth and the provision of additional infrastructure. Opportunities for environmental enhancement exist in relation to the proposed Sub Regional Country Park. The WGC and other SHLAA sites in the vicinity may have the capacity to incorporate water features such as balancing ponds on site which could provide additional benefits in terms of wildlife ponds that could form part of the Sub Regional Country Park.

Strategy

Overall Strategy

The Strategy will be to meet the Regional Plan targets for growth to the year 2026 in both the LPA and PUA whilst avoiding premature, wasteful investment in water services infrastructure and whilst ensuring adequacy of services and seeking some environmental improvements. This strategy will involve development in the SUEs and other SHLAA sites with provision of a new water treatment works in AMP5 and increased capacity at Canwick STW in AMP6. Other potential improvements to water services infrastructure depend on the location and rates of development.

Strategy Review

Local Planning Authorities monitor housing figures annually and the Strategy will require review in three to five years, as development patterns become more clearly defined, and policies are formulated by the new Joint Planning Committee. Revisions to items identified on the initial timelines may be required as the economic situation changes and as the provisions of new legislation come into force (e.g. Flood and Water Management Act 2010).

Strategic Opportunities

Depending on the locations and rates of development, opportunities ought to be taken to:

- Provide new water supply trunk mains
- Improve water usage efficiency measures
- Separate surface water and foul sewage
- Alleviate existing flooding problems
- Improve flood risk management measures (e.g. by construction of flood storage areas)
- Increase green corridors and the use of SUDS
- Improve water quality
- Consider opportunities to contribute to the Carbon Reduction Commitment e.g. applying low energy technologies in expansion of Canwick STW

Note – the RAG status of water services assets will provide a useful indicator for the planning authorities when they consider the phasing and sustainability of future developments.

Future Actions

Parameter	Future Action
Development	2.1 - Continual review of the Strategy in light of known development and significant changes to the forecast growth trajectory.
Water Resources & Supply	<p>3.1 - AWS to implement New Lincoln WTW in AMP5.</p> <p>3.2 - AWS to control leakage, enhance metering and transfer water between WRZ.</p> <p>3.3 - Encourage developers to provide water efficiency measures in new homes.</p> <p>3.4 - Ensure all new properties are metered.</p> <p>3.5 - Implement rainwater harvesting measures wherever appropriate.</p>
Sewerage	<p>4.1 - Where development occurs in areas served by combined sewers endeavour to separate the foul and surface water flows as part of the development.</p> <p>4.2 - AWS to implement a new direct connection to Canwick STW to serve the NEQ.</p> <p>4.3 – City of Lincoln and AWS to review development needs in North Lincoln prior to commencement of the NEQ to ensure that appropriate water infrastructure is in place.</p> <p>4.4 - AWS to review the impact of developing the WGC when housing numbers are finalised and what, if any, mitigation measures are required to alleviate flooding.</p> <p>4.5 - Implement a new direct connection to Canwick STW to serve the SEQ.</p> <p>4.6 - New direct connection to Canwick STW to be in place for development of North Kesteven SHLAA maps 14 and 21.</p> <p>4.7 – West Lindsey DC and AWS to monitor development in Market Rasen and Caistor.</p> <p>4.8 – Sewerage presents constraints to development in Walcott, Billingham, Ruskington and south west Sleaford. If these SHLAA sites are to be developed additional work will be required to identify sustainable solutions. AWS and NKDC to review future growth needs.</p> <p>4.9 - Review the RAG status of foul sewerage in North Kesteven when more detailed information concerning which SHLAA sites are to be developed is available.</p> <p>4.10 – Review the need for UPM studies following site allocation.</p> <p>4.11 – Ensure that no new CSOs are created.</p>
Sewage Treatment	<p>5.1 - Expand Canwick STW in AMP6 to cater for growth.</p> <p>5.2 - Focus future development within the catchment area served by Canwick STW and restrict growth elsewhere within available capacities (Table 5.1).</p> <p>5.3 - Undertake additional work to review Faldingworth STW if development is to go ahead.</p> <p>5.4 - Development in Bardney is considered to be the most sustainable in terms of water infrastructure. Development in Nocton, Dunholme and Welton may require further work to assess water quality implications.</p> <p>5.5 - If further development is to take place in Cherry Willingham, Langworth, Sudbrooke, Metheringham and Dunston local authorities to liaise with AWS regarding potential implications.</p> <p>5.6 - AWS to review potential to invest and improve the foul sewerage system in Market Rasen to take advantage of the available capacity at the STW.</p> <p>5.7 - West Lindsey DC to review development in Caistor in consultation with AWS.</p> <p>5.8 - North Kesteven DC and AWS to consider potential to exploit spare capacities that exist at</p>

Parameter	Future Action
	<p>STWs without the need for expansion of the STW otherwise Navenby, Billingham, Leasingham, Sleaford, Heckington and Wilsford will require upgrades.</p> <p>5.9 - The Environment Agency to tackle diffuse pollution across the River Witham catchment.</p> <p>5.10 - The Environment Agency to address the issue of phosphorus under the WFD.</p>
Surface Water	<p>6.1 - AWS to continue investigating the flood problem at Stamp End.</p> <p>6.2 - Surface Water RAG status to be reviewed following completion of PFRA.</p> <p>6.3: The options for surface water separation should be considered further at the Implementation Stage through a feasibility study.</p> <p>6.4 - Developers to use SUDS wherever possible with due regard to the constraints associated with the specific site.</p> <p>6.5 - Developers to consider strategic balancing ponds for the SUEs.</p>
Flood Risk	<p>7.1 - Ensure that the flood risk associated with all sites that are developed is addressed.</p> <p>7.2 - Environment Agency to implement Flood Risk Management Policies set out in the CFMP.</p>
Environment	<p>8.1 - Maximise opportunities to benefit the Sub Regional Country Park should development occur on the WGC or SHLAA maps 1, 9 13, 16, 20 and 29.</p> <p>8.2 - Incorporate strategic balancing ponds into the three SUEs and maximise the potential to create opportunities for wildlife in ponds and reed-beds.</p> <p>8.3 – Local authorities to identify mechanisms to promote GI.</p>
Infrastructure Requirements	<p>11.1 - Timetable and timeline of future infrastructure requirements to be reviewed on a regular basis in the future, particularly if significant changes occur in the planning process.</p> <p>11.2 – Establish an “Implementation Group” to review and promote the Water Cycle Study to ensure that maximum benefit is gained from work undertaken, and from future policies and technical studies.</p>
Masterplanning the SUEs	<p>12.1 - Developers involved with the SUEs should be encouraged by the planning authorities to use fixed fittings and other measures to reduce water consumption in the home, provide measures for collecting rainwater to reduce consumption of water externally and manage surface water runoff on site as part of an integrated solution to serve the whole site rather than individual plots.</p> <p>12.2 - Masterplanning for Lincoln’s SUEs should endeavour to implement the concept of Water Sensitive Urban Design.</p>

Introduction



1 Introduction

1.1 Background

The Lincoln Policy Area (LPA) was awarded New Growth Point status in October 2006. Over the next ten years and beyond, Lincoln will expand its role as the principal urban area in the county of Lincolnshire by delivering a fundamental change in the level of housing and economic growth in the City and wider area, principally through the development of a series of key sites in and around the City. This will lead to an increase in the number, quality and variety of houses that cater for all requirements; higher population numbers; a larger business base; and a higher quality and quantity of jobs for local people.

This growth will place pressure on the existing water services infrastructure and this water infrastructure has been identified as a potential constraint to the rate and nature of growth within the LPA. In response to this potential constraint, a Water Cycle Study (WCS) was commissioned by the City of Lincoln Council, on behalf of the Lincoln Policy Area Partners', to identify the infrastructure required to support the levels of growth forecast and ensure that the development is sustainable. An Outline WCS was completed in June 2008 for the LPA.

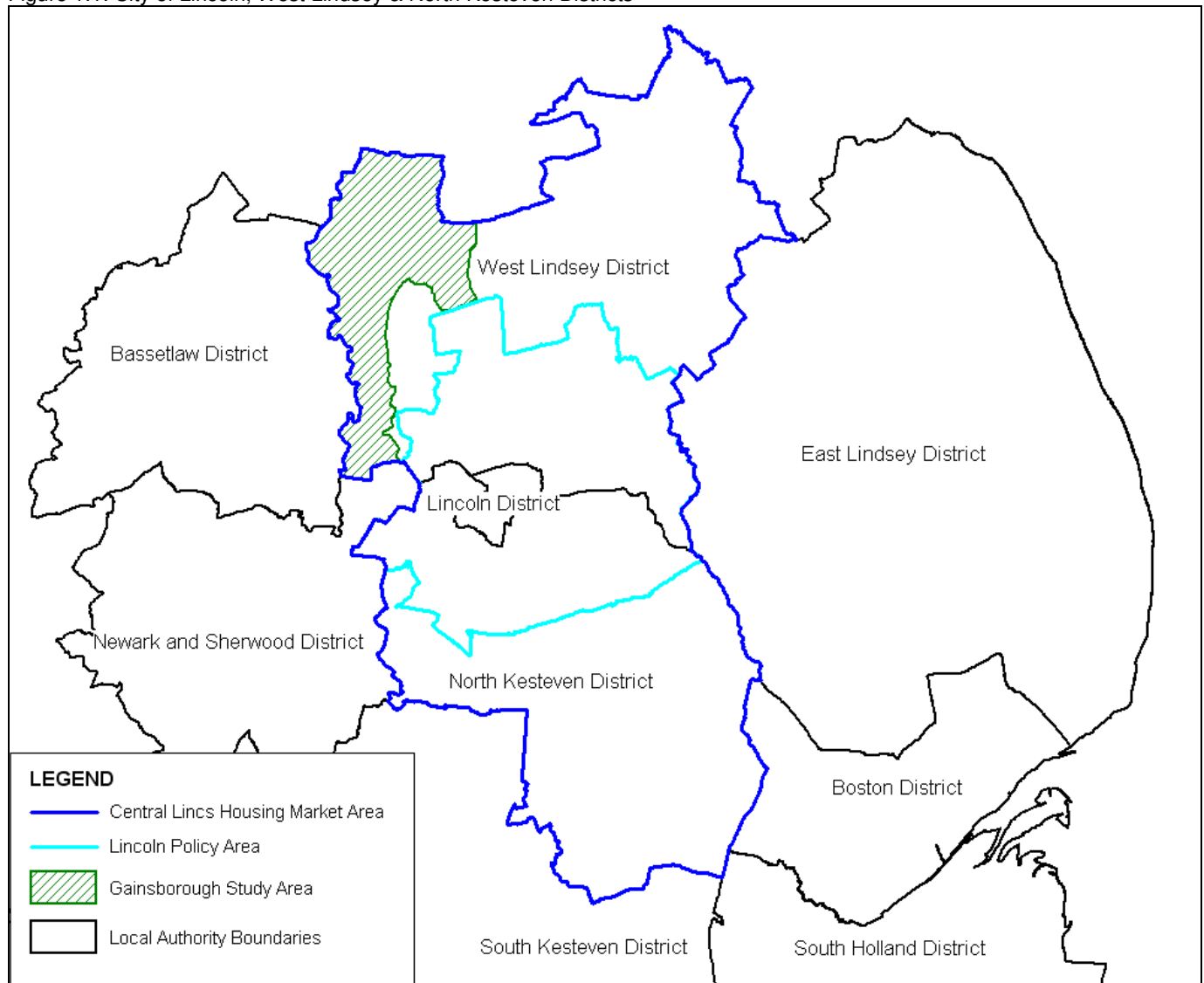
The LPA covers three local authorities; all of the City of Lincoln, and parts of West Lindsey and North Kesteven. It has been defined primarily through an analysis of journey to work patterns related to other data concerning the frequency of public transport services, the existence of key rural settlement services and facilities and existing housing completions and commitments.

New Growth Point status for Gainsborough (West Lindsey), outside the Lincoln Policy Area, was announced in July 2008 (subject to confirmation in the ongoing review of the East Midlands Regional Plan). Over the next 20 years and beyond, Gainsborough is intended to provide the main focus for urban expansion in West Lindsey, expanding its role as the principal town and regionally important regeneration area. The regeneration of Gainsborough will be achieved by delivering a fundamental change in the level of housing and employment opportunities, particularly through the development of a series of neighbourhood extensions to the south, east and north of Gainsborough. A WCS was therefore also required for West Lindsey.

There has been a clear steer from the East Midlands Regional Plan (March 2009) towards joint working between the Local Planning Authorities, which will result in the production of a Joint Core Strategy covering the Central Lincolnshire Housing Market Area; which comprises all of the three local authority districts. (The local planning authorities in the East Midlands Region are grouped together into Housing Market Areas (HMA); each HMA contains information on the strategic context for determining their housing provisions.) To take account of this the local authorities decided to expand the WCS study area to encompass all of West Lindsey and North Kesteven.

Gainsborough and its surroundings in West Lindsey have been considered separately and a stand-alone WCS is being produced for the town in light of its own more recent award of growth point status. There is also the additional complication of two water companies having an involvement with the Gainsborough study whereas only one operates across the rest of the Central Lincolnshire HMA. The Gainsborough WCS has been designed to be complimentary to the Central Lincolnshire WCS. Figure 1.1 illustrates the local authority boundaries, the LPA, the Central Lincolnshire Housing Market Area and the study area of the Gainsborough WCS.

Figure 1.1: City of Lincoln, West Lindsey & North Kesteven Districts



1.2 Stakeholders

This WCS has been funded through the Lincoln Policy Area Growth Point programme with the City of Lincoln Council acting as lead Local Planning Authority on the project with Partners appointing AECOM to undertake the study. The three planning authorities worked in partnership with other key stakeholders; Anglian Water and the Environment Agency to deliver the WCS.

The key stakeholders involved with the study are;

- City of Lincoln Council,
- West Lindsey District Council (DC),
- North Kesteven DC,
- Anglian Water Services Ltd, and
- the Environment Agency.

These key stakeholders have been supported throughout the process by a number of other stakeholders who have interests in the study;

- Lincolnshire County Council,

- Upper Witham Internal Drainage Board (IDB),
- Witham First IDB,
- Witham Third IDB,
- Natural England, and
- Lincolnshire Wildlife Trust.

1.3 Detailed WCS

An Outline WCS was completed for the LPA in June 2008 which identified a number of issues that required further work to ensure that growth would be sustainable; hence this Detailed WCS. The issues requiring further investigation centred on the planning data, foul sewerage and sewage treatment.

The study area has been expanded to include all of West Lindsey (excluding Gainsborough) and North Kesteven post-completion of the Outline WCS for the Lincoln LPA. Therefore this report has considered all aspects of the water cycle to account for these additional areas rather than focusing upon those issues raised in the Outline WCS.

The purpose of the Central Lincolnshire WCS is twofold. Firstly, to identify the limitations of the existing water services infrastructure and the requirements to support the levels of growth identified. Secondly, the WCS will provide an evidence base to help inform the Joint Core Strategy for the Central Lincolnshire area.

The WCS has three key aims:

- To ensure urban development occurs in the most sustainable locations,
- To ensure environmental and infrastructure constraints do not compromise urban development, and
- To identify opportunities for more sustainable or multi-use water infrastructure options.

A detailed WCS is designed to work alongside the latter stages of the Core Strategy development process to review specific site allocations and devise a strategy by which the allocated sites will be sustainable in terms of the water cycle. However a Core Strategy is not in place for Central Lincolnshire.

The City of Lincoln Council, West Lindsey DC, North Kesteven DC and Lincolnshire County Council have recently decided to undertake a Joint Core Strategy covering the Central Lincolnshire HMA. A Central Lincolnshire Joint Strategic Planning Committee came into effect from 12th October 2009 and a Local Development Scheme has been submitted (awaiting approval) timetabling and outlining the documents that will be produced jointly. The Core Strategy will be the first key document produced under the new arrangements.

A Joint Planning Unit is currently being established to deliver the joint LDF work. In light of these changes to the planning structure, the site allocations document is not expected to be delivered until summer 2011.

Irrespective of these issues, a WCS has been progressed for Central Lincolnshire. Consequently, it has not been possible to adhere fully to the Environment Agency guidance for detailed WCS' and develop a water cycle strategy which ensures specific sites are sustainable. Instead an extensive number of potential development sites have been reviewed as far as practicable in light of the status of the Core Strategy. Three Sustainable Urban Extensions (SUEs) proposed for Lincoln have the greatest certainty concerning their development and these have consequently formed the focus of the WCS.

The Environment Agency WCS guidance document lists seven bullet points that a Detailed WCS ought to consider. These are presented below along with a short statement outlining how the Central Lincolnshire WCS has addressed the bullet point.

- complete any detailed assessments identified in the outline study;
 - o recommendations from the Outline WCS included an assessment of improved development data, consideration of Anglian Water's Water Resource Management Plan, consider options for extending sewage treatment works, carry out hydraulic modelling of sewerage and water quality assessments. All of these have been undertaken.
- establish minimum design standards to be applied to new developments to ensure a sustainable and integrated water cycle;
 - o The current design standards and codes of practice for the various authorities have been collected and listed as guidance for developers.

- carry out a sustainability analysis of development options and water cycle infrastructure;
 - o The significant number of potential development sites that may never come forward for development has prevented the study from considering detailed options for water cycle infrastructure. With regard to the three SUEs, sustainable infrastructure for water supply, sewage treatment and sewerage have all been identified.
- provide a detailed framework for the sustainable provision of infrastructure including a timeline of requirements (the water cycle strategy);
 - o Timelines of development requirements have been produced. However the uncertainty concerning whether or not sites will be developed has prevented the formulation of a detailed framework.
- help ensure that water cycle infrastructure will be funded and implemented in a timely manner;
 - o The timelines that have been produced identify when infrastructure is required based upon the phasing of development that has been provided. Time periods have been related to AMP periods within which AWS funding is controlled.
- inform supplementary planning guidance;
 - o Rather than assessing sites allocated by the Core Strategy, the Central Lincolnshire WCS has provided a review of potential development sites that the Local Planning Authorities will be able to take into consideration when they get to the allocation stage, hopefully being able to steer development to locations that have been identified as being more sustainable by the WCS.
- provide the basis for a financial mechanism for developer contributions, or a 'reasonable prospect' of infrastructure provision to link planning conditions;
 - o The detailed modelling that has been undertaken for Lincoln's foul and combined sewerage network has identified a number of areas where development could exacerbate existing, or create new flooding problems. This will enable the planning authority to consult with Anglian Water on planning applications to ensure effective drainage with respect to no increase in flood risk resulting from new development.

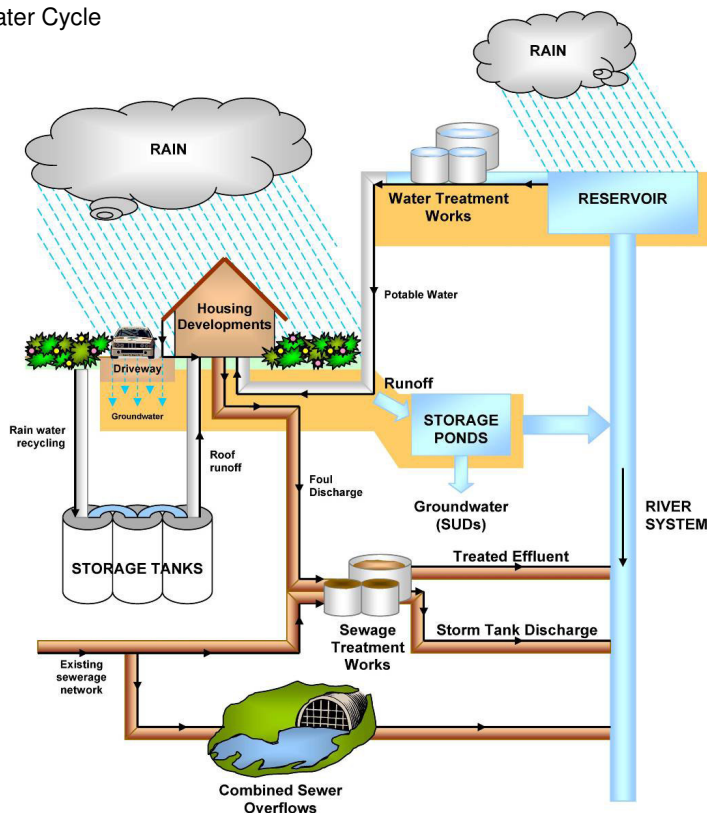
The Central Lincolnshire WCS has identified sustainable means and the infrastructure required to serve the three SUEs to Lincoln and has provided a review of potential development sites in terms of their sustainability with regard to the water cycle.

Appendix A lists the residual risks and assumptions of the Central Lincolnshire WCS.

1.4 Report Format

This report has been structured with due regard to development and the water cycle, illustrated in Figure 1.2.

Figure 1.2: The Water Cycle



As such it has been divided up into the following sections;

- Development Planning,
- Water Resources & Supply,
- Sewerage,
- Sewage Treatment,
- Surface Water Drainage,
- Flood Risk,
- The Environment,
- RAG Summary for the Water Cycle
- Delivering the Targets of the Regional Plan,
- Masterplanning the Sustainable Urban Extensions, and
- Conclusions & Strategy.

1.5 Strategy Development

Although the study has resulted in a Water Cycle Strategy for the Central Lincolnshire HMA it does not mark the end of the process. The Central Lincolnshire WCS has taken account of the most detailed information that is currently available. However, the situation is constantly changing therefore this WCS should be reviewed at regular intervals in the future in light of the changes that will inevitably occur.

Development Planning



2 Development Planning

2.1 Future Growth

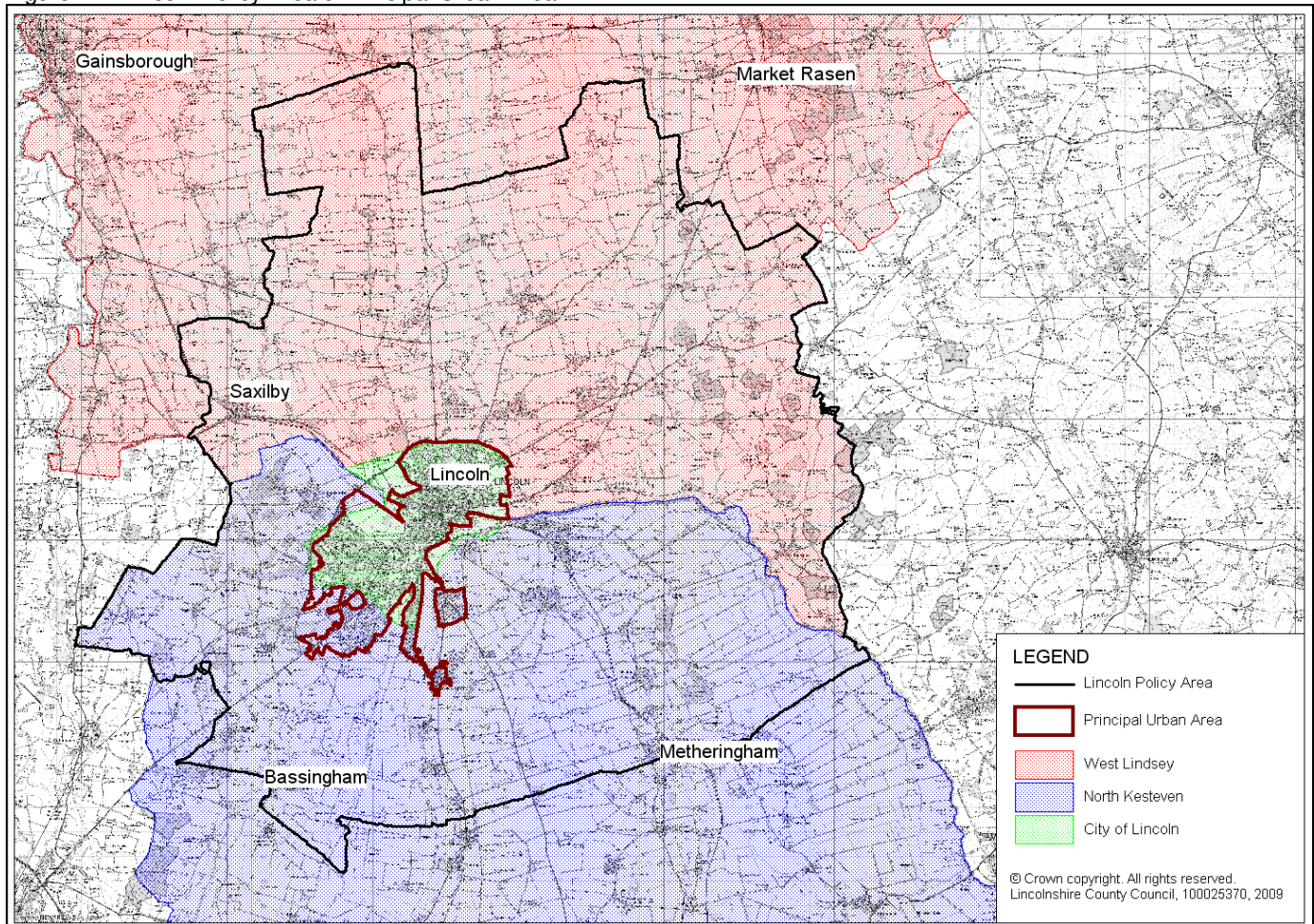
In order to be able to formulate a strategy for water infrastructure provision to support future development, it is important to have an understanding of that development.

Growth Point status was awarded to the LPA in October 2006 and Gainsborough/West Lindsey in July 2008. Growth Points have been set up by Central Government to create more sustainable places to live through developing economic growth, reducing deprivation and encouraging regeneration.

The levels of housing growth associated with Growth Point status are confirmed through the statutory planning process and included in the relevant regional spatial strategy and local development frameworks, with the public consultation, testing, sustainability appraisal, appropriate assessments and examination in public taking place accordingly. Housing targets therefore must be in accordance with the development plan process which for Central Lincolnshire includes RSS8 (and any subsequent review) and the emerging Central Lincolnshire Core Strategy.

The current Regional Spatial Strategy for the East Midlands (RSS8) was published in March 2009 as the East Midlands Regional Plan and it provides a broad development strategy for the East Midlands up to 2026. The plan identified that 25,170 new houses should be built within the LPA over the period 2006-26, of which at least 19,800 should be in or adjacent to the Principal Urban Area (PUA) of Lincoln. The PUA comprises the built-up parts of Lincoln City, North Hykeham, Bracebridge Heath and Waddington. Figure 2.1 illustrates the boundary of the LPA and a boundary for the PUA. The PUA boundary has been produced by the City of Lincoln Council for monitoring purposes only and is not an officially approved boundary.

Figure 2.1: Lincoln Policy Area & Principal Urban Area



The State of the City Report (December 2008) for Lincoln, identified that there are approximately 41,400 households in Lincoln. The additional housing targets identified in the Regional Plan therefore represent a significant increase to the existing urban environment that will place a range of services, including water infrastructure under significant pressure to support the potential future growth. Indeed there will need to be a significant increase in the number houses being built. In order to meet the PUA target of 19,800 houses between 2006 and 2026 an average rate of 990 houses per year will need to be built. This is considerably more than the 662 completions per year achieved between 2006/07 and 2008/09.

The Regional Plan also allocates provision of new housing between individual Local Planning Authority areas for the period between 2006 and 2026. The numbers for West Lindsey and North Kesteven are shown in Table 2.1 below.

Table 2.1: Future Housing Provision in the Central Lincolnshire HMA

Central Lincolnshire HMA	Annual Apportionment From 2006	Total Housing Provision 2006-2026
West Lindsey	480	9,600
North Kesteven	560	11,200

The northern half of North Kesteven (including North Hykeham, Skellingthorpe, Waddington, Washingborough, Heighington and Metheringham) is included within the LPA. The figures for North Kesteven in Table 2.1 do not include contributions from those parts of the Lincoln PUA that lie in the district.

2.2 Completions and Commitments

Between 2006 and 2009 4,180 houses were built in the LPA of which 1,987 were in the PUA. In addition to those houses that have already been built there are existing commitments for 6,453 houses within the LPA of which 4,824 are within the PUA.

Consequently there is a requirement to identify a developable land supply for another 14,537 houses within the LPA of which at least 12,989 should be in the PUA in order to meet the targets set out in the Regional Plan.

2.3 Planning Policy

The Government's specific objectives for housing are principally set out in PPS3: Housing, which includes the aims of providing sufficient housing, creating mixed communities and meeting local housing needs. Emphasis is placed on a 'plan, monitor and manage approach' to housing provision.

The Regional Plan includes a Sub-Regional Strategy (SRS) for the LPA with the purpose of providing additional guidance to Local Development Frameworks on strategic issues that relate to Lincoln and its surrounding hinterland. In particular the SRS aims to set out a strategic context for the strengthening of Lincoln's role as a Principal Urban Area.

The Regional Plan identifies that for the Central Lincolnshire HMA (including the LPA) urban intensification and sustainable urban extensions should be the main focus for providing new housing development in the period 2006 - 2026. In terms of locational preference Policy SRS2 of the Regional Plan prioritises that development should take place on previously developed land where practicable in the following places:-

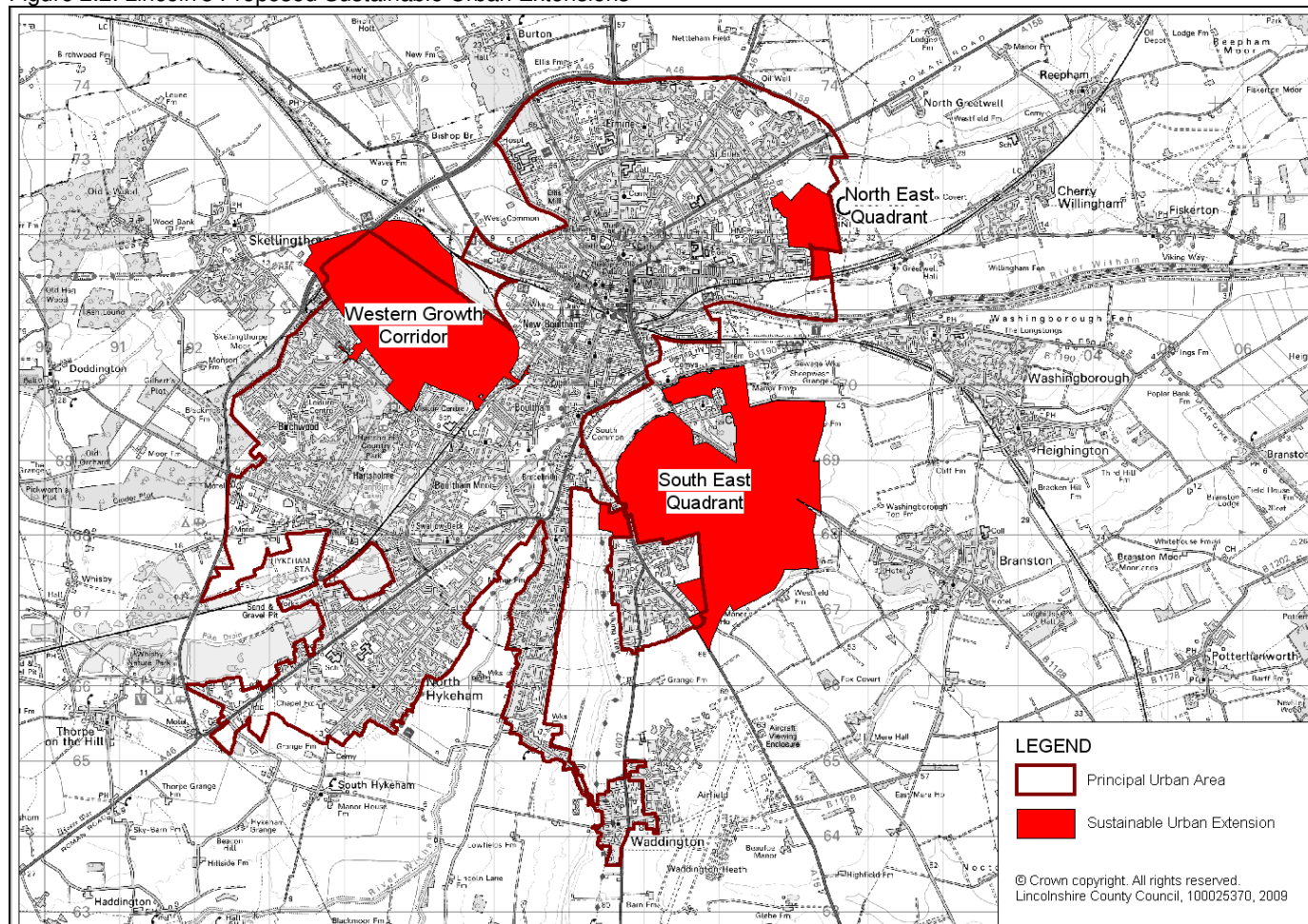
1. Central Lincoln
2. Elsewhere in the built up area of Lincoln and North Hykeham
3. Edge of the built up area
4. Appropriate settlements elsewhere in the LPA

Explanatory notes to Policy 13a of the Regional Plan specify that completions, commitments, urban capacity and potential urban extensions in the three local planning authority districts will contribute to the Lincoln PUA figure of 19,800 and overall 25,170 dwellings figure for the LPA.

2.4 Identifying Areas for Growth

At a technical meeting with the local authorities on 18th March 2009, it was concluded that well over half of the growth in the LPA will be through three proposed Sustainable Urban Extensions (SUEs) to Lincoln; the North East Quadrant (NEQ), the South East Quadrant (SEQ) and the Western Growth Corridor (WGC). The locations of these three SUEs are within or adjoining the PUA as illustrated in Figure 2.2.

Figure 2.2: Lincoln's Proposed Sustainable Urban Extensions



With the exception of the NEQ, there is a great deal of uncertainty associated with the number of properties that could be incorporated into each SUE. Therefore in the case of the SEQ and the WGC, minimum, medium and maximum scenarios were discussed with the planning authorities to cover a range of possibilities (Table 2.2).

Table 2.2: SUE Housing Scenarios

Sustainable Urban Extension	Housing Scenarios
SEQ	Min – 3,250 houses ¹ Med – 6,000 houses Max – 10,000 houses
WGC	Min – 1,700 houses Med – 3,800 houses ¹ Max – 5,000 houses ²
NEQ	2,000 houses

¹ – Taken from the SHLAA

² – Developers aspirations

Unless the maximum housing scenario occurs on the SEQ, it is apparent that the SUEs alone will not meet the targets set out in the Regional Plan for the LPA. Consequently it was necessary to identify other sites of potential development within the LPA that could be used to meet the Regional Plan targets and where development could occur in the wider areas of West Lindsey and North Kesteven outside the LPA.

The Strategic Housing Land Availability Assessment (SHLAA) is a study that makes a preliminary assessment of the suitability of land to meet future housing requirements over a 15 year period. A SHLAA covering both the City of Lincoln and North Kesteven was completed in February 2009 and was considered to provide the best source of information concerning potential future land that could be developed for housing.

The role of the SHLAA is to identify land potentially available for development but not to make detailed judgments about its feasibility or whether it should be allocated for development. Equally, the Central Lincolnshire WCS is not in a position to discount any sites that have been included in the SHLAA. Consequently at a stakeholder meeting held as part of the WCS process it was concluded that the WCS should consider all of the sites included in the City of Lincoln and North Kesteven SHLAA so as to avoid potentially under-estimating water infrastructure requirements in any part of the LPA or wider North Kesteven area.

The Gainsborough (West Lindsey) Growth Point Programme of Development 2008-2026 (October 2008) was considered to be more accurate than the data contained in the West Lindsey SHLAA (March 2008) and has therefore been used by this study.

The Programme of Development does not specify levels of growth for specific areas other than Gainsborough and Market Rasen. Rather it provides numbers of houses that will be achieved across the rural area. West Lindsey DC advised that the most appropriate means of identifying villages that would be affected by future growth would be to base it on historical trends. Consequently average rates of development over the last five years were used to distribute the levels of development forecast in the Growth Point Programme of Development across the villages within West Lindsey (Appendix B).

2.5 Levels of Growth

In order to obtain development figures for the purposes of this WCS study a number of assumptions concerning future development have been made;

- The phasing of development has been tied in with the water company funding cycle, or Asset Management Periods (AMP). These are the four years 2006 to 2010 (AMP4), five years 2010 to 2015 (AMP5), five years 2015 to 2020 (AMP6) and six years 2020-2026 (AMP7 plus one year of AMP8).
- The housing figures contained in the SHLAA time periods have been averaged and taken as indicative of potential development to phase development with the AMP cycle.
- The phasing of development on the SUEs has been informed by the City of Lincoln Council.

Outside the LPA there are sites to potentially deliver 2,357 houses within West Lindsey, 9,362 in North Kesteven and in terms of maximum, medium and minimum numbers for the LPA there are 42,103, 40,523 and 37,033 for respectively. This indicates that the Regional Plan targets of 25,170 and 19,800 for the LPA should be achievable. It is equally apparent that consideration of the SHLAA data vastly exceeds the development targets of the Regional Plan. In light of having to consider all of the SHLAA sites it has not been possible to define a strategy to sustainably serve the sites, particularly when many will not get developed. The WCS has therefore endeavoured to identify sustainability of areas of the HMA in terms of the water cycle.

Tables 2.3 to 2.5 and Figures 2.3 and 2.4 present the housing data that has been considered by the WCS.

Table 2.3: Growth in the Lincoln Policy Area

SHLAA Map Ref	Area	AMP4	AMP5	AMP6	AMP7	Total
		2006-2010	2010-2015	2015-2020	2020-2026	
Inside the Principal Urban Area						
1	Lincoln	8	13	0	0	21
2		74	119	142	194	530
3		137	484	460	62	1,143
4		74	113	4	0	190
5		135	207	8	0	350
6		29	169	190	1	389
7		46	199	296	150	691
8		0	77	115	0	192
9		276	629	541	329	1,776
10		26	600	1,410	853	2,889
11		7	11	0	0	18
12		54	87	75	100	317
13		1	31	216	258	506
14		45	120	78	0	243
15		15	70	90	28	203
16		39	66	21	13	139
17		4	33	39	0	76
14	North Kesteven	0	0	319	479	798
21		3	22	45	28	98
20		6	25	27	6	64
24		21	70	57	0	148
33		18	42	542	776	1,378
29		41	103	109	71	324
40		0	0	8	11	19
27		1	89	201	104	395
36		0	23	321	430	774
31		0	75	144	48	267
41		3	109	200	65	377
Outside the Principal Urban Area						
West Lindsey Villages	Bardney	86	122	78	46	333
	Burton Waters	69	89	70	54	281
	Cherry Willingham	212	178	139	107	637
	Dunholme	20	41	36	31	128
	Faldingworth	6	24	24	23	77
	Fiskerton	8	8	8	8	32
	Hawthorn Avenue	46	22	23	23	114
	Ingham	9	9	9	8	34
	Langworth	4	12	5	0	21
	Nettleham	8	12	10	8	37
	Saxilby	27	50	44	38	160
	Sudbrooke	4	11	9	8	33
Welton	18	27	25	23	93	
North Kesteven Villages*						
56	Bassingham	18	149	182	0	349
17	Branston	48	71	163	245	527
54	Coleby	0	0	14	20	34
44	Dunston	2	2	10	15	29
11	Heighington	5	7	36	53	101
49 & 50	Metheringham	11	294	417	0	722
2 & 4	Skellingthorpe	16	555	964	251	1,786
5 & 6	Washingborough	8	13	190	285	496
43	Withan St Hughes	62	414	496	24	996
37	Nocton	80	0	0	0	80

*AWS indicated that areas of less than 50 houses are not considered to be significant and have therefore not been included.

Figure 2.3: Location of Potential Development within the Lincoln Policy Area

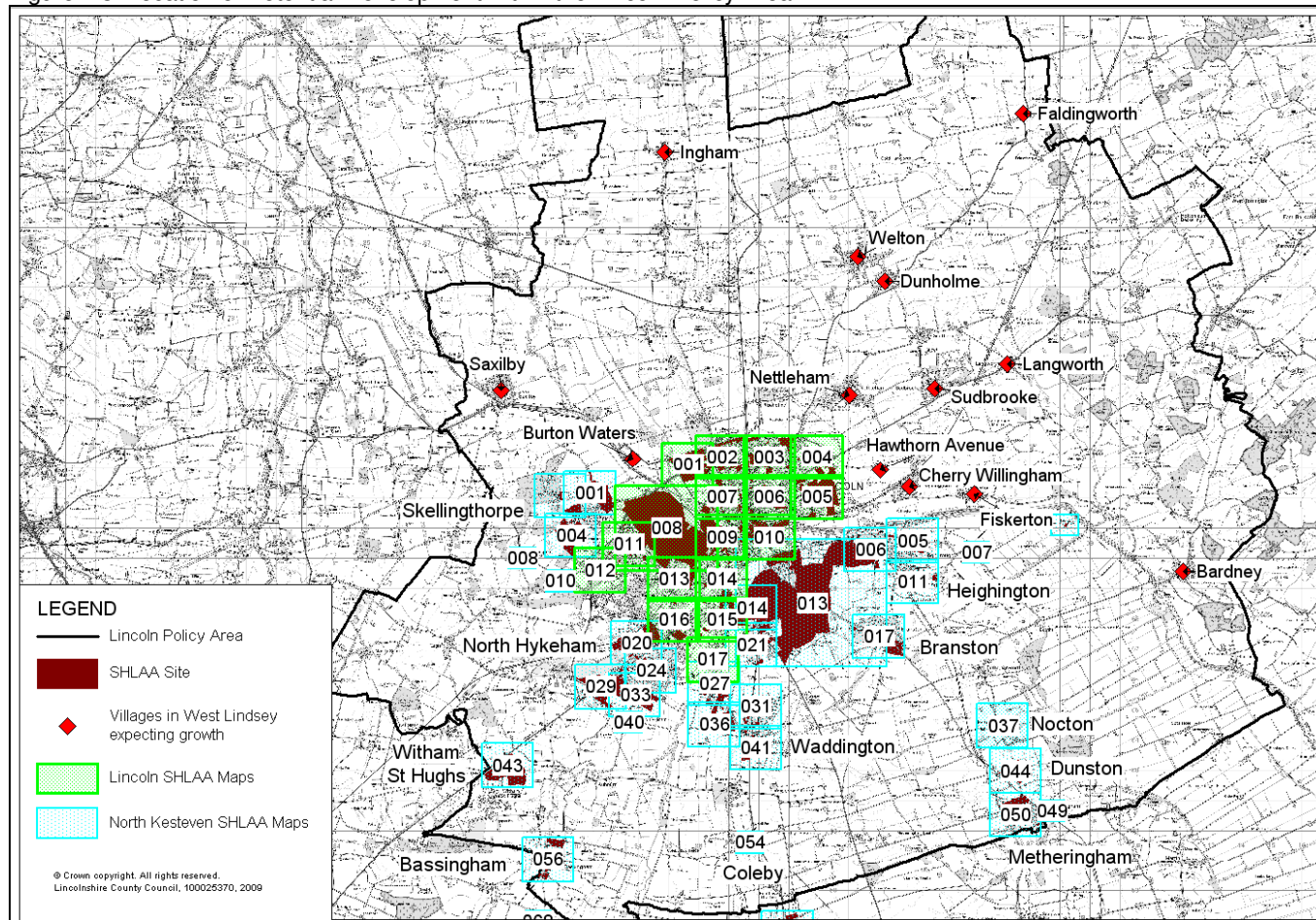


Table 2.4: Significant Growth in West Lindsey outside the Lincoln Policy Area*

Village	AMP4	AMP5	AMP6	AMP7	Total
	2006-2010	2010-2015	2015-2020	2020-2026	
Market Rasen	241	535	436	123	1,335
Middle Rasen	19	23	19	15	76
Caistor	64	160	85	31	340

*excludes Gainsborough which is the subject of a separate WCS

Table 2.4 only presents data for three villages; Market Rasen, Middle Rasen and Caistor. These three have been singled out for review by this WCS since they represent the only locations where significant growth is expected. Appendix B sets out the potential growth anticipated across all of the villages in West Lindsey, both within and outside the LPA, however it was concluded that on account of most of the growth comprising windfall development it did not warrant review as part of the WCS. The study has therefore focused upon Caistor and Market Rasen where significant growth is expected, Middle Rasen has been included on account of its close proximity to Market Rasen and water infrastructure asset linkages.

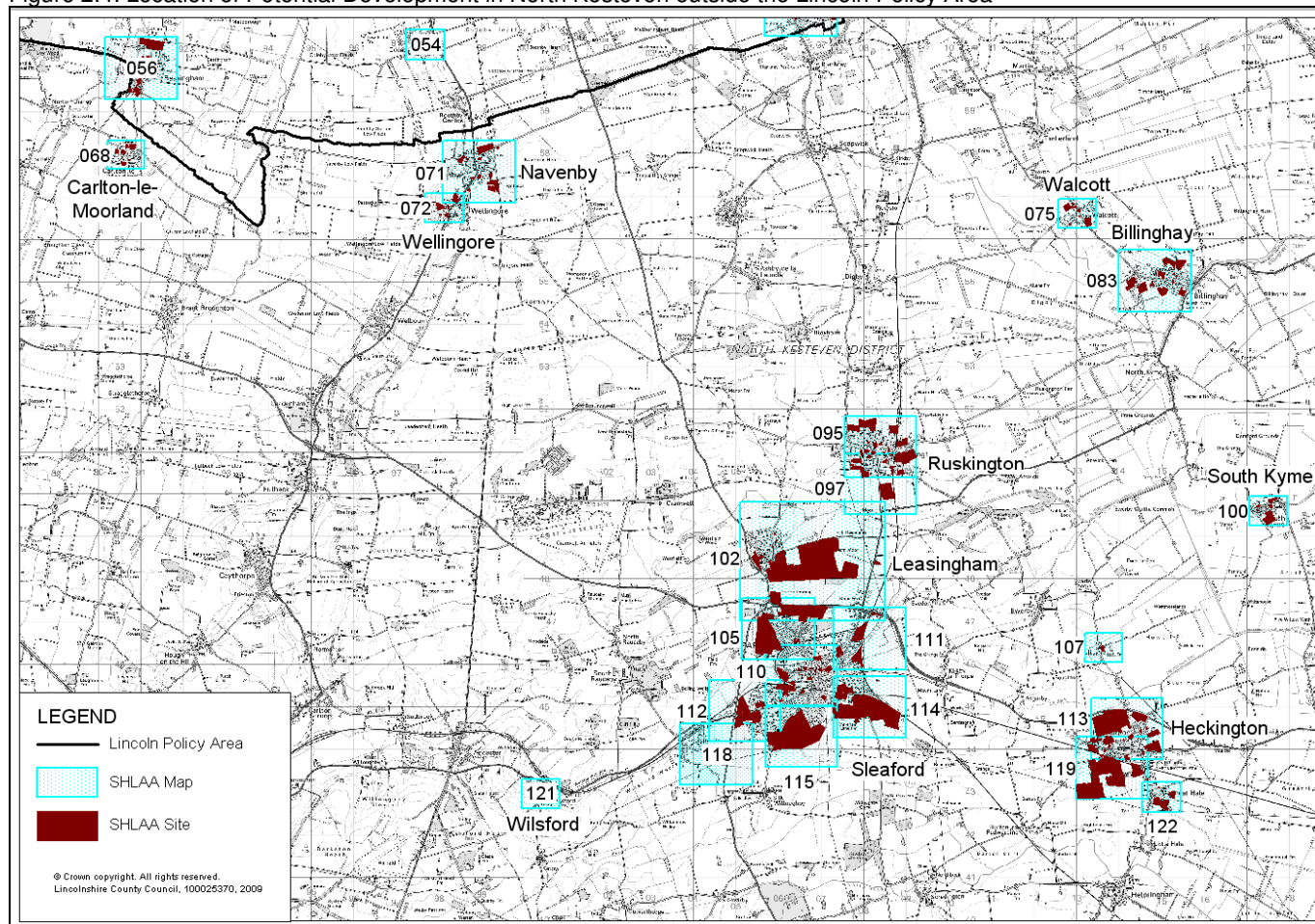
Equally, the villages in West Lindsey listed in Table 2.3 for the LPA is not a complete list (see Appendix B) rather just those villages that could expect significant development.

Table 2.5: Growth in North Kesteven outside the Lincoln Policy Area

SHLAA Map Ref	Village	AMP4	AMP5	AMP6	AMP7	Total
		2006-2010	2010-2015	2015-2020	2020-2026	
68	Carlton-le-Moorland	15	15	16	23	69
71	Navenby	41	41	86	128	296
72	Wellingore	28	27	22	34	111
75	Walcott	2	1	54	81	138
83	Billingham	109	108	90	134	441
95	Ruskington	185	325	249	58	817
102	Leasingham	4	3	306	460	773
105	Sleaford	22	21	463	695	1201
110	Sleaford	49	48	106	158	361
111	Sleaford	0	6	195	278	479
112	Sleaford	2	2	64	95	163
114	Sleaford	5	4	530	796	1335
115	Sleaford	1	0	482	722	1205
113	Heckington	62	61	162	242	527
118	Rauceby	125	125	0	0	250
119	Heckington	4	3	310	466	783
121	Wilsford	79	79	0	0	158

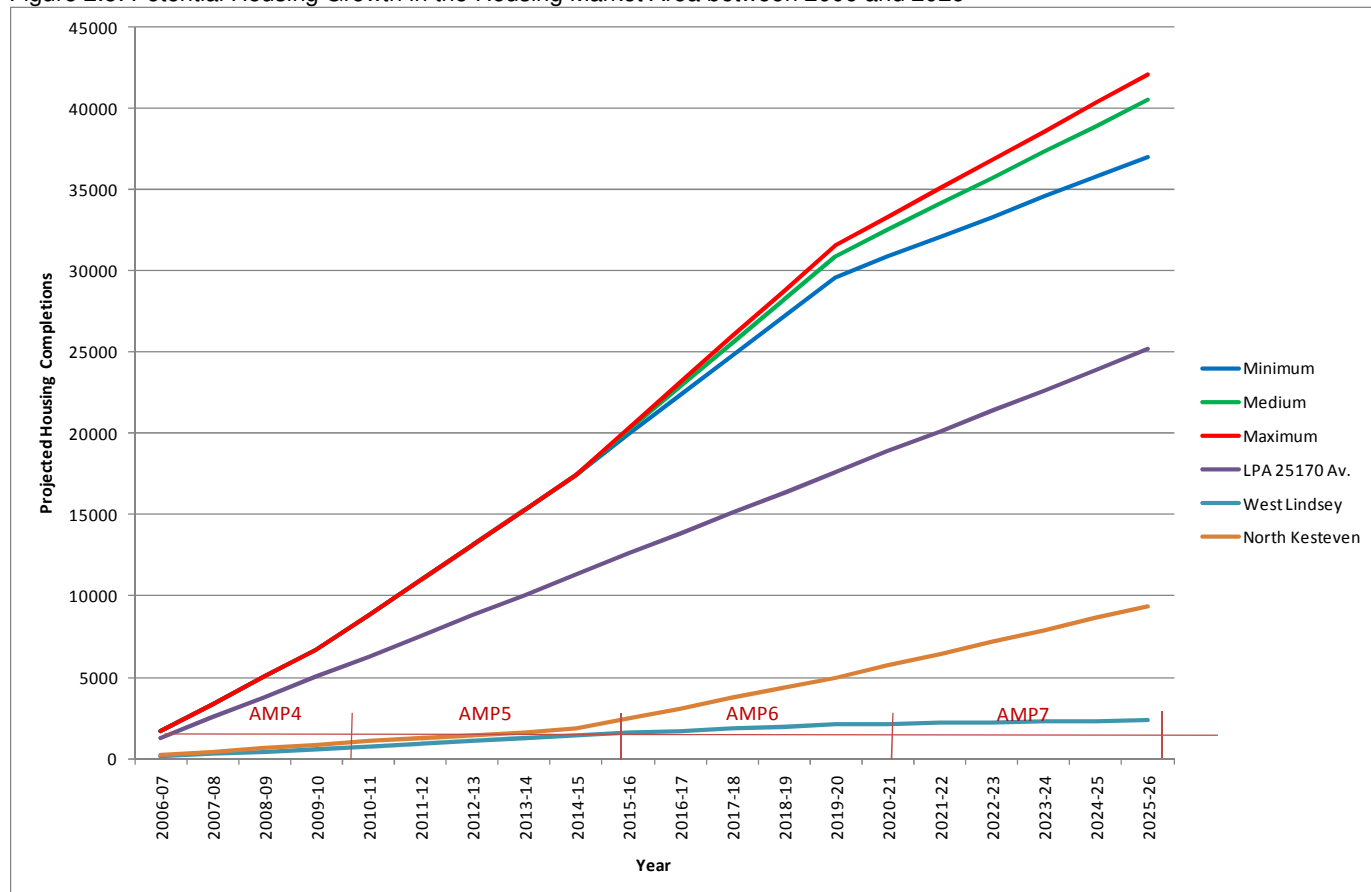
A more comprehensive table of potential development for North Kesteven is included in Appendix B, Table 2.5 presents those areas where more than 50 houses could be built. AWS indicated that developments of less than 50 houses are not considered to be significant in terms of their water infrastructure.

Figure 2.4: Location of Potential Development in North Kesteven outside the Lincoln Policy Area



Given that using the SHLAA data for the City of Lincoln and North Kesteven identifies significantly more houses than are actually required it has been appropriate for the WCS to review the SHLAA sites in terms of which are sustainable in terms of water infrastructure rather than defining a strategy for delivering 25,170 specific houses. Figure 2.5 graphically presents the phasing of development.

Figure 2.5: Potential Housing Growth in the Housing Market Area between 2006 and 2026



2.6 Employment Land

The provision of employment land and facilities also plays a factor in development and as such it is appropriate for a WCS to give due consideration to future employment land.

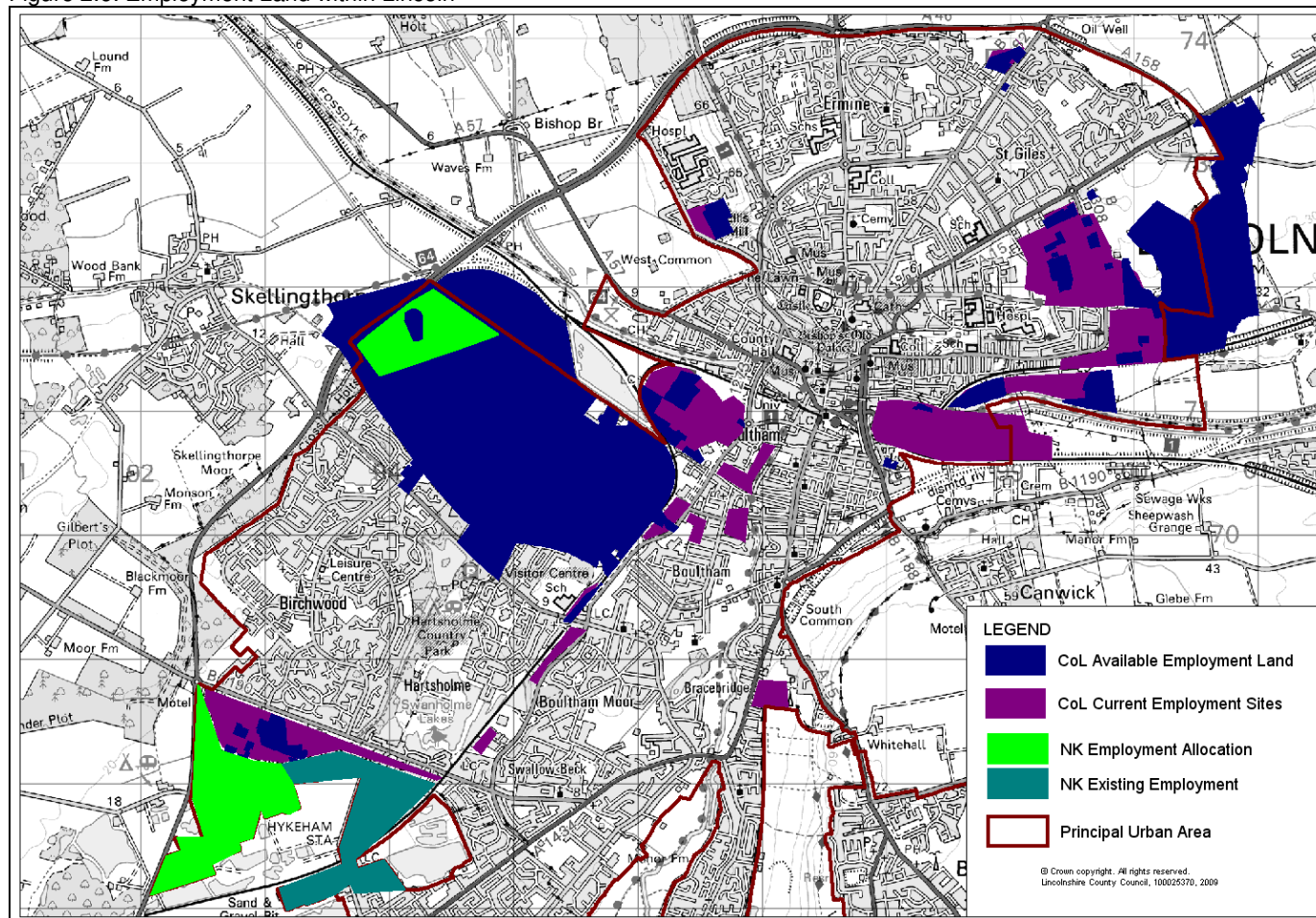
2.6.1 Lincoln

The City of Lincoln Employment Land Review (2009) identified that there are 60.97 hectares of potential employment land comprising 35 sites within Lincoln, although almost 40 hectares is not readily available for development. Of the 20 hectares that is available most is tied to developer or development proposals.

The Employment Land Review highlights that in a worst case scenario 33.29 hectares (15 sites) could be constrained and unavailable for use but adopts a more optimistic estimate that 16.42 hectares will be lost leaving 44.55 hectares, which includes 11 hectares on the WGC which could be considered to be at risk of not being developed.

Figure 2.6 presents the potential employment sites in Lincoln as well as the existing main employment areas.

Figure 2.6: Employment Land within Lincoln



Of the potentially available sites the majority fall within existing employment areas and / or sites that have been included in the SHLAA e.g. WGC & NEQ. However there is no available information concerning the type of employment. Given that there is no specific data concerning employment the assumption was made that none of the employment land would be used by industries which are water intensive and concluded that these sites do not need further consideration.

2.6.2 North Kesteven

The Local Plan for North Kesteven proposes that employment will be concentrated in Sleaford and North Hykeham, and the 'service villages'. The sites within Sleaford fall within SHLAA map 111 and have been factored into the WCS assessment. Where possible, employment allocations have been designated on land that has previously been developed. In releasing land for employment development, the Council look to give priority to brownfield sites over greenfield locations. Probably the most significant employment site coming forward at the present time is Teal Park in North Hykeham (E1-NHK5). Teal Park has been accounted for by the WCS however given that detailed information is not available concerning the other sites, as was the case in Lincoln, it has been assumed that the employment would not be water intensive and they have not been considered further.

Should any water intensive industry establish within the Central Lincolnshire HMA it may be appropriate to re-visit the WCS. Non-intensive water industry located to the south of the River Witham / Fosdyke Canal ought to be able to be accommodated within existing capacities, industry to the north could encounter difficulties as outlined in Section 4 with regard to development of SHLAA sites.

2.7 Potential for Change

Throughout the Outline and Detailed phases of the Central Lincolnshire WCS, future development has presented one of the areas of greatest uncertainty; the study has had to consider a vast number of SHLAA sites that may never get developed. Additionally the creation of a Joint Planning Unit for the Housing Market Area may lead to changes in housing data that has been

used in this study. These factors are further complicated by the current economic climate causing development uncertainty and unpredictable growth rates, and uncertainty associated with not knowing which SHLAA sites may come forward or when this may happen. As a consequence the overall strategy needs to be both flexible and robust to change.

As such it will be necessary to review this WCS on a regular basis to establish if there have been any significant changes to the housing data that will affect the conclusions of this study.

Future Action 2.1 – Continual review of the Strategy in light of known development and significant changes to the forecast growth trajectory.

Water Resources & Supply



3 Water Resources & Supply

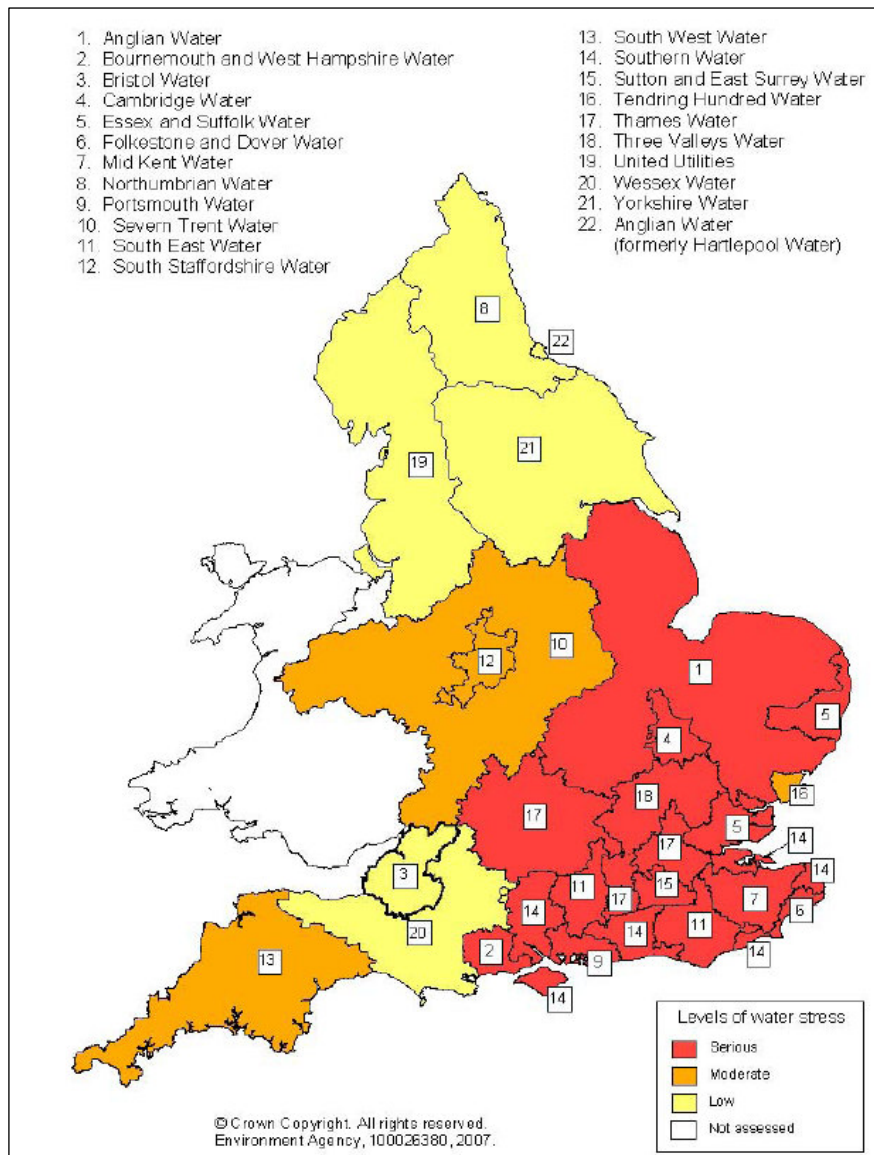
3.1 Introduction

Future development would be significantly constrained if there was insufficient water available to support the levels of growth and / or if the water could not be supplied to the areas accommodating new development. The following section is concerned with the current status of water resources, and the ability to supply potable (drinking) water.

3.2 Water Resources & the Environment Agency

The Environment Agency's assessment of relative water stress for England and Wales is illustrated in Figure 3.1. The LPA and wider Central Lincolnshire HMA fall within region 1 on Figure 3.1, which is served by Anglian Water Services (AWS), and indicates that the study area lies within a region where water resources are under serious stress. The effects of climate change are likely to increase the pressure on existing water resources.

Figure 3.1: Areas of Relative Water



The Environment Agency manages water resources at a local level through Catchment Abstraction Management Strategies (CAMS). Within the CAMS, the Environment Agency's assessment of the availability of water resources is based on a classification system which states the perceived resource availability status, indicating:

- The relative balance between the environmental requirements for water and how much is licensed for abstraction;
- Whether water is available for further abstraction;
- Areas where abstraction needs to be reduced.

The categories of resource availability status are shown in Table 3.1 below. The classification is based on an assessment of a river system's ecological sensitivity to abstraction-related flow reduction.

Table 3.1: CAMS resource availability status categories

Indicative Resource Availability Status	Licence Availability
Water available	Water is likely to be available at all flows including low flows. Restrictions may apply.
No water available	No water is available for further licensing at low flows. Water may be available at high flows with appropriate restrictions.
Over-licensed	Current actual abstraction is such that no water is available at low flows. If existing licences were used to their full allocation they could cause unacceptable environmental damage at low flows. Water may be available at high flows with appropriate restrictions.
Over-abstracted	Existing abstraction is causing unacceptable damage to the environment at low flows. Water may still be available at high flows with appropriate restrictions.

This classification can be used to help assess the potential for additional water resource abstraction opportunities. The LPA and wider area of North Kesteven fall within the Witham CAMS which classifies the region as having 'no water available'.

The resource assessment undertaken by the Environment Agency as part of the CAMS process showed that the Lower Witham between Bardney and Boston had a resource availability status of 'no water available'. Upstream of Bardney, the majority of the river reaches, including those around Lincoln were classed as 'water available'. However, any excess resources in these upstream reaches are needed to provide additional flow support to the lower reach. Therefore the status of 'no water available' must also be applied to the upper reaches.

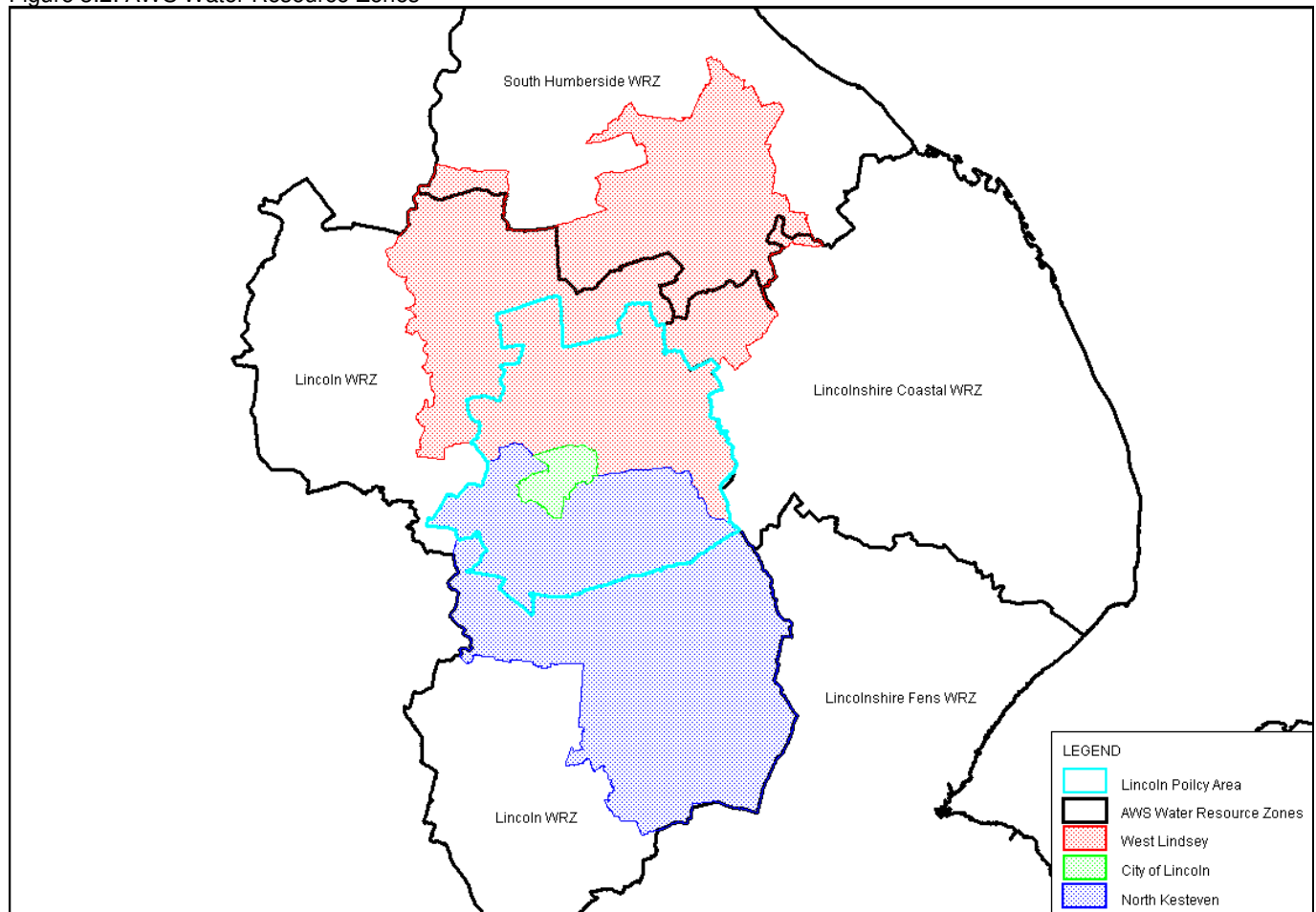
Parts of West Lindsey, outside the LPA, fall within the Grimsby, Ancholme and Louth CAMS which classifies the River Ancholme as having 'water available' although upstream of Toft Newton the system is classified as 'over-licensed'. The water available status of the River Ancholme is in part a result of the Trent-Witham-Ancholme transfer scheme which transfers water from the River Trent to the Fosdyke Canal where it flows into the River Witham before being abstracted again near Short Ferry and pumped to Toft Newton where it flows into the River Ancholme.

3.3 Water Resources & Anglian Water Services

The LPA and all of West Lindsey and North Kesteven fall entirely into the area of supply of AWS who are responsible for the operation and maintenance of the potable water supply system.

AWS has divided its region into Water Resource Zones (WRZ). The Lincoln WRZ covers the entire LPA and all of North Kesteven (Figure 3.2) utilising groundwater resources from the Sherwood Sandstone aquifer to the west of Lincoln and local sources in the Lincolnshire Limestone aquifer to provide water to the public. Water is also imported to the WRZ from the north. The majority of West Lindsey falls within the Lincoln WRZ, although the north east is also covered by the South Humberside WRZ and Lincolnshire Coastal WRZ (Figure 3.2).

Figure 3.2: AWS Water Resource Zones



The Environment Agency's Midlands region has expressed concern that the Sherwood Sandstone aquifer is over licensed. AWS carried out investigations into the impact of abstractions in collaboration with Severn Trent Water and the current position is that no substantial reductions are required. The Environment Agency has also expressed concern at the impact of abstractions from the Lincolnshire Limestone on low flows in rivers and streams, notably at Sleaford and at Welton, although no work has been required to date. It is noted that the National Rivers Authority implemented a borehole upstream of Sleaford purposefully to put water into the River Slea during low flows.

AWS have a statutory duty to produce a Water Resources Management Plan (WRMP) every five years. The purpose of the WRMP is to describe how AWS will manage the supply-demand balance. This will be achieved by a twin-track approach; through investment in the assets that abstract, store, treat and distribute water supplies and through effective management of the demand for water. In view of the significant lead times needed to plan, develop and deploy new water resources, the WRMP looks 25 years ahead to ensure that AWS can meet customer needs.

The basis for the WRMP is the analysis of the balance between supplies and forecast demands for domestic and industrial use. AWS' forecasting model, FORWARD (FORecasting of Water Resources and Demand), compares the difference between supplies and demand as available headroom and selects an optimal solution to maintain secure supplies throughout the planning period. FORWARD produces the following baseline outputs:

- Domestic consumption forecast
- Commercial consumption forecast
- Leakage forecast
- Supply forecast
- Target headroom

The model is used to determine a baseline forecast that assumes no additional investment in options to reduce demand or increase supply beyond the existing base level of activity. Where the baseline forecast identifies Planning Zones with current or emerging supply deficits, the FORWARD programme runs an economic optimisation routine to find the most cost-effective solution available.

The following sections entitled 'Household Population and Occupancy' and 'Planning Allowance' have been provided by AWS.

3.3.1 Household Population and Occupancy

One of the primary drivers of household consumption is occupancy rate, so it is an important factor in understanding past trends and forecasting future trends in demand.

1. Our forecast of domestic population, occupancy, and the number of billed properties is based on the latest forecasts from the Office of National Statistics (ONS) and the Department for Communities and Local Government (DCLG), modified in the early years of the AMP5 period in respect of our current view of the effects of the current situation in the housing market.
2. The start point of our forecast is 2004. Using an apportionment of census data for the districts which we serve (in whole or in part) we derived a new estimate of the water population in our region for that year.
3. The forecasts are based on population forecasts (a) from the Office of National Statistics and property forecasts (b) from the Department of Communities and Local Government. All occupancy data (c) is derived from these two sources. Therefore $a/b=c$, and no further reconciliation is required.
4. By way of a cross-check we commissioned work from Experian Business Strategies who, inter alia, prepared a forecast of population and properties using Regional Spatial Strategy (RSS) material. The results from this RSS 'policy-driven' approach were very similar to the trend-based 'statistical approach' that we used, drawing on the ONS and DCLG published sources.

However, occupancy is not a value that can be observed, and there will be localised variations in occupancy across our region. Where this means that localised variations do not align with the overall picture provided by the method above, it should be recognised that such variations are likely to balance out across Water Resource Planning Zones. In addition, should any variation be due to a higher occupancy rate than forecast, this is taken into account by a planning allowance, or target headroom.

3.3.2 Planning Allowance

An important factor in defining the potential deficit in the availability of water supplies to meet forecast demand is the need for a planning allowance, or target headroom, to address the risks and uncertainties in our calculation of the supply-demand balance. Using the industry standard methodology we require a margin of 5 per cent to maintain the security of supplies in the current year and have allowed for an increase to 15 per cent during the planning period. The extent to which headroom has been used to address an imbalance of water available for use against our demand forecast is reviewed and reset every five years for a new WRMP.

The main drivers for headroom are the uncertainties over population growth and the level of water consumption by domestic customers. Our demand forecast assumes that the population served will increase by up to 18 per cent or some 850,000 people between 2010 and 2035 (across the region served by AWS). We have also assumed a decline in measured water consumption by 2030. This recognises Government expectations as outlined in its recent strategy 'Future Water'. We plan to continue to promote water efficiency initiatives, but equally water savings are achieved through customer behaviour and effective regulation, particularly for the construction of water-efficient new homes. A further incentive is the uncertainty associated with the impact of climate change on water resources.

3.4 Water Resources Status

3.4.1 LPA

The Lincoln WRZ as a whole is forecast to have a deficit of available against target headroom from early in the planning period. (Headroom is added onto estimates of water demand to allow for uncertainties and risks). The WRZ is further broken down into Planning Zones (PZ). The LPA falls across four different PZs; PZ09, PZ14, PZ16 and PZ17 as illustrated in Figure 3.3. Work undertaken by AWS shows that two of the four of PZs covering the LPA are projected to have deficits in headroom by 2036-37 (Table 3.2).

Figure 3.3: AWS Planning Zones

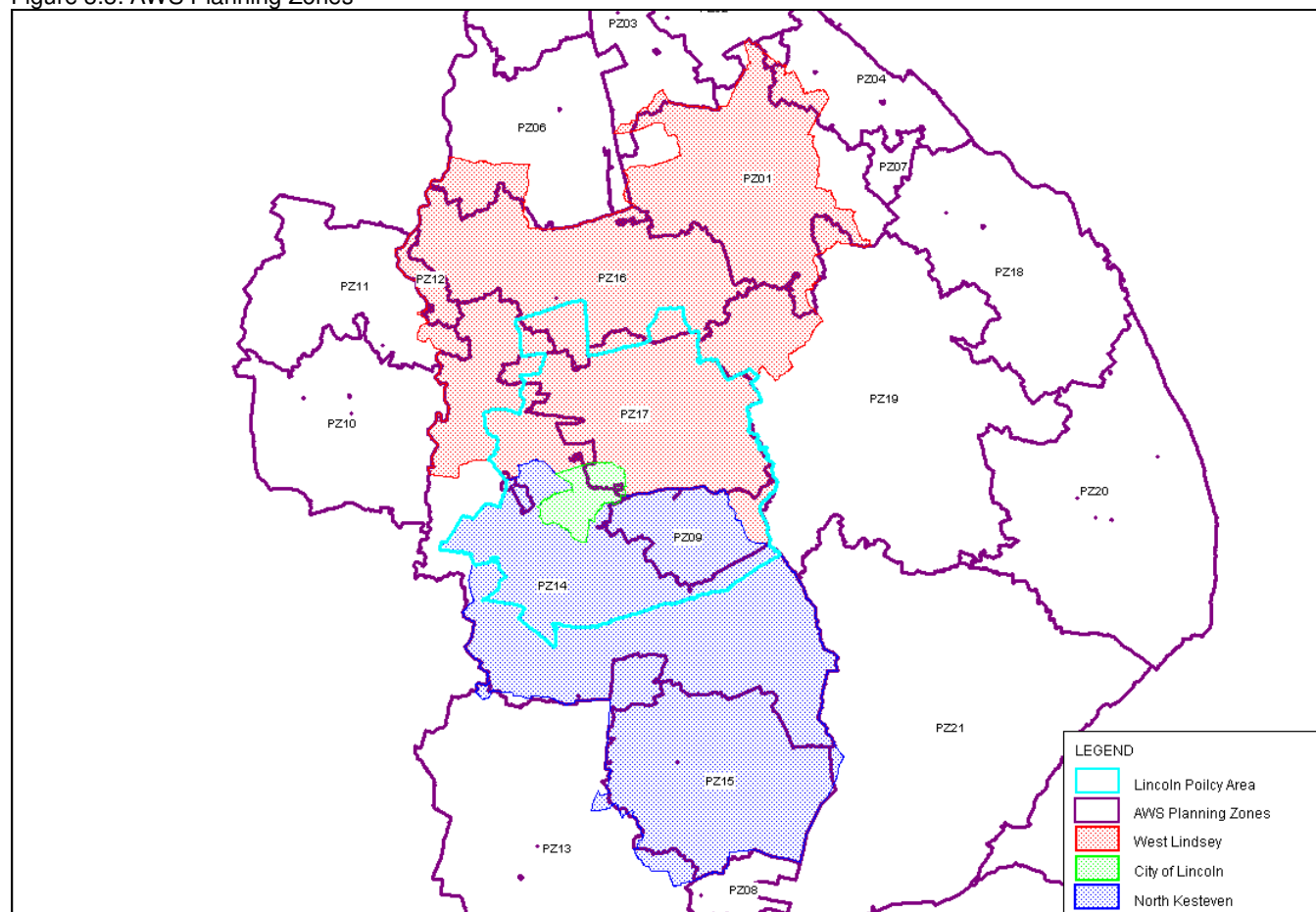


Table 3.2: Forecast deficit in Water Resources across the LPA

Planning Zone		Forecast Deficit in 2035	
		Average (Ml/d)	Peak (Ml/d)
09	Branston	-0.84	-0.12
14	Lincoln	-17.42	-20.53

To overcome these forecast deficits AWS have proposed a number of solutions to ensure that water supplies to these PZs do not fall short. The selected schemes for the two PZs in deficit are summarised in Table 3.3 along with the Asset Management Period (AMP) in which they would be implemented.

Table 3.3: Selected Water Resources Schemes

PZ		Selected option	Period
09	Branston	Active leakage control	AMP9
		Intra WRZ transfers	AMP5-8
		Enhanced metering	AMP5
14	Lincoln	Active leakage control	AMP5
		Pressure reduction	AMP5
		Enhanced metering	AMP5
		New Lincoln WTW	AMP5

A new Water Treatment Works (WTW) is required during AMP5 (2010-15) to supply the Lincoln PZ with a 20 MI/d plant which will also be used for transfer to other PZs including Branston. AWS consider that a new abstraction would be sustained by the import of water to the River Trent catchment from the River Severn catchment. After use and treatment, water would be returned to the River Witham catchment for potential re-use by abstraction downstream.

Future Action 3.1 – AWS to implement New Lincoln WTW in AMP5.

As well as increasing the volume of water supplied to Lincoln City, AWS also intend to manage the demand for water through leakage control, household metering and the promotion of water efficiency, particularly with large industrial customers, although significant savings have already been made.

3.4.2 West Lindsey

Tables 3.4 and 3.5 set out the PZ's covering the additional area of West Lindsey (covered by this WCS), their forecast deficits and the selected options by which to overcome the deficits.

Table 3.4: Forecast deficit in Water Resources in West Lindsey

Planning Zone		Forecast Deficit in 2036-37	
		Average (MI/d)	Peak (MI/d)
04	Grimsby	-59.06	-77.81
06	Scunthorpe South	-0.13	-0.99
19	Louth	-3.23	-5.00

Table 3.5: Selected Water Resources Schemes

PZ	Selected option	Period
Grimsby	Active leakage control	AMP5
	Enhanced metering	AMP5
	Elsham Non-Potable Extension Phase 1	AMP5
	Elsham Non-Potable Extension Phase 2	AMP6
	Pyewipe wastewater re-use	AMP6+
	Humber South Bank Desalination	AMP6+
	Intra WRZ transfers	AMP5
Scunthorpe South	Additional metering	AMP5
	Active leakage control	AMP5
	Water efficiency measures	AMP5
	Intra WRZ transfers	AMP5
Louth	Pressure reduction	AMP5
	Enhanced metering	AMP5
	Intra WRZ transfers	AMP5

Future Action 3.2 – AWS to control leakage, enhance metering and transfer water between WRZ.

3.4.3 North Kesteven

The additional area of North Kesteven is covered by PZs 13, 14, 15 and 21. Tables 3.6 and 3.7 set out those with a forecast deficit and the selected options by which to overcome the deficits.

Table 3.6: Forecast deficit in Water Resources in North Kesteven

Planning Zone		Forecast Deficit in 2036-36	
		Average (MI/d)	Peak (MI/d)
14	Lincoln	-17.42	-20.53
15	Sleaford	-0.78	1.34

Table 3.7: Selected Water Resources Schemes

PZ	Selected option	Period
Lincoln	Active leakage control	AMP5
	Pressure reduction	AMP5
	Enhanced metering	AMP5
	New Lincoln WTW	AMP5
Sleaford	Pressure reduction	AMP8
	Enhanced metering	AMP5
	Intra WRZ transfer	AMP8

The new Lincoln WTW would be used to transfer water supplies to the Sleaford PZ.

3.4.4 Conclusions

AWS have advised that the work they have undertaken as part of the WRMP has accounted for the levels of growth expected across the Housing Market Area being considered by the WCS, and as can be seen from the tables above they have a strategy to manage demand and supply so as to overcome the forecast shortfalls that would otherwise arise by 2035. Table 3.8 presents a RAG summary of the status of Water Resources.

Table 3.8: Water Resources RAG Status

Region	RAG Status
Lincoln Policy Area	AMBER
West Lindsey	AMBER
North Kesteven	AMBER

The RAG status is equivalent to Red Amber Green, where Red would indicate that there is insufficient capacity to accommodate development and further investment is not economically viable, Amber indicates that investment is required to accommodate development however there are no insurmountable obstacles and Green indicates that there is sufficient capacity within the existing infrastructure to accommodate the development without further investment. Therefore in the case of the study area whilst the proposed development cannot be accommodated by the existing water resources, with investment the demand for water can be met.

3.5 Water Supply

Having established that AWS have identified means of ensuring sufficient water resources, there is the issue of whether the existing water supply network can accommodate the increased flows to the potential development areas. AWS have provided a review of their water supply network for the potential development using a RAG classification, where;

- **RED** – there are funding, planning or environmental constraints identified to providing the infrastructure necessary to meet the proposed development.
- **AMBER** – there are funding, planning or environmental constraints identified to providing the infrastructure necessary to meet the proposed development, but measures have been identified which are sustainable and deliverable.
- **GREEN** – there are no identified funding, planning or environmental constraints to providing the infrastructure necessary to meet the proposed development.

AWS informed the WCS that the water supply networks in the LPA would be able to accommodate additional flows and is Green, although new networks would be required in the case of the NEQ and SEQ so they are Amber since they require investment.

3.5.1 West Lindsey

Considering the district of West Lindsey falling outside the LPA, the only areas where the levels of growth are sufficient to raise a concern are Market Rasen and Caistor. In both cases the existing water supply network has been classified as Amber; the existing network would not be able to accommodate the increased flows however there are no constraints to upgrading the system.

3.5.2 North Kesteven

Table 3.9 presents the RAG status for water supply in North Kesteven.

Table 3.9: North Kesteven Water Supply RAG Status

SHLAA Map No.*	Area	Total New Houses	RAG
71	Navenby	296	GREEN
72	Wellingore	111	GREEN
75	Walcott	138	GREEN
83	Billinghay	441	GREEN
95	Ruskington	817	AMBER
102	Leasingham	773	AMBER
105	Sleaford	1,201	AMBER
110	Sleaford	361	AMBER
111	Sleaford	479	GREEN
112	Sleaford	163	AMBER
113	Heckington	527	GREEN
114	Sleaford	1,335	AMBER
115	Sleaford	1,205	AMBER
118	Rauceby	250	GREEN
119	Heckington	783	GREEN
121	Wilsford	158	GREEN

* AWS advised that it was not necessary to include SHLAA Maps containing less than 100 properties in the review.

3.6 Conclusions

AWS have advised that the work that they have undertaken to produce their WRMP has sufficiently accounted for the levels of growth forecast for the LPA and that the water supply network is capable of accommodating the additional 20MI/d to be provided by the New WTW without the need to improve or upgrade the existing system. In light of the WRMP it is concluded that the future growth of Lincoln will not be constrained by the availability of water resources subject to the approval of the New Lincoln WTW in AMP5 which has been included in AWS' Business Plan.

It is also concluded that water supply ought not to constrain future growth. The existing network may not be capable of accommodating increased flows at present, however upgrades to the networks would not be unfeasible or unsustainable. This is particularly true in Sleaford.

As such the issue of water resources and water supply will not be taken further as part of this Detailed WCS.

3.7 Additional Demand Management

Water is becoming scarcer at the same time as population and demand for water is increasing, therefore the development of practical ways to reduce water demand is very important. The Code for Sustainable Homes aims to reduce the consumption of potable water in the home and for external water uses.

Twenty per cent of the UK's water is used domestically with over 50 per cent of this used for flushing toilets and washing. Most of which comes from drinking quality standard or potable water. The amount of potable water used within the dwelling can be reduced by using fixed fittings which reduce water use in WC's, taps and showers. It is recommended that developers are encouraged to provide water efficiency measures such as these in all new developments.

Future Action 3.3 – Encourage developers to provide water efficiency measures in new homes.

Water is an increasingly scarce resource and more and more homes have metered water supplies with householders having to pay for any water they use. Installing water meters is known to have the effect of reducing demand for water and AWS actively encourage this by metering all new households.

Future Action 3.4 – Ensure all new properties are metered.

Another area where demand for water can be reduced, or managed is for outdoors use, particularly for activities such as watering gardens. We cannot dictate the type of gardens that people have but can try to influence them by ensuring developers provide low maintenance gardens in the first place. This can be done by providing new properties with a system to collect rainwater. The simplest and most cost-effective system for rainwater collection is the water butt. Harvesting rainwater also has the additional benefits of reducing:

- the amount of water being discharged into drains and watercourses,
- the risk of localised flooding, and
- overall water bills for householders.

It is recommended that each new house be able to store runoff from its roof that can be used for external purposes such as cleaning cars and irrigating gardens.

Future Action 3.5 – Implement rainwater harvesting measures wherever appropriate.

Foul Water Sewerage

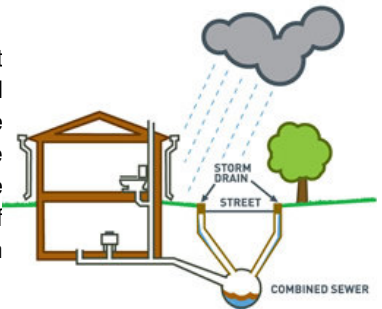


4 Foul Water Sewerage

4.1 Introduction

A significant increase in the number of houses across the study area will result in a significant increase in the volume of foul sewage. In urban areas, surface water (rainwater) and foul sewage were historically drained by a single sewer pipe. This is known as a combined sewer. However more recent developments have installed separate foul and surface water systems. AWS are responsible for the operation and maintenance of the public foul sewerage system. Gainsborough and the surrounding villages in West Lindsey have been separated out into a stand-alone WCS partly because both AWS and Severn Trent Water have foul sewerage infrastructure.

Foul sewerage systems can include both separate foul and combined sewers (which accept foul and surface water flows). Combined sewers are restricted in their extent to central Lincoln (although extensive separate systems are also present). In central Lincoln, where brownfield land served by combined sewers, is re-developed, AWS are seeking to have the foul and surface water flows separated. The removal of the surface water flows from the combined sewers will reduce overloading of the sewer and allow additional foul flows. If developers wish to have new sewers adopted, the drainage systems should be designed in accordance with the latest edition of *Sewers for Adoption*.



AWS have provided a review of their foul / combined sewerage network for the potential development in terms of the RAG classification, where;

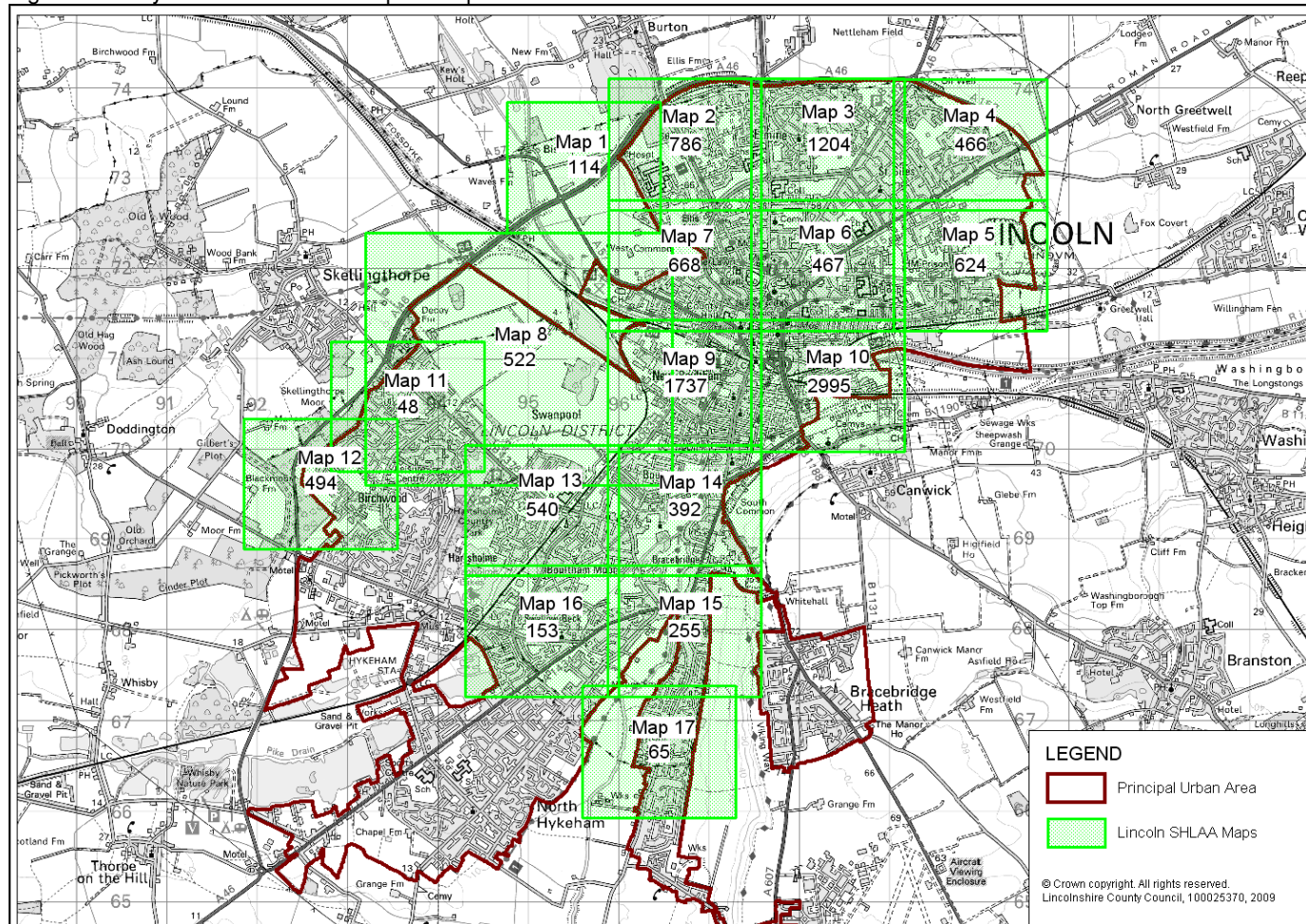
- **RED** - there are funding, planning or environmental constraints identified to providing the infrastructure necessary to meet the proposed development.
- **AMBER** – there are funding, planning or environmental constraints identified to providing the infrastructure necessary to meet the proposed development, but measures have been identified which are sustainable and deliverable.
- **GREEN** - there are no identified funding, planning or environmental constraints to providing the infrastructure necessary to meet the proposed development.

4.2 Sewerage Capacity in the LPA

4.2.1 LPA Draining to Canwick Sewage Treatment Works

AWS have a hydraulic model of the foul and combined sewers that drain to the principal Sewage Treatment Works (STW) serving the City of Lincoln; Canwick. This model has been used to assess the impact of future potential development within the Canwick STW catchment so as to appraise the sustainability of the SUEs and SHLAA sites that were identified in Section 2. In doing so, the development data for Lincoln was grouped together in terms of the SHLAA map reference numbers. Figure 4.1 illustrates the coverage of the SHLAA maps and the total number of properties that were added into the sewer model to represent potential future development.

Figure 4.1: City of Lincoln SHLAA Maps incorporated into Sewer Model



Based upon the results of the modelling exercise the SHLAA maps have been classified using the RAG status as presented in Table 4.1.

Table 4.1: RAG status of SHLAA Maps

SHLAA Map Reference No	RAG Status
NEQ	AMBER
WGC	AMBER
SEQ	AMBER
1	RED
2	RED
3	RED
4	RED
5	RED
6	RED
7	RED
8 [#]	GREEN
9	AMBER
10	RED
11	GREEN
12	GREEN
13	AMBER
14	GREEN*
15	GREEN
16	GREEN

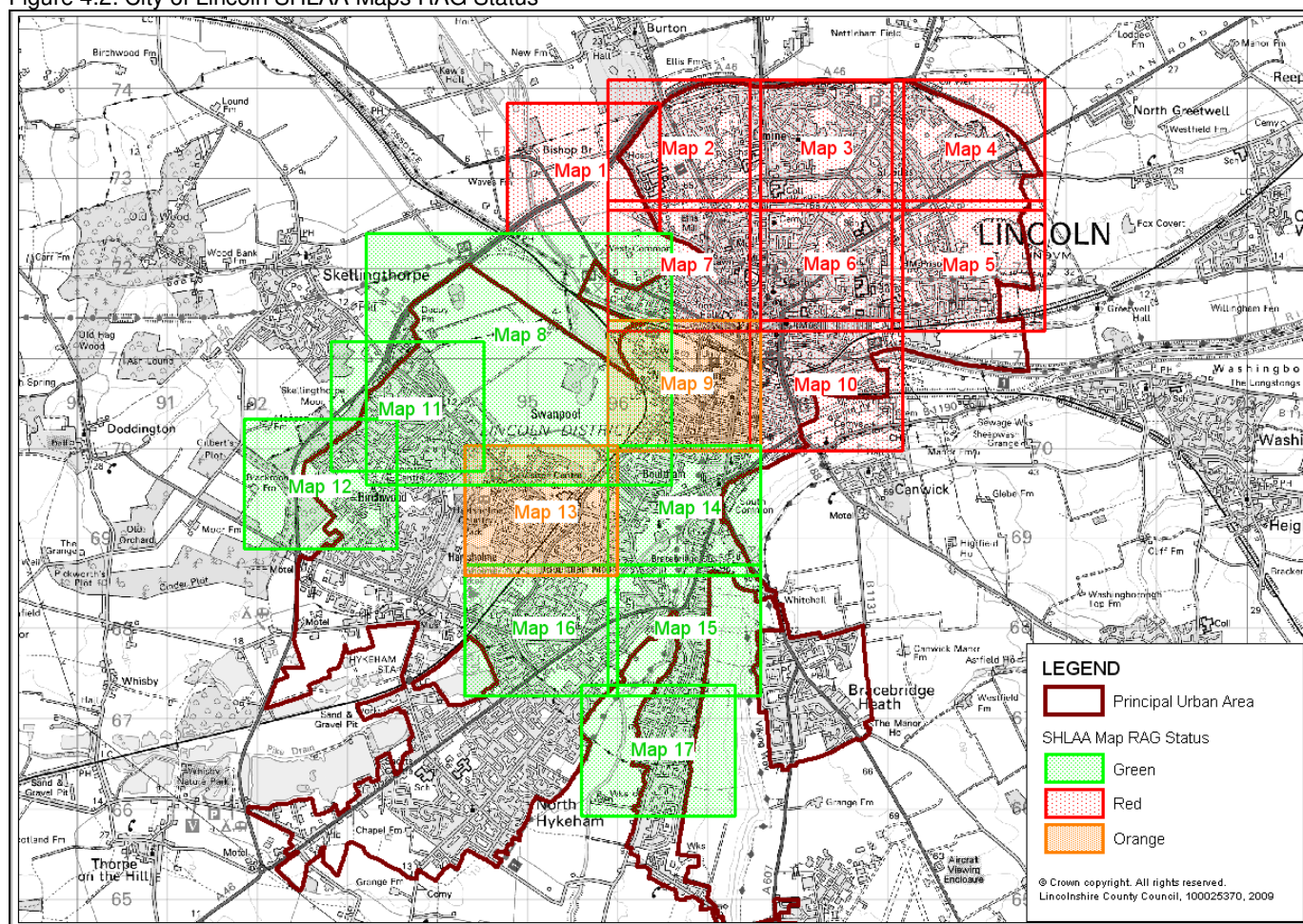
SHLAA Map Reference No	RAG Status
17	GREEN

Relates to SHLAA sites and not the WGC which is in the same area.

* Becomes Amber when the WGC is included in the model.

It is apparent, that all those SHLAA maps north of the River Witham have been classified as being Red (Figure 4.2). The reasoning for this is that the entire area currently comes together at one location; Stamp End, before crossing the River Witham and hence Canwick STW. This single crossing of the river represents a “pinch-point” in the system where there is an existing flood problem. The significance of this flooding issue has been identified by AWS and incorporated in the investment procedure for prioritisation as appropriate. Consequently additional development upstream of Stamp End, which comprises most of North Lincoln, would exacerbate the flood problem and AWS have therefore classified the whole area as Red.

Figure 4.2: City of Lincoln SHLAA Maps RAG Status



It should be noted that the Red foul sewerage status does not mean that no development can occur in North Lincoln. It has been necessary to generalise areas for the purposes of the WCS however not all of map areas 1, 7 and 10 drain via Stamp End. Therefore it will depend on the precise location of the development as to whether or not it will impact upon the Stamp End problem. Sites in SHLAA maps 1, 7 and 10 could be considered as Amber rather than Red although further investigation would be required in conjunction with AWS.

Another aspect that would come into consideration is the existence of combined sewers upstream of Stamp End. If the SHLAA sites fall within an area served by combined sewers hence resulting in regeneration of brownfield land, there is the potential as part of the redevelopment to separate the surface water and foul flows. Removing surface water from the combined sewers would create additional capacity within the system to accept additional foul flows. This would be subject to the capacities of the

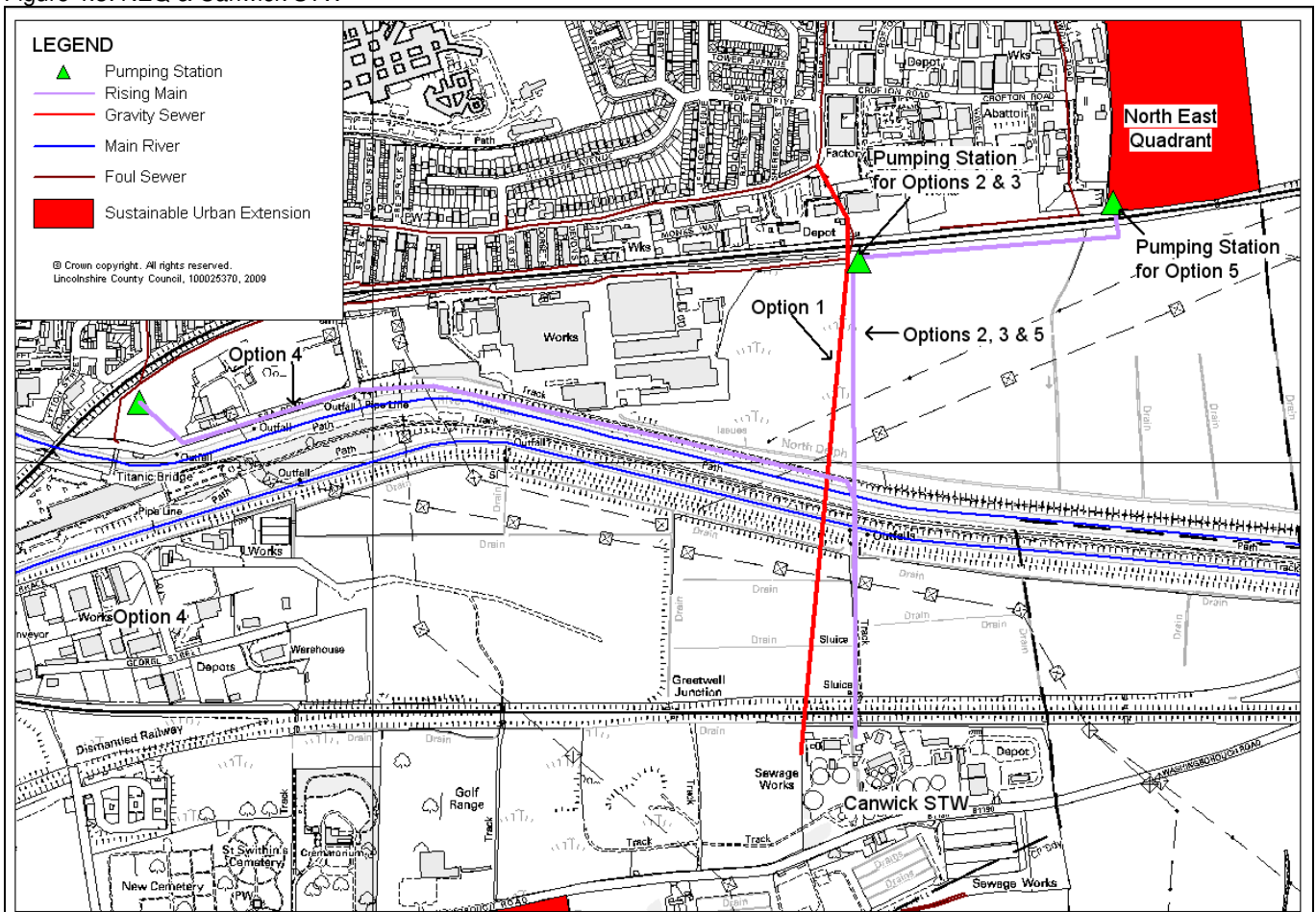
receiving systems and their ability to accept additional surface water flows. Developers would need to fund further investigations to assess this.

Future Action 4.1 – Where development occurs in areas served by combined sewers endeavour to separate the foul and surface water flows as part of the development.

4.2.2 North East Quadrant

The NEQ is located to the North of the River Witham and would therefore also receive a Red RAG status if it were to drain through the Stamp End pinch-point. As part of the WCS, AWS have reviewed a number of engineering options which indicate that the NEQ can be classified as Amber, i.e. with investment the NEQ can be brought forward without exacerbating the existing Stamp End issue. The premise by which the NEQ becomes Amber is that the foul sewage would not drain via Stamp End, but a new, direct connection is provided between the site and Canwick STW (Figure 4.3).

Figure 4.3: NEQ & Canwick STW



Future Action 4.2 – AWS to implement a new direct connection to Canwick STW to serve the NEQ.

AWS have reviewed five options to serve the NEQ that have included the possibility of alleviating the problem at Stamp End. Option 1, a new gravity sewer to Canwick, was discounted due to the engineering practicalities associated with laying a large pipe underneath the River Witham which would need to only be 1m below the river bed. Siltation within the pipe would also be a problem since it would not have a free outfall at Canwick STW.

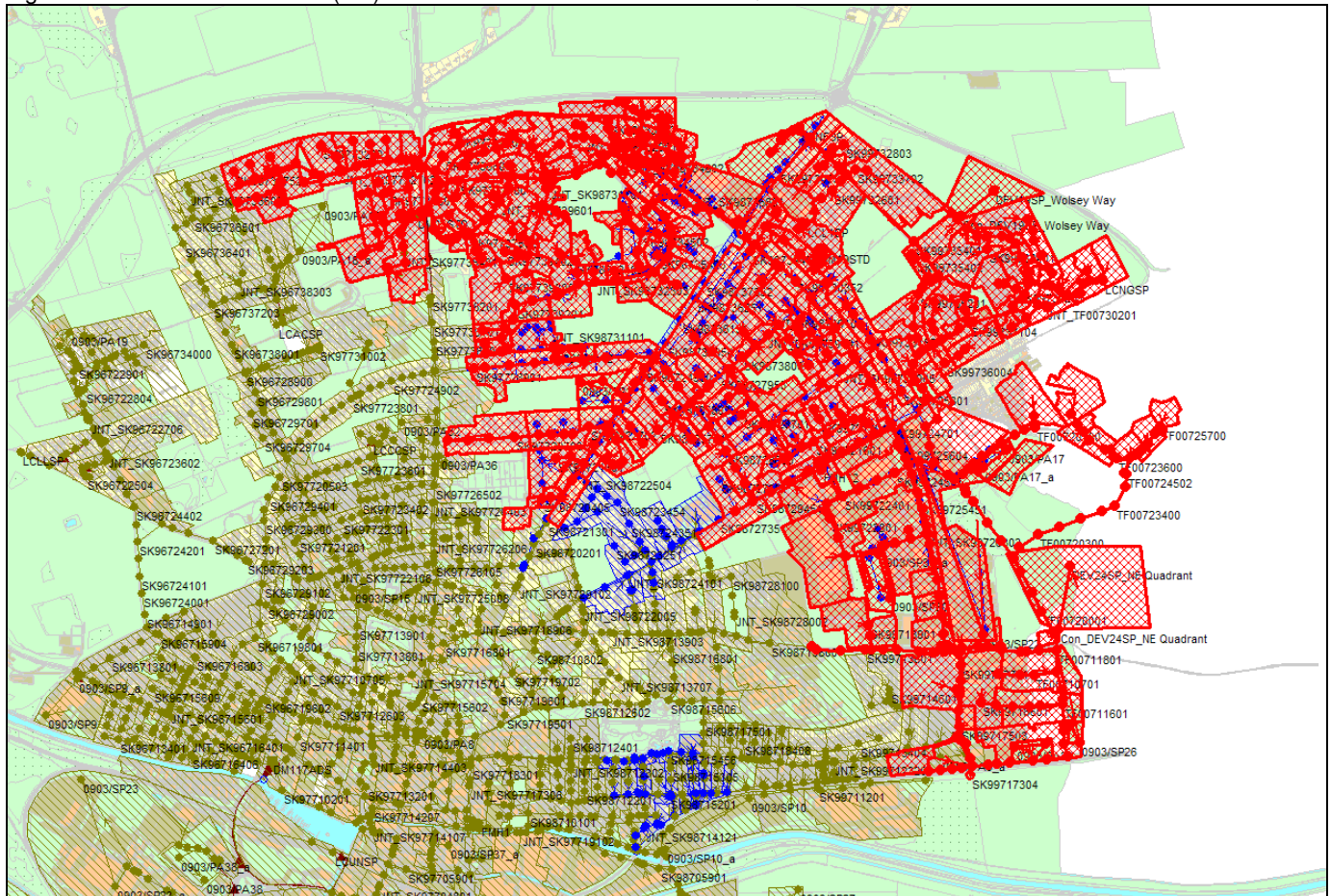
Option 4 presented the only means of resolving the problem at Stamp End but has been ruled out on cost benefit grounds. To alleviate flooding a large pumping station would be required to address all of the foul flows in North Lincoln along with the provision of significant emergency storage should the pumping station fail. The cost of this option was an order of magnitude larger than the next most expensive option; Option 3.

Options 2, 3 and 5 involve construction of a rising main with an associated pumping station to take the NEQ direct to Canwick STW. Option 5 concentrated on only addressing the 2,000 properties to be located on the NEQ and is considered by AWS to be the preferred option on account of it having the least overall cost.

In Option 2 the rising main would connect into the existing network and pick up a small part of the overall catchment draining to Stamp End. The modelling results indicated that this would only offer minor improvements with regard to the flooding at Stamp End.

Option 3 considered the possibility of capturing the foul flows from SHLAA maps 2, 3 and 4 (Figure 4.4) so that they do not drain via Stamp End but through the new direct connection at the NEQ. This option made a more significant impact than Option 2 in terms of reducing the flooding at Stamp End, however accepting additional foul flows from a much larger catchment area, requires a larger diameter sewer and a larger pumping station, which in turn increase the overall costs of delivering the Option.

Figure 4.4: The Additional Area (red) which could be diverted via the NEQ



(Figure provided by AWS.)

Whilst Option 3 illustrates that it is possible to convert SHLAA maps 2, 3 and 4 from Red to Amber, AWS would need to have a high level of certainty concerning the planned re-development in these areas to ensure that the direct sewer connection from the NEQ to Canwick STW was sized correctly. It would be highly unsustainable if the connection ended up being over sized because the development in North Lincoln never came forward or if the connection was put in place to serve the NEQ and subsequently had to be revisited and upgraded at a later date to accommodate re-routing additional flows from North Lincoln.

The WCS recommends that the City of Lincoln / Joint Planning Unit review development needs in North Lincoln prior to commencement of the NEQ to ensure that the water infrastructure in place is sustainable, addressing the big picture.

Future Action 4.3 – Review development needs in North Lincoln prior to commencement of the NEQ to ensure that appropriate water infrastructure is in place.

Conclusions and recommendations:

- Options 1, 2, 3, and 5 do not resolve existing flooding issues at Stamp End which appear to be driven by the extensive area of combined sewerage in the older parts of Lincoln.
- Option 4 does resolve these issues but the cost and practical constraints means it is not a viable solution. AWS will continue to investigate the Stamp End situation as part of their ongoing programme of works.
- Option 1 is theoretically possible but significant risks and issues make Options 2 or 3 preferable.
- Option 5 is the preferred option pending completion of further work on the Stamp End flooding and an assessment of the cost effectiveness of Options 2 & 3.

Option 5 has the following advantages:

- It has the lowest CAPEX and whole life costs of all the Options.
- It would not require negotiations with third party landowners for a pumping station site and permanent access arrangements.
- It has the easiest construction of the Main Rivers crossing of all the Options.
- It provides the opportunity to avoid a costly bore beneath the Lincoln to Spalding railway by utilising an existing culvert just north of Canwick STW.
- Disadvantage is that it only caters for development in the NEQ.

Constraints peculiar to specific options are tabulated in Table 4.2 below:

Table 4.2: Constraints Associated with the NEQ Engineering Options

Details of constraints	Options				
	1	2	3	4	5
Permission required from Network Rail for a new trenchless crossing of the Lincoln to Market Rasen railway line					✓
Permission required from Network Rail for a new trenchless crossing of the Lincoln to Spalding railway line	✓			?	
Permission required from Network Rail to lay a rising main through the existing culvert under the Lincoln to Spalding railway line		✓	✓	?	✓
Negotiations required with third party landowners for pumping station sites and permanent access arrangements		✓	✓	✓	
Deep, live connection required to the existing trunk sewer upstream of the TPS inlet chamber at Canwick STW	✓				
Availability of large diameter pipe material suitable for trenchless crossings of the Main Rivers				✓	
Higher OPEX (costs of pumping, etc)		✓	✓	✓	✓

Constraints common to all options include:

- The proposed pipeline crossings of the Main Rivers (approximately 200m long in difficult ground conditions - waterlogged gravels) are at the limit for conventional directional drilling equipment and might require specialist contractors;
- Flood Defence Consents required from the Environment Agency for trenchless crossings of the River Witham and the North and South Delphs;
- Permissions required for crossings of local IDB watercourses;
- Existing overhead high voltage lines on both sides of the River Witham and the North and South Delphs where plant would be working to construct the trenchless crossings;
- Consideration of impacts on the hydraulic capacity of Canwick STW; and
- Archaeological and environmental impacts and possible mitigation measures.

4.2.3 Western Growth Corridor

AWS also undertook a simplistic, high level modelling study to assess the impact of development on the WGC on the wider foul sewerage network. The WGC development has been considered in combination and added into the model at one location. In reality the development would be distributed across the sewer network, and model. The results are therefore indicative only.

Flows from the WGC would pass through St Bartolp's pumping station, along with those from SHLAA maps 14, 9, 11, 12 and 20. The system highlighted Red in Figure 4.5 is potentially affected by development in the WGC, although the effect in some areas is likely to be minimal.

Figure 4.5: Foul Sewerage Network Affected by the WGC



(Figure provided by AWS.)

The modelling indicated that in the base case, before the WGC is developed, the network illustrated above is subject to between 50 and 80 instances of flooding depending on the rainfall event considered. Incorporating the WGC into the model did not significantly increase the number of locations where flooding occurred and the volume of floodwater escaping from the system only increased by a small percentage.

In light of these model findings AWS concluded that the WGC ought to be considered Amber until it can be proven to be Green. In light of the flooding, in order to develop the WGC downstream mitigation will be required to avoid exacerbating this flooding. Equally a more detailed modelling exercise should be undertaken to overcome the limitations of this study and to confirm the RAG status.

Future Action 4.4 – AWS to review the impact of developing the WGC when housing numbers are finalised and what, if any, mitigation measures are required to alleviate flooding.

4.2.4 South East Quadrant

No modelling studies have been undertaken to assess the SEQ. The location of the SEQ with regard to Canwick STW would suggest that a new direct connection to the works, subject to the extent of the development, is the most sustainable option. Consequently developing the SEQ will not impact upon the existing sewerage network and the SEQ is to be considered Amber since investment will be required to create a new sewer network for the site and connect it to the STW.

Future Action 4.5 – Implement a new direct connection to Canwick STW to serve the SEQ.

North Kesteven SHLAA maps 14 and 21 fall across Bracebridge Heath and AWS have advised that this development would need to be considered in conjunction with the SEQ development and drain to Canwick STW via a new direct connection rather than

connect into the existing network. In light of this these two maps need to be classified as Amber and the direct connection for the SEQ needs to be in place when these sites come forward.

Future Action 4.6 – New direct connection to Canwick STW to be in place for development of North Kesteven SHLAA maps 14 and 21.

4.2.5 LPA Outside the Canwick STW Catchment

In the wider LPA area of West Lindsey and North Kesteven AWS do not have extensive model coverage of the sewerage networks and therefore provided an assessment of foul sewer capacities with regard to accepting addition flows from new development. Table 4.3 presents the RAG status for sites within the LPA that are not covered by the Canwick hydraulic sewer model.

Table 4.3: LPA Sewerage RAG Status

SHLAA Map No	Area	Potential New Houses*	RAG
North Kesteven Inside the PUA			
14	N Hykeham	798	AMBER
20	N Hykeham	64	AMBER
21	N Hykeham	98	AMBER
24	N Hykeham	148	GREEN
27	N Hykeham	395	AMBER
36	N Hykeham	775	AMBER
31	N Hykeham	267	AMBER
41	N Hykeham	377	AMBER
33	S Hykeham	1378	GREEN
29	S Hykeham	325	GREEN
40	S Hykeham	19	GREEN
North Kesteven Outside the PUA			
56	Bassingham	349	AMBER
17	Branston	527	AMBER
54	Coleby	34	GREEN
44	Dunston	29	AMBER
11	Heighington	101	AMBER
49 & 50	Metheringham	722	AMBER
2 & 4	Skellingthorpe	1,785	RED
5 & 6	Washingborough	496	AMBER
43 & 48	Witham St Hughes	996	GREEN
37	Nocton	80	AMBER
West Lindsey Outside the PUA			
West Lindsey Villages Outside the PUA	Bardney	333	AMBER
	Burton Waters	281	GREEN
	Cherry Willingham	637	RED
	Dunholme	128	AMBER
	Faldingworth	77	AMBER
	Fiskerton	32	AMBER
	Hawthorn Avenue	114	AMBER
	Ingham	34	AMBER
	Langworth	21	RED
	Nettleham	37	AMBER
	Saxilby	160	AMBER
	Sudbrooke	33	GREEN
	Welton	93	GREEN

In light of the above table, it would be preferably for development to occur in those areas that have been classified as Green and to avoid those areas in Red. Since the potential development considered in Table 4.3 is based upon SHLAA data with significant uncertainty as to whether or not it will ever come forward in the planning process this assessment has not been taken any further.

When the planning situation develops and there is more certainty concerning specific locations to be developed it is recommended that the above assessment is revisited and taken further to develop specific solutions if appropriate.

4.3 Sewerage Capacity outside the LPA

4.3.1 West Lindsey

Table 4.4 presents the RAG status for notable development sites within West Lindsey outside of the LPA. Other villages across West Lindsey have been excluded from the table on account of the development expected is windfall and of sufficiently low numbers that the impact on the sewerage network would be insignificant.

Table 4.4: West Lindsey Sewerage RAG Status

Area	Total New Houses	RAG
Market Rasen	1,334	AMBER
Middle Rasen	76	GREEN*
Caistor	339	AMBER

*Status will change if Market Rasen growth happens first.

It is apparent that there are no obvious barriers to the development in Table 4.4, but AWS will need to plan and invest to upgrade the sewers to be able to accommodate the increased flows. AWS have indicated that either foul sewers or pumping stations require upgrading and there are no known planning issues for either Market Rasen or Caistor, however Urban Pollution Management (UPM) studies could be required due to the increased number of properties. It is therefore suggested that West Lindsey DC will need to liaise with AWS concerning forthcoming development in Market Rasen and Caistor to ensure that the appropriate infrastructure is in place.

Future Action 4.7 – West Lindsey DC and AWS to monitor development in Market Rasen and Caistor.

4.3.2 North Kesteven

Table 4.5 presents the RAG status for sites within North Kesteven outside of the LPA which are illustrated in Figure 4.6.

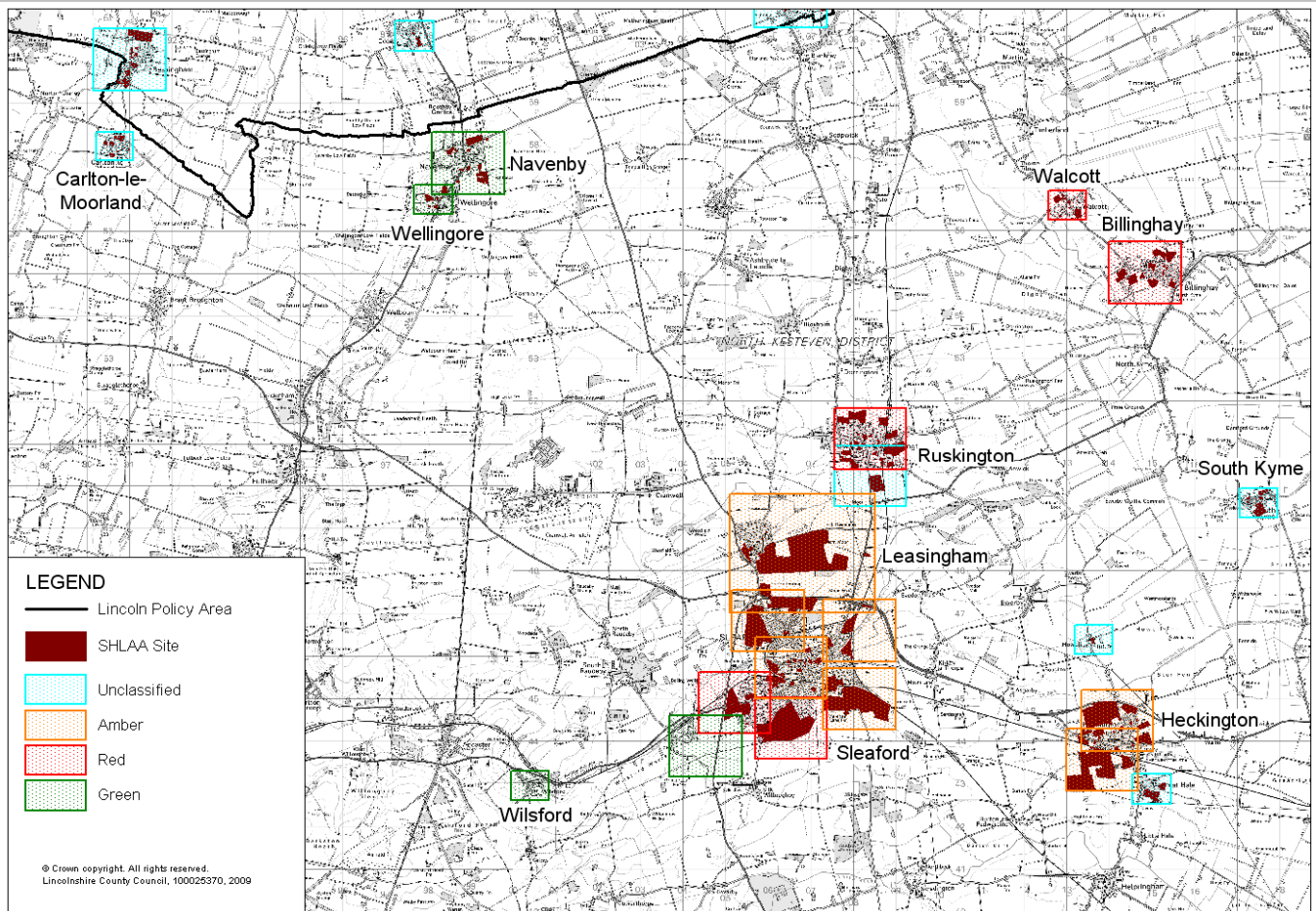
Table 4.5: North Kesteven Sewerage RAG Status

SHLAA Map No*	Area	Total New Houses	RAG
68	Carlton-le-Moorland	69	GREEN
71	Navenby	296	GREEN
72	Wellingore	111	GREEN
75	Walcott	138	RED
83	Billinghay	441	RED
95	Ruskington	817	RED
102	Leasingham	773	AMBER
105	Sleaford	1,201	AMBER
110	Sleaford	361	AMBER
111	Sleaford	479 [#]	AMBER
112	Sleaford	163	RED
114	Sleaford	1,335	AMBER
115	Sleaford	1,205	RED
118	Rauceby	250	GREEN
113	Heckington	527	AMBER
119	Heckington	783	AMBER
121	Wilsford	158	GREEN

*AWS advised that it was not necessary to review SHLAA Maps containing less than 50 houses.

[#] An allowance has been included for potential future employment land

Figure 4.6: North Kesteven Sewage RAG Status



In the case of North Kesteven there are a number of locations where foul sewers appear to present a barrier to growth. The villages of Walscott, Billinghay and Ruskington all fall into this category as do the SHLAA sites to the south west of Sleaford. With regard to those Red sites in Sleaford it is the distance from the existing networks which AWS perceive to be the barrier to development. AWS have indicated that there would need to be considerably more certainty concerning whether or not the SHLAA sites will get developed in order to take this assessment any further.

Future Action 4.8 – Sewerage presents constraints to development in Walscott, Billinghay, Ruskington and south west Sleaford. If these SHLAA sites are to be developed additional work will be required to identify sustainable solutions.

In contrast development of the SHLAA sites in Navenby and Wellingore would be within the existing capacities and therefore would be preferential in terms of the foul sewerage networks.

Given the uncertainty over whether or not the SHLAA sites will come into the planning system it is not appropriate to take the analysis further at this stage. It is recommended that when the planning situation becomes more certain regarding development in Sleaford that the WCS is revisited.

Future Action 4.9 – Review the RAG status of foul sewerage in North Kesteven when more detailed information concerning which SHLAA sites are to be developed is available.

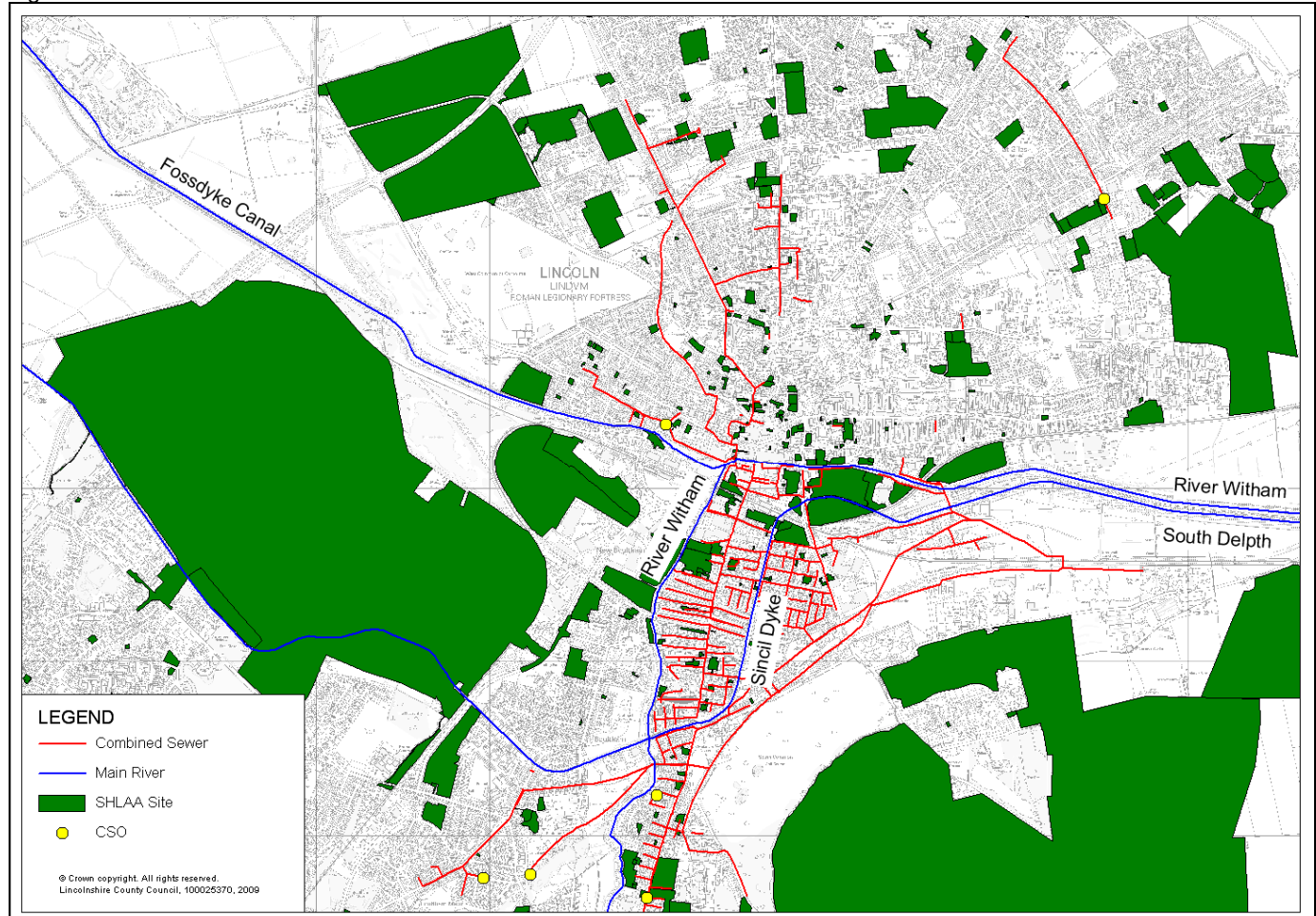
4.4 Combined Sewer Overflows

Combined sewer systems usually have “combined sewer overflows” (CSOs) built into the system. A CSO is designed to allow wastewater and surface water to discharge directly into a watercourse, lake or ocean. The concept being that during wet weather when the combined sewers could become overloaded the CSO allows the diluted wastewater to escape into a watercourse rather than properties.

The discharge of untreated wastewater, albeit diluted with surface water, can prove detrimental to water quality, flora and fauna. Consequently increasing flows upstream of a CSO is something the Environment Agency would like to avoid since this could increase the frequency and severity of spills from the CSO.

There are six CSOs associated with the combined sewers serving central Lincoln (Figure 4.7). Two of these are located north of the River Witham, an area which has already been classified as Red and further development ought to be avoided. The other four CSOs are located in south Lincoln in areas which have been classified as Green. If the development were to lead to an increase in population upstream of the CSO of more than 10% it would be appropriate to assess the impact on the CSO using Urban Pollution Management (UPM) techniques.

Figure 4.7: CSOs in Lincoln



The WGC, NEQ and SEQ, the primary focus of the WCS, would not impact upon any of the CSOs in Lincoln. The SHLAA data in Lincoln could impact upon the CSOs however, given the uncertainty associated with whether or not these sites will get developed it is not appropriate to undertake UPM studies at this stage. Following “site allocation” by the Joint Planning Unit it will be necessary to review the allocated sites with regard to Lincoln’s CSOs and determine if UPM studies are required.

Future Action 4.10 – Review the need for UPM studies following site allocation.

The Environment Agency has stated that the installation of new CSOs is unsustainable and should not be considered for future developments.

Future Action 4.11 – Ensure that no new CSOs are created.

Sewage Treatment



5 Sewage Treatment

5.1 Sewage Treatment in the LPA

Foul water taken away from homes via foul or combined sewers must be treated before it can be returned to the natural environment. There are 22 Sewage Treatment Works (STWs) in the LPA that treat foul sewage before discharging the treated effluent into receiving watercourses. All of these STWs are operated by AWS and vary in size, most are relatively small, serving small villages however the PUA requires much larger STWs. The PUA is served by two STWs; Canwick and North Hykeham which are the two largest STWs in the study area although Canwick serves a considerably larger population and is the principal STW in the area. STWs at South Hykeham and Skellingthorpe are located just outside the PUA.

AWS have provided a RAG review (Table 5.1) of the SHLAA sites with regard to which STW they would drain to, where;

- **RED** – there are funding, planning or environmental constraints identified to providing the infrastructure necessary to meet the proposed development.
- **AMBER** – there are funding, planning or environmental constraints identified to providing the infrastructure necessary to meet the proposed development, but measures have been identified which are sustainable and deliverable.
- **GREEN** – there are no identified funding, planning or environmental constraints to providing the infrastructure necessary to meet the proposed development.

Table 5.1: STW RAG Status in the LPA

Area	Potential New Houses	Relevant STW	Process Capacity	Flow Capacity	Upgrade Required
Lincoln	28,530	Canwick	AMBER	AMBER	AMP6
Branston	527				
Washingborough	496				
North Hykeham	2,026	North Hykeham	AMBER	AMBER	AMP6
Coleby	34				
South Hykeham	1,722	South Hykeham	AMBER	AMBER	AMP7
Bassingham	349				
Carlton-le-Moorland ^{##}	69	Bassingham	AMBER	AMBER	AMP6
Heighington	101	Washingborough	AMBER	AMBER	AMP6
Metheringham	722	Metheringham	AMBER	AMBER	AMP5 [#]
Dunston	29				
Skellingthorpe	1,785	Skellingthorpe	AMBER	AMBER	AMP6
Burton Waters*	281				
Witham St Hughes	996	Swinderby	AMBER	AMBER	AMP5
Nocton	80	Nocton	GREEN	GREEN	N/A
Bardney	333	Bardney	GREEN	GREEN	N/A
Cherry Willingham	637	Reepham	AMBER	GREEN	AMP5 [#]
Langworth	21				
Sudbrooke	33				
Hawthorn Avenue	114				
Dunholme	128	Dunholme	GREEN	GREEN	N/A
Welton	93				
Faldingworth	77	Faldingworth	RED	RED	AMP5
Fiskerton	32	Fiskerton	AMBER	AMBER	AMP6
Ingham	34	Ingham	AMBER	AMBER	AMP5/6 ^{**}
Nettleham	37	Nettleham	AMBER	GREEN	AMP6/7
Saxilby	160	Saxilby	AMBER	GREEN	AMP5/6

* - Drainage catchment in West Lindsey draining into North Kesteven

- Upgrade required but it has not been included in the investment programme for the AMP period.

** - Upgrade would not be undertaken for so few properties

- Drainage catchment outside the LPA draining into the LPA

The final column in Table 5.1 indicates the AMP period when the STW would need upgrading. It should be noted that this is based on the assumption that all of the SHLAA sites get developed.

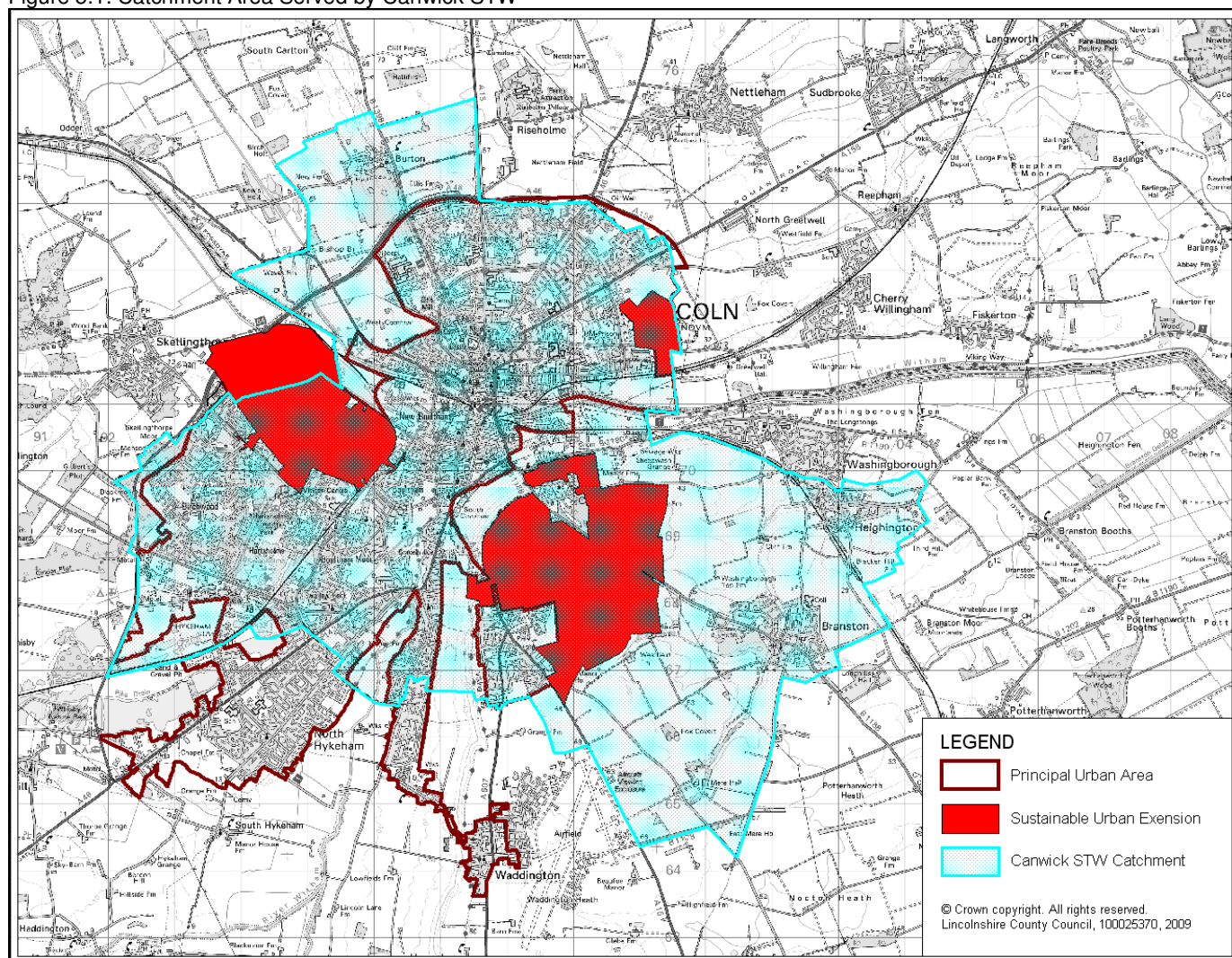
The RAG status has been assigned to the 'Process Capacity' and 'Flow Capacity' of the STW. Flow capacity is the hydraulic capacity to pass flows through the works whilst process capacity is the ability of the works to biologically treat the flows to the required standards.

Table 5.1 presents the RAG status and when each STW would need to be upgraded if it were to serve all of the development identified in the SHLAA. In the case of Green STWs no investment is required to accommodate all of the SHLAA sites, for Red STWs further development causing investment is considered uneconomical. With regard to Amber STWs the important factor in Table 5.1 is when an upgrade would be required. For example, the Bassingham STW has been classified as Amber however, it would not need to be upgraded until AMP6 (2015-20). Therefore based on the phasing of development provided (Table 2.3) there is sufficient spare capacity at the STW to serve the additional 197 SHLAA sites that could come forward in Bassingham and Carlton-le-Moorland before 2015 however investment would be required to serve all 418 SHLAA sites if they were to be developed.

5.1.1 Sewage Treatment within the PUA

It was stated above that the Canwick and North Hykeham STWs serve the population living in the Lincoln PUA. Canwick serves a much larger area and population which is reflected in the number of potential new houses (Table 5.1 and Figure 5.1).

Figure 5.1: Catchment Area Served by Canwick STW



Investment in STWs is a costly exercise requiring significant planning and preparation. As such AWS consider that if upgrades are required to serve the growth identified in the Regional Plan, it would be preferable for the growth to be centred at one STW rather than spread over several. It is apparent that in order to achieve the Regional Plan targets for the PUA and LPA, there would have to be significant growth within the catchment served by Canwick STW. On the basis that investment will have to occur at Canwick STW it would be most economical to focus growth within the area served by Canwick STW and restrict growth elsewhere. Growth could take place within the catchments of other STWs but it is recommended that it is restricted within existing spare capacities thereby avoiding additional investment.

Table 5.2 presents a high level assessment of a number of parameters that could be considered to determine which STW serving the PUA would be most sustainable to extend and upgrade, South Hykeham and Skellingthorpe have been included based upon their proximity to the PUA.

Table 5.2: Sustainability Factors Affecting STWs

STW	Discharge Location with regard to Lincoln	Ability to Extend?	Flood Zone	Other
Canwick	Downstream	Land available on site	FZ1	Favoured by Environment Agency
North Hykeham	Upstream	Land purchase required	FZ3	
South Hykeham	Upstream	Land available on site	FZ2	
Skellingthorpe	Upstream	Land purchase required	FZ3	Highly polluted receiving system

Based upon those factors that have been considered in Table 5.2, it is apparent that Canwick STW would be the most sustainable STW to focus investment at to serve future growth. The treated effluent discharged from the STW would be downstream of Lincoln, whereas the other three STWs are located upstream and therefore the treated effluent from those STWs would have to pass through Lincoln, there is land available within the existing works to expand onto therefore additional land would not have to be purchased and Canwick is located with Flood Zone 1 whereas the other STWs are in Flood Zone 2 or 3.

5.1.2 A Strategy for Canwick STW

AWS are currently completing an AMP4 scheme to reduce the impact of some hydraulic restrictions at Canwick. An additional scheme is proposed for AMP5 to address hydraulic, flow and sanitary consent issues which will ensure that no action will be required to cater for growth prior to AMP6.

The approach by which the Environment Agency assesses STWs compliance with their discharge consents has recently changed. As part of the change some consents (including Canwick) are being revised to fit the new assessment method and to provide a “safety factor” against random variations in weather. The “safety factor” does not provide any additional capacity for growth.

The limited capacity available, together with expected reductions in consumption through demand management are expected to provide adequate capacity for the AMP5 period (to 2015) but it is expected that additional capacity will be required shortly afterwards. The exact timing will depend on the success of demand management measures.

One demand management measure relates to re-development in areas drained by combined sewers (which applies to large parts of central Lincoln). The combined sewer accepts foul water and surface water runoff. If the combined flows are separated when these areas are re-developed, so that only foul flows get into the sewerage system additional capacity is created in the sewer and at the receiving STW since the surface water is no longer in the system. This additional capacity provided by the separation of surface water and foul flows could be used to accommodate some growth. This will be particularly important in the northern part of Lincoln which has a significant amount of re-development potential. It should be noted that removing surface water from combined sewers increases the concentration / biological loading of the foul sewage arriving at the STW which will mean the STW must work harder to improve the quality of the sewage before it can be discharged into a receiving watercourse.

Further capacity could also be provided through other demand management measures such as infiltration reduction. (Infiltration is additional water getting into sewers through cracks in the sewer infrastructure.) However, no specific areas have been identified therefore further investigation will be required to determine whether this is a cost effective method of reducing demand.

Depending on the rate of development, Canwick STW will be extended to cater for growth during AMP6. This will provide capacity at the works for the remainder of the current planning period. AWS is considering a number of options for these extension works, but they are likely to include increasing the terminal pumping station capacity, additional storm treatment capacity, and a new parallel process stream. It is recommended that in extending Canwick STW AWS endeavour to consider

solutions that contribute towards Carbon Reduction Targets. The 23 water companies in England and Wales are responsible for 0.8% of the UK's annual greenhouse gas emissions and from April 2010 have been incorporated into the Carbon Reduction Commitment.

Prior to the AMP6 extension to Canwick some development could be accommodated within the catchments of other STWs; Skellingthorpe, North and South Hykeham. Ideally sites in these STW catchments would be developed prior to AMP6 (2015 - 2020), and in preference to other sites within the Canwick sewerage catchment. However, once the existing capacity is used up at these works, the most sustainable way of serving additional growth in the Lincoln PUA will be to locate it within the Canwick sewerage catchment. Modelling carried out by AWS has highlighted where such development could make best use of existing assets, and where increased capacity would be required (Section 4).

Future Action 5.1 – Expand Canwick STW in AMP6 to cater for growth.

Future Action 5.2 – Focus future development within the catchment area served by Canwick STW and restrict growth elsewhere within available capacities (Table 5.1).

5.1.3 The LPA Outside the PUA

Faldingworth stands out in Table 5.1 as being a concern in light of AWS having flagged the relevant STW as Red. Faldingworth STW, in West Lindsey also has a descriptive consent, it is therefore advisable that if development in this village goes ahead additional work is undertaken to ensure it is sustainable.

Future Action 5.3 – Undertake additional work to review Faldingworth STW if development is to go ahead.

The information in Table 5.1 indicates that development in Bardney, Dunholme, Nocton and Welton would be most preferable on the basis that the STWs that would be impacted by growth in these areas have sufficient spare capacity to accommodate the growth without needing any additional investment to expand the STWs, and have been classified as Green. This existing spare capacity that could accommodate the SHLAA sites does not necessarily mean that the discharge from the STW would not need to be increased if the SHLAA sites were to be developed.

The Environment Agency has indicated that development in Bardney would have the least impact on water quality as the STW discharges to the River Witham. Dunholme STW, serving both Dunholme and Welton discharges into the Barlings Eau system and Nocton STW discharges into a tributary of the Carr Dyke. The Barlings Eau is shown as poor for both Phosphorus and Biology in the River Basin Management Plan and Carr Dyke is currently classified as having Moderate Ecological Quality due to Phosphorus levels. Consequently the Environment Agency is of the opinion that expansion of Dunholme and Nocton STWs is not sustainable. However, the assessment criteria for rejecting development is if the development were to make the WFD targets significantly more difficult to achieve. Therefore if the SHLAA sites come forward further work to review the implications for water quality may be required.

Future Action 5.4 – Development in Bardney is considered to be the most sustainable in terms of water infrastructure. Development in Nocton, Dunholme and Welton may require further work to assess water quality implications.

Elsewhere the STWs have been designated as Amber, whilst they do not currently have sufficient capacity to accept all of the potential growth, with investment they could be upgraded to accommodate the growth. However, adopting the principle that only Canwick STW will be expanded, these Amber STWs would not be invested in and development restricted to within the existing capacities (Table 5.1).

It should be noted that AWS have indicated that investment at the Ingham STW would not be considered justifiable for so few properties and based upon the growth rates provided investment would be required at Reepham and Metherringham STWs in the AMP5 period but the investment required to upgrade Reepham and Metherringham STWs has not been included in AWS' investment programme.

Future Action 5.5 – If further development is to take place in Cherry Willingham, Langworth, Sudbrooke, Metherringham and Dunston local authorities to liaise with AWS regarding potential implications.

5.2 Sewage Treatment outside the LPA

5.2.1 West Lindsey

Table 5.3 presents the STW RAG status for notable development sites within West Lindsey outside of the LPA.

Table 5.3: West Lindsey STW RAG Status

Area	Potential New Houses	Relevant STW	Process Capacity	Flow Capacity	Upgrade
Market Rasen	1,334	Market Rasen	GREEN	GREEN	N/A
Middle Rasen	76				
Caistor	339	Caistor	AMBER	AMBER	AMP5

In the wider West Lindsey area it is apparent that there is only Caistor where sewage treatment could impact on future growth. Purely on the basis of sewage treatment development would be most sustainable in Middle and Market Rasen given the existing spare capacity exceeds the potential number of new houses. Indeed given that the existing spare capacity exceeds potential development and that Caistor may have problems it may be more appropriate to target development towards Market Rasen, particularly in the short term.

Future Action 5.6 – AWS to review potential to invest and improve the foul sewerage system in Market Rasen to take advantage of the available capacity at the STW.

With regard to the constraints at Caistor unless investment occurs in AMP5 development may be restricted

Future Action 5.7 – West Lindsey DC to review development in Caistor in consultation with AWS.

5.2.2 North Kesteven

Table 5.4 presents the RAG status for sites within North Kesteven outside of the LPA.

Table 5.4: North Kesteven STW RAG Status

SHLAA Map Nos.	Area	Total New Houses	Relevant STW	Process Capacity	Flow Capacity	Upgrade
71	Navenby	296	Navenby	AMBER	AMBER	AMP7
72	Wellington	111				
75	Walcott	138	Billinghay	AMBER	AMBER	AMP6
83	Billinghay	441				
95	Ruskington	817	Anwick	GREEN	GREEN	N/A
102	Leasingham	773	Leasingham	AMBER	AMBER	AMP6
105, 110, 111, 112, 114 & 115	Sleaford	4,744	Sleaford	AMBER	AMBER	AMP7
118	Rauceby	250				
113 & 119	Heckington	1,330	Heckington	AMBER	AMBER	AMP6
121	Wilsford	158	Wilsford	AMBER	AMBER	AMP7

*AWS advised that it was not necessary to review SHLAA Maps containing less than 50 houses.

See Table 5.1 for Carlton-le-Moorland.

In terms of sewage treatment there are no significant barriers to growth in North Kesteven. Developing some of the SHLAA sites in Navenby and Wellington could be considered to be sustainable on account of an upgrade not being required until AMP7. However, this STW discharges into a tributary of Navenby Beck, which is tributary of the River Brant. The River Brant is a high priority for an improvement in water quality since it has Bad Potential status due to Dissolved Oxygen (DO) and Phosphorus levels. Further expansion of Navenby STW is therefore not sustainable in the long term unless significant improvements to the current WFD status are guaranteed.

Anwick stands out as being the only STW having sufficient spare capacity at the STW to accept all of the SHLAA sites (in light of a reduction in the volume of trade effluent being treated) however Section 4 identified that there are barriers to overcoming the problems in the sewerage network.

Upgrades and investment would be required at the other STWs if all of the SHLAA sites were to be developed but not until AMP6 or 7, therefore AWS have time to plan for this. North Kesteven DC therefore need to keep AWS informed as to whether or not the SHLAA sites will be coming forward since this will affect when investment is required.

Future Action 5.8 – North Kesteven DC and AWS to consider potential to exploit spare capacities that exist at STWs without the need for expansion of the STW otherwise Navenby, Billinghay, Leasingham, Sleaford, Heckington and Wilsford will require upgrades.

5.3 Water Quality

One factor requiring consideration is the water quality requirements of the receiving watercourses that the various STWs discharge to, and the limitations, or consents that will be imposed upon the STWs by the Environment Agency. A joint position statement on Water Quality has been prepared by AWS and the Environment Agency and has been included in Appendix C. It should be noted that at the time of writing this is still a draft document and may be subject to change.

5.3.1 Water Quality Standards

The Environment Agency monitors water quality throughout the study area with a view to classifying the “health” of the water bodies and setting standards to maintain or improve the water quality. The rivers running through the study area are of varying water quality; upstream of Lincoln the watercourses are generally considered to be of good water quality, which decreases downstream of Lincoln. This is due to the River Till and Fosdyke Canal which are more polluted systems. The Fosdyke Canal and Old River Sleas, downstream of Sleaford exhibit the worst water quality standards across the study area.

Until recently the Environment Agency used the River Ecosystem classification to assess water quality however this was superseded in January 2010 by standards set by the Water Framework Directive (WFD). The WFD is a significant piece of water legislation produced by the European Commission for the European Union. It is designed to integrate the way water bodies are managed across Europe and it requires all inland and coastal waters to reach ‘good status’ by 2015. In summary, the WFD has the aim of achieving healthy rivers, lakes etc and a well-balanced water environment.

The WFD stipulates that the default objectives should be met by 2015, for example ensuring no deterioration of the water environment, or achieving good status. However, the Directive also requires that social, environmental and economic issues should be considered and allows alternative objectives to be set where it may not be able to achieve good status or it will be disproportionately expensive to do so.

The River Ecosystem target for watercourses in the study area was RE3. In line with the WFD, the target has become ‘good’ status. Table 5.5 presents a comparison of the standards for good status and the old RE3 standards. The WFD good status standards have been derived for lowland, high alkalinity water bodies such as those found within the River Witham catchment.

Table 5.5: Comparison of WFD and River Ecosystem Targets

Class	Ammonia (mg/l)	BOD* (mg/l) 90%ile	DO** (% saturation) 10%ile	pH
RE3	1.3	6	60	6 to 9
WFD - GOOD	0.6	5	60	≥6 to ≤9

* - BOD = Biological Oxygen Demand

** - DO = Dissolved Oxygen

The implication of the move from RE3 to ‘good’ is that the water quality targets are more stringent in terms of BOD and Ammonia. The WFD also introduces a standard for phosphorus which has not previously been assessed. In order to achieve ‘good’ status it will be necessary for the Environment Agency to impose tighter, more onerous consents for discharges, such as those from STWs. This will have implications for AWS, particularly if there is a need to increase discharges from certain STWs in response to the proposed housing growth.

Other forms of pollution such as from diffuse sources will also need to be addressed by the Environment Agency in order to achieve good status. The existence of a large farming community across Lincolnshire is likely to be a significant contributor to pollution within the region’s watercourses although historic industry is also a factor. For example part of the reason for the poor water quality in the Fosdyke Canal and surrounding watercourses is elevated levels of ammonia that are a result of a fertilizer factory that closed down over 20 years ago, however the contaminated land continues to leach ammonia into the surrounding watercourses.

5.3.2 Water Quality Assessment Methodology

The Environment Agency advised that it was necessary to review the discharge consents for key STWs being affected by growth within the LPA and provided their in-house software; River Quality Planning (RQP) to undertake these reviews as part of the WCS.

When the Environment Agency review permits for existing discharges or issue permits for new ones their aim is to issue permits that prevent or minimise any deterioration in the quality of water bodies that could otherwise occur as a result of the discharge. This is referred to as 'no deterioration' and the ideal is for no increase in the planned pollutant load discharged to the water body.

The possibility of undertaking more detailed water quality modelling was also considered. The Environment Agency holds a National SIMCAT model which assesses water quality and covers the entire Wash catchment. The SIMCAT model includes the WCS area of interest and could have been made available for the study. It contains river flow and quality and effluent flow and quality for the majority of rivers and STWs. BOD, Ammonia and Phosphate are the main substances included.

However the model has a number of limitations. The structure does not accurately describe the river network through Lincoln and the model has yet to be fully calibrated so although it may have been of some benefit it would still be necessary to use RQP software to calculate indicative consent standards.

The Environment Agency also advised that the SIMCAT model is large and would require a lot of time both running the model and understanding its limitations. As a consequence it was decided not to use the SIMCAT software.

5.3.3 Water Quality Assessment Results

Existing water quality data was obtained from the Environment Agency and compared against the existing discharges from various STWs in the study area to review how the discharge consents would fare against the WFD standards. This initial assessment did not account for any housing growth that would require the STWs to increase their discharges.

Table 5.6 presents the existing discharge consents alongside the indicative consents that would be required to achieve WFD 'good' status. In practice the consent conditions applied will be dependent upon the measured flows and water quality both within the river and discharge at the time of consent review.

Table 5.6: Comparison of existing discharge consents and what is required to achieve WFD 'good' status

Sewage Treatment Works	BOD (mg/l)		Ammonia (mg/l)		Phosphorus (mg/l)	
	Existing	WFD	Existing	WFD	Existing	WFD
Canwick STW	15.00	9.00	15.00	1.46	-	0.04
Reepham STW	15.00	6.96	6.00	0.91	-	#
Dunholme STW	10.00	10.94	4.00	0.79	-	#
Nettleham STW	12.00	12.08	5.00	1.61	-	#
Saxilby STW	15.00	6.38	5.00	1.26	-	0.04
North Hykeham STW	20.00	68.43	15.00	17.05	-	#
Metheringham STW	15.00	9.36	10.00	1.44	-	#
Skellingthorpe STW	10.00	6.74	5.00	#	-	#
Washingborough STW	35.00	35.89	15.00	#	-	#
South Hykeham STW	20.00	9.43	10.00	1.90	-	#
Swinderby STW	20.00	22.30	15.00	4.62	-	#

- It is not possible to achieve the WFD standard due to the water quality in the receiving watercourse

Table 5.6 compares the three key parameters of BOD, ammonia and phosphorus. It is clear that ammonia and phosphorus present the biggest challenges to being able to achieve 'good' status under the WFD since it will require significantly tighter standards than those presently in operation. Whilst the STWs presented in Table 5.6 are all confined to the LPA it can be assumed that the same situation will apply across West Lindsey and North Kesteven, and indeed on a national scale.

It should be noted that at North Hykeham; the numbers for BOD and ammonia are higher for the WFD than existing because the STW discharges directly into the River Witham which has a large flow to dilute pollutants. The Environment Agency would not seek to relax the standards at North Hykeham, no deterioration would apply, but rather tighten them where possible to achieve wider benefits.

Phosphorus will be a significant challenge for the Environment Agency, since at all but two of the STWs in Table 5.6 it is not possible to achieve the WFD standard for phosphorous. This is because the level of phosphorus in the upstream river is already too high before the STW discharge has been considered. Consequently it will be necessary for the Environment Agency to address diffuse pollution within the wider River Witham catchment in order to achieve the standards set by the WFD.

Future Action 5.9 – The Environment Agency to tackle diffuse pollution across the River Witham catchment.

To be able to assess the phosphorus consent further it was agreed between the Environment Agency and AWS that it would be assumed that the upstream water quality was improved (through addressing diffuse pollution) so that 'good' status was being achieved. 5.7 presents the revised results for phosphorus at eleven of the STWs.

Table 5.7: Phosphorus Consents

Sewage Treatment Works	Phosphorus Consent		
	Existing	WFD & Observed Water Quality	WFD & Improved Water Quality
Canwick STW	-	0.04	0.34
Reepham STW	-	#	0.21
Dunholme STW	-	#	0.25
Nettleham STW	-	#	0.33
Saxilby STW	-	0.04	0.22
North Hykeham STW	-	#	1.68
Metheringham STW	-	#	0.24
Skellingthorpe STW	-	#	0.25
Washingborough STW	-	#	0.61
South Hykeham STW	-	#	0.23
Swinderby STW	-	#	#

- standard cannot be achieved

Assuming that the upstream water quality has been improved would at least allow the STWs to discharge some phosphorus, with the exception of Swinderby STW. However the numbers are extremely low; the current limit of conventional wastewater technology is capable of treating phosphorus to a level of 1mg/l. Consequently the STWs would require the use of advanced technologies with high cost and energy consumption which is likely to be unsustainable.

However, the purpose of the water quality assessment was to determine the effects of the forecast growth for Lincoln and if growth would mean the WFD standards could not be achieved. Table 5.8 presents the results of increasing the discharge from three STWs in light of potential growth that may be experienced and the impact it would have on the discharge consent.

Table 5.8: Impact of Growth on Consents Required to meet the WFD

STW	Scenario	DWF (m ³ /d)	Discharge Consent (mg/l)		
			BOD	Ammonia	Phosphorus
Canwick	To meet WFD	32,502	9.00	1.46	0.34
	Plus 17,000 extra Houses	39,901	8.60	1.37	0.33
North Hykeham	To meet WFD	5,288	68.43	17.05	1.68
	Plus all SHLAA data & SEQ Max	8,439	45.89	11.13	1.17
South Hykeham	To meet WFD	1,250	9.43	1.90	0.23
	Plus all SHLAA data & SEQ Max	3,976	7.44	1.24	0.19

It is notable, particularly in the case of Canwick, the main STW serving Lincoln, that a considerable increase in the number of houses being served will not significantly tighten the discharge consent standard beyond what would be required to meet 'good' status under the WFD.

Consequently water quality should not present a barrier to growth, rather the WFD is going to be a significant challenge for the Environment Agency to meet and will require guidance at a national level as to how the issue of phosphorus should be dealt with.

Future Action 5.10 – The Environment Agency to address the issue of phosphorus under the WFD.

5.4 Expansion of Canwick STW & Flood Risk

Focusing future development at Canwick STW means that AWS will need to expand the STW to be able to treat the increase in foul flows it receives. It will also be necessary to increase the volume of treated effluent that is returned to the environment. As water quality was considered above so it is appropriate for the WCS to provide a consideration of what impact the increased discharge might have on flood risk.

It has already been stated earlier in the document that there is considerable uncertainty concerning the levels of growth and location of growth. Therefore in terms of assessing the increased discharge from Canwick STW a worst case scenario was developed. It has been assumed throughout this study that a further 14,537 homes are required within the LPA to achieve the Regional Plan target of 25,170 new homes by 2026. To assess the potential flood risk, it was assumed that Canwick STW has no spare capacity and that all new homes would be built within the Canwick sewerage catchment area.

In doing so, in line with AWS' approach to foul water it was assumed that there are 2.27 people per house, who consumed 208 litres of water per day (includes an allowance for commercial flows and infiltration). The additional flow was combined with the existing consented Dry Weather flow (cDWF) of 29,400 m³/d, which was subsequently increased by 20% to make an allowance for headroom (uncertainty) and natural variability in the weather. This generated an increased DWF of 44,650 m³/d.



The Environment Agency's hydraulic river model of the River Witham was utilised to assess the impact of increasing the discharge from Canwick STW from 29,400 m³/d to 44,650 m³/d. The model has been verified by the Environment Agency.

The model did not include the discharge point from Canwick STW therefore this was added to the model for the current cDWF of 29,400m³/d to establish water levels in the base case. The inflow was subsequently increased to 44,650m³/d and the model re-run so that the impact on water levels could be assessed. The model was run for a range of return period events to assess if the impact of increasing discharge was greater at low flows rather than flood flows. The results of the analysis indicated that the increased DWF would only have a very small impact on water levels of the order of 5mm across all flow events. Whilst the DWF from Canwick STW is increasing significantly, the inflow is still very small in comparison to the volume of water already flowing in the South Delph; the watercourse which the STW discharges into. Sandhill Beck is a small watercourse that flows into the South Delph in the vicinity of the outfall from Canwick STW, the increased discharge from the STW had a very localised impact on water levels along Sandhill Beck which was restricted to the confluence with the South Delph.

The Environment Agency has advised that this small increase in water levels does not pose a significant flood risk and mitigation would not be required.

Surface Water Drainage



6 Surface Water Drainage

6.1 Introduction

Urban areas, such as Lincoln, are predominantly comprised of impermeable materials. Consequently, to avoid a buildup of water on the ground surface, rainfall has historically been channelled away as quickly as possible via sewers. These sewers can be pipes carrying just surface water discharging to watercourses or combined sewers which drain to a STW. The sewers running under the streets of urban areas are of a fixed capacity therefore new development which increases the amount of water getting into the sewers could overwhelm the system resulting in surface water flooding. Surface water is also drained via IDB drains and ordinary watercourses.

Historically, surface water flooding has received relatively little attention in the UK in comparison to fluvial flooding. There have been many documents produced concerning flooding such as CFMPs, Shoreline Management Plans (SMPs) and varying levels of flood risk assessments (Regional, Strategic and site specific), but none of these have addressed surface water adequately to date. However, the growing UK population and effects of climate change mean that surface water flooding could become a much more common occurrence. In light of this a different approach to surface water management is required.

Flooding can also arise when intense rainfall cannot get into the sewers quickly enough and subsequently flows over the ground surface, or when prolonged rainfall exceeds the capacity of the sewer system. As a result of this surface water flooding can happen anywhere making it difficult to predict or manage.

6.2 Existing Situation

The existing situation relating to surface water drainage is complicated by the following;

- Responsibilities for surface water drainage fall across several different organisations; AWS are responsible for public surface water sewers and combined sewers, Lincolnshire County Council for highway drains, IDBs for arterial drains within their district, the Environment Agency for Main Rivers and members of the public for riparian watercourses and private sewers.
- Different design standards are used by the various authorities.
- Systems are interconnected, and various configurations exist e.g. highway drains discharge to surface water sewers which discharge to main rivers, or surface water sewers discharge to arterial drains which are pumped into main rivers, or combined sewers discharge to STWs. Networks vary between sub-catchments and tend to be site specific.
- Often, the adequate functioning of a surface water system depends on the conditions in the receiving system.
- There are significant lengths of combined sewers within Lincoln where surface water is conveyed along with foul sewage.

As a result of this complexity, it is essential that organisations work together to provide an integrated approach to urban drainage issues and surface water flooding. The need to consider an integrated approach to the overall urban drainage has been recognised for some time, and 15 pilot studies were commissioned by Defra to review related issues in 2007. One of these pilot studies was based on Lincoln and some of the key data and outcomes of the Lincoln Integrated Urban Drainage (LIUD) Pilot study are referred to in the following section.

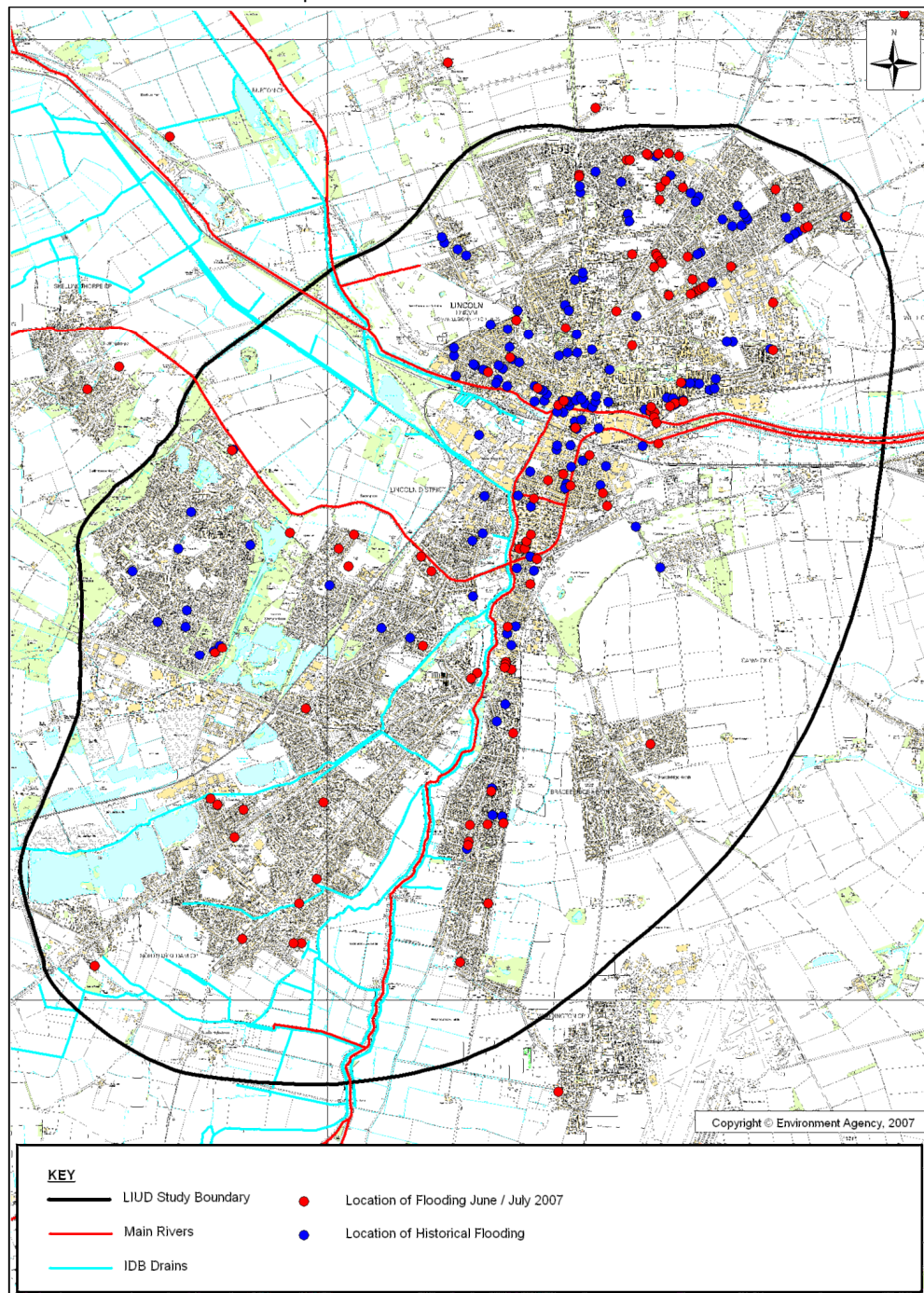
6.3 The Lincoln Integrated Urban Drainage Pilot

6.3.1 Database

The LIUD Pilot was commissioned by Defra to review issues associated with urban drainage. A key output from the LIUD was a database of historic flooding. This was primarily comprised of instances that occurred during the summer of 2007 whilst the LIUD was ongoing, but was supplemented with data from Lincolnshire County Council covering the 1980s and 1990s.

Figure 6.1 presents this historic data concerning surface water flooding.

Figure 6.1: Pluvial Flood Data Collated as part of the LIUD



6.3.2 Managing Surface Water through the Lincoln Drainage Group

Perhaps the key outcome of the LIUD for Lincoln was the creation of the Lincoln Drainage Group. The Lincoln Drainage Group is a partnership of competent authorities with a common interest in ensuring that all significant new developments implement appropriate drainage solutions so as to avoid creating a flood risk for the future. The expertise of the Drainage Group members is used to collectively identify the most appropriate drainage solutions.

The Group enables organisations with drainage expertise who are not statutory consultees in the planning process, to comment on assets which they may have to adopt in the future. It is hoped that identifying the most appropriate means of draining a site at the planning application stage will avoid many of the problems currently faced in a number of areas of the city. These problems

have arisen because planning permission is often granted on the assumption that SUDS will be able to provide a suitable solution. At present there is the potential for a developer to choose the 'least cost option' rather than the option that best fits the particular circumstances.

The Drainage Group informs development plans, infrastructure planning, asset operation and maintenance. It also works towards addressing existing urban drainage problems and new ones that may arise.

The objectives of the Drainage Group, have been summarised as:

The Drainage Group for Lincoln, through a partnership approach, will consider planning applications, identify appropriate mechanisms of drainage and ensure that appropriate drainage schemes are implemented, as well as addressing existing operational problems.

Similar drainage / flood groups led by local authorities also exist elsewhere in Lincolnshire and around the country.

6.3.3 Stamp End

During the summer of 2007 the Stamp End area of Lincoln was subject to surface water flooding. A review of the flooding was incorporated into the LIUD which revealed an interaction between the surface water sewers and the receiving watercourse although a number of other systems are believed to have played a role in the flooding. The issue is yet to be resolved and as was highlighted in Section 5 is the cause for all of the SHLAA sites in North Lincoln to have been classified Red for sewerage.

Future Action 6.1 – AWS to continue investigating the flood problem at Stamp End.

6.4 Surface Water Flooding

Stamp End is one of a number of sites in Lincoln, and across the Central Lincolnshire HMA where there are problems associated with surface water drainage however overall there is a lack of information concerning surface water. As stated in Section 6.1 surface water flooding can happen anywhere and tends to be a short lived phenomenon meaning that many problems often go unreported. In addition to a lack of detail concerning flood incidents there is also a lack of data concerning surface water conduits.

AWS have a very limited number of models covering their surface water sewers which cover only a very small fraction of the Central Lincolnshire HMA and there is relatively little data available concerning ordinary watercourses, highway drains and privately owned sewers. Whilst models do not exist for IDB drains, the IDBs have an excellent working knowledge of their districts.

In light of the uncertainty associated with surface water flooding and the lack of detail concerning surface water networks it has been concluded that it is not possible for the WCS to provide an assessment of their existing capacities and how this might be affected by future development. A precautionary approach has therefore been taken whereby all development has been classified as Amber and will require a site specific assessment for surface water should it come forward in the planning process.

6.4.1 Future Management of Surface Water

Management of surface water flooding is in the process of changing. The Flood and Water Management Act 2010 is designed to improve the UK's resilience to future flooding threats that are likely to be intensified by climate change. The Act received Royal Assent on the 8th April 2010 and implements the recommendations of Sir Michael Pitt's report after the 2007 floods. The Pitt Review called for a better spread of information in the event of flooding and clearer guidelines on which local and government agencies would take responsibility.

Local councils will be given responsibility for surface water flooding for the first time, but the Act gives overall responsibility for flooding to the Environment Agency. It will also require house builders and developers to incorporate drainage that minimises flood damage and improves water quality at new building developments. To encourage the uptake of sustainable drainage systems the automatic right to connect to sewers is to be removed and provision made for unitary and county councils to adopt SUDS for new developments and redevelopments (as referred to in Section 6.7).

In Lincolnshire the County Council, District Councils, Environment Agency, Anglian Water, Internal Drainage Boards and the NFU are already working together to develop an inclusive partnership framework to ensure facilitation of a co-ordinated approach to all aspects of flood and drainage risk management across the county. The County Council is leading this initiative with strong support from partners.

The Lincolnshire Flood Risk and Drainage Management Framework is designed to provide co-ordinated management and delivery of flood risk and drainage functions of all relevant organisations across Lincolnshire. The framework implements the recommendations of the Pitt Review and the provisions of the Flood and Water Management Act in a way that is tailored to suit the geographical, social, economic and environmental characteristics of Lincolnshire. Its purpose is to ensure that local communities and infrastructure are better protected from flood risk, and that improved resilience towards flooding is built into all aspects of planning and service provision in the future.

The Framework comprises two groups; the Strategy Group and the Operations Group. The Strategy Group is an initiative unique to Lincolnshire, and is gaining a national profile. Its purpose is to ensure that the strategic direction of the Environment Agency's flood and coastal risk management overview role is integrated with that of the new leadership role of the lead local flood authority. It will be led by the Environment Agency.

The Operations Group delivers the responsibilities of the lead local flood authority. It will be led by Lincolnshire County Council with support from the Environment Agency, District Councils, Anglian Water and Internal Drainage Boards through the Lincolnshire branch of the Association of Drainage Authorities. Its role is to co-ordinate key countywide functions, empowering the Local Flood Risk and Drainage Groups to deliver flood risk management and drainage solutions at the local level.

It will produce the local flood and coastal flood risk strategy and co-ordinate delivery by partner organisations. As well as ensuring that countywide strategic resources are in place, such as the flood risk asset register and shared information systems, the group will work to resolve specific issues as they arise. This will include addressing uncertainties over individual partners' flood risk and drainage management roles and responsibilities, strategic issues in respect of a particular development, or local issues as and when referred by a local delivery group.

6.4.2 *Surface Water Flood Risk*

The Flood Risk Regulations 2009 transpose the Floods Directive in England and Wales and require Lead Local Flood Authorities (LLFAs), which are County and Unitary Authorities, to:

- Carry out an assessment of "local flood risk", which means considering all sources of flooding except that from Main Rivers, the sea and reservoirs by June 2011. This needs to be done taking account of Main Rivers, the sea and reservoir flooding if they affect local flood risk;
- On the basis of this assessment, identify Flood Risk Areas, which are areas of significant risk, taking into account local sources of flood risk and having regard to national thresholds and Environment Agency Guidance by 22 June 2011;
- Prepare maps showing the level of hazard and risk in Flood Risk Areas by June 2013, and
- Prepare management plans for these Flood Risk Areas by June 2015.

The management plans will need to bring together these different elements, as well as set objectives and measures that relate to the prevention of flooding, protection of individuals, communities and the environment against the consequences of flooding, and arrangements for forecasting and warning.

The first stage is for the competent authorities to prepare a Preliminary Flood Risk Assessment (PFRA) that considers general flood risk from all sources to enable authorities to proceed to the second stage, which involves identifying areas of significant flood risk (Flood Risk Areas). LLFAs are responsible for assessing risk from local sources of flooding, i.e. surface water, groundwater, ordinary watercourses, canals and flooding from lakes within their areas. They will also need to take into account impacts of flooding from Main Rivers, the sea or reservoirs on risk from local sources. The Environment Agency is responsible for assessing flood risk from Main Rivers, the sea and reservoirs.

These PFRAs appear to be very similar to Surface Water Management Plans (SWMPs) which have been promoted by Defra to understand and resolve complex and high risk surface water flooding problems. Lincolnshire County Council will need to undertake a PFRA incorporating the Central Lincolnshire HMA that will include an assessment of surface water. It is therefore recommended that when the results of the PFRA become available they are used to inform the surface water RAG status in this WCS.

The letter and associated guide sent to Local Authorities in England and Wales regarding the implementation of the Flood Risk Regulations can be found in Appendix D.

Future Action 6.2 – Surface Water RAG status to be reviewed following completion of PFRA.

6.5 Design Standards

Section 6.2 touched upon the fact that there are a variety of different standards applied to different systems. Highway drainage would usually be designed for a 1 in 2 year event, surface water sewers should not surcharge for a 1 in 30 year event and the 1 in 100 year event is often the focus of fluvial flooding.

New developments also have differing design standards applied to them. For discharge into a Main River or an Ordinary Watercourse, outside of Internal Drainage Board Districts, the discharge rate will be based on the calculated pre-development (greenfield) run-off rate for the site and for a simple control structure will be based on the QBAR rate. This should be agreed in discussions with the Environment Agency.

If complex controls are to be used for control of discharge rates, calculations for the greenfield run-off rate should be provided for the 1, 30 and 100 year return periods. The methodology set out in the Environment Agency/Defra document "Preliminary Rainfall Runoff Management for Development (W5-074/A/TR1)" should be used as the basis for calculations.

A similar approach may be applicable for discharge to an IDB controlled watercourse however early discussions with the appropriate IDB are essential to ensure that discharge rates consider the design standard of the systems downstream especially if within a pumped catchment which will have a fixed discharge rate based on historic agricultural rates.

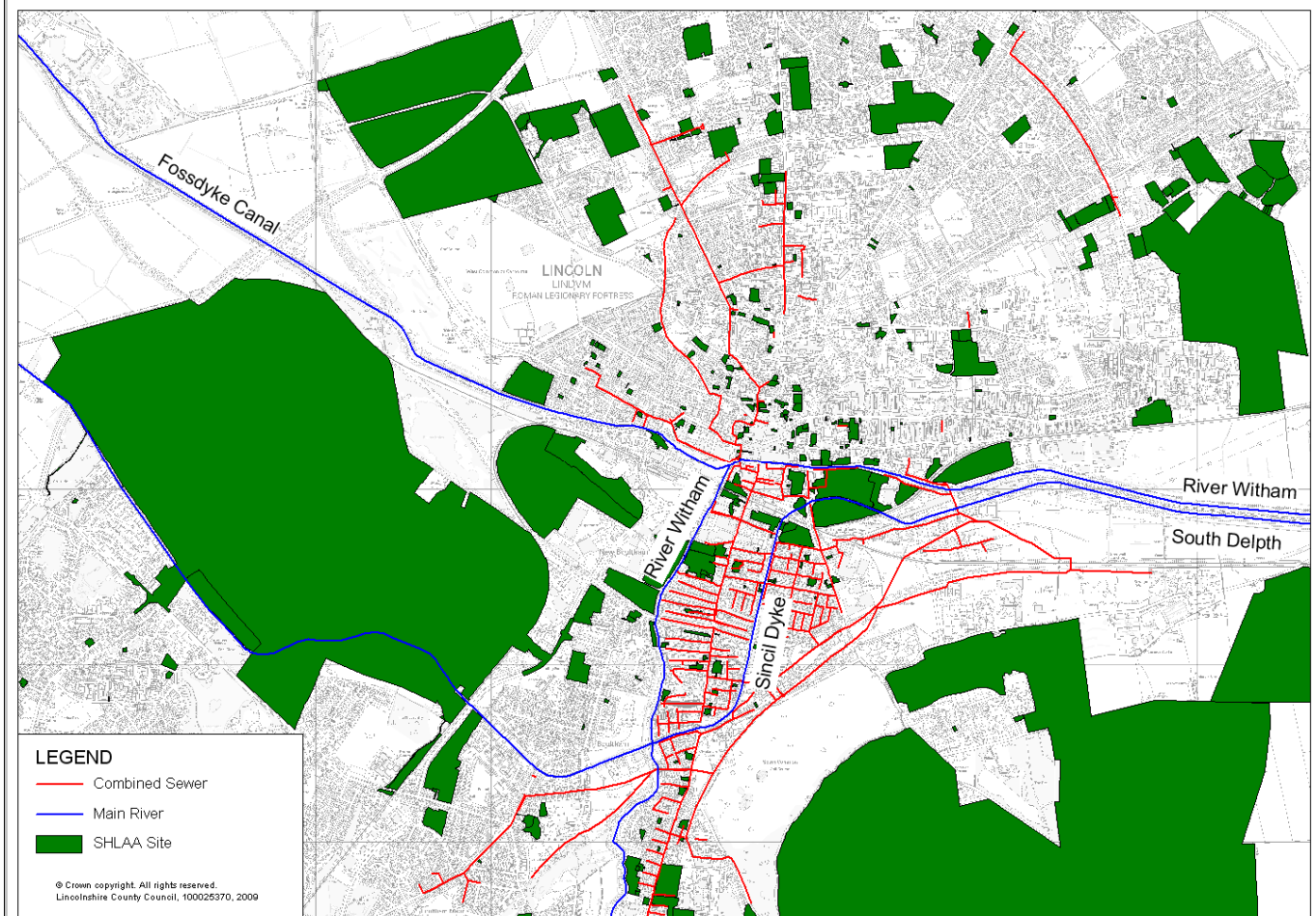
6.6 Surface Water Sewers & New Development

Developers usually prefer for the surface water sewers draining their sites to be adopted by the local water company. Under Section 106 of the Water Industry Act 1991, developers have the right to connect drainage from roofs and paved areas within the curtilages of dwellings within their development where there is an existing surface water sewer available. In order for the water company to take on responsibility for the sewers they should be designed in accordance with *Sewers for Adoption* which provides guidance on the standards of design.

If a developer provides a new surface water sewer which discharges directly to a watercourse this may also be offered for adoption by the water company. This is generally acceptable to AWS where the sewer meets the required engineering specification. The developer is however responsible for obtaining the 'right to discharge' from the riparian owner and consent from the Environment Agency or IDB where appropriate for the outfall structure. The IDB's consent is also required for discharge to a watercourse within their district whether the discharge is direct or via a public or private sewer or SUDS system. This is to ensure that the ability of the watercourse to accept increases in flows is not compromised.

In areas of central Lincoln where combined sewers exist (Figure 6.2), AWS would seek that as part of any re-development of brownfield sites, the foul and surface water flows were separated. The foul flows continuing to go into the combined sewer network but not the surface water. Rather the surface water would be dealt with on site or channelled into new surface water sewers. The obvious benefit of this is that removing surface water flows creates additional capacity for foul flows both in the combined sewer pipe, and hydraulically at the STW.

Figure 6.2: Combined Sewers in Central Lincoln with respect to SHLAA sites



The immediate issue that would arise if a new surface water sewer was planned is that it would require a watercourse to discharge into. This could have the effect of increasing the flood risk at that point. Based on Figure 6.2 the main area of potential for separating the combined flows would appear to lie between the WGC and SEQ. This area has extensive combined sewers and is in close proximity to the River Witham and Sincil Dyke. The Environment Agency is not currently allowing any additional discharge into the Sincil Dyke other than those it already receives as it is a relief channel around Lincoln. They are also conscious of the impacts of climate change and the pressures it places on the River Witham defences, which could be exacerbated by additional surface water flows into the river.

In light of the potentially negative impact on the river system of uncontrolled rates of discharge from surface water sewers a detailed assessment would be required before separation of combined sewers could occur. Given that the three proposed SUEs are to be located on Greenfield sites, separation will not be an issue. However the SHLAA sites that may get developed could fall on brownfield land and have the potential for separation. Generally, proposals that involve surface water drainage / sewerage alterations are difficult to prescribe and assess at an early stage due to the complexity and range of issues including asset condition, existing and proposed development detail, ownership, cost benefit, etc. It is also recognised that the cost of study, design and implementation required should ideally be allocated appropriately to the various beneficiaries. In practice it will be unrealistic to expect that detailed proposals could be provided at Core Strategy stage.

Future Action 6.3: The options for surface water separation should be considered further at the Implementation Stage through a feasibility study.

All surface water should follow the Greenfield rule and Brownfield sites should try to achieve a significant reduction of discharge, ideally 30% to account for climate change.

6.7 Sustainable Drainage Systems

Traditional drainage is designed to move rainwater as rapidly as possible from the point at which it has fallen to a discharge point, either a watercourse or soakaway. This approach has a number of potentially harmful effects:

- Runoff from hard paving and roofing can increase the risk of flooding downstream, as well as causing sudden rises in water levels and flow rates in watercourses.
- Surface water runoff can contain contaminants such as oil, organic matter and toxic metals. Although often at low levels, cumulatively they can result in poor water quality in rivers and groundwater, affecting biodiversity, amenity value and potential water abstraction. After heavy rain, the first flush is often highly polluting.
- By diverting rainfall to piped systems, water is stopped from soaking into the ground, depleting groundwater and reducing flows in watercourses in dry weather.

In recent years there has been a change of thinking; from the historic view of removing rainfall from urban areas as quickly as possible via the sewer network, to managing the water in-situ. This has the effect of reducing the need to upgrade the sewer networks and reduce the risk of flooding. Sustainable Drainage Systems (SUDS) have come to the fore as a means of managing surface water at source. Government guidance in the form of the SUDS Manual (CIRIA 697) promotes the use of SUDS to provide protection against flooding downstream of new developments and as a means of protecting the water quality and amenity of any receiving watercourse.

SUDS include tried-and-tested techniques that are already being implemented on a range of projects and they incorporate cost-effective techniques that are applicable to a wide range of schemes. Planning Policy Statement 25 emphasises the role of SUDS and introduces a general presumption that they will be used; indeed going forward it is hoped that SUDS of one form or another will be incorporated into 75% of new developments. As with other key considerations in the planning process, incorporating SUDS needs to be considered early in the site evaluation and planning process, as well as at the detailed design stage.

The ongoing maintenance of SUDS is a complicated issue and has had the effect of limiting the take up of SUDS. Very rarely would Local Authorities, Internal Drainage Boards, or the Environment Agency agree to take over the long-term maintenance of any SUDS installations. As such developers have been known to set up Management Companies to maintain SUDS where residents can be required to contribute towards annual maintenance costs. However, these arrangements may not be sustainable in the longer term.

The Flood and Water Management Act 2010 is set to bring about changes to facilitate the uptake of SUDS.

Future Action 6.4 – Developers to use SUDS wherever possible with due regard to the constraints associated with the specific site.

Lincolnshire County Council will become the approving and adopting body for all SUDS. All drainage systems in new developments and redevelopments, including SUDS schemes will need to be approved by Lincolnshire County Council before construction can commence. It is also proposed that S106 of Water Industry Act 1991 will be amended to make the right to connect surface water run-off to public sewers conditional on approval of the site drainage plans. Should the SUDS scheme serve more than one property Lincolnshire County Council would subsequently adopt and maintain the scheme where constructed as approved. It will be important for schemes to be accompanied by maintenance plans to ensure that the effectiveness of schemes does not decrease over time.

A national specification is to be developed for SUDS which could follow a similar format to PPS25, where it will be expected that all new developments should incorporate SUDS unless 'testing' can prove otherwise. The testing is likely to apply to both implementation of SUDS and the type of SUDS to be implemented. Ideally the runoff should be managed on site, if that is not possible testing will determine if it can be managed local to the development or regionally in an amenity space.

The SUDS approach to drainage incorporates a wide variety of techniques and as a result, there is no one correct drainage solution for a site. In most cases, a combination of techniques, using the Management Train principle, will be required. The elements of the Management Train are outlined below.

6.7.1 Source Control

Green roofs can improve water quality and reduce the peak flow and the total volume discharged from a roof. In addition, they can enhance insulation and increase the lifespan of the roof. Rainwater reuse (or harvesting) involves the collection and storage of rainwater on site and its use as a substitute for mains water, for example in watering gardens or for flushing toilets.

The need for surface water drains and off-site sewers can be reduced or eliminated where runoff is encouraged to permeate through a porous pavement, such as permeable concrete blocks, crushed stone or porous asphalt.

Depending on the ground conditions, the water may infiltrate directly into the subsoil or be stored in an underground reservoir (for example, a crushed stone layer) before slowly soaking into the ground. If infiltration is not possible or appropriate (for example, because of ground contamination), an impermeable membrane can be used with an overflow to keep the pavement free from water in all conditions. Pollutant removal occurs either within the surfacing or sub-base material itself, or by the filtering action of the reservoir or subsoil.

6.7.2 Infiltration Techniques

An infiltration trench is a shallow, excavated trench that has been filled with stone to create an underground reservoir. Storm water entering the trench is gradually infiltrated into the ground. Their longevity can be enhanced by providing pre-treatment of the storm water using a filter strip, gully or sump pit to remove excessive solids.

Filter drains are widely used by highway authorities for draining roads. They are similar structures through which a perforated pipe runs. This facilitates the storage, filtering and some infiltration of water passing from the source to the discharge point. Pollutants are removed by absorption, filtering and microbial decomposition in the surrounding soil. Systems can be designed to successfully incorporate both infiltration and filter systems.

6.7.3 Swales and Basins

These can be created as features within the landscaped areas of the site, or they can be incorporated into ornamental, amenity and screen-planted areas where they would be looked after as part of the normal maintenance contract. Swales and basins are often installed as part of a drainage network connecting to a pond or wetland, prior to discharge to a natural watercourse.

Swales are grassed depressions which lead surface water overland from the drained surface to a storage or discharge system, typically using the green space of a roadside margin. They may be used to replace conventional roadside kerbs, saving construction and maintenance costs. Compared to a conventional ditch, a swale is shallow and relatively wide, providing temporary storage, conveyance, treatment and the possibility of infiltration under suitable conditions.



A basin is designed to hold back storm runoff for a few hours and to allow the settlement of solids. They are dry outside of storm periods. They provide temporary storage for storm water, reduce peak flows to receiving waters, facilitate the filtration of pollutants (deposited and incorporated into the substrate) and encourage microbial decomposition, as well as allowing water infiltration directly into the ground.

6.7.4 Ponds and Wetlands

Ponds or wetlands can be designed to accommodate considerable variations in water levels during storms, thereby enhancing flood-storage capacity. Although these can be designed as wet or dry ponds, or wetlands, they are most likely to contribute to visual amenity and biodiversity where they include a permanent water body. By allowing adequate detention time, the level of solids removal can be significant. The algae and plants of wetlands provide a particularly good level of filtering and nutrient removal. Ponds and wetlands can be fed by swales, filter drains or piped systems. The use of inlet and outlet sumps enhances performance by trapping silt and preventing clogging of the outlet. Removal of collected sediment from the inlet sump may be needed, although typically this is unlikely to be more than once every seven years.

6.7.5 Geology

The effectiveness and suitability of some of the above SUDS techniques will depend on the ground conditions into which the water permeates. The ground is made up of different layers and the material within each layer will determine how groundwater flows through the catchment. The bedrock is made up of compacted rocks. Above this are less compact rocks, known as drift geology. The top layer is soil. Drift deposits are not always present and when this is the case, the soil is positioned directly on top of the solid geology.

Some types of solid geology can be more permeable than others (e.g. sandstone compared to clay). Permeable bedrock absorbs and stores water, which reduces runoff and can result in rivers taking longer to respond to rainfall events. This reduces peak flows in rivers, and reduces the flood risk as a result.

Where no storage is available, in the less permeable bedrock, less rainfall is absorbed and it can run through the shallow soil strata to the nearest watercourse. The same applies to drift geology (e.g. peat is highly permeable).

6.7.6 Adoption and Maintenance

For SUDS to provide consistent and effective long-term attenuation of runoff from a development, they have to be maintained in an efficient condition for the life of the development. This may involve the control of weed growth in ponds and lagoons, the frequent removal of debris, both natural and man-made, from watercourses and weed screens, the clearance of blockages, sometimes at short notice, from pipes and culverts, and the repair of malicious damage and vandalism. A routine inspection regime is essential to ensure that any such problems are identified and dealt with in a timely manner.

Following the publication of the Pitt Review, the Government made a commitment to resolve some of the barriers to SUDS through the Flood and Water Management Act 2010. This included an announcement that Upper Tier Local Authorities would be given a duty to adopt SUDS drainage systems constructed for new developments. This is an important commitment which will go some way to reducing the impact of new developments on surface water quality and flood risk.

6.8 SUDS & Future Development

In the LPA and wider study area, appropriate SUDS will be required for all new developments whenever practicable. All sites ought to be able to incorporate SUDS to some extent, be it small scale such as permeable pavements and rain water harvesting or larger schemes using swales and soakaways.

The use of SUDS, and the particular technique, is determined by soil type and sub-soil geology in addition to the layout of the development site. Soil types can only be determined by undertaking ground investigations following on from which it will be possible to evaluate the most appropriate SUDS technique based upon the permeability of the soil. In some cases, infiltration techniques may be appropriate, whilst in others, attenuation may be more suitable.

Table 6.1 identifies the geology and permeability in the three major urban growth areas and indicates the types of SUDS which may be suitable. (Developers should check infiltration rates before drainage designs are finalised).

Table 6.1: SUDS & the SUEs

Site	Geology	Soil Type	Soil Characteristics	SUDS Techniques	Source Protection Zone
NEQ	Jurassic Limestone	343a (Elmton 1) Lithomorphous – calcareous over limestone	Shallow, well drained fine loamy soil. Permeable	(Infiltration) ? Attenuation being considered	Outer
WGC	Mainly Drift over Jurassic and Cretaceous clay or mudstone	711f (Wickham 2) Clay soils – with distinctive topsoil. Stagnogley soil – seasonably waterlogged	Slowly permeable, seasonally waterlogged fine loamy over clayey, fine silty over clayey or clayey soil	Attenuation	Total Catchment
	Glacio fluvial Drift (along SW edge of area)	821b (Blackwood) Sandy clay soil	Deep, permeable sandy and coarse loamy soil	Infiltration and attenuation	
	River Alluvium (along Fosdyke Canal)	813c (Fladbury 2) Pelo alluvial clay soil	Variably affected by ground water. Often sandy sub soil	Infiltration and attenuation – depending on water levels	
SEQ	Jurassic Limestone	343a (Elmton 1)	Shallow, well drained fine loamy soil. Permeable	Infiltration and attenuation	Outer

The Environment Agency have defined Source Protection Zones (SPZs) for 2000 groundwater sources such as wells, boreholes and springs used for public drinking water supply. These zones show the risk of contamination from any activities that might cause pollution in the area. The closer the activity, the greater the risk. There are three main zones (inner, outer and total catchment). The zones are used in conjunction with the Environment Agency's Groundwater Protection Policy to set up pollution prevention measures in areas which are at a higher risk, and to monitor the activities of potential polluters nearby. The "outer" zone, within which both the NEQ and SEQ lie, covers pollution that takes up to 400 days to travel to the borehole, or 25% of the total catchment area – whichever area is the biggest. This travel time is the minimum amount of time that pollutants need to be diluted, reduced in strength or delayed by the time they reach the borehole. The "total catchment" zone in which the WGC falls,

is defined by the Environment Agency as the total area needed to support removal of water from the borehole, and to support any discharge from the borehole. Developers should have due regard to the Source Protection Zone that the SUE, or any development site falls in, since it will influence the type of SUDS technique that is appropriate and will be acceptable.

The site layout will influence the location and type of SUDS. Many forms of SUDS have restrictions on their proximity to structures, for example soakaways must be a minimum of 5m from any adjacent structure. It is important for all new development to ensure that SUDS are investigated during design from the outline stages. Detailed information should be provided in the planning application and be considered by the Lincoln Drainage Group.

All new dwellings should consider permeable driveways that will allow run-off to soak into the ground. Where hard paving systems are required products can be specified that still allow run-off to filter through voids and joints to be stored in the sub-base before further infiltration or connection to a drainage system. In areas where pollution is likely to be a problem, systems which allow microbes to develop to break down pollution should be specified.

Another option that should be considered, especially on larger developments, is the possibility of combining SUDS measures that incorporate surface water storage with the provision of water for fire fighting. There may also be other potential benefits of stored surface water re-use; these should be considered on a site specific basis.

It is also the intention that for proposed significant development as above, and development in 'critical drainage areas' will be considered by the Lincoln Drainage Group to formulate a strategy with the developer for appropriate surface water drainage.

One means of reducing runoff is rainwater harvesting – covered in the previous section of demand management.

It is anticipated that in terms of the SUEs the most practical method will be to establish a strategic approach to draining each of the three sites in their entirety rather than sub-dividing the sites. Strategic balancing ponds are an obvious solution to store and manage rainfall on site rather than channelling it into the nearest watercourse.

Future Action 6.5 – Developers to consider strategic balancing ponds for the SUEs.

Fluvial & Groundwater Flood Risk



7 Fluvial & Groundwater Flood Risk

7.1 Introduction

Many of the UK's major towns and cities, including Lincoln, have developed alongside major bodies of water, in the case of Lincoln, the River Witham and its tributaries. (In the wider study area this also applies to Market Rasen on the banks of the River Rase and Sleaford on the River Slea). As these towns and cities have grown over time they have often expanded into the floodplain, or areas that would have stored flood waters when the capacity of the river channel was exceeded. This in turn has placed people, property and infrastructure at risk of flooding. Flood risk is currently very high on the public agenda in light of the significant flooding that has been experienced across the UK in recent years e.g. Boscastle 2004, Carlisle 2005, Hull 2007, and Cockermouth 2009.



As a consequence of the increasing flood risk, PPS25 seeks to steer new development away from areas at highest risk of flooding and ensure that the existing risk is not exacerbated by new development. The Pitt Review and Flood and Water Management Act 2010 have also served to highlight the risks of flooding and put in place strategies and frameworks to mitigate and manage the risk of flooding.

Strategic Flood Risk Assessments (SFRAs) are at the core of the PPS25 approach. They provide essential information on flood risk, taking climate change into account that allows local authorities to understand the risks so that the Sequential Test can be properly applied when considering new development.

7.2 Fluvial Flood Risk

The Environment Agency has produced Flood Zones for all watercourses classified as Main River and other watercourses with catchment areas greater than 3km² and produced Catchment Flood Management Plans to guide investment in flood risk management. The three Local Authorities have also produced SFRAs for their areas to review all types of flooding with regard to significant development and Internal Drainage Boards exist throughout Lincolnshire managing drainage in areas of low lying land.

7.2.1 Lincoln Policy Area

Lincoln has a history of fluvial flooding from the River Witham, its tributaries and from the River Trent. As a result of which many man-made flood defences have been put in place to protect Lincoln from fluvial flooding, such as the Witham and Till Washlands however, the risk of defences failing continues to pose a threat to the City and surrounding areas. Figure 7.1 illustrates historic flood events that have affected Lincoln.

Figure 7.1: Historic Fluvial Flooding in Lincoln

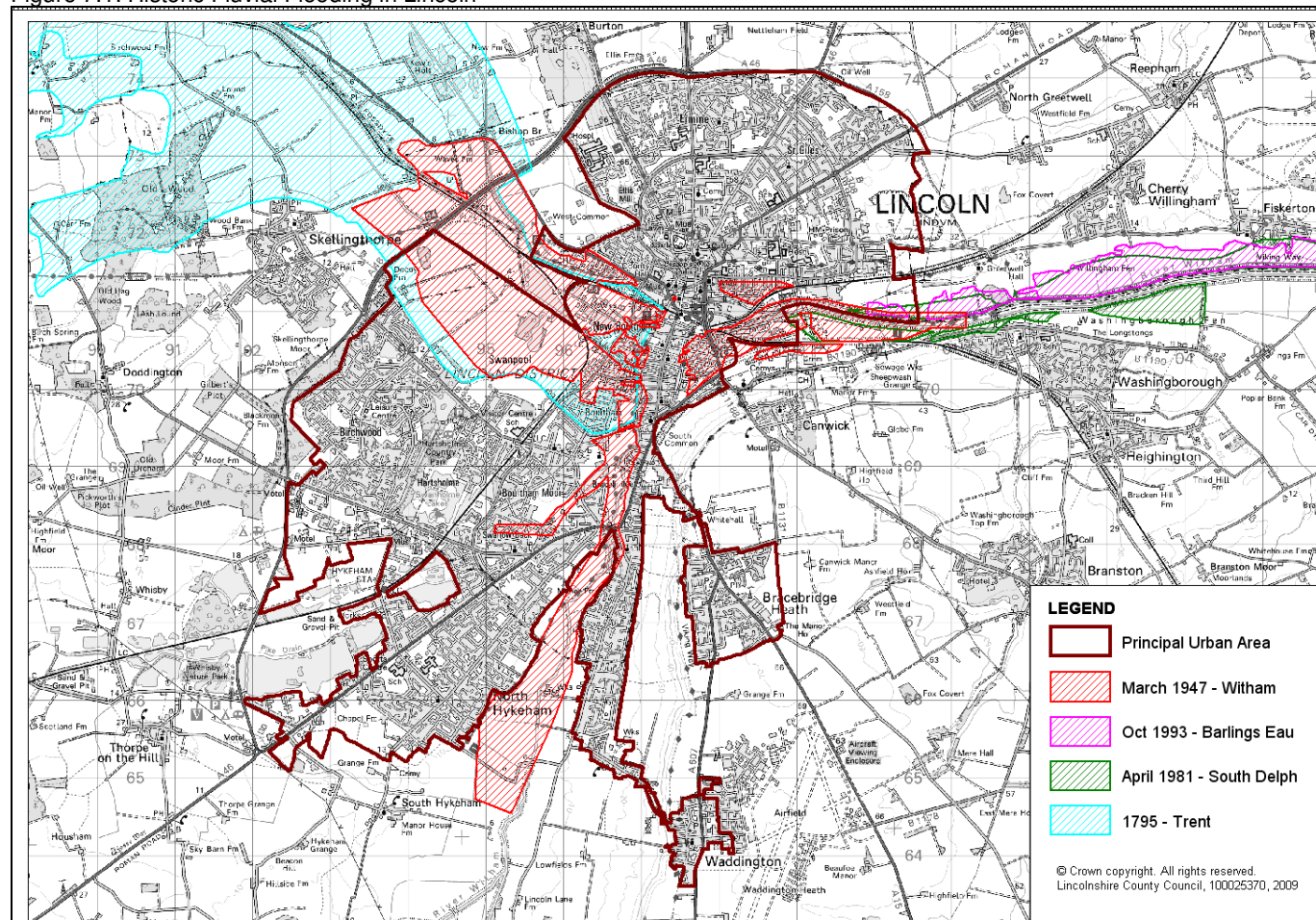
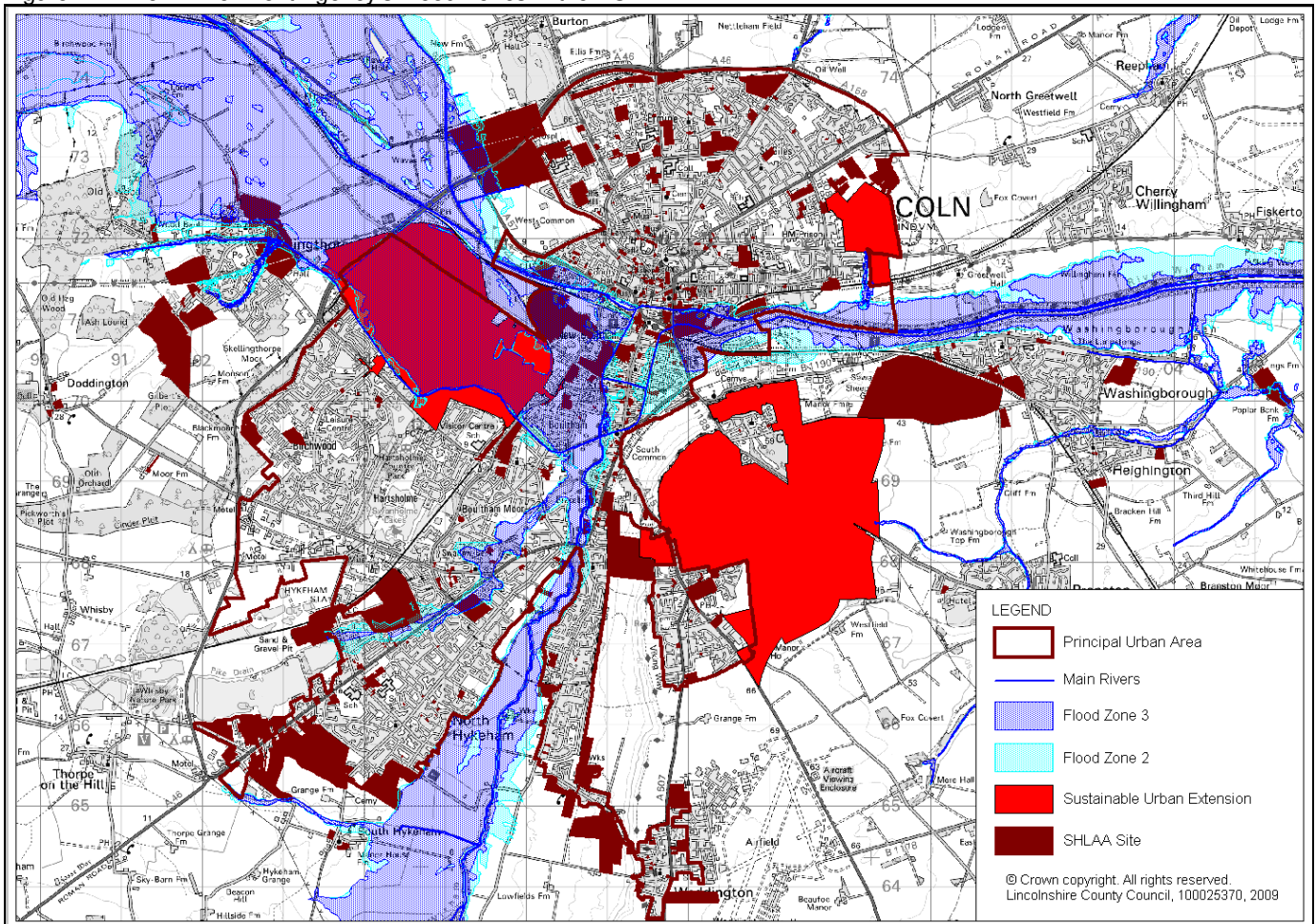


Figure 7.2 presents the Environment Agency's Flood Zones through the Lincoln PUA along with the SHLAA sites and SUEs that are being considered.

Figure 7.2: The Environment Agency's Flood Zones in the PUA



With specific regard to the SUEs, the NEQ lies alongside Greetwell Beck, the Flood Zones of which just impinge upon the site boundary. As a consequence, development of this site will have to ensure that this potential risk is appropriately considered by the site layout and in line with PPS25 ensure that the development does not exacerbate the existing flood risk. Overall the Flood Zones indicate that the fluvial flood risk to the NEQ is small.

The SEQ lies outside of Flood Zones 2 and 3, and its location on top of the Limestone Ridge would suggest that any risk of fluvial flooding is minimal. The eastern site boundary does however cross a tributary of Heighington Beck, upstream of Branston. Development of the site will therefore have to ensure any risk is managed appropriately.

The WGC lies upstream of Lincoln in both Flood Zones 2 and 3. This indicates that the site would be at risk of fluvial flooding if no defences existed and the Environment Agency and Upper Witham IDB are currently objecting to development of the WGC on flood risk grounds. Consequently if development were to occur on the WGC it would need to take due account of the existing residual flood risk and ensure that it did not place people, property or infrastructure at risk of flooding or exacerbate the flood risk elsewhere.

Future Action 7.1 – Ensure that the flood risk associated with all sites that are developed is addressed.

PPS 25 states that the Exception Test should be applied, only after the Sequential Test, to Local Development Documents site allocations for development and used to draft criteria-based policies against which to consider planning applications.

For the Exception Test to be passed:

- A - it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared. If the Development Planning Document has reached the 'submission' stage the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal;

- B - the development should be on developable, previously-developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously-developed land; and
- C - a FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

The River Witham Catchment Flood Management Plan (CFMP) (2008) is a document that has been prepared by the Environment Agency to guide Flood Risk Management over the next 50 to 100 years. It has identified preferred policies of Flood Risk Management for various parts of the catchment. Of key importance to the PUA where the majority of the LPAs growth is to be located are Sub Areas 3 and 4.

Future Action 7.2: Environment Agency to implement Flood Risk Management Policies set out in the CFMP.

Sub Area 4 covers the majority of the existing built up area of Lincoln and has a policy to *“Take further action to sustain the current level of flood risk into the future (responding to the potential increases in risk from urban development, land use change and climate change).”* This acknowledges that the existing flood risk is acceptable however it could get worse in the future and further action is required to manage the risk.

Sub Area 3 has been assigned the policy of *“Take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits, locally or elsewhere in the catchment.”* These have been designated so that if required, they can be used to store flood water as a means of managing the future flood risk to Sub Area 4; the main urban conurbation of Lincoln. This would be in a similar fashion to the existing Washlands on the River Witham and River Till that currently afford flood protection to Lincoln.

The NEQ and SEQ fall within Sub Area 4, however the WGC falls within Sub Area 3 that the Environment Agency wishes to set aside, preventing any development so that the area could potentially be used to provide flood storage if required in the future. This is on the basis of an investigation undertaken to identify means of protecting Lincoln from flooding. A scheme was eventually constructed during the late 1980's, and resulted in the River Witham and River Till Washlands.

In order to arrive at the optimum scheme a number of alternative locations to site the washlands, and a range of standards of protection, were considered to maximise the benefit to cost ratio. The valleys of the River Till and Fosdyke Canal, River Witham, and River Brant, and Shire Dyke and Claypole Drain were all split into possible flood compartments and full hydrological studies undertaken. In identifying possible storage sites the following basic criteria was used;

- Where possible natural contours or existing embankments should be used for limiting the extent of the washlands.
- New lengths of embankments should be kept to a minimum.
- Flooding close to residential property should be avoided where possible.

Costs were calculated for each potential site for the storage volume required to give different standards of protection.

The only site identified in 1982 where major development may take place in the LPA was referred to in the report as site A, South of the Fosdyke Canal. This site is now known as WGC.

The final standard of protection chosen in 1982 was for a return period of 1:100 years and the following costs are all at 1982 prices based on that return period. The optimum cost for the River Witham/Brant site chosen was estimated to cost £6.97m and the Fosdyke Canal/River Till site £4.64m. Site A; the WGC, was estimated at £8.9m and was the most expensive site south of the Fosdyke Canal.

After this initial exercise further discussions were held with the Panel Engineer, appointed in respect of the Reservoirs Act and the following design criteria were adopted;

- Containing embankments should be provided with 150mm of freeboard and protected with concrete revetment.
- Top water levels should be kept as close as possible to river levels expected during the equivalent flood event under existing conditions.
- New upstream embankments should be avoided wherever possible because they could make conditions worse for areas outside and upstream of the washlands.

Each of the areas under consideration were reanalysed and re-costed using the above design criteria and some of the previous washland sites were ruled out. The WGC site was one of those which was ruled out and not considered suitable for storage on its own or in combination with any other site.

As part of the CFMP, all those sites that were previously considered, but rejected by the 1980s study have been incorporated into Sub Area 3. This is on the basis that Lincoln may need additional protection from flooding in the face of climate change, these sites may need to be re-considered for designation as washlands to store flood waters hence the intention of the Environment Agency is to set these areas aside to ensure that they could be considered should the need for a new flood alleviation scheme arise.

It is also apparent from Figure 7.2 that a number of SHLAA sites fall within Flood Zones 2 and 3. On flood risk grounds alone, there would be a preference to develop those sites in Flood Zone 1 rather than Zones 2 or 3.

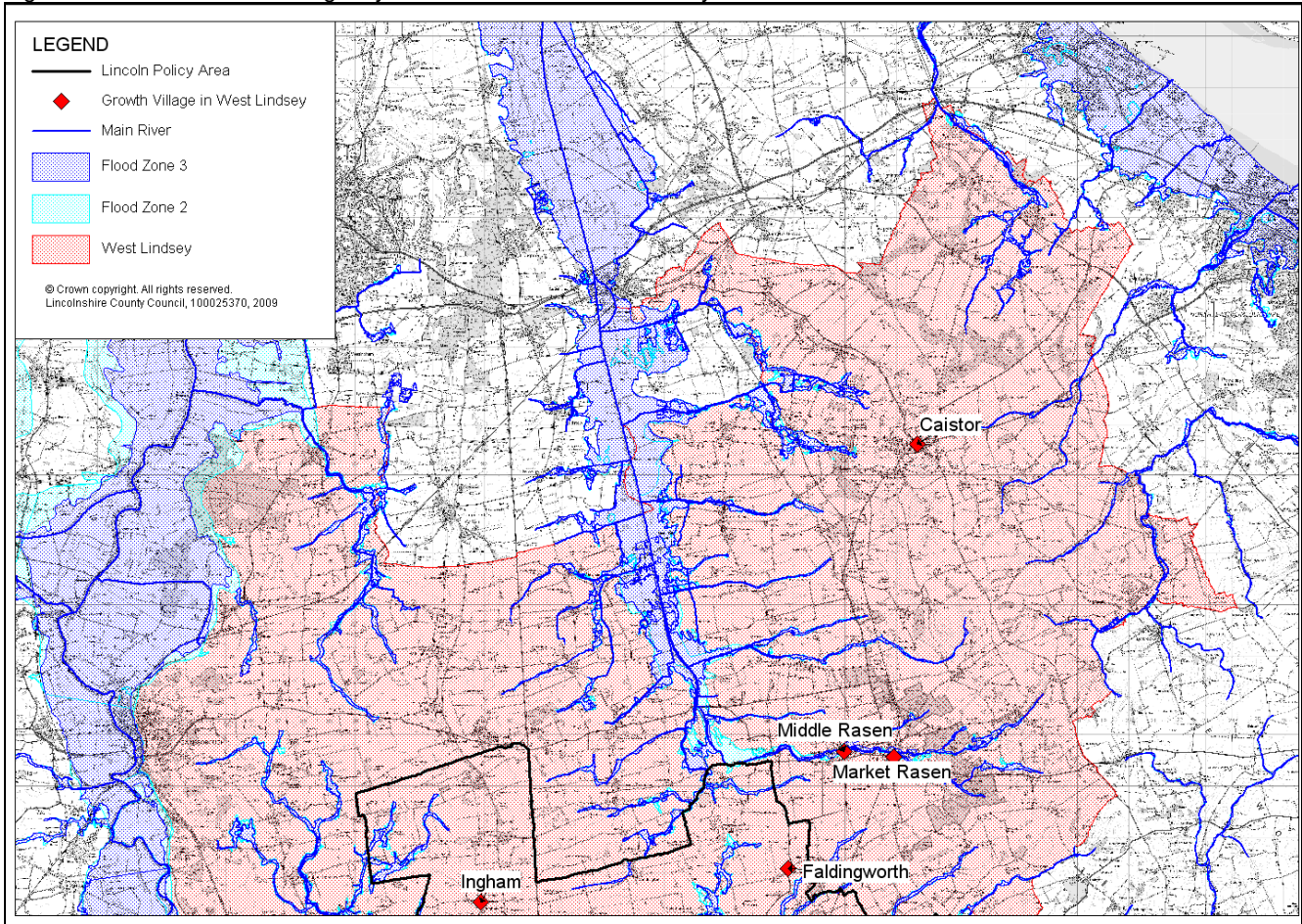
The SFRA for the LPA (February 2010) concludes that the fluvial flood risk is high within the LPA. Whilst the urban area of Lincoln has significant flood protection the effects of climate change could cause the flood defences to be overtopped causing significant flooding to South Western areas of the city. It is noted that the CFMP intends to retain the existing standards of flood defence to combat the effects of climate change. A breach or failure of a flood defence would have a significant effect on the city and would cause widespread flooding. This is particularly relevant to the WGC which falls within an area classified as 'Danger for All' in light of the flood depths that could result from a breach in an embankment. This reflects the Environment Agency's and Upper Witham IDB's objections to development of the WGC on flood risk grounds.

7.2.2 West Lindsey

West Lindsey straddles the watershed between the River Witham to the south and the River Ancholme to the north. Figure 7.3 presents the Environment Agency's Flood Zones for the River Ancholme and its tributaries, the main watercourse being the River Rase flowing through Market Rasen.

The two areas in West Lindsey where there is likely to be significant development (excluding Gainsborough) are Caistor and Market Rasen. Caistor is set well away from the Environment Agency Flood Zones however the River Rase flows through Market Rasen posing a risk of fluvial flooding. Any development in Market Rasen and any of the other villages will need to take due account of potential flooding and ideally be sited outside Flood Zones 2 and 3.

Figure 7.3: The Environment Agency's Flood Zones in West Lindsey

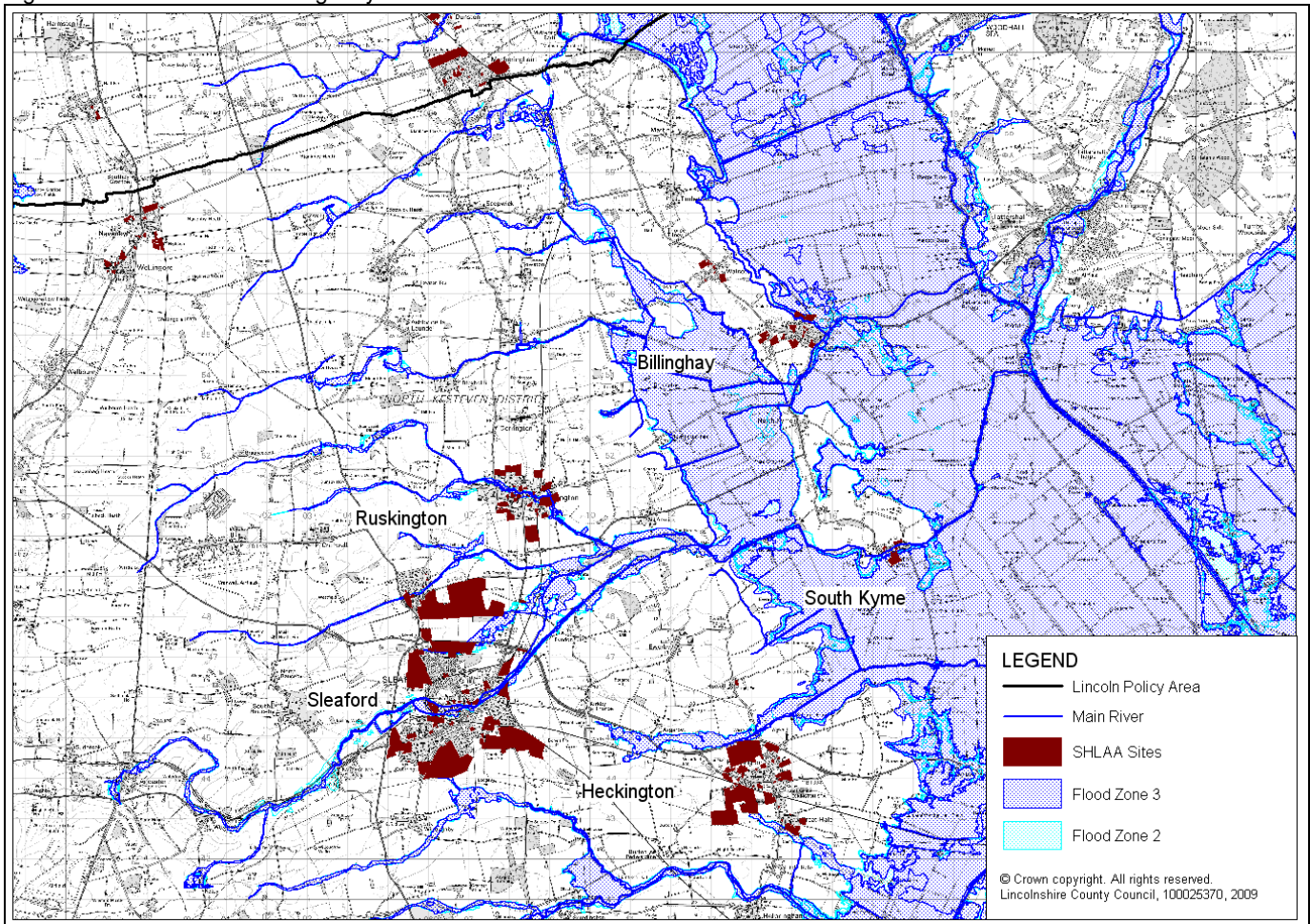


7.2.3 North Kesteven

North Kesteven covers a large and predominantly rural area situated on the western side of Lincolnshire, south of the City of Lincoln. The drainage pattern of North Kesteven, both west and east of the limestone ridge, is dominated by the River Witham. Although the great majority of the district lies within the Witham catchment the south eastern part of the district drains to the South Forty Foot Drain and a very small area on the western fringe of the district drains to the River Trent.

The Environment Agency's Flood Zones across North Kesteven are illustrated in Figure 7.4.

Figure 7.4: The Environment Agency's Flood Zones in North Kesteven



Whilst the towns of Sleaford, Ruskington and Heckington all lie on or in close proximity to a watercourse, those watercourses have relatively narrow or confined Flood Zones. However the SHLAA sites in these three areas and in South Kyme and Billinghay are within the Flood Zones and at risk of fluvial flooding.

7.2.4 Internal Drainage Boards

An Internal Drainage Board (IDB) is a statutory body which provides flood protection and water level management services. IDBs are found across England in low lying areas; three operate within the LPA and a total of eight across the Central Lincolnshire Housing Market Area;

Upper Witham IDB	Gainsborough IDB	Black Sluice IDB
Witham 1 st IDB	Ancholme IDB	Newark IDB
Witham 3rd IDB	Isle of Axholme IDB	

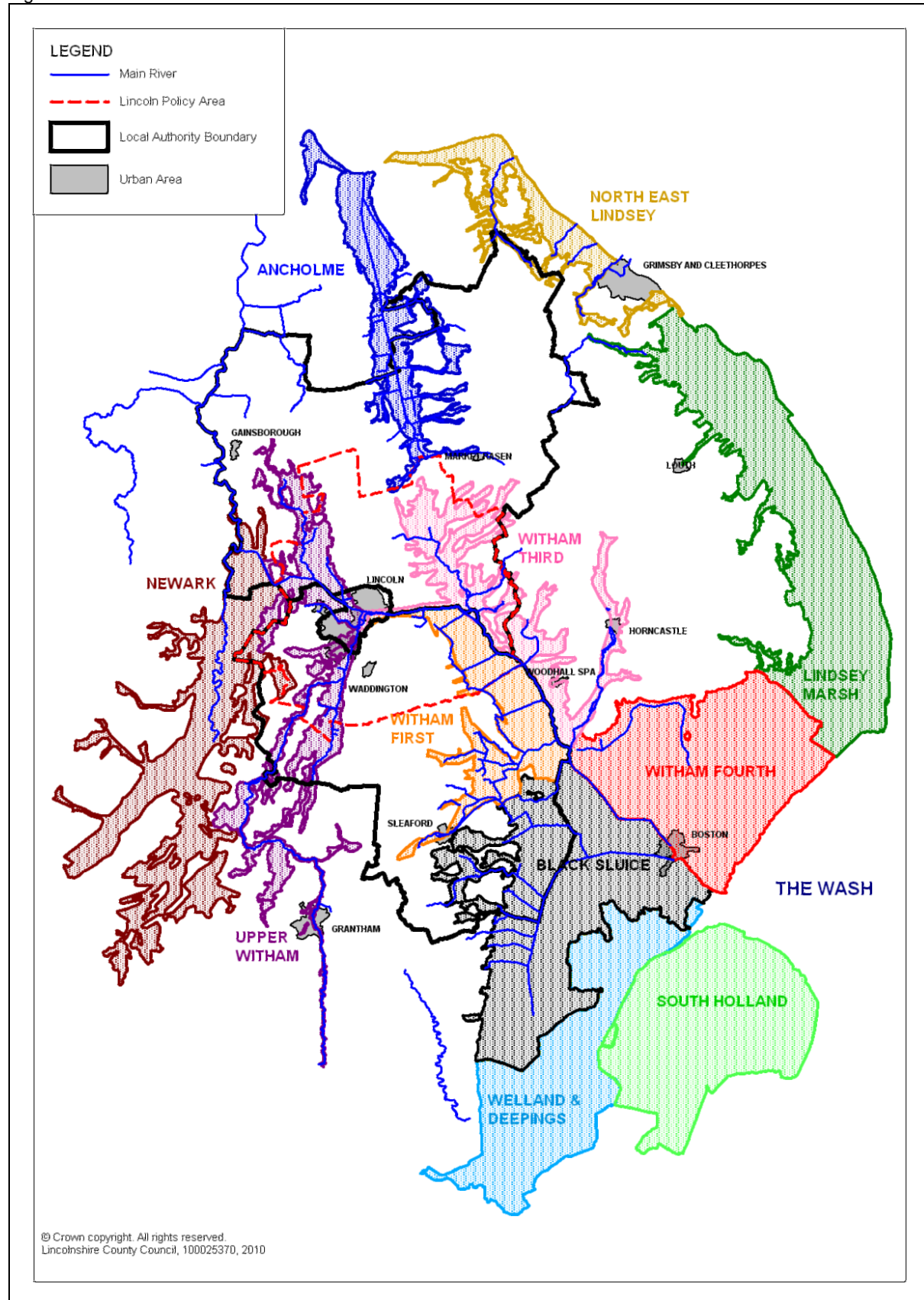
IDBs have permissive powers under the Land Drainage Act to supervise all land drainage matters within their district. IDB maintained watercourses assist in the removal of storm water from low lying areas behind Environment Agency maintained flood defences on the River Witham and the Fossdyke Canal. Pumping stations operated by the IDB's aid in removing this water, and thus reducing flood risk.

IDBs mainly operate in the lower parts of the country where the drainage is often pumped into the higher level main rivers. Land in pump-drained catchments is subject to two main but distinct types of flood risk. The first and more serious is inundation resulting from the overtopping or breaching of the flood defences of the high-level embanked watercourse into which the catchments are pumped. The second is flooding which can arise if the runoff entering the arterial drainage system exceeds the

capacity of the pumps or that of the drainage channels leading to the pumping station. Residual risk flooding could also occur as a result of a mechanical or electrical failure at the pumping station.

Large parts of Lincoln discharge surface water into watercourses under the control of IDBs therefore early discussions with the appropriate IDB could assist in the provision of sustainable solutions to surface water management and disposal. Figure 7.5 illustrates the IDB districts.

Figure 7.5: IDB Districts



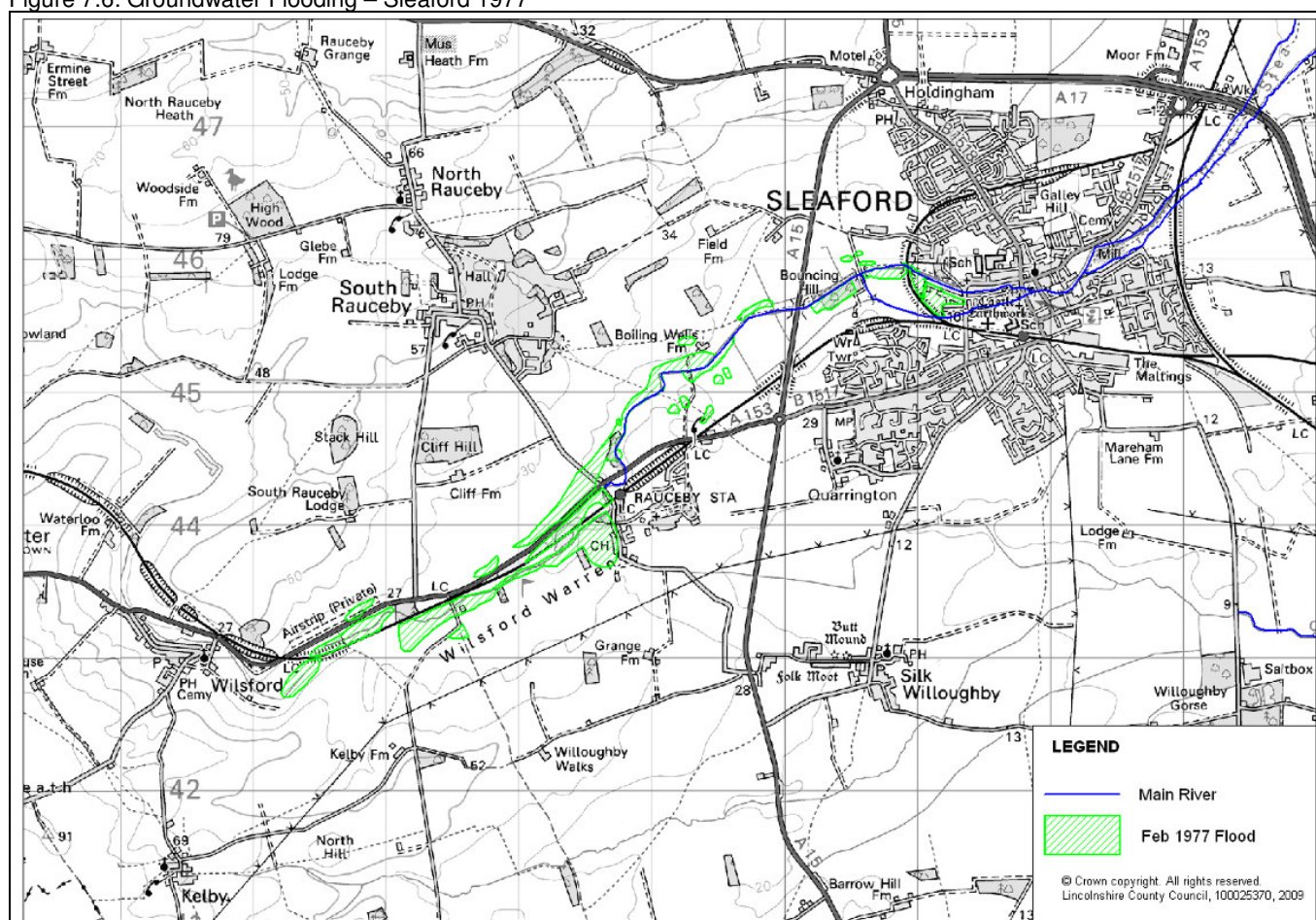
7.3 Groundwater Flooding

Groundwater flooding is often very different to flooding from rivers. It is generally not closely linked to recent rainfall events and it is difficult to predict its spatial extent. Groundwater flooding can often be of a much longer duration than fluvial flooding, lasting for several weeks, with significant social disruption. It is also harder to predict, so flood warning may not be provided.

Groundwater flooding occurs when the water table rises above the ground level and flows or ponds on the ground surface. Long term high rainfall totals are the primary cause of high groundwater levels, which means groundwater flooding is more likely during the winter months when we receive the majority of rainfall. The flooding archive only contains one groundwater flooding incident, the February 1977 flood in Sleaford when 200 acres and one property were flooded (Figure 7.5). However, the flood archive tends to focus on fluvial events and is not considered to be comprehensive, so this figure should be used with caution since there could be many more instances of groundwater flooding that have gone unrecorded.

Groundwater flooding in Heighington and Washingborough has also been identified. Unfortunately no detailed information is available for these incidents. The number of incidents however, suggests that groundwater flooding is not a significant issue.

Figure 7.6: Groundwater Flooding – Sleaford 1977



7.4 Conclusions

It is concluded that fluvial flooding presents a very real threat to the LPA, particularly the WGC and a number of SHLAA sites. Future growth can only occur if the risk is managed in a sustainable way, taking full account of the flood risk via Flood Risk Assessments. Tables 7.1, 7.2 and 7.3 present a RAG classification for potential development in terms of the fluvial flood risk, where;

- **RED** – Majority of SHLAA sites fall within FZ3.
- **AMBER** – At least one site within the map boundary falls within a flood zone and mitigation measures may be required.
- **GREEN** – No sites within the SHLAA map fall within the Flood Zones.

Table 7.1: LPA Flood Risk RAG Status

SHLAA Map No	Area	RAG
	NEQ	AMBER
	WGC	RED
	SEQ	GREEN
Lincoln		
1		AMBER
2		GREEN
3		GREEN
4		GREEN
5		GREEN
6		GREEN
7		AMBER
8		AMBER
9		RED
10		RED
11		GREEN
12		GREEN
13		GREEN
14		RED
15		AMBER
16		AMBER
17		AMBER
North Kesteven		
14	Bracebridge Heath	GREEN
20	N Hykeham	AMBER
21	Bracebridge Heath	GREEN
24	N Hykeham	GREEN
27	N Hykeham	AMBER
36	N Hykeham	GREEN
31	N Hykeham	GREEN
41	N Hykeham	GREEN
33	S Hykeham	AMBER
29	S Hykeham	AMBER
40	S Hykeham	GREEN
56	Bassingham	AMBER
17	Branston	GREEN
54	Coleby	GREEN
44	Dunston	AMBER
11	Heighington	GREEN
49 & 50	Metheringham	GREEN
2 & 4	Skellingthorpe	AMBER
5 & 6	Washingborough	GREEN
43	Witham St Hughes	GREEN
37	Nocton	AMBER
West Lindsey Villages Outside the PUA	Bardney	AMBER
	Burton Waters	AMBER
	Cherry Willingham	GREEN
	Dunholme	AMBER
	Faldingworth	GREEN
	Fiskerton	AMBER
	Hawthorn Avenue	GREEN
	Ingham	GREEN
	Langworth	AMBER
	Nettleham	AMBER
	Saxilby	AMBER
	Sudbrooke	AMBER
	Welton	AMBER

Table 7.2: West Lindsey Flood Risk RAG Status

SHLAA Map No	Area	RAG
N/A	Caistor	GREEN
N/A	Market Rasen	AMBER
N/A	Middle Rasen	AMBER

Table 7.3: North Kesteven Flood Risk RAG Status

SHLAA Map No	Area	RAG
68	Carlton-le-Moorland	GREEN
71	Navenby	GREEN
72	Wellingore	GREEN
75	Walcott	GREEN
83	Billinghay	AMBER
95	Ruskington	AMBER
97	Ruskington	AMBER
100	South Kyme	AMBER
102	Leasingham	AMBER
105	Sleaford	AMBER
107	Heckington	GREEN
110	Sleaford	AMBER
111	Sleaford	AMBER
112	Sleaford	GREEN
113	Heckington	AMBER
114	Sleaford	GREEN
115	Sleaford	AMBER
118	Rauceby	GREEN
119	Heckington	AMBER
121	Wilsford	GREEN
122	Heckington / Great Hale	AMBER

The Environment



8 The Environment

8.1 Introduction

An objective of a WCS is to ensure that the planning process gives due regard to the environmental capacity of the water environment. This relates to giving consideration to potential constraints and risks relating to ecology, nature conservation and biodiversity.

This section presents a strategic overview of the natural environment that could be affected by future potential development and subsequent changes in the water cycle. The primary objective of this appraisal is to describe the key environmental features in the locality of potential development sites.

There is no statutory basis for this environmental appraisal. It is intended to complement, but not replace, the full consideration of ecological issues required during the statutory environmental assessment of proposals arising from the Local Development Framework process – including Strategic Environmental Assessment (SEA), Sustainability Appraisal (SA) and any 'Appropriate Assessment' requirements under the Conservation (Natural Habitats &c.) Regulations 1994, as amended – and any subsequent, more detailed, Environmental Impact Assessments (EIA) required for specific developments.

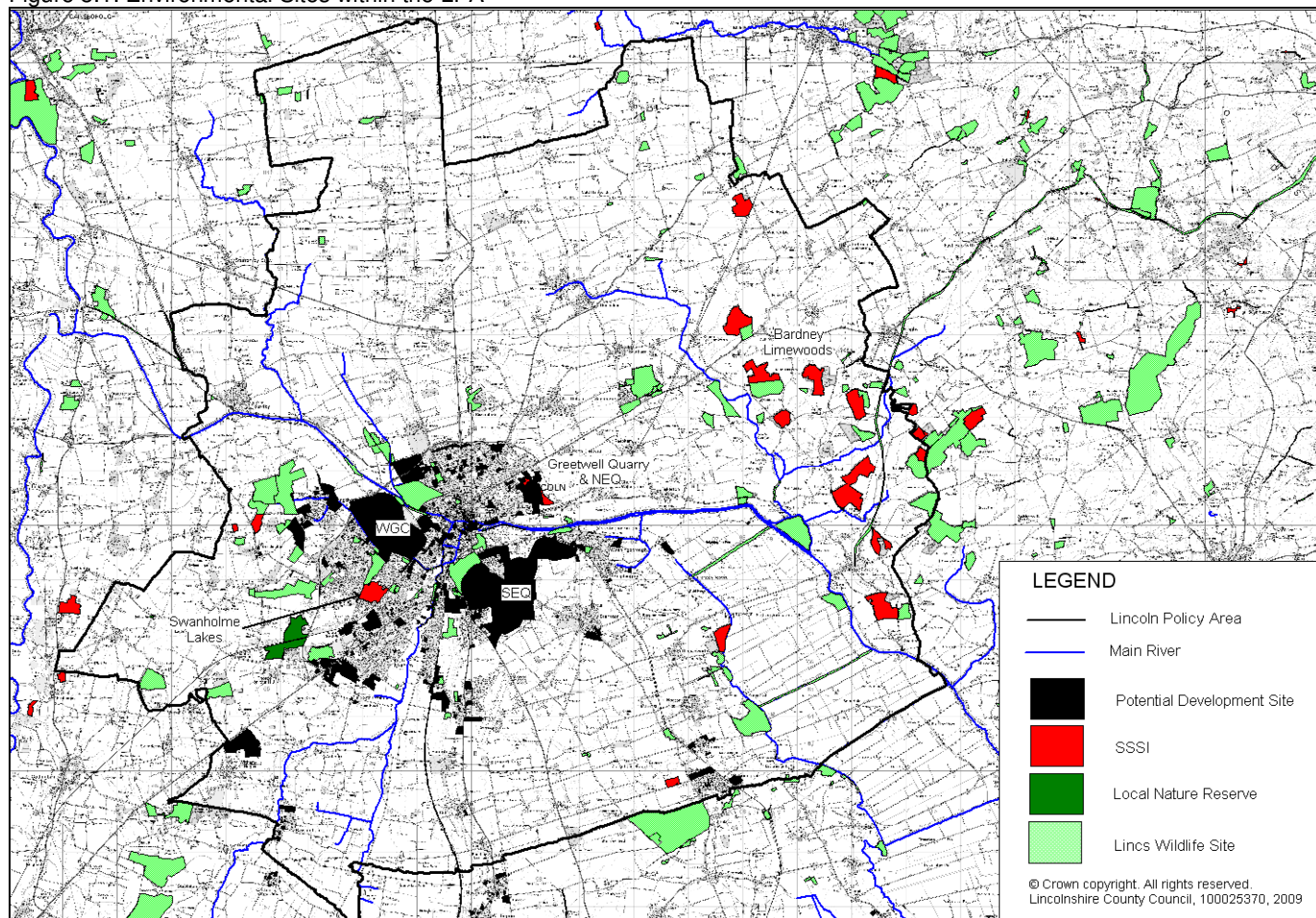
8.2 Environmentally Designated Sites

There are no internationally protected sites within the LPA or the wider West Lindsey and North Kesteven areas, this covers Ramsar sites, Special Protection Areas (SPA) and Special Areas of Conservation (SAC). Data has been obtained concerning Sites of Special Scientific Interest (SSSI), National Nature Reserves (NNR), Local Nature Reserves (LNR) and Lincolnshire Wildlife Trust Sites.

8.2.1 Lincoln Policy Area

Figure 8.1 presents the sites of environmental importance within the LPA.

Figure 8.1: Environmental Sites within the LPA



Note that National Nature Reserves do not appear in Figure 8.1 because the sites also have SSSI status.

Based on the information available there are eight SSSIs, one NNR, and three LNRs within, or adjoining the LPA boundary, these are listed in Table 8.1 below. Of the eight SSSIs Bardney Limewoods and Swanholme Lakes are water related SSSIs. It should be noted that the Bardney Limewoods SSSI is split up over several sites which is why there are more than eight red SSSI sites appearing in Figure 8.1.

Table 8.1: Sites of Environmental Importance within or adjoining the LPA

Designation	Site
SSSI	Doddington Clay Woods
	Swanholme Lakes
	Greetwell Hollow Quarry
	Bardney Limewoods
	Potter Hanworth Wood
	Metheringham Heath Quarry
	Goslings Corner (outside LPA but adjoining the boundary)
NNR	Wickenby Wood
	Bardney Limewoods
LNR	Whisby Nature Park
	Swanholme Lakes
	Cross O'Cliff Orchard

In addition to the 12 sites listed in Table 8.1, there are also 116 Lincolnshire Wildlife Trust Sites located within the LPA, these are listed in Appendix E, of which 37 are associated with wet habitats.

Of the three SUEs to Lincoln only the NEQ impacts on any environmentally designated sites, namely Greetwell Hollow Quarry SSSI. However both the WGC and SEQ, not to mention many of the SHLAA sites share a boundary with a Lincolnshire Wildlife Trust Site. The WGC impacts on six Lincolnshire Wildlife Trust sites: Old Decoy, Swanpool Skewbridge, Fen Plantation, Foal Close and the Catchwater Drain. The SEQ footprint does not impact on any sites although is juxtaposed to the Lincoln South Common which is a Lincolnshire Wildlife Trust site.

Natural England has made the following comments concerning some of the SSSIs;

- **Swanholme Lakes SSSI** – We note development proposals to the north of the SSSI, and have commented on the need to ensure that sufficient Green Infrastructure is designed into the WGC proposals to reduce impacts upon Swanholme Lakes SSSI. Swanholme Lakes SSSI is a water body SSSI with features which are sensitive to changes in the water table, and changes to nutrient inputs.
- **Doddington Clay Woods SSSI** – This site is woodland, and is only sensitive to significant changes in the water table sufficient to interfere with natural successional processes. We note development is proposed for the Skellingthorpe area. Although the quantum of development is such as to be unlikely to have direct impacts, indirect impacts through recreational disturbance is possible. It is for these reasons why Natural England have been a strong advocate for a Green Infrastructure strategy for the Lincoln Growth Area.
- **Greetwell Quarry SSSI** – This site is geological. We have discussed the protection and long-term management of exposures as part of the plans for the development here. There are no significant water sensitivity issues on this site.
- **Potterhanworth Wood SSSI** – This site, whilst woodland, has extensive wet rides with wetland vegetation and is therefore sensitive to changes in the local water table, which could impact upon the plant communities present on-site. It is a small, rather isolated SSSI and given that no development is proposed in this locality, we do not believe it is likely that this site will be affected by these proposals.
- **Metheringham Heath Quarry SSSI**. This site is geological, with no significant water sensitivity issues. The site has potential for creative restoration as limestone grassland, providing significant BAP habitats. There is a small level of development proposed for Metheringham. This is a private site with no access provision. It is unlikely that development on the levels proposed is likely to impact on this site.

8.2.2 West Lindsey

Table 8.2 presents the sites of environmental importance within the wider West Lindsey area outside the LPA.

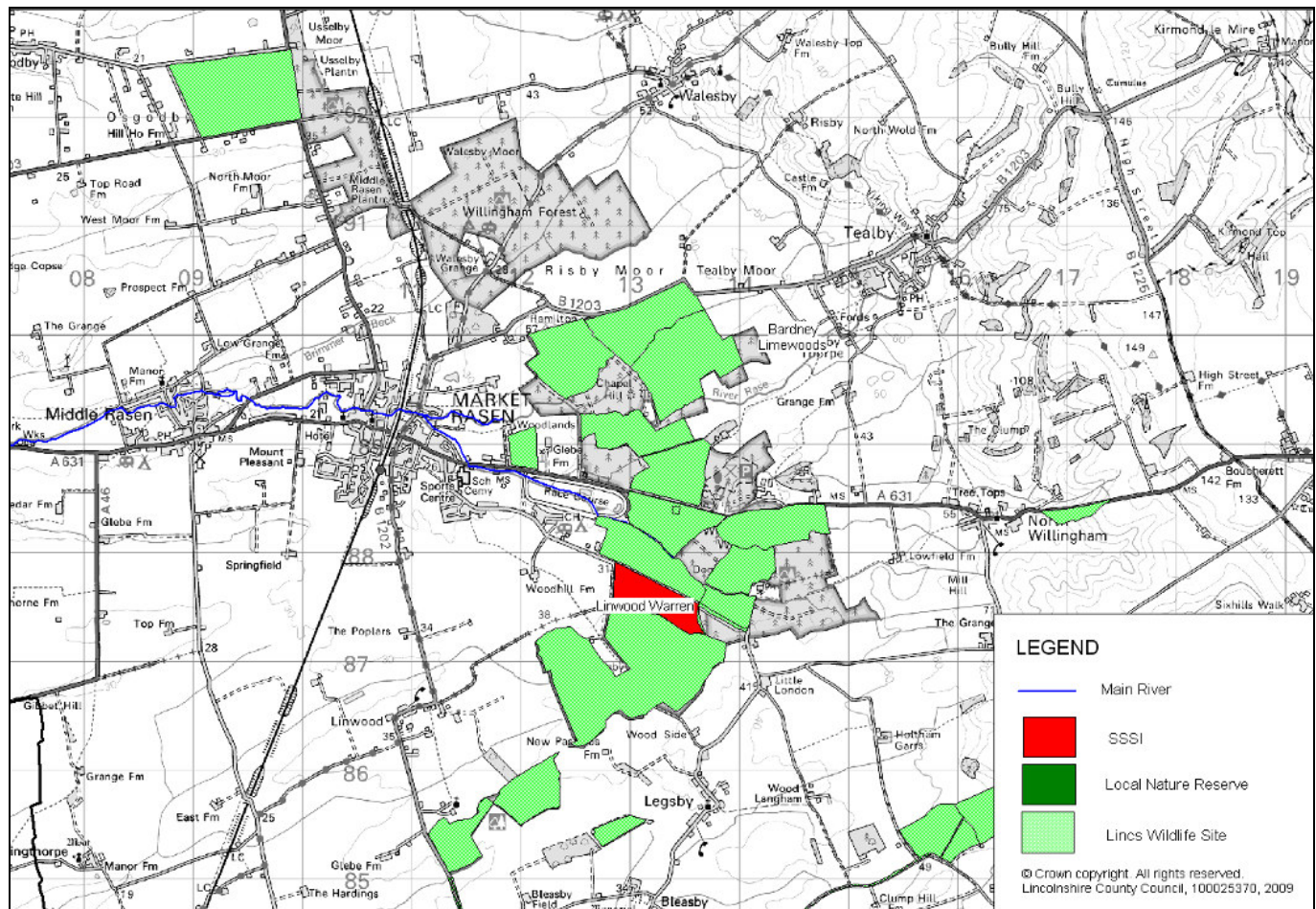
Table 8.2: Sites of Environmental Importance within or adjoining the wider West Lindsey area

Designation	Site
SSSI	Swallow Wold
	Nettleton Chalk Pit
	Kingerby Beck Meadow
	Linwood Warren
	Normanby Meadow
	Hainton Sheepwalk (adjoining boundary)
	Cliff House

The West Lindsey study area, outside of the LPA, is only expecting growth, beyond windfall, in Market Rasen and Caistor (note Gainsborough is considered in the Gainsborough WCS). Development within Caistor will not impact upon any sites of environmental importance. The nearest site is the Nettleton Chalk Pit which is located 3km to the south.

In the case of Market Rasen development should avoid the eastern periphery of the village where there are a number of Lincolnshire Wildlife Trust sites and the Linwood Warren SSSI (Figure 8.2).

Figure 8.2: Environmental Sites in the vicinity of Market Rasen, West Lindsey



Natural England has made the following comments concerning some of the SSSIs;

- **Swallow Wold SSSI** – This site has no water sensitivity issues and is remote from areas identified in West Lindsey as targets for growth.
- **Nettleton Chalk Pit SSSI** – See comments for Swallow Wold SSSI.
- **Kingerby Beck Meadow SSSI** – This site, whilst neutral grassland, does support pockets of marshy vegetation typical of seasonal waterlogging and is therefore sensitive to changes in water tables, as well as nutrient inputs. It is relatively remote from Market Rasen and its nature is such as to be unlikely to be attractive for recreational purposes. Given its location, the proposals here are not likely to represent concern, though a note of the site sensitivity should be made.
- **Normanby Meadow SSSI**– The issues here are similar to those at Kingerby Beck Meadow, and the same conclusions can be drawn.
- **Linwood Warren SSSI**– This site is heathland, including areas of wet heath close to Market Rasen. It is a site highly sensitive to changes to water availability and nutrient inputs through surface water run-off. It is also sensitive to recreational disturbance and large enough to represent a potentially attractive local recreational resource. Natural England would wish to see alternative recreational opportunities, which could be linked to the woodland resource to the North, which would be linked to the quantum of development proposed in Market Rasen. Green Infrastructure design in new development may also mitigate for potential recreational impacts on Linwood Warren.
- **Hainton Sheepwalk SSSI** – This site is not sensitive to water issues. It is also not close to areas proposed for development nor is it likely to represent an attractive recreational resource (it is privately owned with no access).
- **Cliff House SSSI** – See comments on Hainton Sheepwalk.

8.2.3 North Kesteven

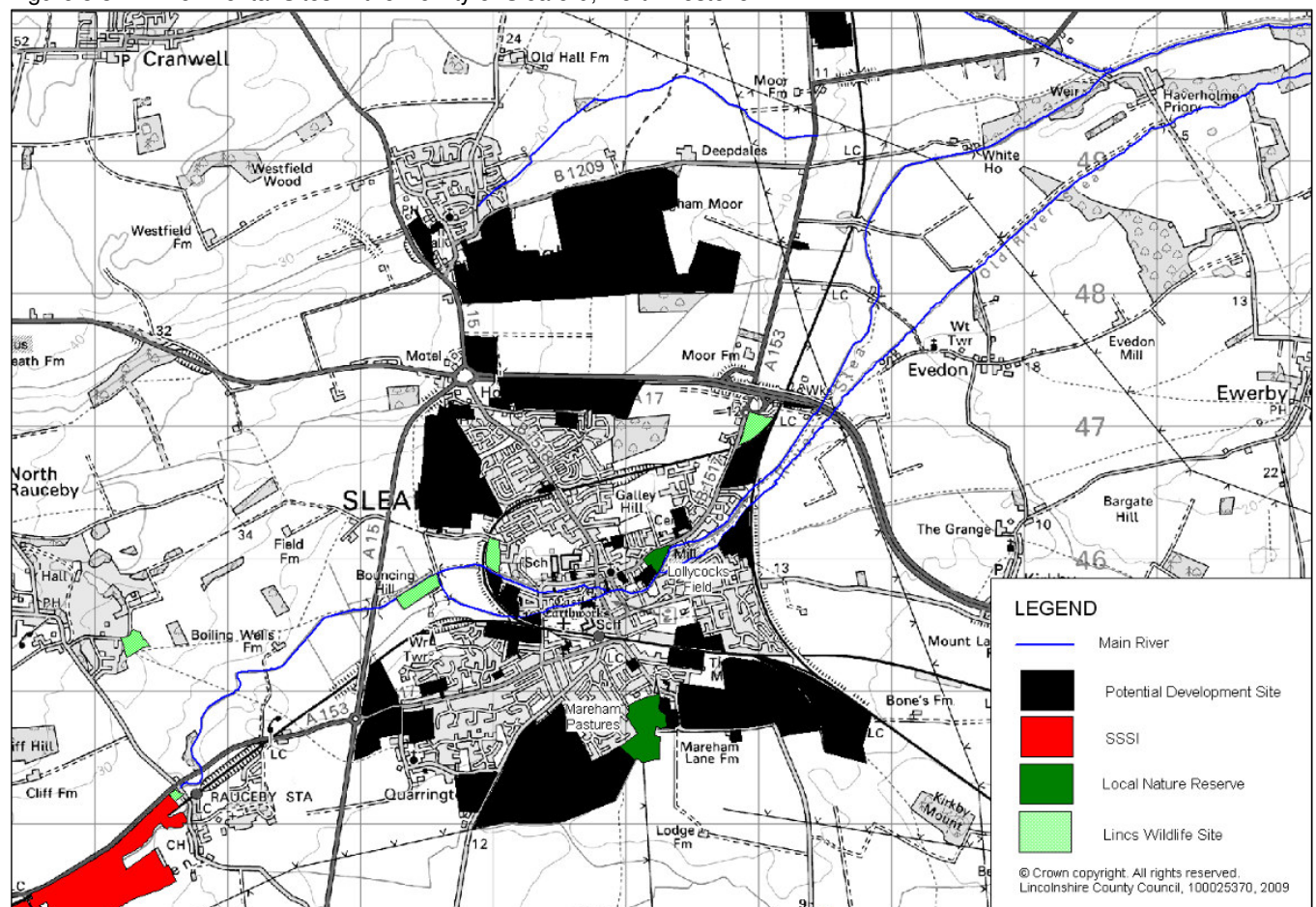
Table 8.3 presents the sites of environmental importance within the wider North Kesteven area outside the LPA.

Table 8.3: Sites of Environmental Importance within or adjoining the wider North Kesteven area

Designation	Site
SSSI	Wilsford & Rauceby Warrens
	Wilsford Heath Quarry
	Ancaster Valley (adjoining boundary)
	Copper Hill(adjoining boundary)
LNR	Lollycocks Field
	Mareham Pastures

With regard to the North Kesteven SHLAA sites reviewed, the only ones that are in close proximity to a site of environmental importance are in Sleaford. The two Local Nature Reserves listed in Table 8.3 are located in Sleaford and share a border with some of the SHLAA sites that could get developed (Figure 8.3). It would be important that development of these sites did not occur to the detriment of the Nature Reserves.

Figure 8.3: Environmental Sites in the vicinity of Sleaford, North Kesteven



Natural England has made the following comments concerning some of the SSSIs;

- Wilsford and Rauceby Warren SSSI** – This site is highly sensitive to changes in the water table, containing seasonally wet waterbodies with fluctuating water levels. Great crested newts are also a feature of this SSSI. Natural England would have concerns about any development which would interfere with existing water availability. The site is also small, and sensitive to disturbance. There is an existing development at the former Rauceby Hospital site, and Natural England would have potential concerns about the carrying capacity of the area were further development proposed. We note that significant development is

proposed to the south of Sleaford and we would recommend that provision is made within this to permit sufficient green infrastructure provision to encourage recreational visits away from Rauceby and Wilsford Warren SSSI.

- **Wilsford Heath Quarry SSSI** - This site is not sensitive to water issues, and is in private ownership. It is not likely to be affected by the location or the quantum of development proposed.
- **Ancaster Valley SSSI** – This site is not likely to be affected by changes to water tables or water availability, though may be sensitive to nutrient enrichment from surface water run-off. We note that there is no significant development proposed for Ancaster.
- **Copper Hill SSSI** – This site is a road verge SSSI and is not likely to be affected by water quality of availability issues. It's location means that it is not likely to be at risk from recreational disturbance.

8.3 Conclusions

Tables 8.4, 8.5 and 8.6 present a RAG classification for potential development in terms of their proximity to environmentally designated sites, where;

- **RED** – Development would have a significant adverse impact upon an environmentally important site.
- **AMBER** – At least one site within the map boundary is close to an environmental site.
- **GREEN** – No sites within the SHLAA map are in close proximity to an environmental site.

Table 8.4: LPA Environmental RAG Status

SHLAA Map No	Area	RAG
	NEQ	AMBER
	WGC	AMBER
	SEQ	AMBER
Lincoln		
1		AMBER
2		AMBER
3		GREEN
4		AMBER
5		AMBER
6		AMBER
7		AMBER
8		AMBER
9		AMBER
10		AMBER
11		AMBER
12		AMBER
13		AMBER
14		AMBER
15		AMBER
16		AMBER
17		AMBER
North Kesteven		
14	Bracebridge Heath	AMBER
20	N Hykeham	AMBER
21	Bracebridge Heath	AMBER
24	N Hykeham	GREEN
27	N Hykeham	AMBER
36	N Hykeham	AMBER
31	N Hykeham	AMBER
41	N Hykeham	AMBER
33	S Hykeham	GREEN
29	S Hykeham	AMBER
40	S Hykeham	GREEN
56	Bassingham	GREEN
17	Branston	GREEN

SHLAA Map No	Area	RAG
54	Coleby	GREEN
44	Dunston	GREEN
11	Heighington	GREEN
49 & 50	Metheringham	GREEN
2 & 4	Skellingthorpe	AMBER
5 & 6	Washingborough	AMBER
43	Witham St Hughes	GREEN
37	Nocton	GREEN
West Lindsey	Bardney	AMBER
	Burton Waters	GREEN
	Cherry Willingham	GREEN
	Dunholme	GREEN
	Faldingworth	GREEN
	Fiskerton	GREEN
	Hawthorn Avenue	GREEN
	Ingham	GREEN
	Langworth	AMBER
	Nettleham	GREEN
	Saxilby	AMBER
	Sudbrooke	AMBER
	Welton	GREEN

Table 8.5: West Lindsey Environmental RAG Status

SHLAA Map No	Area	RAG
N/A	Caistor	GREEN
N/A	Market Rasen	AMBER
N/A	Middle Rasen	GREEN

Table 8.6: North Kesteven Environmental RAG Status

SHLAA Map No	Area	RAG
68	Carlton-le-Moorland	GREEN
71	Navenby	GREEN
72	Wellingore	GREEN
75	Walcott	GREEN
83	Billinghay	AMBER
95	Ruskington	AMBER
97	Ruskington	GREEN
100	South Kyme	GREEN
102	Leasingham	AMBER
105	Sleaford	GREEN
107	Heckington	GREEN
110	Sleaford	AMBER
111	Sleaford	AMBER
112	Sleaford	GREEN
113	Heckington	GREEN
114	Sleaford	AMBER
115	Sleaford	AMBER
118	Rauceby	GREEN
119	Heckington	GREEN
121	Wilsford	GREEN
122	Heckington / Great Hale	GREEN

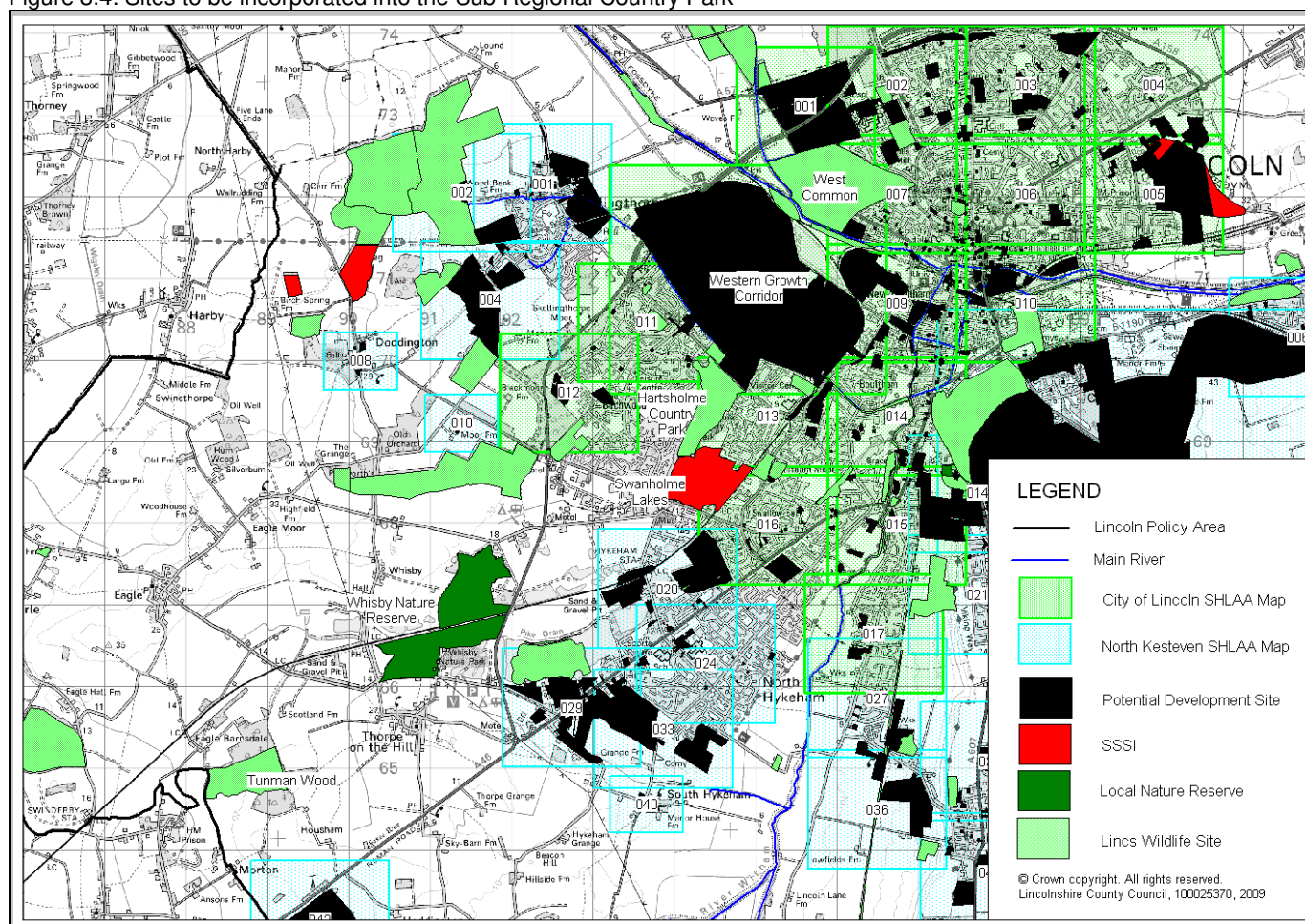
8.4 Environmental Enhancement

8.4.1 Sub Regional Country Park

The City of Lincoln Council has been working with North Kesteven District Council, West Lindsey District Council and Lincolnshire County Council on developing sustainable recreation by creating a Sub Regional Country Park. The concept is to create an easily accessible network of managed outdoor places to encourage residents and visitors to make the most of the green spaces, historic sites and leisure facilities that are available to them in and around Lincoln.

The Sub Regional Country Park will encompass an area from the West Common, Boultham Mere, Hartsholme Country Park, Whisby Nature Park, and right down to Tunman Wood, at Eagle Barnsdale (Figure 8.4). SHLAA sites within City of Lincoln maps 1, 9 13 and 16, North Kesteven maps 20 and 29 and the WGC all fall within close proximity of many of these open spaces and should they come forward in the planning process represent an opportunity to promote and benefit the Sub Regional Country Park.

Figure 8.4: Sites to be incorporated into the Sub Regional Country Park



Future Action 8.1 – Maximise opportunities to benefit the Sub Regional Country Park should development occur on the WGC or SHLAA maps 1, 9 13, 16, 20 and 29.

8.4.2 Balancing Ponds

Balancing ponds are a key SUDS technique to strategically manage surface water runoff from urban areas. They provide benefits in terms of reducing flood risk by detaining runoff on site rather than contributing to the flood peak in local watercourses and improving the quality of urban runoff by removing pollutants before they enter local ecosystems. Balancing ponds also present an opportunity to work towards meeting some of the Biodiversity Action Plan (BAP) targets for Lincolnshire.

There is a Lakes and Ponds BAP target to create 200 new wildlife ponds across the County where appropriate on land of low conservation importance. Additionally there is a BAP target to expand the area of wet reed-beds by 280 hectares across the County by 2015. It is envisioned that strategic balancing ponds could be implemented on each of the proposed SUEs to Lincoln City. Consequently it ought to be possible to take advantage of the opportunity that this presents to incorporate wildlife ponds and reed-beds amongst the balancing ponds.

Future Action 8.2 – Incorporate strategic balancing ponds into the three SUEs and maximise the potential to create opportunities for wildlife in ponds and reed-beds.

8.4.3 Natural England

Natural England has been a full and active partner in the process to deliver a network of Green Infrastructure (GI) in the greater Lincoln area, and are generally pleased with the progress made in this regard. Natural England do, however believe that GI is not just relevant to large-scale major development, but has a role to play in smaller developments where recreational disturbance may otherwise impact upon sensitive sites. Natural England have identified this as a potential issue in both Sleaford and Market Rasen, and Natural England would recommend that the local authorities identify what mechanisms might exist locally to create and promote GI provision which seeks to reduce potential disturbance impacts on environmentally sensitive sites.

Future Action 8.3 – Local authorities to identify mechanisms to promote GI.

RAG Summary for the Water Cycle



9 RAG Summary for the Water Cycle

9.1 The Lincoln Policy Area

9.1.1 Sustainable Urban Extensions

Table 9.1 presents a summary of the RAG reviews that have been undertaken for the SUEs.

Table 9.1: Summary of RAG Status for the SUEs

SUE	Water Resources	Water Supply	Sewerage	Sewage Treatment	Surface Water	Flood Risk	Environment
NEQ	AMBER	AMBER	AMBER	AMBER	AMBER	AMBER	AMBER
WGC	AMBER	GREEN	AMBER	AMBER	AMBER	RED	AMBER
SEQ	AMBER	AMBER	AMBER	AMBER	AMBER	GREEN	AMBER

In terms of the three SUEs, which have been identified as the primary means of delivering the majority of growth forecast for the PUA and LPA, they could be described as being sustainable in terms of the water cycle since there is only the WGC which has had a potential “show-stopper” identified.

Each SUE will require some investment in terms of infrastructure to serve it but on the whole there is no reason why the investment cannot or should not occur. AWS need, and intend to invest in water resources for the Lincolnshire area by providing a new water treatment works in Lincoln, and the location of the NEQ and SEQ will mean that new trunk mains are required to supply the sites with potable (clean) water.

The same situation is true of foul sewerage; the location of the NEQ and SEQ will mean that new sewers are required to serve the sites however this investment is beneficial in terms of the wider sewerage network serving Lincoln which has been identified as having existing problems. New sewers for the NEQ and SEQ with direct discharge to the STW will mean the developments do not exacerbate the existing situation. The WGC will be able to take advantage of existing trunk sewers and modelling has demonstrated that the additional flows will not significantly exacerbate problems elsewhere within the sewer network.

It has been identified that there is not sufficient capacity within the existing STWs to serve all of the growth within the LPA and AWS has indicated that they would prefer to invest at one STW rather than several. Canwick STW has been identified as being the most preferable STW to expand and invest in to serve the growing population of the LPA.

Flood risk has been classified as Red for the WGC because of its location within FZ3 and is the most significant issue with regard to the three SUEs. This is also reflected in the Environment Agency’s and Upper Witham IDB’s objection to development of the site on flood risk grounds and classification of the site to be set aside for flood storage in the CFMP. In order to deliver the targets of the Regional Plan (see Section 10) it is envisaged that the WGC will have to be developed to some extent, and if this includes those areas within Flood Zones 2 and 3 appropriate flood risk management infrastructure will need to be put in place.

All three SUEs are adjacent to sites of environmental importance however appropriate development should not adversely affect these sites. Indeed the WGC presents a significant opportunity to bring about environmental enhancements if it were to be developed in such a way as to benefit Swanholme Lakes SSSI and the proposed Sub Regional Country Park.

It is concluded that appropriate development of the NEQ and SEQ if suitably managed should be able to go ahead without being detrimental to the water cycle.

9.1.2 SHLAA Sites

Table 9.2 presents a summary of the RAG status that has been assigned to each of the sites / SHLAA maps that have been assessed as part of the WCS.

Table 9.2: Summary of RAG Status for the SHLAA Sites in the LPA

SHLAA Map No / Area	Water Resources	Water Supply	Sewerage	Sewage Treatment	Surface Water	Flood Risk	Environment
Lincoln							
1	AMBER	GREEN	RED	AMBER	AMBER	AMBER	AMBER
2	AMBER	GREEN	RED	AMBER	AMBER	GREEN	AMBER
3	AMBER	GREEN	RED	AMBER	AMBER	GREEN	GREEN
4	AMBER	GREEN	RED	AMBER	AMBER	GREEN	AMBER
5	AMBER	GREEN	RED	AMBER	AMBER	GREEN	AMBER
6	AMBER	GREEN	RED	AMBER	AMBER	GREEN	AMBER
7	AMBER	GREEN	RED	AMBER	AMBER	AMBER	AMBER
8	AMBER	GREEN	GREEN	AMBER	AMBER	AMBER	AMBER
9	AMBER	GREEN	AMBER	AMBER	AMBER	RED	AMBER
10	AMBER	GREEN	RED	AMBER	AMBER	RED	AMBER
11	AMBER	GREEN	GREEN	AMBER	AMBER	GREEN	AMBER
12	AMBER	GREEN	GREEN	AMBER	AMBER	GREEN	AMBER
13	AMBER	GREEN	AMBER	AMBER	AMBER	GREEN	AMBER
14	AMBER	GREEN	GREEN	AMBER	AMBER	RED	AMBER
15	AMBER	GREEN	GREEN	AMBER	AMBER	AMBER	AMBER
16	AMBER	GREEN	GREEN	AMBER	AMBER	AMBER	AMBER
17	AMBER	GREEN	GREEN	AMBER	AMBER	AMBER	AMBER
North Kesteven inside the PUA							
14	AMBER	GREEN	AMBER	AMBER	AMBER	GREEN	AMBER
20	AMBER	GREEN	AMBER	AMBER	AMBER	AMBER	AMBER
21	AMBER	GREEN	AMBER	AMBER	AMBER	GREEN	AMBER
24	AMBER	GREEN	GREEN	AMBER	AMBER	GREEN	GREEN
27	AMBER	GREEN	AMBER	AMBER	AMBER	AMBER	AMBER
36	AMBER	GREEN	AMBER	AMBER	AMBER	GREEN	AMBER
31	AMBER	GREEN	AMBER	AMBER	AMBER	GREEN	AMBER
41	AMBER	GREEN	AMBER	AMBER	AMBER	GREEN	AMBER
33	AMBER	GREEN	GREEN	AMBER	AMBER	AMBER	GREEN
29	AMBER	GREEN	GREEN	AMBER	AMBER	AMBER	AMBER
40	AMBER	GREEN	GREEN	AMBER	AMBER	GREEN	GREEN
North Kesteven outside the PUA							
Bassingham	AMBER	GREEN	AMBER	AMBER	AMBER	AMBER	GREEN
Branston	AMBER	GREEN	AMBER	AMBER	AMBER	GREEN	GREEN
Coleby	AMBER	GREEN	GREEN	AMBER	AMBER	GREEN	GREEN
Dunston	AMBER	GREEN	AMBER	AMBER	AMBER	AMBER	GREEN
Heighington	AMBER	GREEN	AMBER	AMBER	AMBER	GREEN	GREEN
Metheringham	AMBER	GREEN	AMBER	AMBER	AMBER	GREEN	GREEN
Skellingthorpe	AMBER	GREEN	RED	AMBER	AMBER	AMBER	AMBER
Washingborough	AMBER	GREEN	AMBER	AMBER	AMBER	GREEN	AMBER
Witham St Hughes	AMBER	GREEN	GREEN	AMBER	AMBER	GREEN	GREEN
Nocton	AMBER	GREEN	AMBER	GREEN	AMBER	AMBER	GREEN
West Lindsey outside the PUA							
Bardney	AMBER	GREEN	AMBER	GREEN	AMBER	AMBER	AMBER
Burton Waters	AMBER	GREEN	GREEN	AMBER	AMBER	AMBER	GREEN
Cherry Willingham	AMBER	GREEN	RED	AMBER	AMBER	GREEN	GREEN
Dunholme	AMBER	GREEN	AMBER	GREEN	AMBER	AMBER	GREEN
Faldingworth	AMBER	GREEN	AMBER	RED	AMBER	GREEN	GREEN
Fiskerton	AMBER	GREEN	AMBER	AMBER	AMBER	AMBER	GREEN

SHLAA Map No / Area	Water Resources	Water Supply	Sewerage	Sewage Treatment	Surface Water	Flood Risk	Environment
Hawthorn Avenue	AMBER	GREEN	AMBER	AMBER	AMBER	GREEN	GREEN
Ingham	AMBER	GREEN	AMBER	AMBER	AMBER	GREEN	GREEN
Langworth	AMBER	GREEN	RED	AMBER	AMBER	AMBER	AMBER
Nettleham	AMBER	GREEN	AMBER	AMBER	AMBER	AMBER	GREEN
Saxilby	AMBER	GREEN	AMBER	AMBER	AMBER	AMBER	AMBER
Sudbrooke	AMBER	GREEN	GREEN	AMBER	AMBER	AMBER	AMBER
Welton	AMBER	GREEN	GREEN	GREEN	AMBER	AMBER	GREEN

It is apparent from Table 9.2 that sewerage, sewage treatment and flood risk are all potential problems for development in different parts of the LPA.

Section 4 highlighted that development across North Lincoln is currently constrained by the foul and combined sewerage system and until the existing problem is resolved, AWS will require detailed investigations on a site by site basis to ensure that new development does not exacerbate the existing problem. A number of possibilities have been identified whereby these Red sites could be brought forward and proven to be Amber rather than Red. One would be if re-development occurred in an area served by combined sewers, where removing the surface water from the combined sewer would effectively create additional capacity for foul flows. Another possibility is to re-route a large part of the sewerage system away from the existing problem to take advantage of the new river crossing that will be implemented to serve the NEQ.

Sewerage has also been identified as a problem in Skellingthorpe, Cherry Willingham and Langworth. AWS will require detailed investigations on a site by site basis to ensure that new development does not create problems within the foul sewerage system. It should be noted that this investigation and subsequent investment may be warranted to utilise the spare capacity that exists at the relevant STWs (note that the assessment has considered all sites; the STWs may have spare capacity but not sufficient to serve all of the potential growth).

Sewage treatment has been identified as a constraint at Faldingworth STW in West Lindsey. Therefore if development is to occur in Faldingworth further infrastructure upgrades will be required. If AWS' recommendation to follow a strategy of restricting investment at STW to just one; Canwick, the other STWs currently classified as Amber could be considered Green up to their headroom limits and then Red.

In West Lindsey development would be considered most sustainable in Burton Waters, Sudbrooke and Welton.

In North Kesteven development would be most favoured in Coleby and least preferable in Skellingthorpe. Elsewhere development ought to be within the existing capacities avoiding need for additional investment.

Ultimately foul sewerage is the major constrain to future growth (Table 9.2). To reflect this Section 10 reviews the potential to achieve the Regional Plan targets for the LPA as if sewerage was the sole constraint upon development.

9.2 West Lindsey

Table 9.3 presents a summary of the RAG status that has been assigned to the three villages in West Lindsey, outside the LPA that have been assessed as part of the Central Lincolnshire WCS.

Table 9.3: Summary of RAG Status for West Lindsey

Village	Water Resources	Water Supply	Sewerage	Sewage Treatment	Surface Water	Flood Risk	Environment
Caistor	AMBER	AMBER	AMBER	AMBER	AMBER	GREEN	GREEN
Market Rasen	AMBER	AMBER	AMBER	GREEN	AMBER	AMBER	AMBER
Middle Rasen	AMBER	AMBER	GREEN	GREEN	AMBER	AMBER	GREEN

With regard to sewerage infrastructure the forecast growth in Middle Rasen is within existing capacities and more sustainable than that in Market Rasen or Caistor. Investment would however be required in the water supply network and water resources and development would need to take due account of flood risk and any environmentally designated sites in close proximity to the sites. For both Caistor and Market Rasen AWS have indicated that investment would be required in sewers and / or pumping

stations and UPM studies may be required, however an indication of when this investment would be required has not been provided.

Caistor presents a problem in terms of the timing of development. Whilst the water cycle parameters for water and wastewater are Amber, indicating investment is required, that investment is needed immediately. AWS have indicated that there is no spare capacity at Caistor STW and the development phasing profile suggests that 64 houses could have been built between 2006 and 2010, and 180 are planned for the 2010-2015 period. It would therefore appear necessary to provide additional infrastructure to be able to serve this development. Given that AWS have not included any works in the current AMP programme it is possible that this may not occur until 2015 at the earliest if AWS get it into the budget for the next AMP period (AMP6).

9.3 North Kesteven

Table 9.4 presents a summary of the RAG status that has been assigned to each of the SHLAA maps that have been assessed in North Kesteven outside the LPA as part of the Central Lincolnshire WCS.

Table 9.4: Summary of RAG Status for North Kesteven

SHLAA Map No	Water Resources	Water Supply	Sewerage	Sewage Treatment	Surface Water	Flood Risk	Environment
68 – Carlton-le-Moorland	AMBER	N/A	GREEN	AMBER	AMBER	GREEN	GREEN
71 – Navenby	AMBER	GREEN	GREEN	AMBER	AMBER	GREEN	GREEN
72 – Wellingore	AMBER	GREEN	GREEN	AMBER	AMBER	GREEN	GREEN
75 – Walcott	AMBER	GREEN	RED	AMBER	AMBER	GREEN	GREEN
83 – Billingham	AMBER	GREEN	RED	AMBER	AMBER	AMBER	AMBER
95 – Ruskington	AMBER	AMBER	RED	GREEN	AMBER	AMBER	AMBER
97 – Ruskington	AMBER	N/A	N/A	N/A	AMBER	AMBER	GREEN
100 – South Kyme	AMBER	N/A	N/A	N/A	AMBER	AMBER	GREEN
102 – Leasingham	AMBER	AMBER	AMBER	AMBER	AMBER	AMBER	AMBER
105 – Sleaford	AMBER	AMBER	AMBER	AMBER	AMBER	AMBER	GREEN
107 – Heckington	AMBER	N/A	N/A	AMBER	AMBER	GREEN	GREEN
110 – Sleaford	AMBER	AMBER	AMBER	AMBER	AMBER	AMBER	AMBER
111 – Sleaford	AMBER	GREEN	AMBER	AMBER	AMBER	AMBER	AMBER
112 – Sleaford	AMBER	AMBER	RED	AMBER	AMBER	GREEN	GREEN
113 – Heckington	AMBER	GREEN	AMBER	AMBER	AMBER	AMBER	GREEN
114 – Sleaford	AMBER	AMBER	AMBER	AMBER	AMBER	GREEN	AMBER
115 – Sleaford	AMBER	AMBER	RED	AMBER	AMBER	AMBER	AMBER
118 – Rauceby	AMBER	GREEN	GREEN	AMBER	AMBER	GREEN	GREEN
119 – Heckington	AMBER	GREEN	AMBER	AMBER	AMBER	AMBER	GREEN
121 – Wilsford	AMBER	GREEN	GREEN	AMBER	AMBER	GREEN	GREEN
122 – Heckington / Great Hale	AMBER	N/A	N/A	AMBER	AMBER	AMBER	GREEN

It is apparent from Table 9.4 that given the current planning information available, foul sewerage presents a barrier to further growth in Walcott, Billingham, Ruskington and parts of Sleaford. It is worth noting that whilst the STWs serving North Kesteven may struggle to serve all of the SHLAA sites, they do have capacity to accept some of the sites. Consequently it may be appropriate for AWS to invest in the foul sewerage network, where appropriate, to enable the spare capacity at various STWs to be utilised.

9.3.1 Sleaford

The SHLAA data identifies potential sites for 4,744 houses in and around Sleaford. With regard to foul sewerage, SHLAA maps 112 and 115 to the south west of Sleaford have been classified as Red and unable to accommodate additional flows. Excluding maps 112 and 115 reduces the number of potential houses in Sleaford to 3,376. The Sleaford STW that would serve these sites if developed has existing capacity to accommodate approximately 3,500-4,000 houses. Therefore, the most sustainable means of developing Sleaford would appear to be to develop those sites within SHLAA maps 105, 110, 111 and 114 and not those within maps 112 and 115. Whilst this would require investment in the sewerage network and water supply network by AWS to serve these developments, the STW would not require upgrading and could be classified as Green rather than Amber. (The Amber status is on account of not being able to accommodate all of the SHLAA sites).

In the case of Ruskington, the SHLAA identifies potential to site 817 houses but the foul sewerage network has been deemed incapable of accommodating any additional flows and classified as Red. However, the Anwick STW serving Ruskington, has spare capacity for an additional 5,500-6,000 houses before an upgrade would be required. Therefore if significant development were to be planned in the future, in the form of a SUE for the Sleaford / Leasingham / Ruskington area, it would be advantageous for it to be sited to use the spare capacity that exists at Anwick STW.

**Delivering the Targets of the
Regional Plan for the LPA**



10 Delivering the Targets of the Regional Plan for the LPA

10.1 Sustainable Urban Extensions

The Regional Plan indicates that 25,170 new houses ought to be built within the LPA between 2006 and 2026. Of those, 19,800 must be within or adjacent to the PUA. Taking 2006 as year 1 and then accounting for completions and commitments these numbers drop to 14,537 in the LPA and 12,989 in the PUA.

The three SUEs; the NEQ, WGC and SEQ are intended to provide the majority of the growth within the LPA and are the primary focus of this WCS.

Table 10.1 presents likely build rates for the SUEs as received from City of Lincoln and based on the earliest realistic start dates which have been adjusted to fit the 2026 timeframe of the Regional Plan in Table 10.2.

Table 10.1: Phasing of Development on the SUEs

SUE	AMP5	AMP6	AMP7	AMP8	AMP9	TOTAL
	2010-2015	2015-2020	2020-2025	2025-2030	2030-2035	
WGC-min	550	800	350	0	-	1,700
WGC-max	550	1500	1,500	1,450	-	5,000
NEQ	500	1,250	250	0	-	2,000
SEQ-min	0	1,250	1,150	850	-	3,250
SEQ-max	0	2,500	2,500	2,500	2,500	10,000

Table 10.2: Phasing for the SUEs restricted to the 2026 Planning Horizon

SUE	AMP5	AMP6	AMP7(+1 yr)	TOTAL
	2010-2015	2015-2020	2020-2026	
WGC - min	550	800	350	1,700
WGC - max	550	1,500	1,790	3,840
NEQ	500	1,250	250	2,000
SEQ - min	0	1,250	1,320	2,570
SEQ - max	0	2,500	3,000	5,500

It is noteworthy that in the case of the WGC the maximum number of houses is not deliverable within the 2026 timeframe and in the case of the SEQ; the maximum and minimum numbers of houses are not deliverable within the 2026 timeframe. If the maximum numbers were realised for the WGC and SEQ, the three SUEs would deliver 11,340 houses, thereby failing to meet the Regional Plan for both the PUA and LPA.

10.2 SHLAA Sites

To make up the anticipated shortfall against the Regional Plan targets it is necessary to consider the SHLAA sites within the WCS assessment against the RAG status. As summarised in the previous section, a key factor with regard to the SHLAA sites is foul sewerage. Therefore the following assessment only considers the SHLAA sites against the RAG status for sewerage. It is however, acknowledged that in reality many other factors will also play a role in determining which SHLAA sites get developed.

10.3 Development Scenarios

Four scenarios have been developed based upon the minimum and maximum numbers of houses considered developable on the SUEs, and, having a preference to develop those SHLAA sites that have been classified as Green for sewerage. Scenarios one to three test the numbers deliverable in the PUA and scenario four considers the LPA.

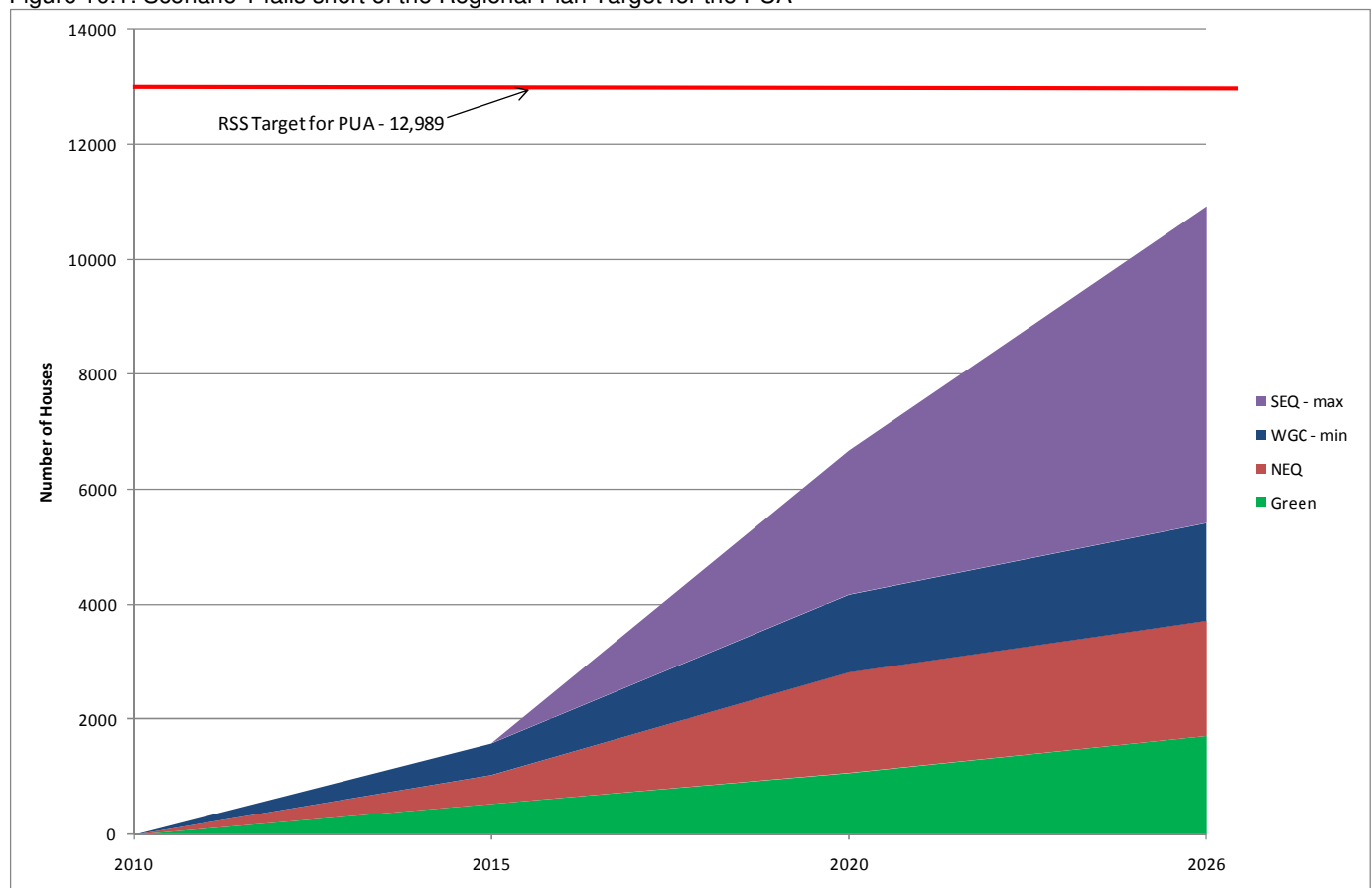
Table 10.3: Scenario 1 – to test the numbers deliverable in the PUA

Source	Number of houses	
	Unrestricted	Restricted to 2026
'Green' SHLAA sites*	1,716	1,716
NEQ	2,000	2,000
WGC	1,700	1,700
SEQ	10,000	5,500
Total	15,416	10,916

*This figure comprises 177 units in North Hykeham and 1,539 green SHLAA sites in South Lincoln comprising SHLAA map numbers ; 8, 11, 12, 15, 16 and 17.

In Scenario 1 (Table 10.3) the figures for the SUEs are maximum scenarios presuming the Environment Agency's and Upper Witham IDB's objections to the WGC on flood risk grounds are upheld. In this instance, the unrestricted total number of houses deliverable exceeds the requirement of 12,989 to meet the Regional Plan target for the PUA; however this takes no account of the Regional Plan timescales. The 12,989 units ought to be built by 2026. Therefore if 5,500 houses were delivered for the SEQ rather than the 10,000 the total build within the period would be 10,916 which would subsequently fall short of the target by 16% (Figure 10.1).

Figure 10.1: Scenario 1 falls short of the Regional Plan Target for the PUA



The SHLAA sites have been distributed evenly across the 16 year period between 2010 and 2026 in all of the figures throughout this section. Table 10.4 sets out the numbers that have been considered in Scenario 2 for the PUA.

Table 10.4: Scenario 2 – to test the numbers deliverable in the PUA

Source	Number of houses	
	Unrestricted	Restricted to 2026
'Green' SHLAA sites*	1,716	1,716
NEQ	2,000	2,000
WGC	5,000	3,840
SEQ	10,000	5,500
Total	18,716	13,056

The figures for the SUEs are maximum scenarios presuming the Environment Agency's and Upper Witham IDB's objections to the WGC on flood risk grounds are overruled. In this scenario, the unrestricted total number of houses deliverable exceeds the requirement of 12,989 units for the PUA. Taking into account the time element and restricting the numbers to 2026, only 3,840 and 5,500 houses would be delivered on the WGC and SEQ respectively, dropping the total houses delivered down to 13,056 by 2026. Scenario 2 would therefore exceed the 12,989 houses required in the PUA (Figure 10.2).

Figure 10.2: Scenario 2 exceeds the RSS Target for the PUA

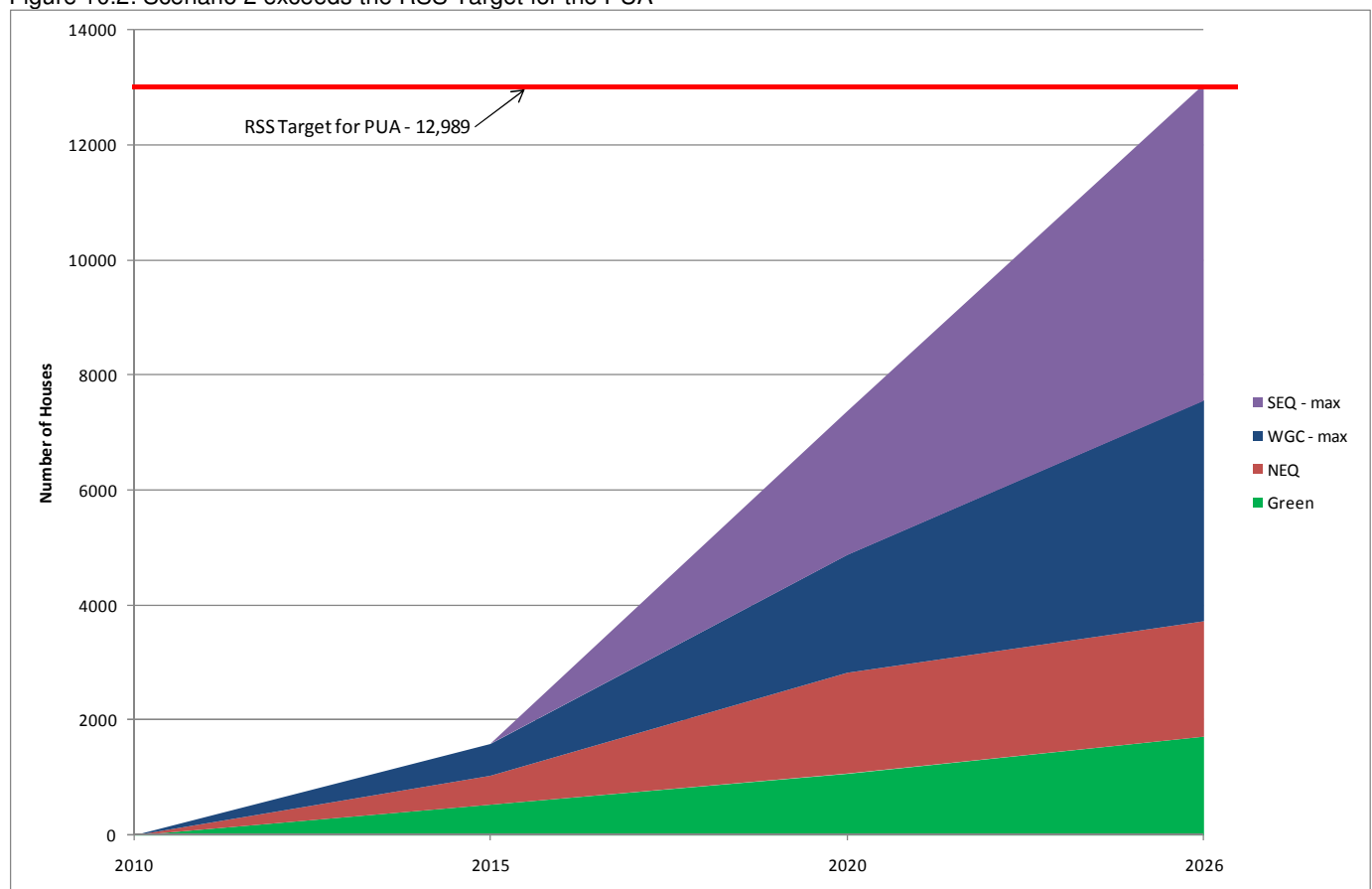


Table 10.5 sets out the numbers that have been considered in Scenario 3 for the PUA.

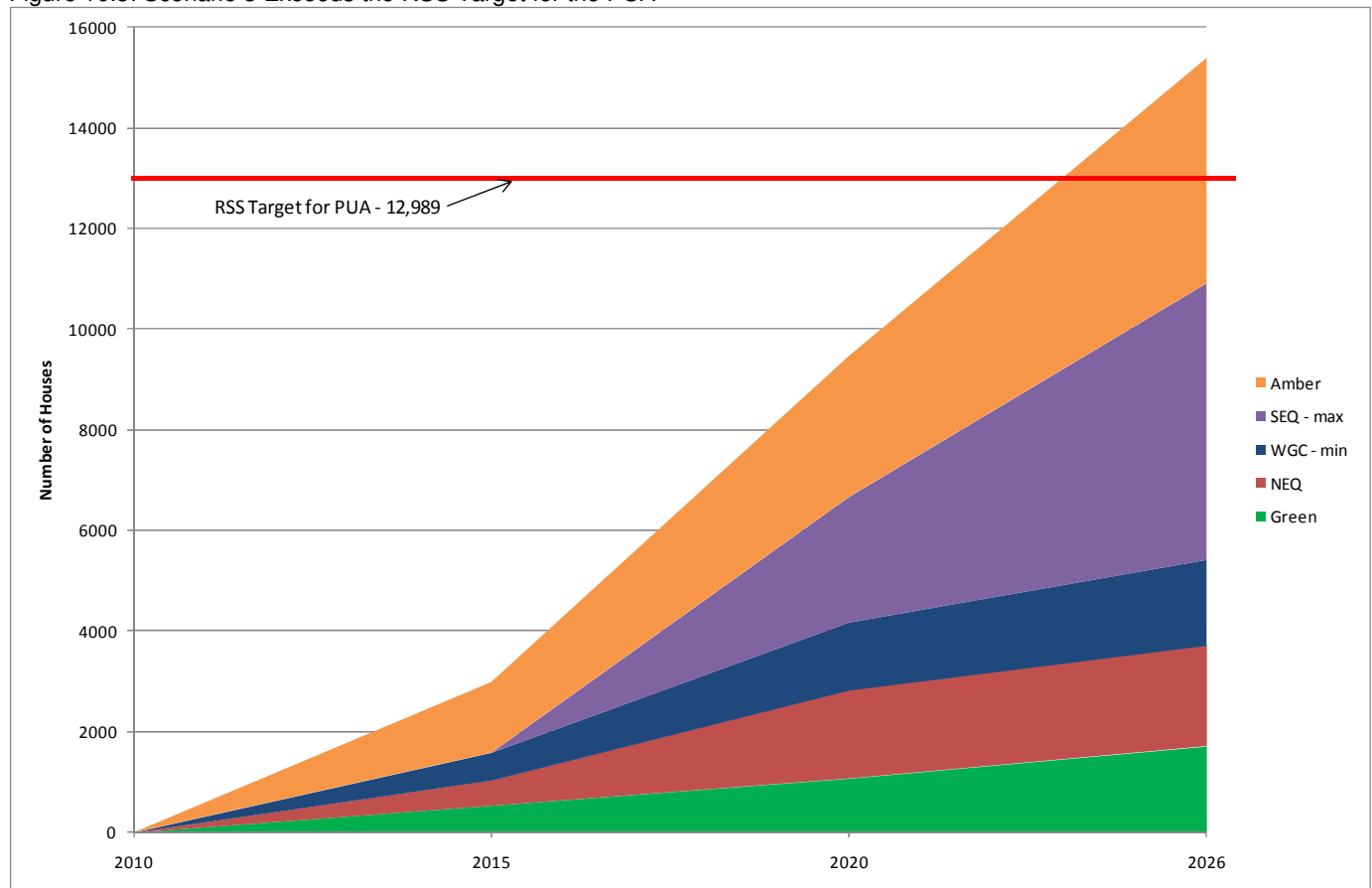
Table 10.5: Scenario 3 – to test the numbers deliverable in the PUA

Source	Number of houses	
	Unrestricted	Restricted to the 2026
'Green' SHLAA sites*	1,716	1,716
'Amber' SHLAA sites [#]	4,472	4,472
NEQ	2,000	2,000
WGC	1,700	1,700
SEQ	10,000	5,500
Total	19,888	15,388

[#]This figure comprises SHLAA map numbers; 9, 13 & 14 plus 1,803 units in North Hykeham.

Scenario 3 has accounted for the maximum units that could be built on the SEQ and the minimum on the WGC presuming the Environment Agency's and Upper Witham IDB's objections to the WGC on flood risk grounds are upheld. It also considers the SHLAA sites that the sewerage RAG assessment classified as Amber i.e. investment would be required to serve these sites. Scenario 3 is able to deliver the required RSS target number within the 2026 timeframe for the PUA and LPA (Figure 10.3).

Figure 10.3: Scenario 3 Exceeds the RSS Target for the PUA



Variations to the numbers considered as part of Scenario 3 could include;

- If minimum numbers were realised on the SEQ (2,570) and the maximum on the WGC (3,840) the total would be 14,598, which would still exceed the Regional Plan target.
- If minimum numbers were to be realised on both the WGC (1,700) and the SEQ (2,570) the total falls to 12,458 which falls marginally short of the Regional Plan target.

It is therefore concluded that; whilst there are sufficient sites available to meet the Regional Plan target figure of 12,989 houses for the PUA by 2026, in order to do so it will be necessary to utilise all of the Green SHLAA sites and NEQ, some Amber SHLAA sites will have to be developed and maximum numbers realised on either the WGC or the SEQ. If both the WGC and the SEQ only achieve minimum build numbers not only would all of the Amber SHLAA sites be required but some Red sites may also have to be considered if the Regional Plan target were to be met.

Restricting the house building on the SUEs to the 2026 horizon means that Scenario 1 is not viable.

Table 10.6 sets out the numbers that have been considered in Scenario 4 for the LPA.

Table 10.6: Scenario 4 – to test the numbers deliverable in the LPA

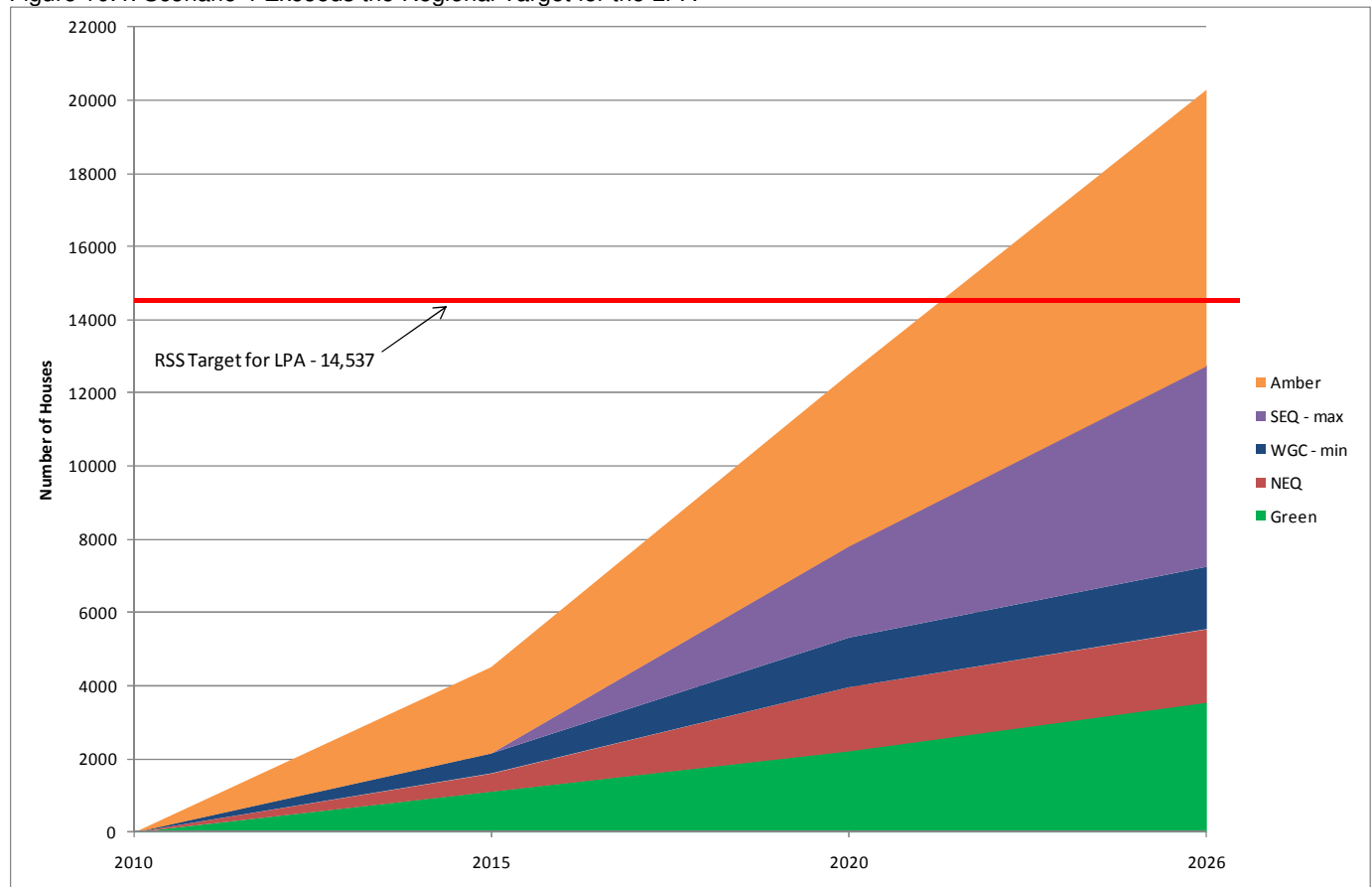
Source	Number of houses	
	Unrestricted	Restricted to the 2026
'Green' SHLAA sites**	3,542	3,542
'Amber' SHLAA sites#	7,559	7,559
NEQ	2,000	2,000
WGC	1,700	1,700
SEQ	10,000	5,500
Total	24,801	20,301

**This figure comprises of 177 in North Hykeham, 1400 in South Hykeham, 333 in Bardney, 93 in Welton and 1,539 green SHLAA sites in South Lincoln comprising sub-catchments, 8, 11, 12, 15, 16, 17.

#This figure comprises all amber SHLAA sites across the LPA including Lincoln SHLAA map numbers; 9, 13 & 14.

Scenario 4 presumes that the Environment Agency's and Upper Witham IDB's objections to the WGC on flood risk grounds are upheld. The unrestricted total number of units in Scenario 4 exceeds that required to meet the Regional Plan target (14,537), however it does not take into account the 2026 planning horizon which reduces the number delivered on the SEQ to 5,500. Accounting for this reduces the number of units delivered by 2026 to 20,301 which is still in excess of that required for the RSS – Figure 10.4.

Figure 10.4: Scenario 4 Exceeds the Regional Target for the LPA



Even if the minimum number were realised on the SEQ (2,570) the Regional Plan target for the LPA could still be achieved. It is therefore concluded that there are sufficient sites available to meet the Regional Plan targets, but in order to do so it will be necessary to utilise Amber sites for the PUA and LPA. Excluding Amber sites, and assuming maximum numbers on the WGC and SEQ would not meet the target. Therefore AWS will have to undertake some investment in the foul sewerage system in order to deliver future growth.

Infrastructure Requirements



Re-routing the north of Lincoln via a direct connection courtesy of the NEQ has the potential to change the Red status of between 2,000 and 2,800 units to Amber. This area of Lincoln has the additional benefits that the development would be located in Flood Zone 1 and whilst there have been historic pluvial flood issues this may present opportunities to solve them.

However, the decision to re-route North Lincoln away from Stamp End would need to be taken before work commences on the NEQ. This is because it will influence the sizing of pipes connecting the NEQ to Canwick STW. It would be uneconomic for AWS to invest in a connection for 2,000 properties on the NEQ only to have to upgrade the connection a few years later to accommodate additional flows from North Lincoln. Equally there is little value investing in a large scheme to serve the NEQ and all of North Lincoln if the development in North Lincoln is not realised.

Therefore if AWS is to invest in a scheme for the NEQ they would require City of Lincoln to provide them with some certainty whether or not the re-development and growth are going to happen in North Lincoln.

11.1.2 Western Growth Corridor

The WGC has some uncertainty over the levels of growth that will be deliverable. If the Environment Agency and Upper Witham IDB objections to development on flood risk grounds is upheld and 1,700 properties are delivered, AWS's work to date indicates that this would not require any further improvements to the system. Alternatively if 5,000 properties are delivered it is anticipated that some mitigation works might be required within the sewerage system to overcome potential flooding. Based on the build rates presented in Table 10.2, these mitigation measures would not be required until AMP6; 2015-20. AWS have recommended that due to uncertainties in the modelling work undertaken the site should be considered Amber until proven Green.

If development includes those areas within Flood Zones 2 and 3 appropriate flood risk management infrastructure will need to be put in place.

11.1.3 South East Quadrant

Table 10.2 suggests that house building on the SEQ is not going to start until 2015 at the earliest. Indeed delivery of the SEQ is linked to the building of the eastern bypass which is now scheduled to commence in 2013. It will be necessary to have a direct connection for foul sewerage from the SEQ to Canwick STW in place by the time building starts. This will obviously be influenced by progress of the bypass and developers intentions to bring the SEQ forward.

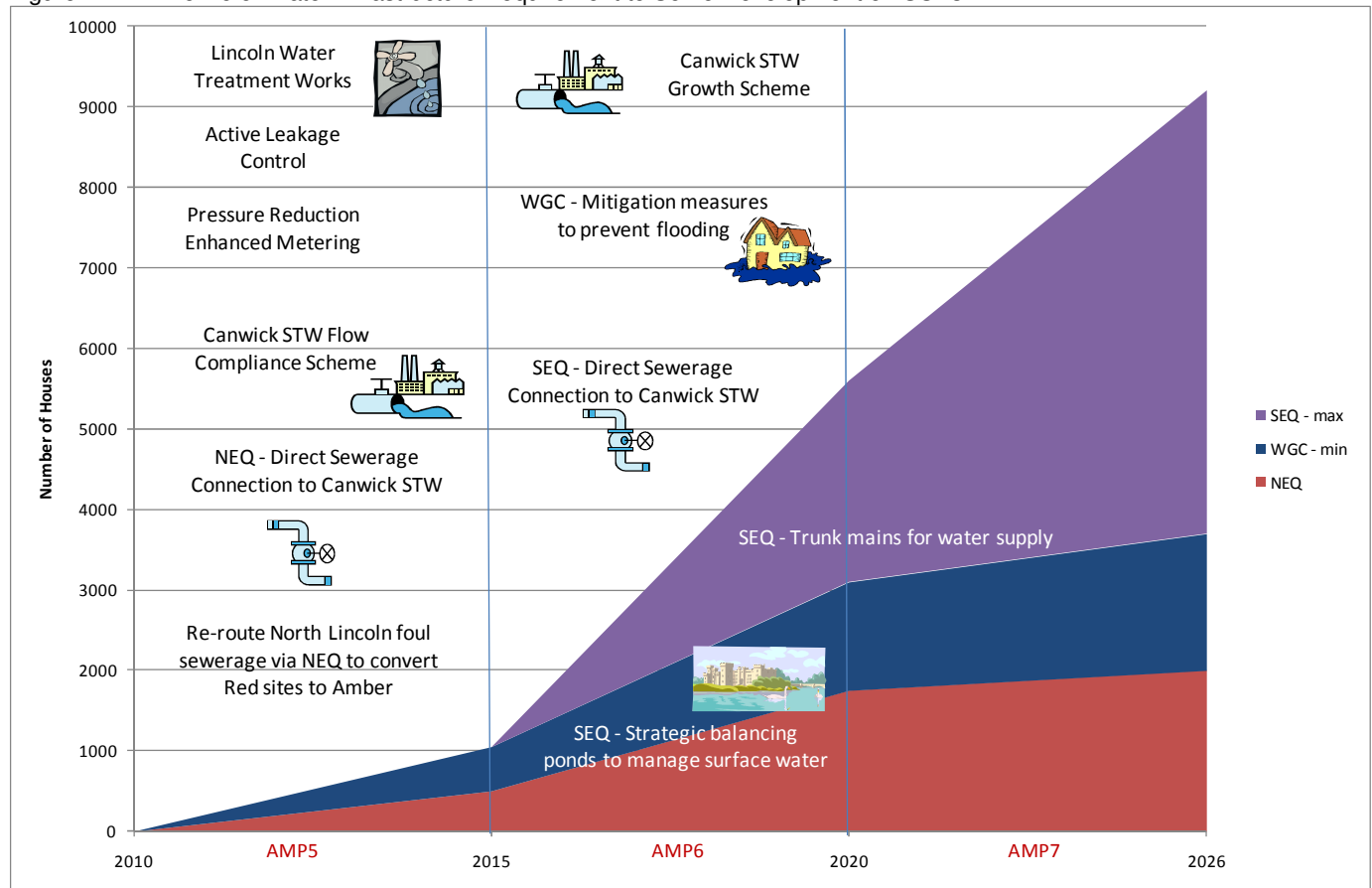
11.1.4 Infrastructure Investment for Lincoln's SUEs

In addition to the foul sewerage requirements referred to above that are required to serve growth in Lincoln, it is also known that several other water infrastructure assets will be required, these are illustrated in Table 11.1 and Figure 11.2.

Table 11.1: Timetable of Water Infrastructure Required in Lincoln to Deliver Growth on SUEs

Asset Management Period	Infrastructure Required
AMP4 2005 – 2010	- Canwick STW Scheme to remove hydraulic restrictions
AMP5 2010 – 2015	- New Lincoln WTW - Canwick STW Flow Compliance Scheme - NEQ - Direct sewerage connection to Canwick STW including a new pumping station
AMP6 2015 – 2020	- Canwick STW Growth Scheme - WGC – Potential need for mitigation measures to prevent flooding depending on final numbers developed - SEQ – Direct sewerage connection to Canwick STW - SEQ – Trunk mains for water supply - SEQ – Strategic balancing lagoons for surface water
AMP7 2020 – 2025 +2026	- SEQ – Trunk mains for water supply

Figure 11.2: Timeline of Water Infrastructure Requirement to Serve Development on SUEs



The timetable above has been derived based upon the growth rates provided by the City of Lincoln in Table 10.1. Given that the assessment is being generalised over five year AMP periods it is argued that using a different growth rate(s) is going to make little, if any difference to the table above.

Future Action 11.1 – Timetable and timeline of future infrastructure requirements to be reviewed on a regular basis in the future, particularly if significant changes occur in the planning process.

11.1.5 SHLAA Sites

In the case of the Green SHLAA sites, no additional infrastructure or upgrades are required to the existing infrastructure in order to be able to deliver the sites. Consequently there is nothing further to comment on regarding these Green SHLAA sites.

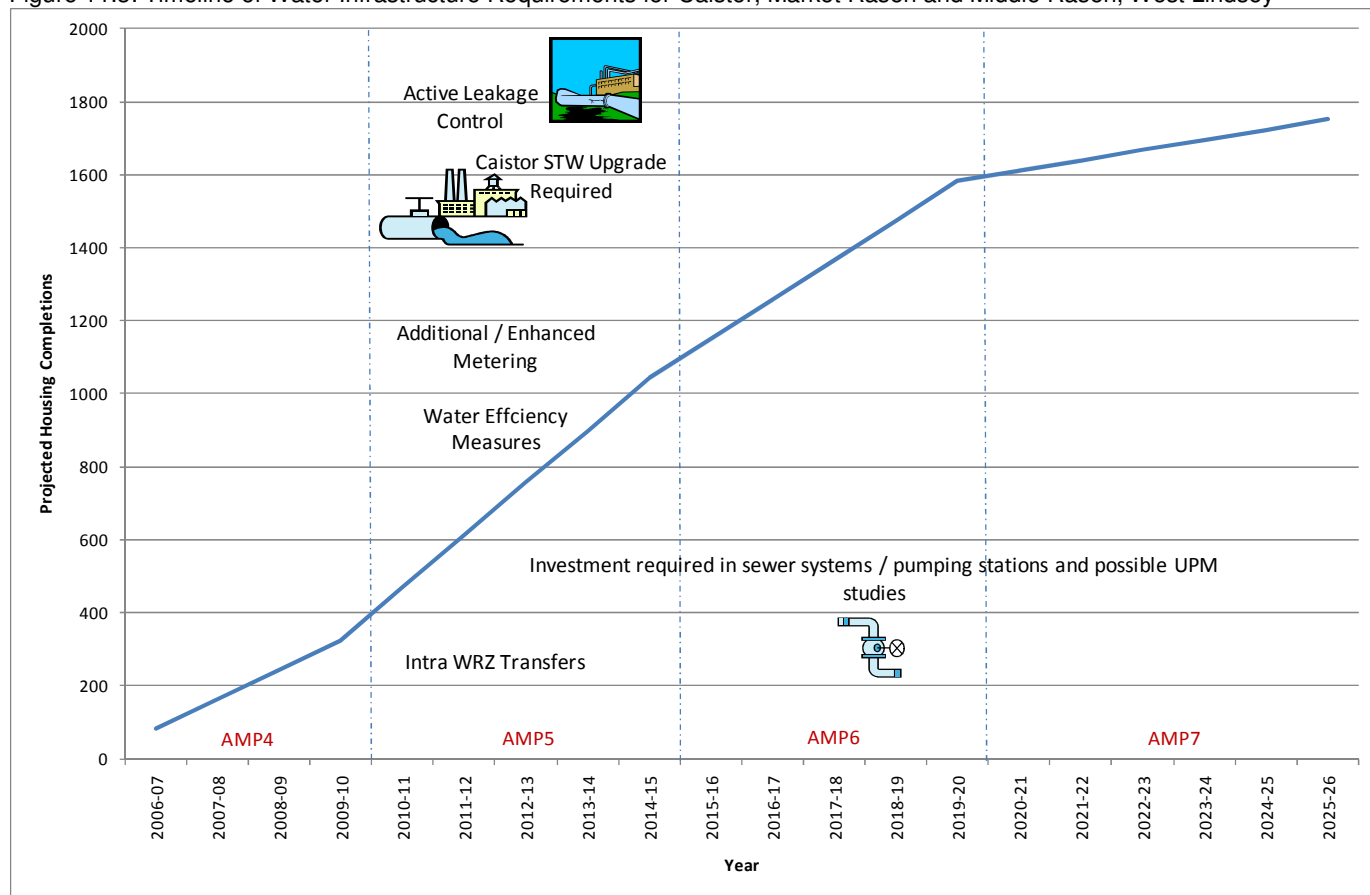
In the case of the Amber SHLAA sites, AWS have indicated that there are simply too many sites to be able to review each in turn with a view to establishing what improvements would be required to bring them forward. The uncertainty over whether or not the sites will come forward in the planning process means that AWS would undertake a significant amount of unnecessary work. Therefore this WCS is restricted to reporting that development of these Amber sites would require investment in additional infrastructure.

Since some Amber sites will have to be developed to achieve the Regional Plan targets it will be necessary for each to be reviewed on a case by case basis when they come forward to determine the exact impact of the SHLAA development site and what improvement works would be required.

11.2 West Lindsey

Figure 11.3 presents a timeline of infrastructure requirements for the West Lindsey villages of Caistor, Market Rasen and Middle Rasen.

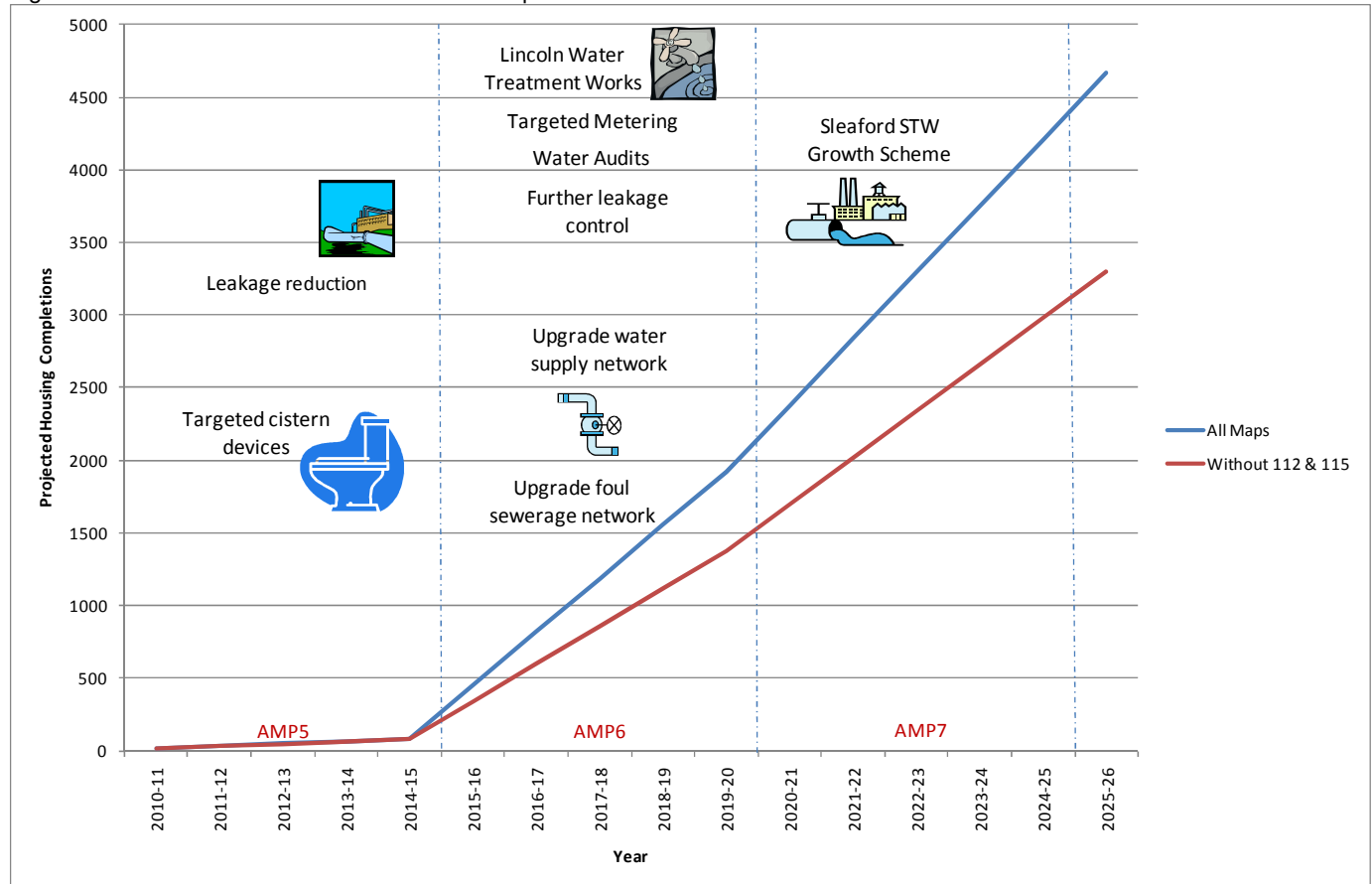
Figure 11.3: Timeline of Water Infrastructure Requirements for Caistor, Market Rasen and Middle Rasen, West Lindsey



11.3 North Kesteven

Figure 11.4 presents a timeline of infrastructure requirements for Sleaford on the basis that SHLAA maps 112 and 115 are not developed but all of the other SHLAA sites do come forward. The infrastructure requirements are based upon the findings of the previous sections reviewing the water cycle.

Figure 11.4: Timeline of Water Infrastructure Requirements for Sleaford



11.4 Challenges to be Overcome in Providing Water Services Infrastructure

The overall challenges will depend on the scale and rate of development, the extent of infrastructure requirements, potential impacts on the environment, the degree of complexity in selecting preferred, sustainable options, lead-in times, availability and phasing of expenditure, and on the degree of clarity of organisational responsibilities. Each of these is covered below.

11.4.1 Scales and Rates of Development

Data made available to this study has illustrated that there are sufficient developable sites to achieve the targets set in the Regional Plan. However, currently the economic situation appears to be limiting growth rates, and developers are not progressing major sites (i.e. the SUEs). There are some issues which will have to be resolved before development can go ahead e.g. flooding concerns relating to the WGC. Some SHLAA sites are proceeding, but these, generally, are much smaller than the SUEs.

Notwithstanding the current economic situation, it is clear that the water treatment works at Lincoln and extension of Canwick STW will be required – irrespective of the exact location of development. AWS is closely monitoring completion rates to avoid early, wasteful investment.

11.4.2 Extent of Infrastructure Requirements

The SUEs are large enough to enable beneficial planning of new infrastructure e.g. balancing lagoons, new trunk mains, creation of wetlands. However, most SHLAA sites will be serviced from existing networks and may have constraints such as insufficient capacities, lack of space to expand, temporary disruption of traffic, noise, loss of amenity. Individual SHLAA sites will be unlikely

to require large amounts of investments in infrastructure, but their phasing cannot be predicted as readily as the SUEs, and their detailed planning maybe complex (e.g. separation of foul and surface water).

11.4.3 Potential Impacts on the Environment

Development and the provision of water services infrastructure can have adverse impacts on the environment, but they can also lead to environmental enhancements. Section 8 of this report provides an overview of the effects of development on the natural environment, and Section 5 gave consideration to the impacts on water quality. The construction of new or altered infrastructure often creates temporary, adverse environmental impacts - which have to be managed or controlled during the construction process. However, permanent adverse impacts are much less prevalent and may be limited to some sterilisation of land for building (over trunk mains, rising mains, sewers etc), and to some loss of visual amenity. The study identifies opportunities for creation of strategic balancing ponds in connection with the three SUEs, and for promoting development of a Sub-Regional Country Park if certain SHLAA sites come forward.

11.4.4 Selecting Sustainable Options

Sustainable options for development and infrastructure provision are not necessarily the “least cost” investment options. Selection of options can be quite complex and involve consideration of existing problems in addition to new requirements, planned replacement of assets and consideration of whole life costs. As the locations and phasing of developments become more defined, detailed infrastructure provision will be more clearly identified. The challenge will be to select options which are “sustainable” in the long term – both economically and environmentally.

11.4.5 Lead in Times

Planning applications for major developments (e.g. the three SUEs) can take three to four years to process. Smaller (SHLAA) sites may be dealt with in six to nine months. Provision of water services infrastructure requires lead-in times for Feasibility Studies, Modelling and Detailed Design. Overall time periods will depend on the scale and nature of the new assets, but could be several years for the new treatment works, and several months for the new mains extensions/sewers. Consultation processes and obtaining legal consents affect both development and infrastructure provisions. The co-ordination of timetables is a major challenge.

11.4.6 Availability and Phasing of Expenditure

In any AMP period, the expenditure available to AWS is that which is approved by OFWAT. Developers will only invest if the economic climate is reasonable and if the general public can buy and rent properties at affordable prices. The Environment Agency budgets depend on limits defined by DEFRA and LPAs / IDBs rely on Environment Agency approved grants for drainage schemes. Some developments depend on expenditure by other service providers, such as the SEQ is reliant on provision of the Eastern Bypass by the Highways Authority. The challenge is to secure appropriate levels of expenditure and then to ensure that it is used effectively.

11.4.7 Organisation Responsibilities

The Flood and Water Management Act 2010 will change some responsibilities for surface water drainage and will introduce new requirements on water companies. During the transitional period there may be a lack of willingness (by some organisations) to commit resources, or to take initiatives until roles and responsibilities are clearly defined by the Act. Lack of financial resources may result in desirable projects being delayed.

11.5 Approaches to Overcoming the Challenges

The challenges defined above can be overcome if the organisations involved continue to work in a “partnership” mode. Each of the major stakeholders can contribute significantly to the achievement of an effective, integrated water cycle strategy and the following sections identify some key points.

11.5.1 Local Planning Authorities

The formation of the Joint Planning Committee should enable:

- Allocation of housing numbers across all parts of the HMA
- Development of Action Area Plans
- Better indication of locations and phasing of preferred developments
- Discussions with developers regarding progress of SUEs

- Determination of policy relating to WGC and SEQ

The local planning authorities will be able to take into account the RAG status of water infrastructure at various locations, and hold discussions with AWS regarding preferred options, phasing, and practical implementation issues. They will also take into account other relevant planning policies e.g. regeneration.

11.5.2 Lincolnshire County Council

The County Council will become the LLFA for local flood risk and have to produce PFRAs under the Floods Directive. The information coming out of the PFRAs ought to be able to inform the surface water RAG status for the WCS. The County Council will also become responsible for approving and adopting SUDS under the Flood and Water Management Act 2010.

11.5.3 Anglian Water

The main objective is to provide infrastructure when required to service approved growth. In AWS Integrated Management System Policy for water services, it is acknowledged that “growth and climate (change)” are significant challenges.

However, AWS has strategic and business unit plans on which it sets and reviews its objectives, obligations and targets. These include, inter alia:

1. Developer Services – this provides one-stop assistance to developers and local authority planning teams;
2. Strategic Asset Management Team – which manages spending on assets and sets spending targets for capital schemes;
3. Asset Planning – which prioritises what needs to be done, develops standards and policies, and assesses performance and risk;
4. The “Alliance” – which is the business model for AWS and its engineering partners to work collectively to design and contract assets;
5. The Investment Programme Planning and Management Team (IPPMT) – which plans and monitors one and two year rolling programmes, as well as five year capital investment programme; and
6. Risk and Value Management – to support effective risk management.

The above units will help with the planning, design and provision of infrastructure at both the strategic and local level. The IPPMT should be particularly useful in providing a degree of flexibility which will be needed as various SHLAA sites come forward.

11.5.4 Environment Agency

The Environment Agency will be involved in the processes as “Regulator, Statutory Consultee, Provider and Operator of Flood Risk Management systems, and a provider of grants to local planning authorities and IDBs.

The Agency will be able to use their various planning and operational resources to assist in the determination of sustainable options, and strategic solutions.

Future Action 11.2 – Establish an “Implementation Group” to review and promote the Water Cycle Study to ensure that maximum benefit is gained from work undertaken, and from future policies and technical studies.

Masterplanning the Sustainable Urban Extensions



12 Masterplanning the Sustainable Urban Extensions

12.1 Introduction

When the three SUEs come forward it is important that the water cycle is a primary consideration throughout the planning process from conception through to the detailed design. The following section presents a number of concepts that the planning authorities could encourage the developers to incorporate into the SUEs in the interests of the sustainability of the water environment.

12.2 Code for Sustainable Homes

The Code for Sustainable Homes is a voluntary standard designed to improve the overall sustainability of new homes in England by setting a framework within which the building industry can design and construct homes to higher environmental standards. The Code measures the sustainability of a home against nine design categories, rating the 'whole home' as a complete package. The design categories are:

- Energy and CO₂ Emissions
- Water
- Materials
- Surface Water Runoff
- Waste
- Pollution
- Health and Wellbeing
- Management
- Ecology

Each category includes a number of environmental issues which have a potential impact on the environment. Of particular relevance to the WCS are the categories of Water and Surface Water Run-off.

The Water category has two aims relating to water consumption within the home and water consumed outside the home for activities such as car washing and garden watering. The internal water use aim is *"To reduce the consumption of potable water in the home"*. The amount of potable water used within houses can be reduced by using fixed fittings which reduce water use in WC's, taps and showers. Further reductions could be achieved by installing grey water or rain water collection and treatment systems.

The external water aim is *"To encourage the recycling of rainwater and reduce the amount of mains potable water used for external water uses."* The installation of water butts is a very simple yet extremely effect means of reducing the volume of potable water used externally.

The Surface Water Runoff category also has two aims, one to manage runoff from developments and a second concerning flood risk. The aim of managing surface water runoff from developments is to design housing developments which avoid, reduce and delay the discharge of rainfall to public sewers and watercourses. This will protect watercourses and reduce the risk of localised flooding, pollution and other environmental damage.

The flood risk aim is to encourage housing development in low flood risk areas, or to take measures to reduce the impact of flooding on houses built in areas with a medium or high risk of flooding.

Future Action 12.1 – Developers involved with the SUEs should be encouraged by the planning authorities to use fixed fittings and other measures to reduce water consumption in the home, provide measures for collecting rainwater to reduce consumption of water externally and manage surface water runoff on site as part of an integrated solution to serve the whole site rather than individual plots.

12.3 Water Neutrality

The concept of water neutrality has arisen as a response to plans for housing growth in areas where water resources are under pressure. Without water neutrality, or a similarly robust response, housing growth will lead to increased demand for water at a time when climate change threatens to reduce water supply. This presents clear risks to the water environment.

Water neutrality is an ambitious concept which aims to ensure there is enough water to support new development without requiring additional water resources. The definition used by the Environment Agency and the Government is that the total water use after development does not exceed the total water use before development.

A water neutrality strategy will involve a range of measures designed to offset the predicted increase in water that would result from a new development in a business-as-usual scenario. This predicted increase will be limited by implementing water efficiency measures for the *new* buildings. The remaining increase will then be offset by reducing water use in *existing* buildings.

An alternative approach to water neutrality would not relate it specifically to new housing development. Instead, a water-stressed area would be selected, and a strategy put in place not to exceed water use from the baseline year.

The Environment Agency published a report with the Department for Environment, Food and Rural Affairs (Defra) and Communities and Local Government (CLG) in 2007 which showed it is possible to move towards water neutrality in the Thames Gateway. The Gateway is a major growth area that will help deliver the Government's aims to build more homes. Water resources are very stretched in the area. However, the scale of development in the Gateway also presents an opportunity to make the area an exemplar for sustainable development.

Water neutrality is achievable through a combination of measures:

- increasing the level of metering;
- introducing variable tariffs;
- improving water efficiency of new housing;
- retrofitting existing homes with water efficient options;
- reducing demand from non-households.

In October 2009, the Environment Agency published a new study which demonstrates that water neutrality provides an overall economic as well as environmental benefit to society. Analysis showed that for every £1 invested in water neutrality, benefits of about £1.40 would be realised. This benefit depends principally on using less water and energy in homes and businesses through more efficient use of water, particularly hot water use. From an environmental perspective, everyone gains from reduced CO₂ emissions resulting from domestic energy savings and abstracting less water in a water-stressed area helping to protect water quality and biodiversity.

The WCS partners may wish to consider establishing a water neutral area for Lincoln. AWS have identified that additional water resources are available to serve the planned growth however implementing a water neutral scheme could help to limit the amount of additional water that is required.

12.4 Water Sensitive Cities

As part of the drive towards sustainability there is an increasing awareness and consideration of our impact upon the water cycle. WCS' are being developed across the UK to ensure that significant development can be supported by the water cycle without having an adverse impact upon it. However, UK cities have a long way to go before they can be described as being "Water Sensitive Cities"; a utopia where anthropogenic activities work in harmony with the water cycle.

Figure 12.1 presents a schematic of a natural water balance, an urban water balance and the water balance where "water sensitive urban design" (WSUD) has integrated the built and natural environments. The UK situation is much closer to the urban water balance than either of the other two.

Figure 12.1: Water Balances & Urban Areas

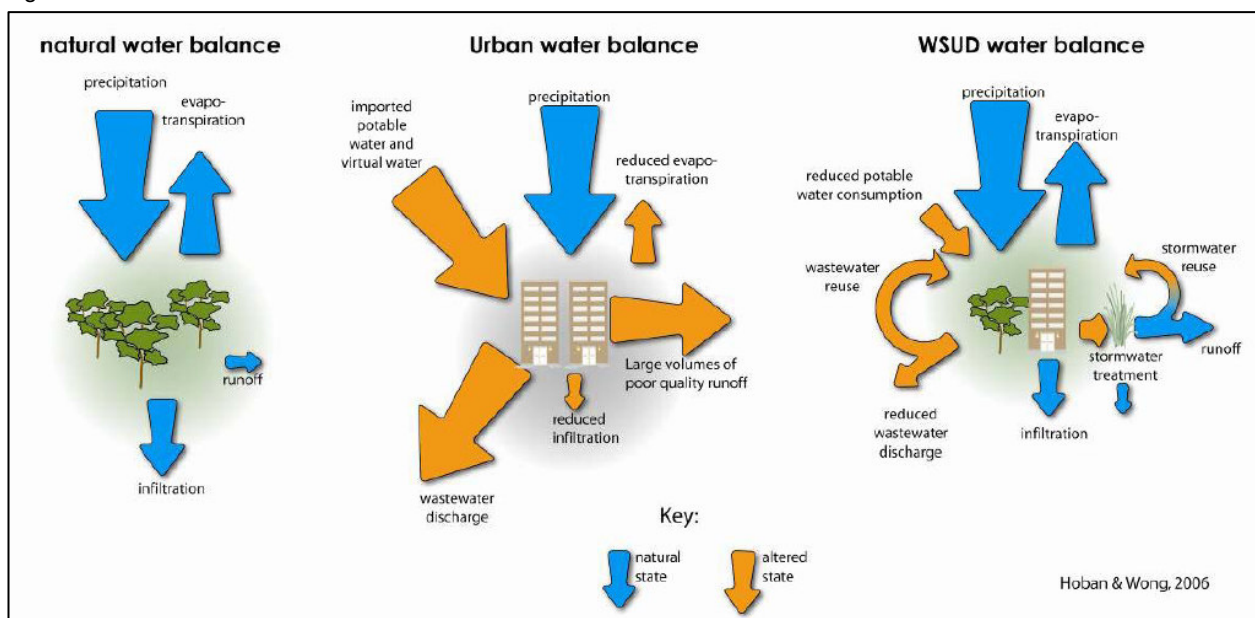


Table 12.1 charts the development of cities over time which presents the gradual movement, or development, towards water sensitive cities.

Table 12.1: Development's Relationship with Water

Cumulative Socio-Political Drivers					
Water supply access & security	Public health protection	Flood protection	Social amenity, environmental	Limits on natural resources	Intergenerational equity, resilience to climate change
WATER SUPPLY CITY	SEWERED CITY	DRAINED CITY	WATERWAYS CITY	WATER CYCLE CITY	WATER SENSITIVE CITY
Supply hydraulics	Separate sewerage schemes	Drainage, channelisation	Point & diffuse pollution management	Diverse, fit-for-purpose sources & conservation, promoting waterway protection	Adaptive, multifunctional infrastructure & urban design reinforcing water sensitive behaviours
Service Delivery Functions					

It could be argued that the UK is currently transitioning between being a Drained City to a Waterways City, for example the Environment Agency are moving away from a stance of flood defence to one of flood risk management and new development is encouraged to reduce site runoff, or even that the UK is moving towards Water Cycle Cities. However there is still a long way to go before we achieve Water Sensitive Cities, we are still getting to grips with sustainable *drainage* systems.

In contrast, Australian's would argue that they are transitioning between Waterways Cities and Water Cycle Cities by implementing WSUD. Developments in Australia seek to collect and use rain water throughout new developments rather than trying to drain it from the site.

Planted biofiltration areas are integrated with roof gardens to collect rainfall, treat the water and provide additional roof insulation. Biofiltration has the benefit of slowing down water flows by 6-12 hours so that water can be released gradually. The grey water that is collected and treated by the biofiltration areas (roof gardens) can be used for a variety of uses.

A tall building will allow the grey water to be cascaded between floors down the building under gravity, being used directly to flush toilets and irrigate green walls on the outside of the build. Water from sinks or showers can also be used to irrigate these green walls, and excess water would be captured to supplement toilet flushing in the floors below. The cascading living green wall provides treatment of the grey water before it is returned to the building. Green walls have the added benefits of providing insulation thereby lowering energy consumption, and regulate the local microclimate.

Such concepts are common place in Australia but relatively unheard of in the UK. This is not because Australian cities receive less rainfall than their UK counterparts and therefore need to make their resources stretch further. As illustrated in Table 12.2 Lincoln receives considerably less rainfall than the major Australian cities.

Table 12.2: Annual Rainfall Comparisons

City	Annual Rainfall (mm)
Lincoln	600
London	650
Melbourne	655
Perth	870
Sydney	1,200

It is recommended that the masterplanning for Lincoln's SUEs should endeavour to implement the concept of WSUD by considering water early within the design process. The strategies should seek to collect and use rainfall within the developments rather than draining it off the site, via SUDS and thereby decreasing the use of potable water supplies. The IDB's and Environment Agency should have an early involvement in any discussions to try to provide sustainable solutions.

Future Action 12.2 – Masterplanning for Lincoln's SUEs should endeavour to implement the concept of WSUD.

Conclusions & Strategy



13 Conclusions & Strategy

13.1 Conclusions

In summary the following bullet points are offered to bring out the pertinent conclusions of the Central Lincolnshire WCS;

- The targets set out in the Regional Plan will not be achieved through the SUEs alone.
- Factors such as the current economic climate mean that future development across the study area is highly uncertain. Unpredictable build rates and uncertainty of which SHLAA sites may come forward are complicated further by the current status of the Local Development Framework. Therefore the overall strategy needs to be both flexible and robust to change.
- The SEQ is considered to be the most sustainable of the three SUEs, followed by the NEQ then the WGC. The WGC is the only SUE with a significant issue, namely the flood risk associated with the site.
- There are significant constraints within the existing foul and combined sewerage network which represents the primary constraint in terms of the water cycle to developing the SHLAA sites.
- In order to meet the Regional Plan targets it will be necessary for AWS to invest in the foul sewerage system to release some Amber SHLAA sites and maximum numbers will have to be realised on either the WGC or the SEQ.
- If both the WGC and the SEQ only achieve minimum build numbers not only would all of the Amber SHLAA sites be required but some Red sites would also be needed.
- The NEQ presents an opportunity to alleviate the constraints on the foul and combined sewerage system in North Lincoln.
- Additional water resources are required to service the Regional Plan target figures and some new water supply trunk mains will be needed to serve the NEQ and SEQ.
- Investment will be required at STWs in order to cater for the Regional Plan targets. AWS plan to invest for major growth at Canwick STW and recommend that growth in other catchments be limited to that which can be accepted within the existing capacities of the receiving STWs.
- Potential growth does not preclude compliance with the WFD however there are outstanding water quality issues concerning phosphorous that the Environment Agency need to assess along with water companies as part of their ongoing WFD related work.
- There are no areas where sites with environmental designations would be adversely affected by growth and the provision of additional infrastructure. Opportunities for environmental enhancement exist in relation to the proposed Sub Regional Country Park. The WGC and other SHLAA sites in the vicinity may have the capacity to incorporate water features such as balancing ponds on site which could provide additional benefits in terms of wildlife ponds that could form part of the Sub Regional Country Park.

13.2 Strategy

13.2.1 Overall Strategy

The Strategy will be to meet the Regional Plan targets for growth to the year 2026 in both the LPA and PUA whilst avoiding premature, wasteful investment in water services infrastructure and whilst ensuring adequacy of services and seeking some environmental improvements. This strategy will involve development in the SUEs and other SHLAA sites with provision of a new WTW in AMP5 and increased capacity at Canwick STW in AMP6. Other potential improvements to water services infrastructure depend on the location and rates of development.

13.2.2 Strategy Review

Local Planning Authorities monitor housing figures annually and the Strategy will require review in three to five years, as development patterns become more clearly defined, and policies are formulated by the new Joint Planning Committee. Revisions to items identified on the initial timelines may be required as the economic situation changes and as the provisions of new legislation come into force (e.g. Flood and Water Management Act 2010).

13.2.3 Strategic Opportunities

Depending on the locations and rates of development, opportunities will be taken to:

- Provide new water supply trunk mains
- Improve water usage efficiency measures
- Separate surface water and foul sewage
- Alleviate existing flooding problems
- Improve flood risk management measures (e.g. by construction of flood storage areas)
- Increase green corridors and the use of SUDS
- Improve water quality
- Consider opportunities to contribute to the Carbon Reduction Commitment such as applying low energy technologies in expansion of Canwick STW

Note – the RAG status of water services assets will provide a useful indicator for the planning authorities when they consider the phasing and sustainability of future developments.

13.2.4 Future Actions

Parameter	Future Action
Development	2.1 - Continual review of the Strategy in light of known development and significant changes to the forecast growth trajectory.
Water Resources & Supply	3.1 - AWS to implement New Lincoln WTW in AMP5. 3.2 - AWS to control leakage, enhance metering and transfer water between WRZ. 3.3 - Encourage developers to provide water efficiency measures in new homes. 3.4 - Ensure all new properties are metered. 3.5 - Implement rainwater harvesting measures wherever appropriate.
Sewerage	4.1 - Where development occurs in areas served by combined sewers endeavour to separate the foul and surface water flows as part of the development. 4.2 - AWS to implement a new direct connection to Canwick STW to serve the NEQ. 4.3 - Review development needs in North Lincoln prior to commencement of the NEQ to ensure that appropriate water infrastructure is in place. 4.4 - AWS to review the impact of developing the WGC when housing numbers are finalised and what, if any, mitigation measures are required to alleviate flooding. 4.5 - Implement a new direct connection to Canwick STW to serve the SEQ. 4.6 - New direct connection to Canwick STW to be in place for development of North Kesteven SHLAA maps 14 and 21. 4.7 – West Lindsey DC and AWS to monitor development in Market Rasen and Caistor. 4.8 – Sewerage presents constraints to development in Walcott, Billingham, Ruskington and south west Sleaford. If these SHLAA sites are to be developed additional work will be required to identify sustainable solutions. 4.9 - Review the RAG status of foul sewerage in North Kesteven when more detailed information concerning which SHLAA sites are to be developed is available. 4.10 – Review the need for UPM studies following site allocation.

Parameter	Future Action
	4.11 – Ensure that no new CSOs are created.
Sewage Treatment	<p>5.1 - Expand Canwick STW in AMP6 to cater for growth.</p> <p>5.2 - Focus future development within the catchment area served by Canwick STW and restrict growth elsewhere within available capacities (Table 5.1).</p> <p>5.3 - Undertake additional work to review Faldingworth STW if development is to go ahead.</p> <p>5.4 - Development in Bardney is considered to be the most sustainable in terms of water infrastructure. Development in Nocton, Dunholme and Welton may require further work to assess water quality implications.</p> <p>5.5 - If further development is to take place in Cherry Willingham, Langworth, Sudbrooke, Metheringham and Dunston local authorities to liaise with AWS regarding potential implications.</p> <p>5.6 - AWS to review potential to invest and improve the foul sewerage system in Market Rasen to take advantage of the available capacity at the STW.</p> <p>5.7 - West Lindsey DC to review development in Caistor in consultation with AWS.</p> <p>5.8 - North Kesteven DC and AWS to consider potential to exploit spare capacities that exist at STWs without the need for expansion of the STW otherwise Navenby, Billinghay, Leasingham, Sleaford, Heckington and Wilsford will require upgrades.</p> <p>5.9 - The Environment Agency to tackle diffuse pollution across the River Witham catchment.</p> <p>5.10 - The Environment Agency to address the issue of phosphorus under the WFD.</p>
Surface Water	<p>6.1 - AWS to continue investigating the flood problem at Stamp End.</p> <p>6.2 - Surface Water RAG status to be reviewed following completion of PFRA.</p> <p>6.3: The options for surface water separation should be considered further at the Implementation Stage through a feasibility study.</p> <p>6.4 - Developers to use SUDS wherever possible with due regard to the constraints associated with the specific site.</p> <p>6.5 - Developers to consider strategic balancing ponds for the SUEs.</p>
Flood Risk	<p>7.1 - Ensure that the flood risk associated with all sites that are developed is addressed.</p> <p>7.2: Environment Agency to implement Flood Risk Management Policies set out in the CFMP.</p>
Environment	<p>8.1 - Maximise opportunities to benefit the Sub Regional Country Park should development occur on the WGC or SHLAA maps 1, 9 13, 16, 20 and 29.</p> <p>8.2 - Incorporate strategic balancing ponds into the three SUEs and maximise the potential to create opportunities for wildlife in ponds and reed-beds.</p> <p>8.3 – Local authorities to identify mechanisms to promote GI.</p>
Infrastructure Requirements	<p>11.1 - Timetable and timeline of future infrastructure requirements to be reviewed on a regular basis in the future, particularly if significant changes occur in the planning process.</p> <p>11.2 – Establish an “Implementation Group” to review and promote the Water Cycle Study to ensure that maximum benefit is gained from work undertaken, and from future policies and technical studies.</p>
Masterplanning the SUEs	<p>12.1 - Developers involved with the SUEs should be encouraged by the planning authorities to use fixed fittings and other measures to reduce water consumption in the home, provide measures for collecting rainwater to reduce consumption of water externally and manage</p>

Parameter	Future Action
	<p>surface water runoff on site as part of an integrated solution to serve the whole site rather than individual plots.</p> <p>12.2 - The masterplanning for Lincoln's SUEs should endeavour implement the concept of Water Sensitive Urban Design.</p>

Whilst it has been deemed impractical to incorporate the future actions into supplementary planning guidance, it is recommended that they are given due consideration by the planning authorities when considering planning applications and will be fed into the evidence base for developing the Joint Core Strategy.

Guidance for Developers



14 Guidance for Developers

14.1 Introduction

This section is intended to provide Developers with guidance so that they can demonstrate to the planning authorities that they have given due attention to the water cycle. The principal mechanism for this is the Developers Checklist which has been carried over and modified from the Outline WCS for Lincoln. It has taken into account a similar guidance document produced by the Lincoln IUD Pilot study and currently referred to by the Lincoln Drainage Group.

14.2 Contact Points

The main organisations involved in the water cycle process are the Environment Agency, Anglian Water and the relevant Local Planning Authority. Internal Drainage Boards and the County Council (Highways Department) may also be involved, depending on the location and nature of the development. Developers should liaise with all these organisations to obtain the necessary approvals, agreements and permissions.

14.3 Items of The Water Cycle To Be Considered

This list below is intended to give Developers an indication of items which should be considered in connection with various elements of the Water Cycle.

	Checklist Items	Completed Y/N?
1.	Water Resources	
1.1	Confirm that water supply capacity is available and that demand can be met in accordance with the Water Cycle Strategy.	Y/N
1.2	Provide water efficiency measures in new homes.	Y/N
1.3	Implement rainwater harvesting measures and consider re-use of rainwater.	Y/N
2.	Water Supply	
2.1	Identify if agreement is required for provision of new water supply, off site, mains.	Y/N
2.2	Agree layout for water distribution mains, within site boundaries.	Y/N
3.	Water Consumption	
3.1	Confirm that the development can meet a water consumption target of 120l/h/d and enclose supporting details (e.g. proposals for rainwater harvesting, grey water recycling, low/dual flush toilets and water saving tap and shower fittings).	Y/N
3.2	Identify a strategy for the supply of water for fire fighting.	Y/N
4.	Sewerage	
4.1	Agree strategy for surface water and foul drainage with Lincoln Drainage Group (to ensure integrated approach and to avoid increasing pluvial flooding).	Y/N
4.2	If the site is over 1ha, a FRA will be required to comply with PPS25 and an indication will be required of the extent of impermeable areas both before and after development.	Y/N
4.3	Demonstrate that surface water runoff rates will not be increased and that balancing arrangements will be designed in accordance with the Environment Agency Technical Report "Preliminary Rainfall Runoff Management for Developments (W5-074/A/TR1).	Y/N
4.4	Apply for Byelaw consents from the Environment Agency and/or the Internal Drainage Board if new outfalls are proposed into watercourses, or if new buildings/structures are proposed within a specified distance from the banks. (For the EA and Witham 1 st and 3 rd IDBs this distance is 9 metres. For the Upper Witham IDB it is 6 metres). Designs will have to be in accordance with relevant standards/specifications.	Y/N

	Checklist Items	Completed Y/N?
4.5	If site is in an area classified as Amber or Red for foul sewerage have appropriate discussions with Anglian Water taken place and additional works undertaken where necessary?	Y/N
4.6	If appropriate, has the potential to separate combined systems been considered?	Y/N
5.	Sustainable Drainage Systems (SUDS)	
5.1	Provide details of any SUDS proposed and supporting evidence, e.g. ground investigation results as per BRE 365 – Soakaway Design. For design guidance of SUDS see CIRIA publication C697.	Y/N
5.2	Confirm methods of interception and infiltration (where applicable) and quantify the amount of surface water to be controlled by SUDS.	Y/N
5.3	Confirm the arrangements for the future ownership and maintenance of all SUDS installations.	Y/N
6.	Sewage Treatment	
6.1	Confirm whether or not sewage treatment capacity is available in accordance with the Water Cycle Strategy and whether a financial contribution is required to works extensions.	Y/N
6.2	Identify if new outfall sewer to STW is required in the Water Cycle Strategy, and possible costs.	Y/N
7.	Flood Risk Management	
7.1	Has a Flood Risk Assessment (FRA) been prepared, as required by Planning Policy Statement Note 25: (- Annex 'E')?	Y/N
7.2	Is development proposed within flood zones 2 or 3 (see Environment Agency Flood Map)?	Y/N
7.3	If the answer to 7.2 is 'Yes', have the Sequential Test and the Exception Test been applied (see Annex 'D' of PPS25), and account taken of Vulnerability classification?	Y/N
7.4	Will arterial drains be affected by surface water runoff from the development, and will financial contributions be required from the Internal Drainage Board or the Environment Agency?	Y/N
7.5	Has the Lincoln Drainage Group agreed the principles for flood risk management on the site?	Y/N
7.6	Demonstrate that all sources of flooding have been taken into account, and that allowances have been made for the possible impacts of climate change.	Y/N
7.7	Where residual risks are involved, demonstrate that appropriate mitigation measures will be provided, e.g. raising of floor levels, flood resilience and resistance measures, dry access/egress, compensatory flood storage areas, etc (see Annex 'G' of PPS25).	Y/N
8.	Pollution Prevention	
8.1	Provide details of measures to minimise pollution to watercourses during construction.	Y/N
8.2	Provide details of pollution prevention measures for the life of the development such as oil and silt interceptors. Consider whether permeable pavement areas are protected from siltation.	Y/N
9.	Conservation / Enhancement of Ecological Interest	
9.1	Confirm that an environmental assessment, proportional to the size and nature of the development, has been undertaken. This should identify any impacts on wildlife habitats (include surveys) and detail suitable mitigation measures, where necessary.	Y/N
9.2	Confirm that the green infrastructure, such as the surface water system, links to the neighbouring green infrastructure to assist the creation and maintenance of green corridors.	
9.3	Identify opportunities for creating or improving watercourse habitats, where practicable.	Y/N
9.4	Confirm whether the Local Biodiversity Action Plan (LBAP) has been consulted and whether any habitats or species detailed within the LBAP are present or near the development site.	Y/N

This Checklist will need to be developed and updated to ensure it is in line with the emerging Lincolnshire Flood Risk and Drainage Management Framework.

14.4 Reference Documents

The following documents should be referred to, as necessary for the relevant water cycle process.

Source	Document
Environment Agency	CFMPs, Flood Maps, Byelaws Various documents giving standing advice available on network
Anglian Water	Sewers for Adoption
Local Planning Authorities	SFRAs, LPA Policies, Building Regulations
Lincs CC (Highways)	Road Specification – highway drains
Internal Drainage Boards	Byelaws, Policies
National	PPS25, R & D Technical Reports, BRE365 – Soakaway Design, SUDS – CIRIA Report 522

Abbreviations

AMP	Asset Management Period
AWS	Anglian Water Services
BOD	Biological Oxygen Demand
CAMS	Catchment Abstraction Management Strategy
CFMP	Catchment Flood Management Plan
CSO	Combined Sewer Overflow
cDWF	consented Dry Weather Flow
DC	District Council
FORWARD	FORcasting of Water Resources and Demand
FZ	Flood Zone
GI	Green Infrastructure
HMA	Housing Market Area
IDB	Internal Drainage Board
LIUD	Lincoln Integrated Urban Drainage Pilot Study
LLFA	Lead Local Flood Authorities
LNR	Local Nature Reserve
LPA	Lincoln Policy Area
m ³ /d	cubic metres per day
NEQ	North East Quadrant
NNR	National Nature Reserve
PFRA	Preliminary Flood Risk Assessment
PPS25	Planning Policy Statement 25
PUA	Principal Urban Area
PZ	Planning Zone
RAG	Red Amber Green
RQP	River Quality Planning
RSS	Regional Spatial Strategy
SA	Sustainability Appraisal
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SEQ	South East Quadrant
SFRA	Strategic Flood Risk Assessment
SHLAA	Strategic Housing Land Availability Assessment
SMP	Shoreline Management Plan

SPA	Special Protection Area
SRS	Sub-Regional Strategy
SSSI	Site of Special Scientific Interest
STW	Sewage Treatment Works
SUDS	Sustainable Drainage Systems
SUE	Sustainable Urban Extension
SWMP	Surface Water Management Plans
UPM	Urban Pollution Management
WCS	Water Cycle Study
WFD	Water Framework Directive
WGC	Western Growth Corridor
WRMP	Water Resource Management Plan
WRZ	Water Resource Zone
WSUD	Water Sensitive Urban Design
WTW	Water Treatment Works

References

- AECOM (July 2009). West Lindsey Strategic Flood Risk Assessment. Final Report.
- AECOM (November 2009). North Kesteven Strategic Flood Risk Assessment. 2008 Revision Report.
- Anglian Water (April 2008). Draft Water Resources Management Plan.
- City of Lincoln (December 2008). State of the City Report. Integrating the 4th LDF Annual Monitoring Report.
- City of Lincoln (October 2009). Employment Land Review.
- Communities and Local Government (November 2006). Planning Policy Statement 3 (PPS3): Housing.
- EKOS Consulting (February 2009). North Kesteven and City of Lincoln Strategic Housing Land Availability Assessment. Second Final Draft Report.
- Environment Agency (March 2004). The Witham Catchment Abstraction Management Strategy.
- Environment Agency (April 2006). The Grimsby, Ancholme and Louth Catchment Abstraction Management Strategy.
- Environment Agency (March 2008). The Lower Trent and Erewash Catchment Abstraction Management Strategy.
- Environment Agency. Calculation of River Needs Consents. (For version 2.5 of RQP).
- Faber Maunsell (June 2008). Lincoln Integrated Urban Drainage Pilot SLD2309. Final Report.
- Faber Maunsell (July 2008). Lincoln Water Cycle Study Stage 1 – Outline Strategy.
- Government Office for the West Midlands (March 2009). East Midlands Regional Plan.
- JBA Consulting (February 2010). City of Lincoln Strategic Flood Risk Assessment.
- Taylor. R. (October 1982). River Witham System Scheme Lincoln Flood Alleviation. Engineer's Report, section 90 of the Land Drainage Act 1976. MAFF Ref:- L.D.W. 31379.
- West Lindsey District Council (March 2008). West Lindsey Strategic Housing Land Availability Assessment (SHLAA) 2008.
- West Lindsey District Council (October 2008). Gainsborough (West Lindsey) Growth Point. Programme of Development 2008 – 2026.
- WRc. Sewers for Adoption.

Appendices



Appendix A: Residual Risks & Assumptions

Table A1: Residual Risks

Risk Status: **OPEN** = Residual Risk
CLOSED = Accepted Risk

Risk Factor	Initial Probability	Consequence	Mitigation Measure	Action	Latest Probability	Comments / Status
Section 1 – Quality						
Q1. Supply of inaccurate data	L	Errors in report	Verify data before submission.	All	M	OPEN - Whilst every effort has been made to ensure that the data used within the WCS is accurate there is the possibility that errors have crept in or more likely that with time the data will become outdated and superseded. The Outline WCS for Lincoln now contains inaccuracies in light of updates to data-sets.
Q2. Incomplete data	M/H	Report qualified – future revision required	Ensure data is most up to date available, consider alternatives, delay conclusions.	All	M	OPEN - The WCS has made use of the best available planning data at the time of writing. The WCS will need to be a living document to be revised as information concerning future development improves.
Q3. Different assumptions made by various parties	M/H	Conflict regarding conclusions in the report	Agree assumptions at an early stage in the study, and confirm/record at stakeholder meetings.	AECOM with relevant stakeholders AW/EA	L	CLOSED
Q4. Use of documents/data not accepted by all stakeholders	M	Report not accepted by all stakeholders	Caveat report findings as appropriate in agreement with stakeholders.	AECOM	L	CLOSED
Q5. Report not acceptable to some stakeholders	L	Report not signed off by all stakeholders	Ensure full consultation and adoption of partnership mode. Seek stakeholder acceptance to report throughout life of project.	AECOM	L	CLOSED
Q6. Lack of identification of Key Stakeholder	M	Inadequate input on specialist items	Agree contact names and communication plan,	All	L	CLOSED

[illegible]

Table A2: Assumptions

Item	Comment
Housing Numbers on Lincoln's SUEs	Minimum, medium and maximum scenarios were developed for the WGC and SEQ in light of the uncertainty concerning the final numbers that may ultimately arise.
Housing Targets	The Regional Plan released on the 12 th March 2009 dictated that housing targets for the LPA and PUA. The West Lindsey Growth Point Programme of Development dictated development within West Lindsey.
Location of Development	Within West Lindsey the Growth Point Programme of Development and historic patterns of development were used to inform where future development would take place. Within the City of Lincoln and North Kesteven the main sites thought likely to go ahead were the three SUEs. However it was therefore considered appropriate to consider all of the developable sites contained within the North Kesteven and City of Lincoln Strategic Housing Land Availability Assessment, Second Final Draft Report (February 2009).
Minimum Size of Development Sites	All developable sites within the SHLAA have been considered grouped by their SHLAA map reference number. In their assessments AWS did not consider SHLAA maps containing less than 100 houses for water supply or less than 50 houses for wastewater in light of the numbers being considered insignificant at this level of assessment.
Extant Planning Permissions	Extant planning permissions to be distributed over the next 10yrs.
Building Rates / Lead-in times of Planning Consents	The SHLAA has been used to inform the phasing of developable sites. The phasing of development on the SUEs was informed by the City of Lincoln Council. The West Lindsey Growth Point Programme of Development dictated development rates within West Lindsey.
Occupancy rates / Water Consumption / Leakage / Flow Increases	All addressed by AWS in their high level reviews and detailed modelling work that has informed the WCS.
Load Increases at WWTW	New consents calculated for key WWTW based on potential development within the sewerage catchment and assuming AWS' standards for occupancy rates and water consumption.
Water Framework Directive	It has been necessary to assume that the Environment Agency will achieve good status in receiving watercourses with regard to phosphorous, to be able to calculate new consents for WWTWs.
Lead-in times and construction times of water infrastructure	Not applicable. It was determined that the WCS and timelines ought to identify when infrastructure is required, not when it can be provided.
Employment Areas	Data relating to future employment areas was limited and restricted the ability of the WCS to fully incorporate it into the assessment.
Development in Flood Zones	All developable SHLAA sites have been considered. The Flood Zones were one parameter that they have been assessed against.

Appendix B: West Lindsey & North Kesteven Housing Data

Table B1: Growth in the Lincoln Policy Area

Village	AMP4	AMP5	AMP6	AMP7	Total
	2006-2010	2010-2015	2015-2020	2020-2026	
Aisthorpe	0	0	0	0	1
Apley	0	0	0	0	0
Bardney	86	122	78	46	333
Barlings	0	0	0	0	1
Brattleby	0	0	0	0	0
Broadholme	2	0	0	0	2
Broxholme	0	0	0	0	1
Bullington	0	0	0	0	0
Burton	0	0	0	0	0
Burton Waters	69	89	70	54	281
Cammeringham	1	0	0	0	1
Cherry Willingham	212	178	139	107	637
Cold Hanworth	0	0	0	0	0
Dunholme	20	41	36	31	128
Faldingworth	6	24	24	23	77
Fillingham	8	0	0	0	8
Fiskerton	8	8	8	8	32
Friesthorpe	0	0	0	0	1
Fulnetby	0	0	0	0	1
Glentworth	13	0	0	0	13
Goltho	0	0	0	0	0
Grange-de-Lings	0	0	0	0	0
Hackthorn	0	0	0	0	0
Hawthorn Avenue	46	22	23	23	114
Holton-Cum-Beckering	0	0	0	0	0
Ingham	9	9	9	8	34
Ingleby	0	0	0	0	0
Kingthorpe	0	0	0	0	0
Langworth	4	12	5	0	21
Lincoln Fringe (n Greetwell)	16	16	16	15	64
Lincoln Fringe (Nettleham)	53	185	76	0	314
Lincoln Fringe (Riseholme)	0	0	0	0	0
Nettleham	8	12	10	8	37
Newball	0	0	0	0	0
New Toft	0	0	0	0	1
Newton-by-Toft	0	0	0	0	0
North Carlton	1	2	1	0	4
North Greetwell	7	10	9	8	34
Odder	1	5	2	0	8
Rand	0	0	0	0	0
Reasby	0	0	0	0	0
Reepham	5	16	11	8	40
Riseholme	0	0	0	0	0
Saxilby	27	50	44	38	160

Village	AMP4	AMP5	AMP6	AMP7	Total
	2006-2010	2010-2015	2015-2020	2020-2026	
Scampton	2	0	0	0	2
Scothern	0	0	0	0	1
Snarford	0	0	0	0	0
Snelland	0	0	0	0	0
South Carlton	0	0	0	0	0
Southrey	3	2	1	0	5
Spidlington	2	1	0	0	4
Stainfield	0	0	0	0	0
Stainton-by-Langworth	0	1	0	0	2
Sudbrooke	4	11	9	8	33
Thorpe-le-Fallows	0	0	0	0	1
Toft-next-Newton	0	1	0	0	2
Welton	18	27	25	23	93
Wickenby	0	0	0	0	1

Table B2: Growth in West Lindsey outside the Lincoln Policy Area, excluding that being addressed by the Gainsborough WCS

Village	AMP4	AMP5	AMP6	AMP7	Total
	2006-2010	2010-2015	2015-2020	2020-2026	
Market Rasen	241	535	436	123	1334
Middle Rasen	19	23	19	15	76
Caistor	64	160	85	31	339
Atterby	0	1	0	0	2
Bigby	8	16	11	8	43
Bishop Bridge	0	0	0	0	0
Bishop Norton	31	19	17	15	83
Bleasby Moor	2	0	0	0	2
Bransby	0	0	0	0	0
Brocklesby	0	0	0	0	0
Brookenby	4	7	3	0	15
Buslingthorpe	1	0	0	0	2
Caenby	1	0	0	0	1
Cabourne	0	0	0	0	0
Claxby	0	0	0	0	0
Clixby	0	0	0	0	0
Coates	0	0	0	0	0
Cuxwold	0	0	0	0	0
East Firsby	0	0	0	0	1
Glentham	14	8	8	8	38
Grasby	13	10	9	8	39
Great Limber	6	6	3	0	15
Hardwick	1	0	0	0	1
Heapham	1	0	0	0	2
Hemswell Cliff	1	0	0	0	1
Holton-le-Moor	0	0	0	0	0
Keelby	2	6	3	0	11
Kettleby	0	0	0	0	1
Kexby	2	0	0	0	2
Kingerby	0	0	0	0	0

Village	AMP4	AMP5	AMP6	AMP7	Total
	2006-2010	2010-2015	2015-2020	2020-2026	
Kirkby	4	0	0	0	4
Kirmond-le-Mire	0	0	0	0	0
Legsby	3	0	0	0	4
Linwood	0	0	0	0	1
Lissongton	1	3	1	0	5
Moortown	0	0	0	0	1
Nettleton	13	15	11	8	46
Normanby-by-Stow	0	0	0	0	0
Normanby-by-Spital	5	8	8	8	29
Normanby-le-Wold	0	0	0	0	0
North Kelsey	5	5	2	0	12
North Kelsey Moor	0	0	0	0	1
North Owersby	0	0	0	0	0
North Willingham	1	0	0	0	1
Osgodby	6	8	8	8	30
Owmby	0	0	0	0	0
Owmby-by-Spital	1	0	0	0	2
Rigby	0	0	0	0	0
Rothwell	1	3	1	0	5
Saxby	0	0	0	0	0
Searby	4	0	0	0	5
Sixhills	0	0	0	0	0
Snitterby	2	8	3	0	14
Someby	0	0	0	0	0
South Owersby	2	6	2	0	10
South Kelsey	14	7	8	8	37
Springthorpe	0	1	0	0	2
Spital in the Street	0	0	0	0	0
Stainton-le-Vale	0	0	0	0	0
Stow	2	3	1	0	6
Sturgate	0	0	0	0	0
Sturton-by-Stow	10	13	10	8	41
Swalloow	7	0	0	0	7
Swinhope	0	0	0	0	0
Tealby	0	1	0	0	2
Thonock	0	0	0	0	0
Thoresway	0	0	0	0	0
Thorganby	0	0	0	0	1
Thornton-le-Moor	0	0	0	0	0
Torksey Lock	0	0	0	0	0
Upton	4	1	1	0	7
Usselby	0	0	0	0	0
Waddingham	13	9	8	8	38

Village	AMP4	AMP5	AMP6	AMP7	Total
	2006-2010	2010-2015	2015-2020	2020-2026	
Walesby	1	1	0	0	3
West Firsby	0	0	0	0	0
West Rasen	0	0	0	0	0
Willingham-by-Stow	9	8	8	8	33
Willoughton	3	0	0	0	4
Total	526	900	671	261	2357

Table B3: Growth in North Kesteven outside the Lincoln Policy Area

SHLAA Map Ref	Village	AMP4	AMP5	AMP6	AMP7	Total
		2006-2010	2010-2015	2015-2020	2020-2026	
42	Swinderby	1.5	1.5	0	0	3
52	Birch Holt	0.5	0.5	0	0	1
55	Martin	1	1	0	0	2
58	Martin	4.5	4.5	0	0	9
61	Birch Holt	1	1	0	0	2
66	Timberland	4	4	0	0	8
67	Scopwick	3.5	3.5	0	0	7
68	Carlton-le-Moorland	15	15	15.6	23.4	69
70	Stapleford	1	1	0	0	2
71	Navenby	41	41	85.6	128.4	296
72	Wellingore	27.5	27.5	22.4	33.6	111
75	Walcott	1.5	1.5	54	81	138
77	Rowston Top	1	1	0	0	2
81	Billinghay	2	2	0	0	4
82	Digby	5.5	5.5	0	0	11
83	Billinghay	108.5	108.5	89.6	134.4	441
84	Asnby de la Launde	0.5	0.5	0	0	1
85	Brant Broughton	1	1	0	0	2
86	Wellbourn	2	2	0	0	4
87	Beckingham	1	1	0	0	2
90	North Kyme	7.5	7.5	0	0	15
91	Dorrington	2.5	2.5	0	0	5
92	Leadenham	0.5	0.5	0	0	1
93	Sutton	1.5	1.5	0	0	3
94	Ruskington	21.5	21.5	0	0	43
95	Ruskington	185	325	248.8	58.2	817
96	Anwick	1.5	1.5	0	0	3
97	Ruskington	0	3.6	5.4	0	9
98	Cranwell	0.5	0.5	0	0	1
100	South Kyme	2.5	2.5	4.8	7.2	17
101	Byards Leap Fm	1	1	0	0	2
102	Leasingham	3.5	3.5	306.4	459.6	773
104	Evedon	15.5	15.5	0	0	31
105	Sleaford	21.5	21.5	463.2	694.8	1201
107	Heckington	0	0	8	12	20
109	Kirkby la Thorpe	0.5	0.5	0	0	1
110	Sleaford	48.5	48.5	105.6	158.4	361
111	Sleaford	0	6.4	194.8	277.8	479

SHLAA Map Ref	Village	AMP4	AMP5	AMP6	AMP7	Total
		2006-2010	2010-2015	2015-2020	2020-2026	
112	Sleaford	2	2	63.6	95.4	163
114	Sleaford	4.5	4.5	530.4	795.6	1335
115	Sleaford	0.5	0.5	481.6	722	1205
113	Heckington	61.5	61.5	161.6	242.4	527
118	Rauceby	125	125	0	0	250
119	Heckington	3.5	3.5	310.4	465.6	783
121	Wilsford	79	79	0	0	158
122	Heckington / Great Hale	14	14	4.4	6.6	39
123	Burton Penwardine	0.5	0.5	0	0	1
126	Little Hale	3.5	3.5	0	0	7
127	Helpringham	1	1	0	0	2
128	Swarby	4.5	4.5	0	0	9
129	Scredington	0.5	0.5	0	0	1
131	Osbourneby	0.5	0.5	0	0	1
132	Swaton	2.5	2.5	0	0	5
134	Newton	1	1	0	0	2
135	Threekingham	0.5	0.5	0	0	1
	Total	841.5	991.5	3148.2	4384.8	9366

Appendix C: Water Quality Joint Position Statement

AWS / EA Anglian: Joint Position Statement for Water Cycle Studies Water Quality Issues and Water Framework Directive

Background

The Water Framework Directive (WFD) provides a new system of classifying the Chemical and Ecological status of rivers, lakes, and transitional waters (known as waterbodies). This new system 'raises the bar' in terms of setting more stringent standards for some substances and includes other substances which have not previously been assessed.

The chemical classification system is broken down into five categories; high, good, moderate, poor and bad. Our rivers must achieve 'good' status for water chemistry if they are to achieve good ecological status by 2015.

Current Guidance

The Environment Agency guidance requires water cycle studies (WCS) to take into account standards set out in River Basin Management Plans (RBMPs); indeed several WCSs are specified as measures to be completed in the RBMP. It does not give guidance on the approach to adopt in assessing whether the WFD is a potential constraint to development.

Issues

No deterioration

From a water quality perspective the scope of a water cycle study is to demonstrate that the achievement of all relevant requirements is not compromised, which includes ensuring there is no deterioration in water quality. This principle is also the basic requirement of the WFD which places a duty on the Environment Agency to ensure there is no deterioration in current status. This is a statutory requirement. We cannot make a decision to allow deterioration based on technical feasibility or disproportionate cost assessment

Improvements

Schemes to improve the status of a waterbody will be identified as part of the National Environment Programme and included in the quality enhancement section of Asset Management Plans. These schemes are subject to a technical feasibility and disproportionate cost assessment.

Many of these schemes will need to be delivered over the next 10-15 years. However, it is important to know now if the ability to meet good status will be made more difficult due to future housing growth. For example, a town which doubles in size and therefore requires standards up to the limits of conventional wastewater treatment to prevent deterioration in the receiving water could mean that achieving good status becomes impossible.

Recommendations

No Deterioration

A WCS should identify consent standards required to prevent deterioration from the current WFD status of the waterbodies downstream of the discharge. Assessing 'no deterioration' within a WCS should involve the following steps:

1. determine whether the planned growth can be accommodated within the current flow consent. (If there is headroom in the flow consent then the growth can be accommodated with no revision to current sanitary consent standards) It is still important to calculate the effect of the growth on the discharge and water quality to highlight where there may be future risks;
2. identify the current status of the downstream waterbody. (This is the status for which we have 95% statistical confidence and is not necessarily the same as the status quoted in the RBMP – Environment Agency Water Quality Planners can

advise on the current status). If the current status is high, then Environment Agency staff should be contacted to confirm whether High or Good should be used as the agreed waterbody status for further calculations.

3. calculate the required consent standard to prevent deterioration from the agreed waterbody status (see step 2). (Some deterioration can be allowed within the status limits, as long as it does not result in a change in status)
4. identify where the required limits are more stringent than that which can be achieved by conventional wastewater treatment technology. (In this case proposed growth poses a significant risk to meeting the statutory requirements of the WFD).

Improvements

If the downstream waterbody does not currently achieve good status then the WCS should identify where housing growth may prevent our ability to meet WFD standards in the future by following the steps below:

1. assume upstream quality is good (i.e. is in the middle of good status);
2. calculate the standards required to achieve good status downstream based on current consented flows;
3. calculate the standards required to achieve good status downstream based on proposed consented flows;
4. assess whether there is a significant difference between the two sets of standards (current flows and proposed flows). This allows us to determine whether growth makes a significant difference to the future ability to meet good status.

Further, detailed guidance on assessing no deterioration is currently in development by the Environment Agency. Working guidance is available from Environment Agency Water Quality Planners, who will also be able to advise on the conclusions of any assessment.

The final consent standards will be determined as part of pre-application determination, or the next periodic review.

Appendix D: Implementation of the Flood Risk Regulations

Date: 25 March 2010

To: Local Authorities in England and Wales

Dear Colleague,

Implementation of Flood Risk Regulations 2009

We write further to the letter of 10 December on the Floods Directive, to explain the implications of the new regulations, and how they relate to the Flood and Water Management Bill (the Bill) and current flood management practice.

The Brief Guide to the Regulations attached explains the different stages of implementation. The Environment Agency aims to provide more detailed draft guidance on the first stage of the Directive next month.

As you will know the Flood Risk Regulations 2009 (SI 2009/3042) http://www.opsi.gov.uk/si/si2009/uksi_20093042_en_1 transpose the Floods Directive in England and Wales. The aim of the Directive is to reduce the likelihood and consequence of flooding by establishing a common framework for understanding and managing flood risk. The work required by these Regulations will form the building blocks of the local strategies proposed in the Bill.

Although the Regulations only set a deadline for the Environment Agency (EA) to publish flood risk assessments, maps and plans, the EA will need time to fulfil its duty to scrutinise the documents for quality assurance and to ensure national consistency. The EA has determined that it will need to see these products six months before each deadline and we agree with this. Although not part of the regulations the date by which the EA requests the documents is legally binding and so these dates are included in the summary below.

Requirements of the Flood Risk Regulations

The Regulations require Lead Local Flood Authorities (LLFAs), which are County and Unitary Authorities, to:

- Carry out an assessment of “local flood risk”, which means considering all sources of flooding except that from main rivers, the sea and reservoirs by June 2011. This needs to be done taking account of main rivers, the sea and reservoir flooding if they affect local flood risk;
- On the basis of this assessment, identify Flood Risk Areas, which are areas of significant risk, taking into account local sources of flood risk and having regard to national thresholds and EA Guidance by 22 June 2011;
- Prepare maps showing the level of hazard and risk in Flood Risk Areas by June 2013, and

- Prepare management plans for these Flood Risk Areas by June 2015.

The management plans will need to bring together these different elements, as well as set objectives and measures that relate to the prevention of flooding, protection of individuals, communities and the environment against the consequences of flooding, and arrangements for forecasting and warning.

This process is to be repeated over subsequent six year cycles. As part of the six-yearly review and update of the management plans, if there have been any instances where the steps identified in the previous version of a plan have not been implemented, it will be necessary to explain why this was the case.

There are provisions for exceptions to some of these stages which are explained in the attached Guide.

How does this process relate to the Local Flood Risk Management Strategies under the Flood and Water Management Bill?

When enacted the Flood and Water Management Bill¹ will require lead local flood authorities to develop and implement local flood risk management strategies, which relate to local sources of flood risk. These will be based on an assessment of risk which should incorporate the preliminary flood risk assessment required by the Directive, as well as the maps and plans for Flood Risk Areas. We expect the process of implementing the Directive and putting in place these strategies to be iterative and integrated as the strategies will need to be in place after the preliminary flood risk assessment but before the Directive maps and plans. The Directive maps and plans will not duplicate the strategies but inform them, and local authorities will have the discretion to treat these products as the key components of their strategies.

Under the Bill, local authorities will also have to ensure that their local strategies are consistent with the national flood and coastal erosion risk management strategy to be developed by the Environment Agency. This will provide the strategic overview and a broad framework for local flood risk management. It will cover all sources of flood risk, and this along with guidance will support and facilitate the development of local strategies.

Timescales on the implementation of this and other elements of the Bill will be decided shortly after the Bill receives royal assent, but it is currently intended that the national strategy will be in place from spring 2011 and the first local strategies from late 2011 onwards.

We are also reviewing how these requirements could be brought into the next round of the Local Area Agreements, as we consider the next iteration of National Indicator 189 for the period 2011 to 2014.

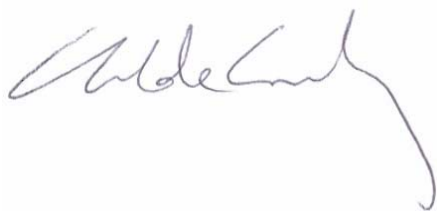
¹ The Flood and Water Management Bill is currently before Parliament and is expected to receive Royal Assent in April 2010. The Bill implements many of the recommendations made by Sir Michael Pitt in his review of the 2007 floods. For more details, see the factsheet at: www.defra.gov.uk/environment/flooding/documents/policy/fwmb/factsheet-localauthority.pdf

The Way Forward

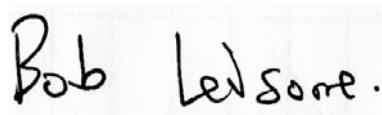
For LLFAs, the initial stages of implementing the Flood Risk Regulations will primarily involve bringing together work that is done at a District or Unitary level at present with national scale information and assessments carried out by the Environment Agency. We recognise that this will involve some work but we are seeking to ensure it is kept to a minimum by EA providing nationally available information. In addition, the Directive only requires available or readily derivable information² to be used for the initial risk assessment stage so does not require significant costs to be incurred in obtaining new data. This preliminary work will ensure a sound basis for implementation of the Flood and Water Management Bill for which government has committed to fully fund new burdens for local authorities.

In implementing the Flood Risk Regulations, LLFAs should make maximum use of guidance and preparatory work to be carried out by the EA, as well as existing work from spatial planning and flood risk management. Efficient and effective implementation will also involve continued close partnership within and between local authorities, the EA and water and sewerage companies, to achieve a shared understanding and management of flood risk.

Yours sincerely



Chris de Grouchy, Defra



Bob Ledsome, CLG

cc Local Government Association

² Meaning information which is in the possession of the person preparing the report or one of the other public bodies from whom LLFAs can request information under regulation 36, or is in the public domain

Brief Guide to Implementation of the Flood Risk Regulations

Although the Regulations only set a deadline for the Environment Agency (EA) to publish flood risk assessments, maps and plans, the EA will need time to fulfil its duty to scrutinise the documents for quality assurance and to ensure national consistency. The EA has determined that it will need to see these products six months before each deadline.

Although not part of the regulations the date by which the EA requests the documents will be legally binding and so these dates are included in the guide below.

The Stages of the Flood Risk Management Cycle

1st Stage – Preliminary Assessment Report – Local Authorities to complete by 22 June 2011

The first stage is for the competent authorities to prepare an assessment that considers general flood risk from all sources to enable authorities to proceed to the second stage, which involves identifying areas of significant flood risk (Flood Risk Areas) on basis of this report.

Lead local flood authorities (LLFAs) - county councils and unitaries - are responsible for assessing risk from local sources of flooding, i.e. surface water, groundwater, ordinary watercourse, canals and flooding from lakes within their areas. They will also need to take into account impacts of flooding from main rivers, the sea or a reservoirs on risk from local sources. The EA is responsible for assessing flood risk from main rivers, the sea and reservoirs.

To assist local authorities, the EA will put together a provisional assessment of risk on the basis of national datasets. This will be provided during November 2010. LLFAs will then need to consider whether the assessment needs to be supplemented by locally held data. This data should already be available as a result of the process of drawing up Strategic Flood Risk Assessments.

LLFAs will need to send their completed preliminary assessment report to the EA by 22 June 2011. The EA will review this assessment and, if considered appropriate, suggest changes that need to be made. Final preliminary assessment reports will need to be published by the EA before 22 December 2011.

Guidance

The EA is preparing guidance on how to prepare a preliminary assessment report. This should be released as a living draft in April 2010 and will enable LLFAs to begin preparatory work.

Links to Existing Work

For local authorities with good quality Strategic Flood Risk Assessments we do not foresee that significant additional work is necessary to carry out this assessment considering the intended role of the EA in analysing national datasets and providing a provisional assessment of risk. This assessment of risk is closely related to the development of local flood risk management strategies and will be a key component of the evidence base of those strategies.

2nd Stage - Identifying Flood Risk Areas – by 2011

LLFAs will then need to identify Flood Risk Areas, which are those areas where the risk from flooding is significant, on the basis of this assessment.

LLFAs will need to have regard to EA guidance, including national criteria on significant risk, in selecting these areas. This guidance will ensure consistency in the choice of these areas across the country. The provisional assessment provided by the EA on the basis of national datasets will give an indication of Flood Risk Areas, so local authorities will be checking that they agree with this identification and consulting as they see necessary. If local authorities decide to choose a larger number of Flood Risk Areas than this guidance suggests, this will not be impossible but it may have a bearing on funding.

LLFAs should aim to send their determination of Flood Risk Areas to the EA by 22 June 2011 along with their preliminary flood risk assessment, if this is possible. Although Flood Risk Areas do not have to be chosen under the Directive by December 2011 it is important to recognise that the tasks involved in the hazard and risk mapping are substantial. So those LLFAs that succeed in meeting this target date will stand a better chance of being able to complete Directive maps for which a deadline does apply.

Once local authorities have submitted their determination, the EA will review this and can make recommendations. If a lead local authority disagrees with the EA, then Ministers will make the final determination. In making this determination, Ministers will ensure that the cumulative effect of flood risk assessed by the EA and the local authority is taken into account. In practise, it is expected that there will be an additional level of scrutiny at a local level through local Overview and Scrutiny Committees.

Guidance

EA guidance on the national criteria and threshold for Flood Risk Areas will be issued, in consultation form, in the Summer of 2010 and finalised before the end of the year.

Links to existing work

The work carried out in respect of SFRAs should give LLFAs a provisional indication of where there will be Flood Risk Areas.

3rd Stage – Flood hazard maps and flood risk maps – by 22 June 2013

The third stage applies only to Flood Risk Areas. LLFAs will need to prepare flood hazard maps and flood risk maps that show the potential extent and consequences of flooding in a Flood Risk Area. Flood hazard maps will show the likely extent, direction and speed of a flood and its probability, whereas flood risk maps will show the number of people, economic and industrial activities and protected areas affected as well as any impact on water quality.

LLFAs will need to send these maps to the EA to review by 22 June 2013, so that these maps can be finalised and ready for publication by the EA before 22 December 2013.

Guidance

The Environment Agency will provide guidance in January 2012 to enable lead local flood authorities to complete flood hazard and flood risk maps. A 'living draft' may precede this.

Links to Existing Work

These risk maps will show risk at the level of detail required by Level 2 Strategic Flood Risk Assessments.

4th Stage – Flood Risk Management Plans (FRMPs) – by 22 June 2015

The fourth stage requires management plans to be put in place for Flood Risk Areas. In preparing the plans, LLFAs will need to bring together objectives and measures that relate to: the prevention of flooding; protection of individuals, communities and the environment against the consequences of flooding; and arrangements for forecasting and warning.

This will involve considering the need for flood management actions, resilience measures and for work to be done by partners – such as internal drainage boards and water companies. LLFAs will have the option of including these plans as an integral part of their local flood risk management strategy under the Bill, or of using these plans to inform their strategy. You should note that anything which is part of the local strategy has the benefit of an obligation on other authorities to either act consistently with the strategy or at least have regard to it.

These plans will need to be submitted to the EA for review so that final plans can be published before 22 December 2015.

Guidance

The Environment Agency will provide guidance to enable local authorities to complete these plans.

Links to existing work

Where they have been completed, Surface Water Management Plans (SWMPs) will form the basis of a FRMP which LLFAs will need to co-ordinate and, if necessary enhance to meet the required level of detail.

Exceptions to the Preliminary Assessment Report

The Flood Risk Regulations allow an LLFA to avoid preparing a preliminary assessment report if, before 22 December 2010, it has either:

- Carried out an assessment (whether or not it meets preliminary assessment report requirements) of flood risk within its whole area and considers that there is a Flood Risk Area, or
- It has determined that it will prepare a flood hazard map, flood risk map and flood risk management plan for the whole of its area.

An LLFA will need to be able to demonstrate that it has made a flood risk assessment for all sources of flood risk other than main river, the sea and reservoirs to satisfy the first exception. The second exception will require detailed maps and plans for a local authority's entire area so is likely to cost considerably more than focusing on just the Flood Risk Areas.

More details on this issue will follow in the Preliminary Assessment Report guidance provided by the Environment Agency.

Publication and review

The Environment Agency is responsible for publishing all Floods Directive assessments, maps and plans before 22 December in the year each product is due. Lead local flood authorities will need to review and update their PFRAs, maps and FRMPs no later than 6 years after the first version is completed. So the first review of the PFRA must be sent to the EA for review by 22 June 2017.

Cross-border catchments

Defra and the Scottish Government are currently preparing administrative arrangements for the Solway Tweed cross border river basin district. In common with other catchment areas that cross administrative borders, it will be important to secure good partnership working between environmental agencies and local authorities. Separate guidance on cross-border arrangements for the Solway Tweed will be issued in due course.

EA Guidance

To assist local authorities in meeting the requirements of the Flood Risk Regulations in England and Wales, the Environment Agency will prepare guidance, tools and templates where appropriate for each stage: the preliminary assessment reports, flood hazard and flood risk maps and flood risk management plans. All guidance documents will be shared with the LGA and Welsh LGA before they are finalised to ensure they are fit for purpose.

The first set of guidance will explain the process for developing the preliminary assessment maps and reports. This will be issued as a living draft from April 2010 and finalised in the autumn. You may contact the guidance project directly using the contacts below.

Guidance will also be provided on the criteria and threshold for identifying Flood Risk Areas on the basis of the preliminary assessment. The EA will issue this guidance in consultation form in summer 2010 but it will not be finalised until the end of the year, as it will first need to be signed off by the Secretary of State and Welsh Ministers.

The Environment Agency has established a project to support the tasks associated with delivering Preliminary Flood Risk Assessments. The project will provide:

1. Preliminary Assessment Maps
2. Guidance on the form of Preliminary Assessment Reports
3. Recommendations on the criteria for identifying Flood Risk Areas (where the risk of flooding is significant).

These outputs are for both the Environment Agency and Lead Local Flood Authorities in England and Wales. The project aims to produce draft outputs by the end of March 2010. Input from interested Lead Local Flood Authorities is welcome. The project manager is Gary Ellis (gary.ellis01@environment-agency.gov.uk).

Work is also ongoing to establish a National Receptor Dataset, to support the assessment of the consequences of flooding for Preliminary Assessment Reports and Flood Risk Maps. The project manager is Rachel Wood (rachel.wood1@environment-agency.gov.uk).

Following this work the Environment Agency will develop guidance for the flood mapping and flood risk management plan stages. The guidance on flood risk management plans will be co-ordinated with revised guidance on Surface Water Management Plans as they will form a key component.

Appendix E: Lincolnshire Wildlife Trust Sites

Name	Habitat
Eagle Hall Wood	Spruce Plantation / Ash Plantation / Birch Plantation / Birch Wood / Mixed Wood / Tall Wood
Tunman Wood	Spruce Plantation / Mixed Wood / Hazel Coppice / Scrub / Tall Herb
Pickworth's Plot	Woodland
Cinder Plot	Woodland
Gilberts Plot	Woodland
Struch Hill Wood	Woodland
Ash Lound and Brick Kiln Holt	Woodland
Skellingthorpe Big Wood	Woodland
Skellingthorpe Old Wood	Woodland
Hardwick Crossing (BR WL7)	Woodland / Grassland
Fosdyke Fen	Birch / Elder / Sallow Scrub / Tall Herb / Marsh / Pools
Burton Gravel Pits	
Bishop's Bridge Woodland	Woodland / Scrub / Marsh / Ditches
Brattleby Thorns	Woodland
Big Wood	Woodland / Hawthorn Scrub / Tall Herb
Larch Plantation	Woodland
Ash Holt	Woodland
Fillingham Lake	Lake / Sycamore Wood / Hawthorn Scrub / Tall Herb
Ingham Cliff Farm Road Verge	Grassland
Ermine St to RAF Scampton	Grassland
Hackthorn House Pool	Drain / Pool / Aquatic Plants / Grass Banks
Riseholme Hall Wood	Woodland
Toft Newton Reservoir	Water
Toft Newton Belt	Wood
Newton Fox Covert	Woodland
Faldingworth Wood	Woodland
Shaft Wood	Woodland
Friesthorpe Grassland	Hayfield
Cold Hanworth Holt	Woodland
Snarford Holt	Woodland
The Nook	Woodland / Hedge
Collow Holt	Woodland
North Hykeham Gravel Pit	Lake / Scrub (Willow) / Grassland / Aquatic Grass / Birch Plantation / Bramble / Heather Scrub
Pike Drain	Stream / Aquatic Plants / Grass Banks / Hawthorn Hedge
Inns Pit (Gravel Pit)	Pools / Grassland / Salix, Gorse / Hawthorn Scrub / Tall Herb / Typha
Little Meadow Close, North Hykeham	Meadow / Hedge
Hartsholme Country Park	Lake / Aquatic Plants / Grassland / Birch / Oak Scrub
Boultham Moor	Woodland / Open Water
Pike Drain Marsh	Willow Scrub / Glyceria Marsh / Grassland / Pond
The Pheasanry	Woodland / Grassland
Foal Close	Woodland / Scrub / Grassland / Marsh
Birchwood Community Park	Parkland / Scrub / Open Water / Grassland

Name	Habitat
Blue Lagoon	Open Water / Woodland / Scrub
Island Lake - Birchwood	Open Water
Mormon Field, Skellingthorpe Road	Grassland
Fen Plantation	Woodland
Catchwater Drain	Drain
Swanpool Skewbridge	Pool / Phragmites / Oak / Birch Wood / Hawthorn Scrub / Tall Herb
Pyewipe Main Drain	Drain
Pyewipe Junction	Tall Herb / Swamp and Fen / Scrub
Lincoln West Common	Grassland / Wet Grassland
West Cliff, Burton Road	Grassland / Scrub
Hobblers Hole	Grassland / Marshy Grassland / Hedgerow / Pond / Scrub
Old Quarry, Lincoln	Calc Grassland / Scrub
Dean and Chapter Quarry	Scrub / Grassland / Wasteland / Rock Face
Lincoln Castle Grounds	
Roman Aqueduct Marsh	Marsh
Witham East and South Delph	Scrub Open Water
Cow Paddle	
Lincoln South Common	Grassland
Cross O'Cliff Brickpit	Scrub / Grassland / Tall Herbs
Bracebridge Heath Clay Pit	
Leadenham – Lincoln Disused Railway	Scrub / Grassland / Tall Herb / Marginal Vegetation
Waddington Pit	
Harmston Quarry	Quarry / Bare Ground / Grassland
Waddington Pasture	Grassland / Pasture
Witham Marshes	Glyceria Marsh
River Witham (Bracebridge)	Grassland / Marsh / Open Water
Bracebridge Corner	Grassland
The Witham Leys	Lake / Phragmites / Scrub / Woodland
Greetwell Wood	Woodland / Scrub / Tall Herb
Greetwell Hall (Bottom Field) Wood	Woodland
Washingborough Junction	Grassland / Aquatic / Woodland
Washingborough Pits	Woodland
New 10 Acre Covert	Woodland
New Oak Holt and Station Plantation	Woodland
Sudbrooke Park Lake	Lake
Sudbrooke Park	Woodland / Lake
Rand Wood	
Barlings Park	Woodland / Scrub / Tall Herb
Barlings Pits	Pits / Willow Scrub / Reedbed / Poplar Plant / Pasture / River
Newball Wood (Forestry Commission part)	Plantation / Coppice / Rides
Short Wood	Mixed Deciduous Wood
Gate Cliff Wood	Woodland / Scrub / Tall Herbs
Spring Wood	Mixed Deciduous Wood
Goltho Pond and Meadow	Woodland / Pond
Sheperds Road Farm Verges	Grass
Black Plantation	Woodland
Square Wood	Woodland

Name	Habitat
Pleasure House Wood	Wood
College Wood	
Louth to Bardney Disused Railway	Scrub / Tall Herb / Short Herb
Cream Poke Wood	Wood
Chambers Plantation	Coniferous Plantation / Grassland / Damp Grassland / Deciduous Grassland / Acid Grassland
Austacre / Knowles Wood (Bardney)	Woodland / Coniferous Plantation / Tall Herbs / Scrub
Snakeholme Pit	Pool / Drain / Hedge / Reedbeds / Grassland
Barlings Eau	River / Banks
Long Wood	Woodland / Tall Herbs
Fiskerton Brickpit and River Witham Banks	Ponds / Reedbeds / Scrub
Branston Delph	Delph / Banks
Branston Island	Arable / River
Bardney Settling Ponds	Ponds / Reedbeds / Dry Ponds / Tall Herb
Birch Wood Bardney	Deciduous Woodland
Bloxam Lane Woods	Woodland
Dunston Heath Old Quarry	Grassland / Scrub / Bare Ground / Rock Faces / Water
Nocton Wood	Woodland / Tall Herb
Nocton Delph	Delph / Aquatic Plants / Pasture
Metherringham Barff	Woodland
Fox Covert	Deciduous Woodland
Curtois Holt	Woodland
Queen Dyke Holt	Woodland
Burnt Wood	Woodland
Neville Wood	Woodland / Bracken / Tall Herbs
Long Holt East	Woodland
Top Barff	Woodland
Bottom Barff	Sycamore Wood / Pine / Poplar / Elder Scrub / Bracken