

# BRE Client Report

## BRE Dwelling Level Housing Stock Modelling and Database for Lincolnshire County

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## Executive summary

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- A number of local authorities within the County of Lincolnshire commissioned BRE to undertake a series of modelling exercises on their housing stock<sup>1</sup> – Boston, City of Lincoln, East Lindsey, West Lindsey, North Kesteven and South Kesteven. Separate reports were produced for each council describing the modelling work and providing details of the results obtained from the dwelling level models and database. Each council was also provided with their database to enable them to obtain specific information whenever required. This current report provides a high level summary for the County of Lincolnshire.
- The main aims of this work were to provide estimates of:
  - The percentage of dwellings meeting each of the key indicators<sup>2</sup> for Lincolnshire overall and broken down by tenure and then mapped by ward (private sector stock only)
  - Information relating to Local Authority Housing Statistics (LAHS) reporting for the private sector stock – Energy Performance Certificate (EPC) ratings and category 1 hazards<sup>3</sup>
- BRE Housing Stock Models were used to provide such estimates at dwelling level with a focus on private sector housing. The key indicators provide the local authorities in Lincolnshire with detailed information on the likely condition of the stock and the geographical distribution of properties of interest.
- A stock modelling approach has been developed and used by BRE for many years and the most recent 2014 models have been updated to make use of the results of the 2011 English Housing Survey (EHS)<sup>4</sup> and additionally now incorporate a technique known as geomodelling<sup>5</sup> which makes use of Ordnance Survey (OS) data. These dwelling level models are used to estimate the likelihood of a particular dwelling meeting the criteria for each of the key indicators. These outputs can then be

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<sup>1</sup> The exception was South Holland, however high level results for this local authority have been included in this report to enable the provision of county-wide results and comparisons across the local authorities.

<sup>2</sup> Housing Health and Safety Rating System (HHSRS) category 1 hazards, excess cold, falls, disrepair, fuel poverty, low income households

<sup>3</sup> City of Lincoln also commissioned BRE to supply information on Houses in Multiple Occupation (HMOs). As they were the only council to request this there is no scope for comparison with other councils, therefore HMO information has not been included in this summary report.

<sup>4</sup> 2011 is the latest available data. Prior to the 2014 models EHS 2009 data was used.

<sup>5</sup> The OS data has been used to update a number of the model inputs – the main value of the OS data is the ability to determine the dwelling type with much greater confidence – see Appendix B for more information.



mapped to provide the authority with a geographical distribution of each of the key indicators which can then be used to target resources for improving the housing stock.

- The headline results are as follows:

### Headline Results for County of Lincolnshire

**Lincolnshire has a higher percentage of private sector dwellings failing each of the key indicators compared to England – in particular for excess cold and fuel poverty. [See the full results](#)**

**21% of private sector stock in the county is estimated to have a category 1 hazard. The greatest proportion is in East Lindsey (27%) and the lowest is in City of Lincoln (15%). [See the full results](#)**

**15% of private sector stock in the county is estimated to have an excess cold hazard. The highest proportions are in East Lindsey (23%) and the lowest is in City of Lincoln (4%). [See the full results](#)**

**11% of private sector stock in the county is estimated to have a falls hazard. The highest proportions are in City of Lincoln (13%) and the lowest is in North Kesteven and South Holland (both 9%). [See the full results](#)**

**7% of private sector stock in the county is estimated to be in disrepair. The highest proportion is in City of Lincoln (9%) and the lowest is in North Kesteven (5%). [See the full results](#)**

**For the private sector stock, East Lindsey has the highest proportions of fuel poverty under both the 10% and Low Income High Costs definitions – 29% and 18%, respectively. [See the full results](#)**

**25% of the private sector stock in the county is estimated to be occupied by low income households. The highest proportion is in City of Lincoln (31%) and the lowest is in North Kesteven (20%). [See the full results](#)**

**For the private sector stock, City of Lincoln has the best average SimpleSAP rating (56) and East Lindsey has the lowest (46). The average SimpleSAP rating for the county as a whole is 51. [See the full results](#)**

**Maps are provided throughout the report for the above variables**

**EPC ratings - The percentage of private rented stock with an EPC rating below Band E for Lincolnshire County as a whole is 26.5%. East Lindsey has the highest percentage falling below Band E (34.1%) and City of Lincoln has the lowest (17.0%). [See the full results](#)**

**Cost of mitigating category 1 hazards – the total cost in the county as a whole is estimated to be £188 million. East Lindsey and West Lindsey have the highest percentage of private sector dwellings with hazards (27% and 25% respectively) and City of Lincoln has the lowest (15%). [See the full results](#)**



### Key illustrations of headline results

The chart below shows the percentage of private sector dwellings in the County of Lincolnshire failing each of the key indicators compared to the percentage for England as a whole (2011 EHS data). Lincolnshire has a higher percentage of private sector dwellings failing each of the key indicators compared to England – in particular for excess cold and fuel poverty.

*Comparison of Lincolnshire with England (EHS 2011), % of private sector dwellings failing each of the indicators*



The following table shows the percentage of private rented stock falling into each of the EPC ratings bands (based on SimpleSAP) for the county overall and by local authority. Whilst the majority of properties in the private rented sector fall in the Bands D and E, a significant proportion fall into Bands F and G (26.5% for Lincolnshire overall).

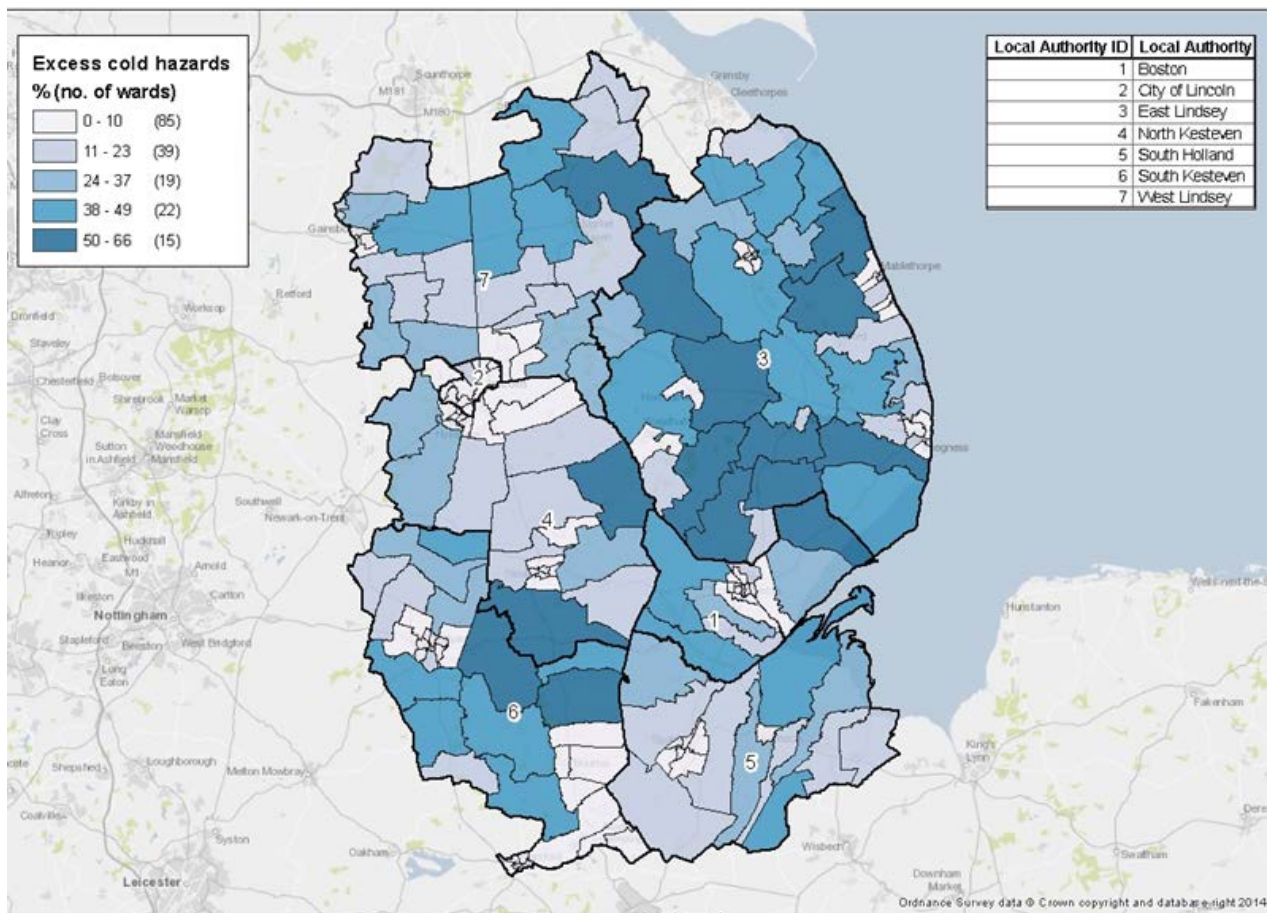
*Percentage of private rented stock falling into each of the EPC ratings bands (based on SimpleSAP) by local authority*

Distribution of EPC rating bands by local authority - private rented sector								
EPC rating band	Boston	City of Lincoln	East Lindsey	North Kesteven	South Holland	South Kesteven	West Lindsey	Lincolnshire County
(92-100) A	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
(81-91) B	0.2%	0.2%	0.1%	0.1%	0.2%	0.2%	0.1%	0.1%
(69-80) C	12.2%	11.7%	9.3%	13.5%	12.7%	12.6%	7.0%	11.2%
(55-68) D	30.7%	32.1%	28.6%	35.4%	33.0%	32.5%	26.4%	31.1%
(39-54) E	33.3%	39.0%	27.9%	26.7%	29.5%	28.8%	32.2%	31.1%
(21-38) F	13.9%	12.5%	19.6%	15.0%	15.3%	15.6%	19.8%	16.1%
(1-20) G	9.7%	4.5%	14.5%	9.2%	9.3%	10.3%	14.5%	10.3%



The map below shows the distribution of excess cold hazards across the county, indicating that this hazard is concentrated in rural areas where there are less flats and there tend to be more properties off the gas network.

*Percentage of private sector dwellings in Lincolnshire estimated to have a HHSRS category 1 hazard for excess cold*






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## 1 Introduction

The majority of councils within the County of Lincolnshire commissioned BRE to undertake a series of modelling exercises on their housing stock<sup>6</sup> – Boston, City of Lincoln, East Lindsey, West Lindsey, North Kesteven and South Kesteven. Separate reports were produced for each council describing the modelling work and providing details of the results obtained from the dwelling level models and database. Each council was also provided with their database to enable them to obtain specific information whenever required. This current report provides a high level summary for the County of Lincolnshire.

The stock models and database provide each council with dwelling level information on various key housing indicators, focussing on private sector housing. The key indicators provide each council with detailed information on the likely condition of the stock and the geographical distribution of properties of interest. These properties are likely to be suitable targets for energy efficiency improvements or other forms of intervention, such as mitigating Housing Health and Safety Rating System (HHSRS) hazards. The key indicators are split into indicators related to house condition, energy efficiency and household vulnerability as shown in **Table 1** (see Appendix A for full definitions):

**Table 1:** Key indicators split into categories

Indicator	House condition indicators	Energy efficiency indicators	Household vulnerability indicators
Presence of HHSRS cat 1 hazard	✓		
Presence of Cat 1 hazard for excess cold	✓	✓	
Presence of Cat 1 hazard for falls	✓		
Dwellings in disrepair	✓		
Fuel Poverty (10% and Low Income, High cost definitions)			✓
Dwellings occupied by low income households			✓
SimpleSAP rating		✓	

**N.B. Presence of category 1 hazard for falls does NOT include the hazard of falling between levels**

<sup>6</sup> The exception was South Holland, however high level results for this local authority have been included in this report to enable the provision of county-wide results and comparisons across the local authorities.



The single indicators shown in **Table 1** can also be combined within each database to provide powerful information on the housing stock, for example dwellings suffering from excess cold and also occupied by households on a low income. The true potential of the databases lies in their ability to produce combined indicators such as this, as it allows council officers to explore the stock and to assess the likely scope of any programmes they might wish to implement.

It is also possible to extract other information from the database which is of use to local authorities. This information includes estimates relating to the Department for Communities and Local Government's (DCLG) Local Authority Housing Statistics (LAHS) reporting of Energy Performance Certificate (EPC) ratings and costs of mitigating hazards.

The key indicators and other information are derived from the Housing Stock Database which is made up of a series of dwelling level stock models. The BRE dwelling level stock models have been used for many years to provide key housing indicators to local authorities. The most recent 2014 models have been updated to make use of the results of the 2011 English Housing Survey (EHS)<sup>7</sup> and additionally now incorporate a technique known as geomodelling<sup>8</sup> which makes use of Ordnance Survey (OS) data. The models also make significant use of the Experian UK Consumer Dynamics Database of dwelling and household indicators as inputs to the models.

The information in each of the databases can be used to ensure councils meet various policy and reporting requirements. For example, local housing authorities are required to review housing conditions in their districts in accordance with the Housing Act 2004<sup>9</sup>.

Furthermore, having this information available will also help to facilitate housing strategy delivery. It will enable a targeted intervention approach to improving housing; therefore allowing councils to concentrate their resources on housing in the poorest condition or with the greatest health impact.

## 1.1 Project aims

The main aim of this project was to provide data on key private sector housing indicators for each of the separate counties in Lincolnshire<sup>10</sup>. The main aims of this work were therefore to provide estimates of:

- The percentage of dwellings meeting each of the key indicators for Lincolnshire overall and broken down by tenure and then mapped by ward (private sector stock only)
- Information relating to LAHS reporting for the private sector stock - EPC ratings and category 1 hazards

Information on the policy background to this work is included in Appendix C and the remainder of this report focusses on a description of the overall stock modelling approach, followed by the modelling results for the County of Lincolnshire covering each of the main aims above.

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<sup>7</sup> 2011 is the latest available data. Prior to the 2014 models EHS 2009 data was used.

<sup>8</sup> The OS data has been used to update a number of the model inputs – the main value of the OS data is the ability to determine the dwelling type with much greater confidence – see Appendix B for more information.

<sup>9</sup> <http://www.legislation.gov.uk/ukpga/2004/34/contents>

<sup>10</sup> With the exception of South Holland.



## 2 Overview of the BRE Dwelling Level Housing Stock Modelling approach

This section provides a simplified overview of the BRE dwelling level housing stock modelling approach. More detail on the methodology is provided in Appendix B.

A stock modelling approach has been developed and used by BRE for many years and dwelling level models are used to estimate the likelihood of a particular dwelling meeting the criteria for each of the key indicators (and other outputs of interest). These outputs can then be mapped to provide the council with a geographical distribution of each of the key indicators which can then be used to target resources for improving the housing stock. The process itself is actually made up of a variety of data sources, calculations and models.

The models are principally informed by the Department for Communities and Local Government's (DCLG) English Housing Survey (EHS)<sup>11</sup>. The survey is not used to supply data for the database, but rather it allows the identification of patterns in the housing stock, so that this knowledge can be applied, in the form of mathematical algorithms, to impute key indicators and energy characteristics from other data available at the national level. The particular approach for Lincolnshire, however, makes significant use of the Experian UK Consumer Dynamics Database of dwelling and household indicators as inputs to the models. One example is the BRE SimpleCO<sub>2</sub> Model which is based on dwelling level inputs from Experian and expands on these using imputation techniques to provide sufficient information to calculate the likely energy efficiency of each dwelling in the stock. Some of the key housing indicators, such as HHSRS excess cold category 1 hazards and BRE's SimpleSAP<sup>12</sup>, can be directly inferred from this data.

**Figure 1** shows a simplified flow diagram of the overall BRE housing stock modelling approach. The process is made up of a series of data sources and models which, combined with various imputation and regression techniques and the application of other formulae, make up the final database. The database is essentially the main output of the modelling and provides information on the key indicators and other data requirements (e.g. energy efficiency variables). More detailed information on the data sources and models is provided in Appendix B, but to summarise:

**The data sources are:**

EHS, Experian, Ordnance Survey (OS) MasterMap.

**The Models are:**

SimpleSAP, Fuel Poverty, HHSRS (all hazards, falls hazards and excess cold), Disrepair and Low Income Households.

<sup>11</sup> The most recent survey used in the housing stock models is 2011.

<sup>12</sup> A Simplified version of the SAP model that produces an output broadly comparable to SAP. The SimpleSAP model is distinct from both full SAP and RD SAP in that uses a smaller, simplified set of inputs.



The data sources and models are linked as shown in the flow diagram and the modelling process itself can be divided into “energy inputs” and “other inputs”, which are summarised as follows:

**Energy inputs** - are developed from Experian. The EHS data is used to impute (using cold deck imputation<sup>13</sup>) and interpolate where there are gaps in the data. The “energy inputs” are then fed into the SimpleCO<sub>2</sub> Model to produce the “energy outputs” for the database plus information on excess cold for the HHSRS Model and information on energy costs for the Fuel Poverty Model.

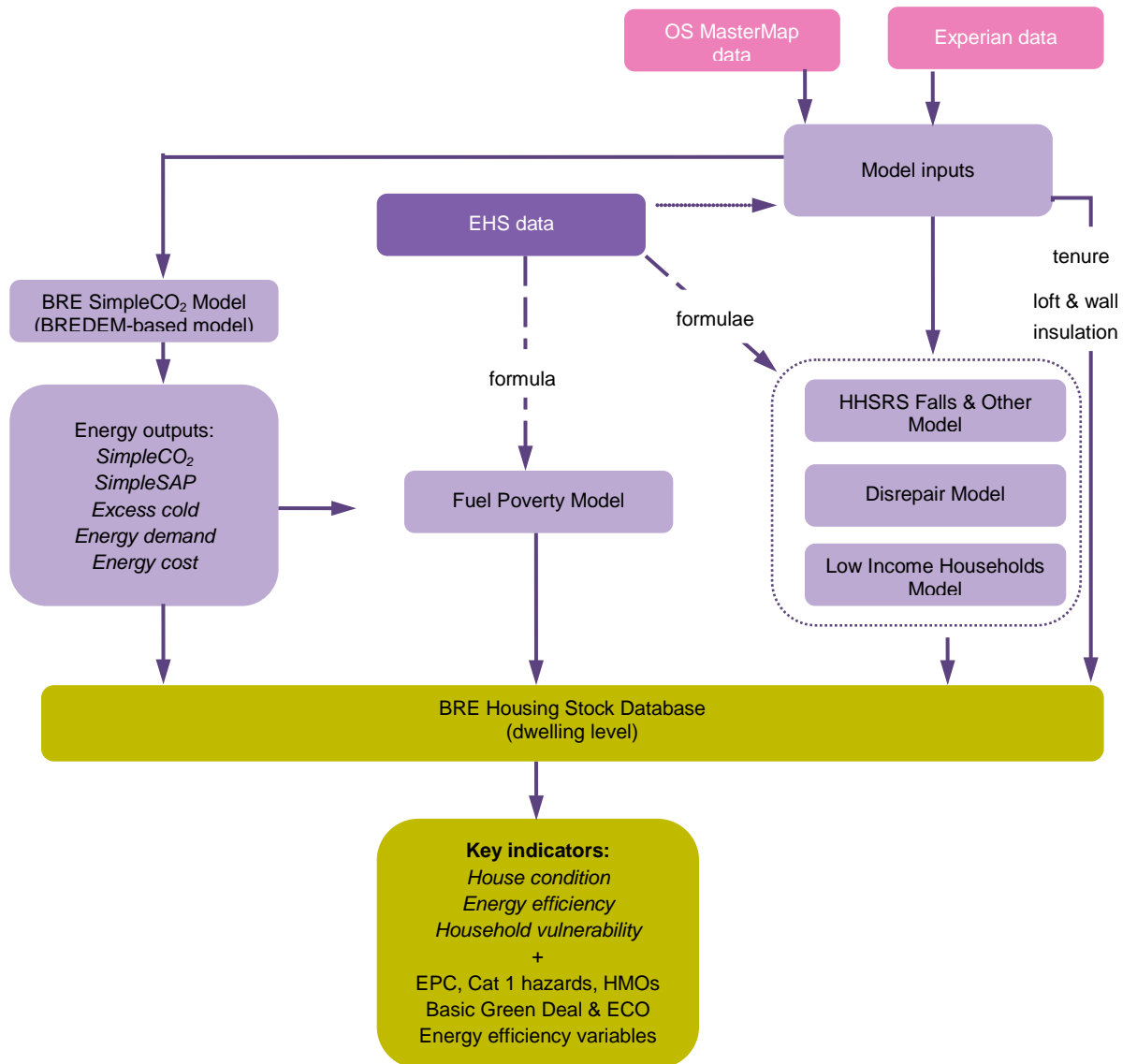
**Other inputs** – are developed from Experian, OS MasterMap and other local data sources. The EHS data is used to impute (using cold deck imputation<sup>13</sup>) and interpolate where there are gaps in the data. The “other inputs” are then fed into the HHSRS, Disrepair, and Low Income Models (note that tenure data is fed directly into the database). Information from the EHS also feeds into the Fuel Poverty, HHSRS, Disrepair and Low Income Models.

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<sup>13</sup> Cold deck imputation is a process of assigning values in accordance with their known proportions in the stock.



**Figure 1:** Simplified flow diagram of overall BRE housing stock modelling approach (N.B. the EHS data is only used to inform the mathematical algorithms of the model – it does not provide data)



- BRE housing stock modelling process
- Other data inputs
- Data used for imputation & interpolation
- Outputs
- Data
- Imputed (cold deck)
- Information



### 3 Summary results for Lincolnshire from the BRE Dwelling Level Housing Stock Models and Database

As described in the previous section, the housing stock modelling process consists of a series of different stock models with the main output being the database. The results provided in this section are a high level summary for the County of Lincolnshire as a whole. The individual reports and databases provided to each council are at a more detailed level.

The first sub-section below provides a map of the local authorities making up the County of Lincolnshire and a table summarising the tenure split for each local authority. The second section provides a comparison of the County of Lincolnshire with England based on the 2011 English Housing Survey (EHS).

The results are then displayed in the remaining sub-sections and include maps of a number of variables, thus enabling quick observation of the geographical distribution of areas of interest. The maps show the percentages of dwellings by ward for each local authority that are estimated to have met the requirements for each of the variables. The ranges shown in the map keys are defined based on the Jenks' Natural Breaks algorithm of the COA statistics<sup>14</sup>. The outputs in the lightest and darkest colours on the maps show the extreme ends of the range, highlighting the best and the worst areas. The maps also highlight the differences between areas, showing that the results for some areas are much worse than for others and these are the specific areas which might warrant attention. The maps also show that within local authorities there can be large differences between the results at ward level.

The sub-sections are as follows:

Comparison of the key indicators across the Lincolnshire local authorities (see Appendix A for full definitions):

- Presence of HHSRS category 1 hazard
- Presence of category 1 hazard for excess cold
- Presence of category 1 hazard for falls
- Dwellings in disrepair
- Fuel poverty (10% and Low Income High Costs definitions)
- Dwellings occupied by low income households
- Simple SAP rating

Comparison of information relating to LAHS reporting<sup>15</sup>:

- EPC ratings
- Cost of mitigating category 1 hazards

<sup>14</sup> Natural breaks classes are based on natural groupings inherent in the data.

<sup>15</sup> As the City of Lincoln were the only local authority to commission information on HMOs there is no scope for comparison with other councils, therefore HMO information has not been included in this summary report.

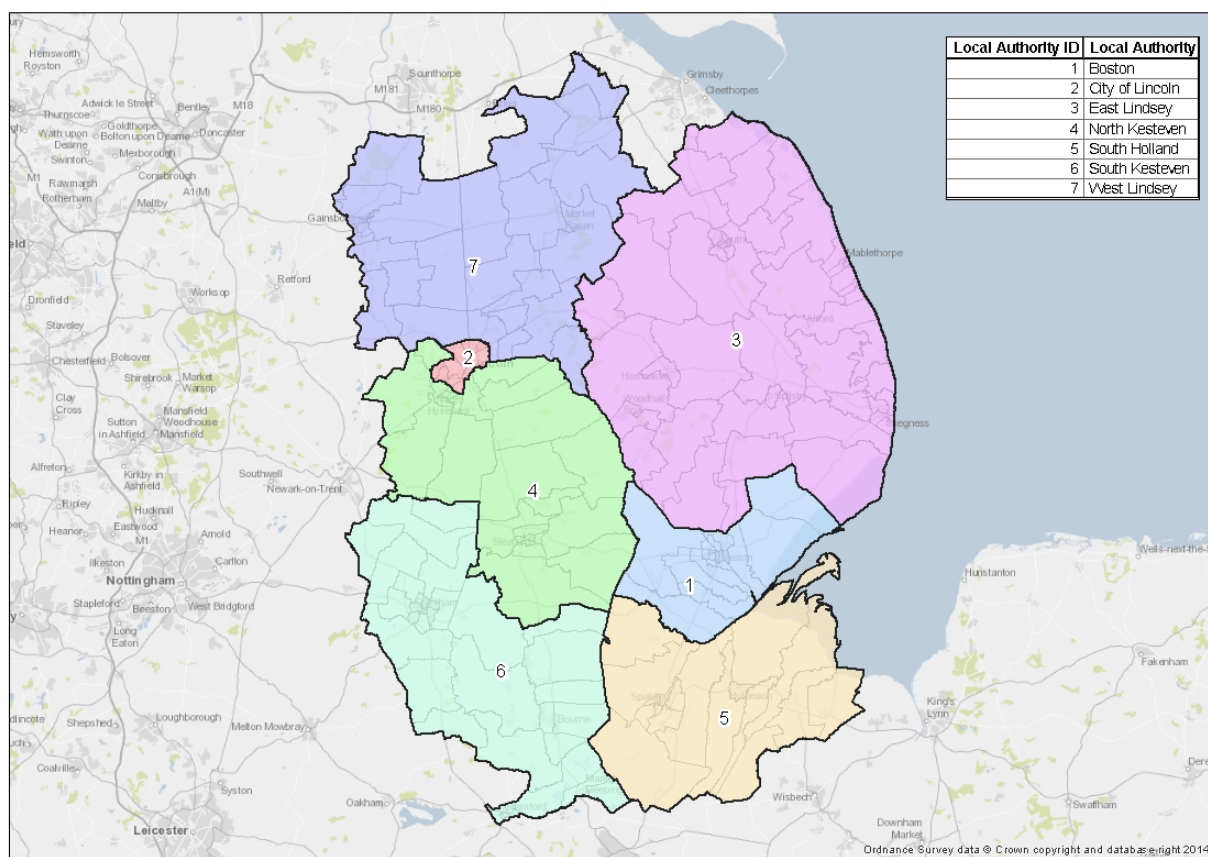


### 3.1 Overview of Lincolnshire County

**Map 1** below shows the 7 local authorities making up the County of Lincolnshire. The majority of data in this report is shown as a high level summary separated into local authorities; however, each local authority has been provided with a database which provides data at more disaggregated levels, e.g. ward, Census Output Area (COA).

**Table 2** provides an overview of the housing stock in Lincolnshire broken down by local authority and tenure.

**Map 1:** The local authorities in Lincolnshire





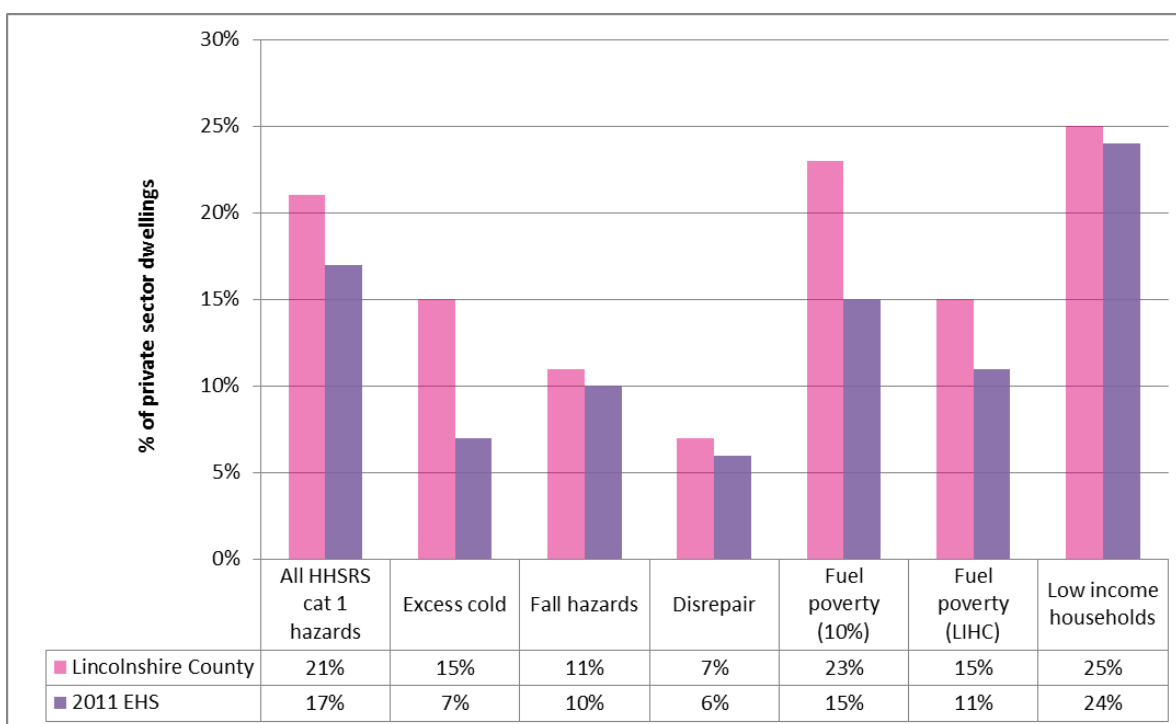
**Table 2:** Overview of Lincolnshire housing stock by tenure for each local authority

Local authority	No. of dwellings			
	Private sector stock		Social	TOTAL
	Owner occupied	Private rented		
Boston	18,402	4,595	5,297	<b>28,294</b>
City of Lincoln	23,573	9,632	9,751	<b>42,956</b>
East Lindsey	45,128	11,254	7,111	<b>63,493</b>
North Kesteven	35,750	6,595	4,927	<b>47,272</b>
South Holland	28,189	4,956	4,949	<b>38,094</b>
South Kesteven	42,119	9,080	8,181	<b>59,380</b>
West Lindsey	29,916	5,908	4,553	<b>40,377</b>
<i>Lincolnshire County</i>	<i>223,077</i>	<i>52,020</i>	<i>44,769</i>	<i>319,866</i>

### 3.2 Comparison of Lincolnshire County with England

**Figure 2** shows the percentage of private sector dwellings in the County of Lincolnshire failing each of the key indicators compared to the percentage for England as a whole (2011 EHS data). Lincolnshire has a higher percentage of private sector dwellings failing each of the key indicators compared to England – in particular for excess cold and fuel poverty.

This is also the case for SimpleSAP ratings for the private sector stock, where Lincolnshire County has an average rating of 51 compared to 55 for England as a whole.

**Figure 2:** Comparison of Lincolnshire with England (EHS 2011), % of private sector dwellings failing each of the indicators



### 3.3 Comparison of the key indicators across the Lincolnshire local authorities

The following sub-sections provide the results for each of the key indicators.

#### 3.3.1 Presence of HHSRS category 1 hazard

**Table 3** shows the percentage of dwellings estimated to have a HHSRS category 1 hazard by local authority and tenure and for the County of Lincolnshire as a whole. The greatest proportion of all stock with hazards is in East Lindsey (25%) and the lowest is in City of Lincoln (13%).

For the private sector stock, the highest proportion is in East Lindsey (27%) and the lowest is in City of Lincoln (15%) with the figure for the county as a whole being 21%.

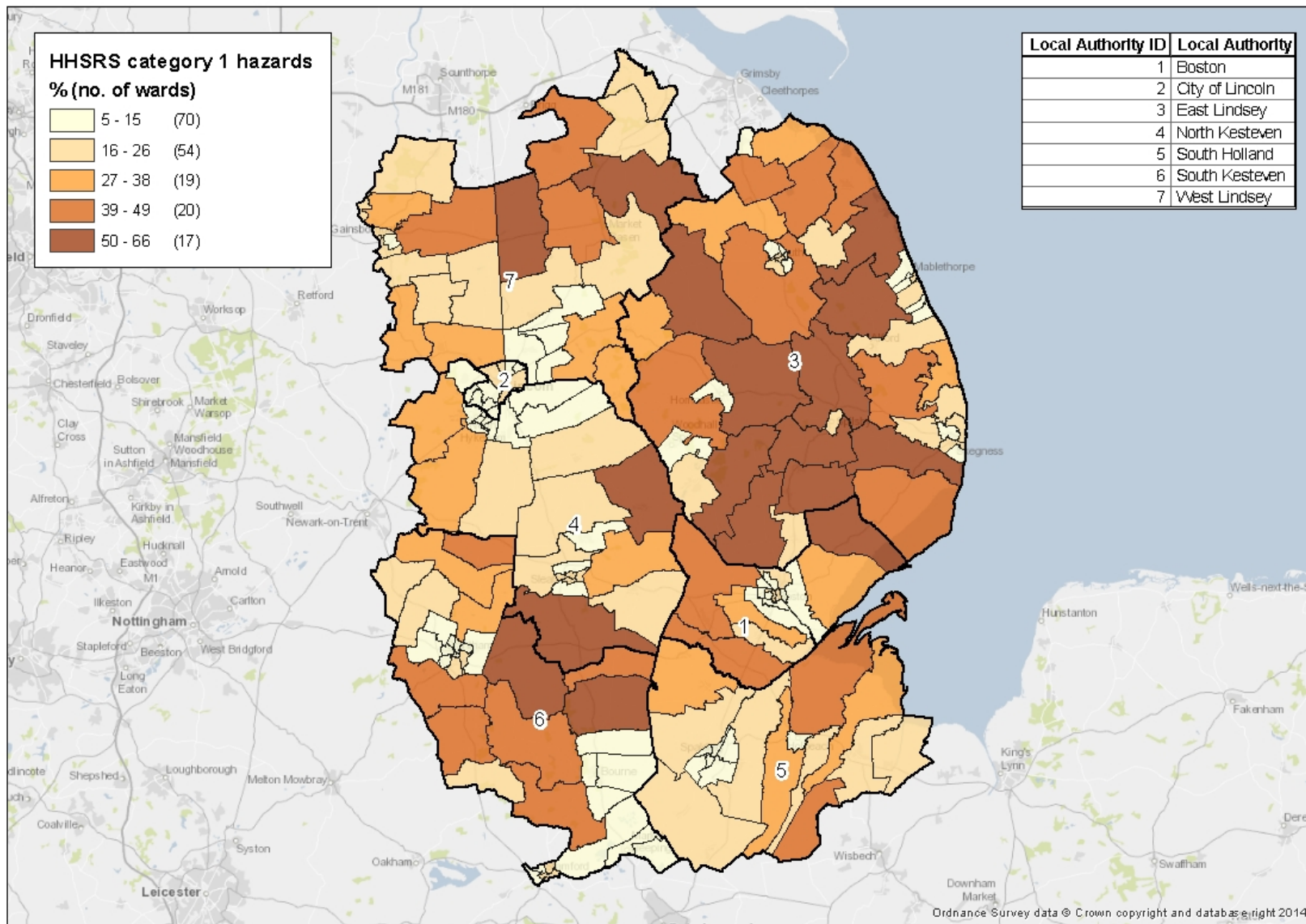
Overall the social stock has a lower proportion of dwellings with hazards compared to the other tenures.

**Map 2** shows the geographical distribution of private sector dwellings in Lincolnshire estimated to have a HHSRS category 1 hazard. The greatest numbers of hazards are concentrated in East Lindsey and the least in City of Lincoln.

**Table 3:** Percentage of dwellings estimated to have a HHSRS category 1 hazard by local authority and tenure

Local authority	% of dwellings with HHSRS category 1 hazards				
	Private sector stock			% of social	% of all stock
	% of private sector	% of owner occupied	% of private rented		
Boston	22%	22%	24%	9%	<b>20%</b>
City of Lincoln	15%	12%	21%	6%	<b>13%</b>
East Lindsey	27%	27%	30%	12%	<b>25%</b>
North Kesteven	18%	18%	22%	11%	<b>18%</b>
South Holland	19%	19%	23%	9%	<b>18%</b>
South Kesteven	18%	17%	25%	10%	<b>17%</b>
West Lindsey	25%	23%	33%	12%	<b>23%</b>
<i>Lincolnshire County</i>	<i>21%</i>	<i>20%</i>	<i>25%</i>	<i>9%</i>	<i>19%</i>

**Map 2:** Percentage of private sector dwellings in Lincolnshire estimated to have a HHSRS category 1 hazard





### 3.3.2 Presence of category 1 hazard for excess cold

The percentage of dwellings estimated to have the presence of a category 1 hazard for excess cold is shown in **Table 4**, for the County of Lincolnshire as a whole and broken down by local authority and tenure. The greatest proportion of all stock with the presence of an excess cold hazard is in East Lindsey (22%) and the lowest is in City of Lincoln (4%).

For the private sector stock, the highest proportion is in East Lindsey (23%) and the lowest is in City of Lincoln (4%) with the figure for the county as a whole being 15%.

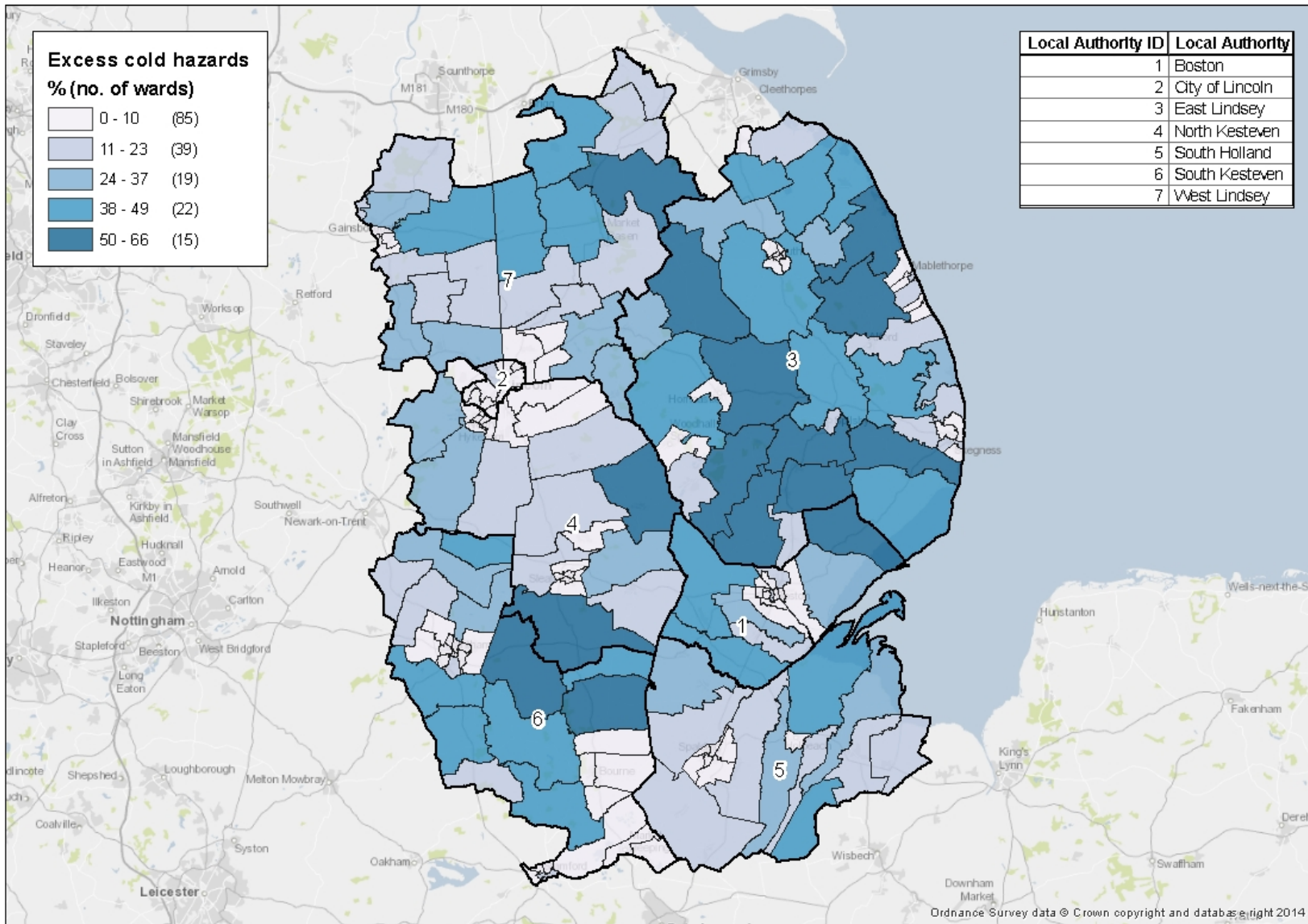
Overall the social stock has a lower proportion of dwellings with excess cold hazards compared to the other tenures, with the exception of the City of Lincoln which shows the percentage of owner occupied stock is slightly lower than for the social stock.

**Map 3** shows the geographical distribution of private sector dwellings in Lincolnshire estimated to have a category 1 hazard for excess cold. The greatest concentrations of excess cold are mainly in rural areas where there are less flats and there tend to be more properties off the gas network.

**Table 4:** Percentage of dwellings estimated to have a HHSRS category 1 hazard for excess cold by local authority and tenure

Local authority	% of dwellings with category 1 hazard for excess cold				
	Private sector stock			% of social	% of all stock
	% of private sector	% of owner occupied	% of private rented		
Boston	16%	16%	16%	8%	<b>14%</b>
City of Lincoln	4%	2%	9%	3%	<b>4%</b>
East Lindsey	23%	22%	26%	10%	<b>22%</b>
North Kesteven	14%	13%	17%	10%	<b>13%</b>
South Holland	15%	14%	17%	8%	<b>14%</b>
South Kesteven	13%	11%	18%	8%	<b>12%</b>
West Lindsey	19%	18%	25%	10%	<b>18%</b>
<i>Lincolnshire County</i>	<i>15%</i>	<i>15%</i>	<i>19%</i>	<i>7%</i>	<i>14%</i>

**Map 3:** Percentage of private sector dwellings in Lincolnshire estimated to have a HHSRS category 1 hazard for excess cold





### 3.3.3 Presence of category 1 hazard for falls

**Table 5** shows the percentage of dwellings estimated to have a category 1 hazard for falls by local authority and tenure and for the County of Lincolnshire as a whole. The greatest proportion of all stock with falls hazards is in City of Lincoln and West Lindsey (both 11%) and the lowest is in North Kesteven and South Holland (both 8%).

For the private sector stock, the highest proportion is in City of Lincoln (13%) and the lowest is in North Kesteven and South Holland (both 9%) with the figure for the county as a whole being 11%.

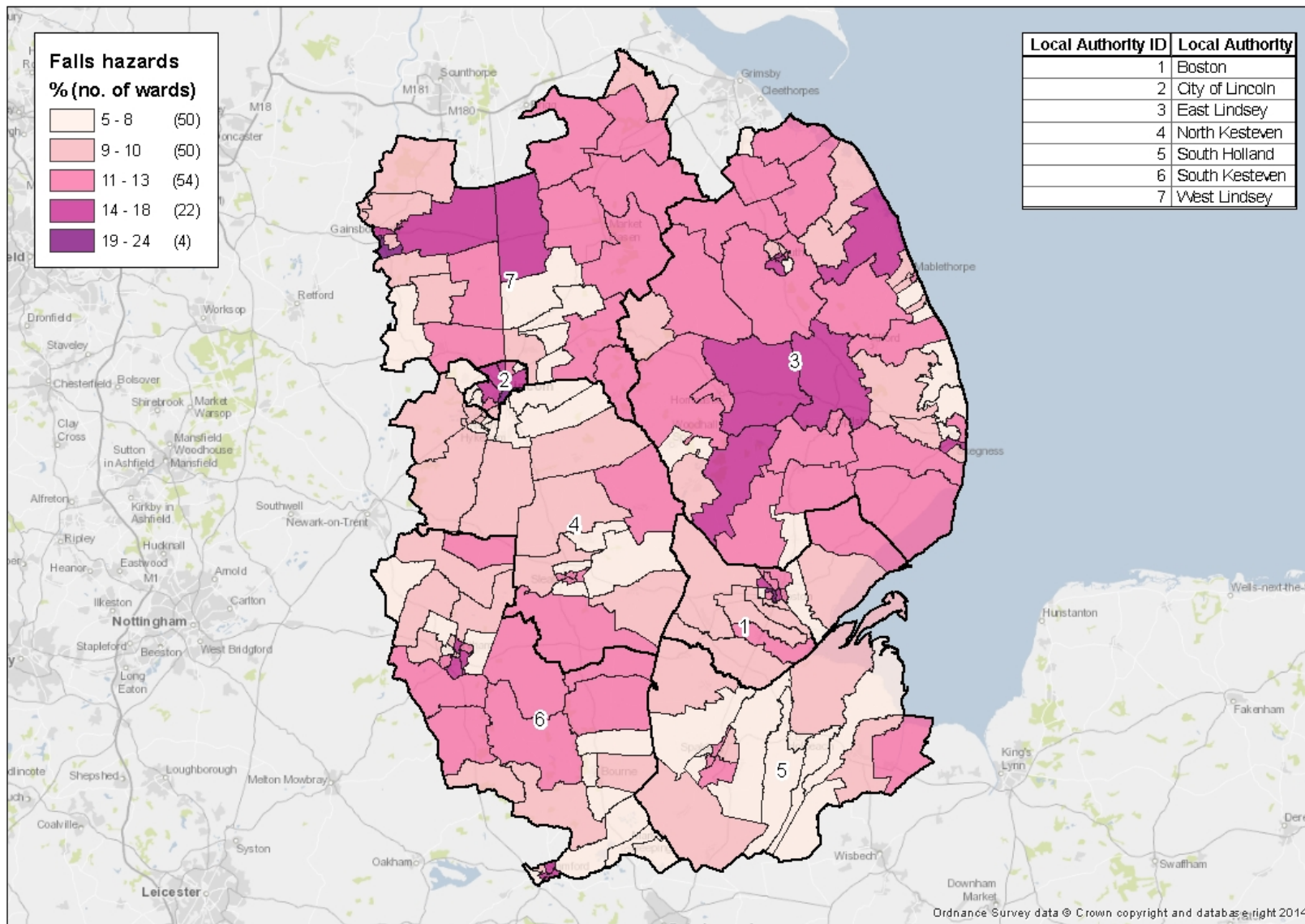
Overall the social stock has a lower proportion of dwellings with falls hazards compared to the other tenures.

**Map 4** shows the geographical distribution of private sector dwellings in Lincolnshire estimated to have a category 1 hazard for falls. The greatest numbers of hazards are concentrated in the north and north east of the county and particularly in more urban areas. This may be a result of more terraced housing in urban areas which tends to result in more falls hazards.

**Table 5:** Percentage of dwellings estimated to have a HHSRS category 1 hazard for falls by local authority and tenure

Local authority	% of dwellings with category 1 hazard for falls				
	Private sector stock			% of social	% of all stock
	% of private sector	% of owner occupied	% of private rented		
<b>Boston</b>	11%	10%	16%	3%	<b>10%</b>
<b>City of Lincoln</b>	13%	11%	18%	3%	<b>11%</b>
<b>East Lindsey</b>	11%	10%	15%	3%	<b>10%</b>
<b>North Kesteven</b>	9%	8%	12%	3%	<b>8%</b>
<b>South Holland</b>	9%	8%	13%	3%	<b>8%</b>
<b>South Kesteven</b>	10%	9%	15%	3%	<b>9%</b>
<b>West Lindsey</b>	12%	11%	18%	3%	<b>11%</b>
<b>Lincolnshire County</b>	<b>11%</b>	<b>9%</b>	<b>16%</b>	<b>3%</b>	<b>10%</b>

**Map 4:** Percentage of private sector dwellings in Lincolnshire estimated to have a HHSRS category 1 hazard for falls





### 3.3.4 Dwellings in disrepair

This indicator is based on the former Decent Homes Standard which states that a dwelling fails this criterion if it is not found to be in a reasonable state of repair. This is assessed by looking at the age of the dwelling and the condition of a range of building components (including walls, roofs, windows, doors, electrics and heating systems).

**Table 6** shows the percentage of dwellings estimated to be in disrepair by local authority and tenure and for the County of Lincolnshire as a whole. The greatest proportion of all stock in disrepair is in City of Lincoln and East Lindsey (both 8%) and the lowest is in North and South Kesteven and South Holland (all 5%).

For the private sector stock, the highest proportion is in City of Lincoln (9%) and the lowest is in North Kesteven (5%) with the figure for the county as a whole being 7%.

Overall the social stock has a lower proportion of dwellings in disrepair compared to the other tenures.

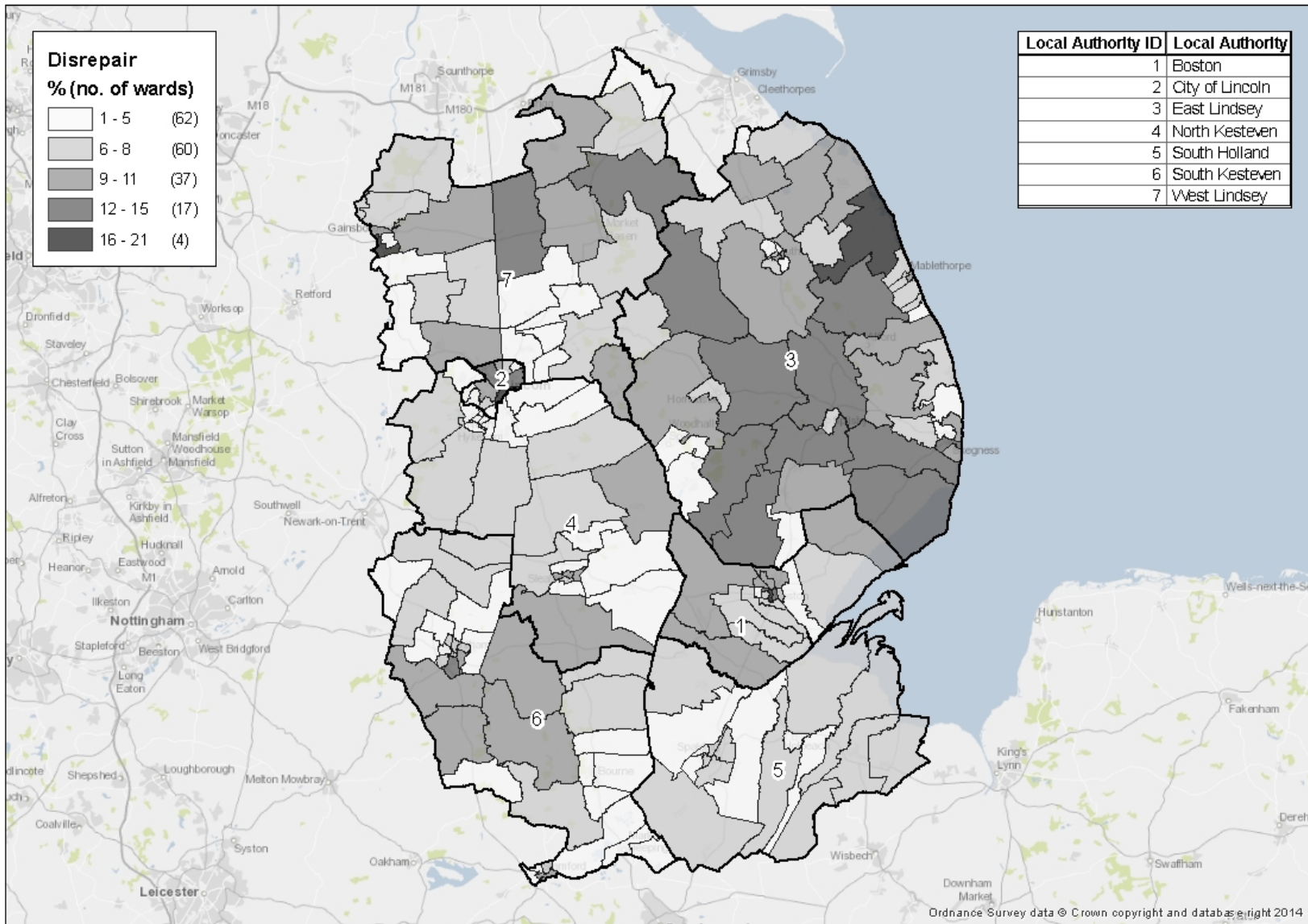
**Map 5** shows the geographical distribution of private sector dwellings in Lincolnshire estimated to be in disrepair. The greatest numbers of hazards appear to be concentrated towards the north and north east of the county.

**Table 6:** Percentage of dwellings estimated to be in disrepair by local authority and tenure

Local authority	% of dwellings in disrepair				
	Private sector stock			% of social	% of all stock
	% of private sector	% of owner occupied	% of private rented		
Boston	8%	7%	14%	2%	7%
City of Lincoln	9%	7%	15%	3%	8%
East Lindsey	8%	7%	13%	2%	8%
North Kesteven	5%	5%	9%	2%	5%
South Holland	6%	5%	10%	2%	5%
South Kesteven	6%	5%	11%	2%	5%
West Lindsey	8%	7%	14%	2%	7%
Lincolnshire County	7%	6%	12%	2%	7%



**Map 5: Percentage of private sector dwellings in Lincolnshire to be in disrepair**





### 3.3.5 Fuel poverty (10% and Low Income High Costs definitions)

This report covers both the original definition and the new definition of fuel poverty which is currently being rolled out by government.

The original definition states that a household is said to be in fuel poverty if it spends more than 10% of its income on fuel to maintain an adequate level of warmth (usually defined as 21°C for the main living area, and 18°C for other occupied rooms). For the purposes of this report this is termed 'fuel poverty (10%)'.

Under the new definition, a household is said to be in fuel poverty if they have required fuel costs that are above average (the national median level) and were they to spend that amount they would be left with a residual income below the official poverty line. This is known as the Low Income High Costs (LIHC) definition. For the purposes of this report this is termed 'fuel poverty (LIHC)'.

**Table 7** and **Table 8** show the results based on the 10% and LIHC definitions respectively. In general the estimated percentages are lower under the LIHC definition. For the private sector stock, East Lindsey has the highest proportions of fuel poverty under both definitions – 29% and 18%.

**Map 6** and **Map 7** show the results based on the 10% and LIHC definitions respectively and both indicate that the highest concentrations tend to be in the rural areas.

**Table 7:** Percentage of dwellings estimated to be in fuel poverty by local authority and by tenure – 10% definition

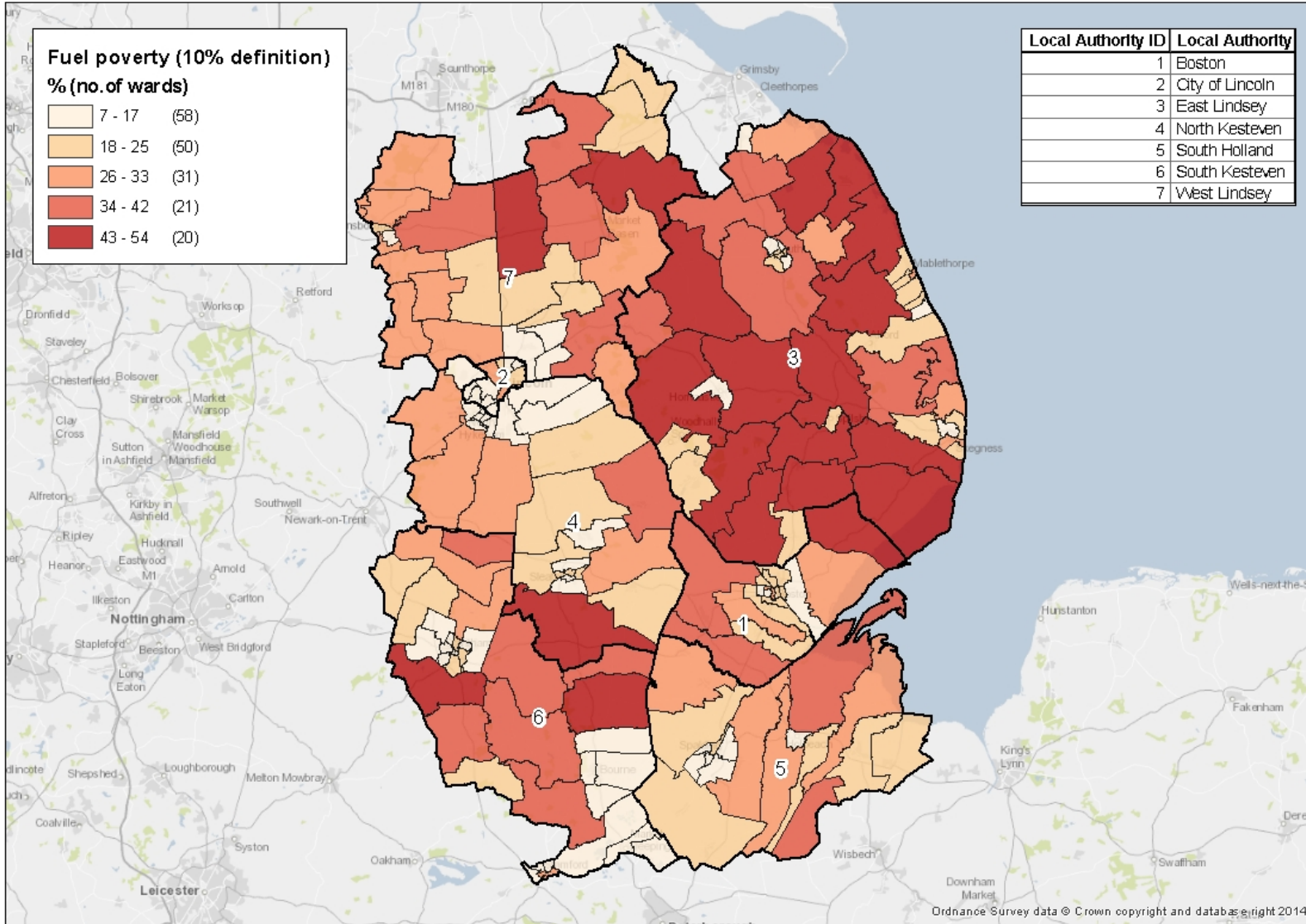
Local authority	% of dwellings in fuel poverty (10% definition)				
	Private sector stock			% of social	% of all stock
	% of private sector	% of owner occupied	% of private rented		
Boston	25%	23%	31%	20%	<b>24%</b>
City of Lincoln	18%	14%	28%	18%	<b>18%</b>
East Lindsey	29%	28%	35%	21%	<b>28%</b>
North Kesteven	19%	18%	25%	19%	<b>19%</b>
South Holland	21%	20%	28%	19%	<b>21%</b>
South Kesteven	19%	17%	28%	18%	<b>19%</b>
West Lindsey	26%	24%	36%	21%	<b>25%</b>
Lincolnshire County	<b>23%</b>	<b>21%</b>	<b>30%</b>	<b>19%</b>	<b>22%</b>



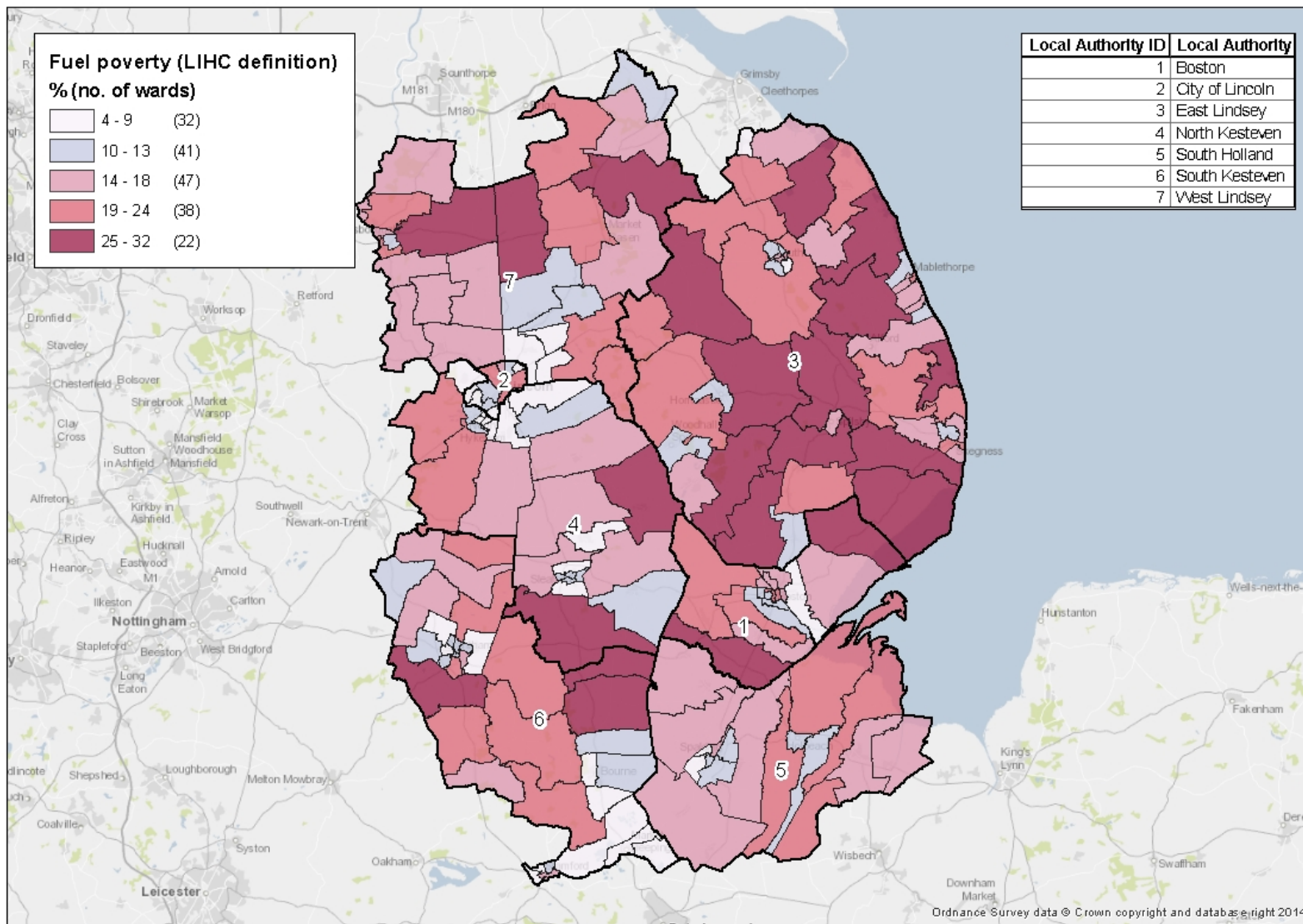
**Table 8:** Percentage of dwellings estimated to be in fuel poverty by local authority and by tenure – Low Income High Costs (LIHC) definition

Local authority	% of dwellings in fuel poverty (LIHC definition)				
	Private sector stock			% of social	% of all stock
	% of private sector	% of owner occupied	% of private rented		
<b>Boston</b>	16%	14%	28%	19%	<b>17%</b>
<b>City of Lincoln</b>	14%	9%	26%	16%	<b>14%</b>
<b>East Lindsey</b>	18%	15%	30%	19%	<b>18%</b>
<b>North Kesteven</b>	13%	11%	24%	18%	<b>13%</b>
<b>South Holland</b>	14%	12%	26%	18%	<b>14%</b>
<b>South Kesteven</b>	13%	10%	26%	17%	<b>13%</b>
<b>West Lindsey</b>	16%	13%	31%	18%	<b>17%</b>
<b>Lincolnshire County</b>	<b>15%</b>	<b>12%</b>	<b>27%</b>	<b>18%</b>	<b>15%</b>

**Map 6:** Percentage of private sector dwellings in Lincolnshire estimated to be occupied by households in fuel poverty – 10% definition



**Map 7:** Percentage of private sector dwellings in Lincolnshire estimated to be occupied by households in fuel poverty - Low Income High Costs definition





### 3.3.6 Dwellings occupied by low income households

**Table 9** shows the percentage of dwellings estimated to be occupied by low income households by local authority and tenure and for the County of Lincolnshire as a whole. The greatest proportion of all stock occupied by households on a low income is in City of Lincoln (41%) and the lowest is in North Kesteven (25%).

For the private sector stock, the highest proportion is in City of Lincoln (31%) and the lowest is in North Kesteven (20%) with the figure for the county as a whole being 25%.

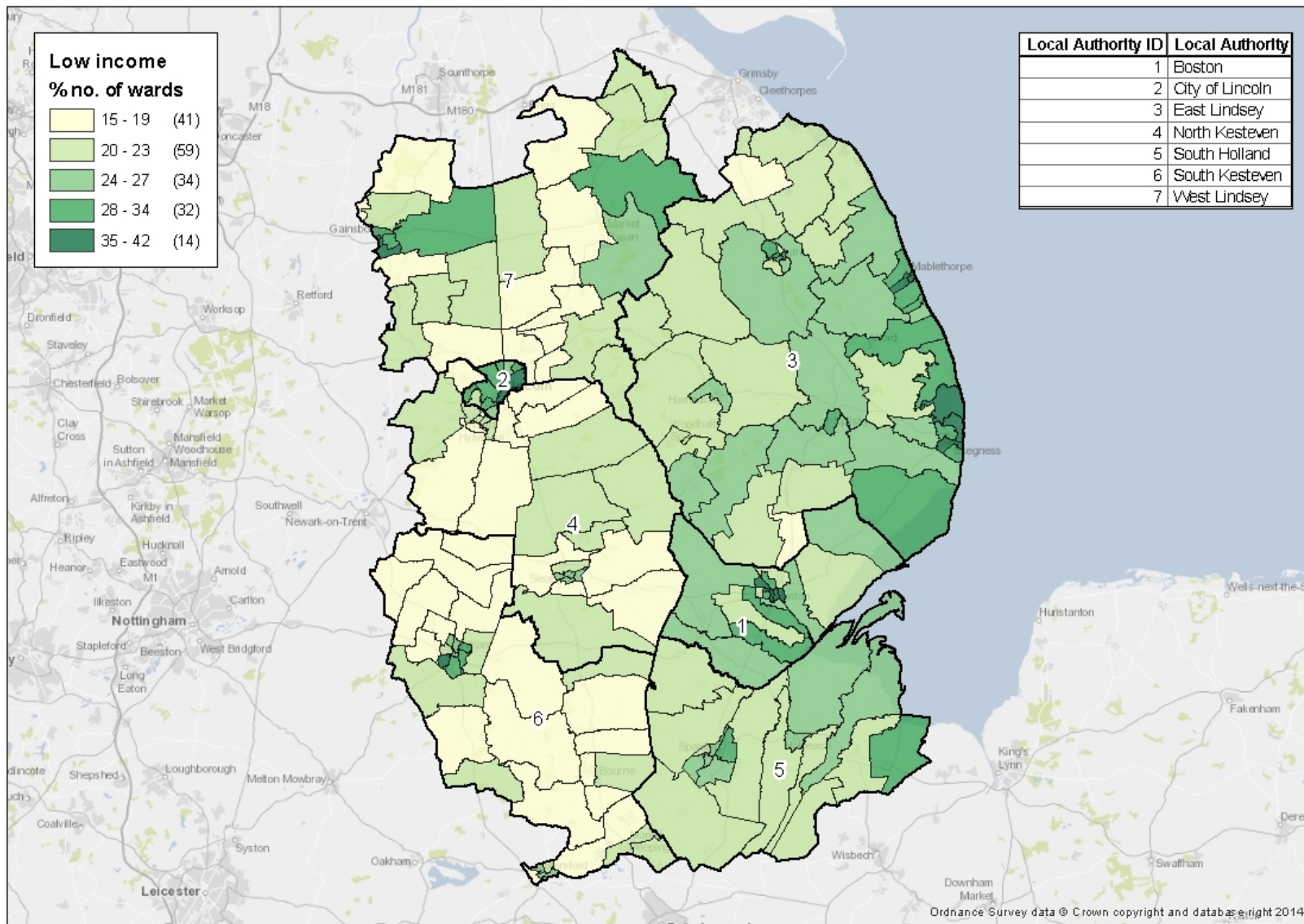
Overall the social stock has a higher proportion of dwellings on low income compared to the other tenures.

**Map 8** shows the geographical distribution of private sector dwellings in Lincolnshire on low income. The greatest numbers are generally concentrated in the more urban areas.

**Table 9:** Percentage of dwellings estimated to be occupied by low income households by local authority and by tenure

Local authority	% of dwellings on low income				
	Private sector stock			% of social	% of all stock
	% of private sector	% of owner occupied	% of private rented		
Boston	29%	24%	48%	79%	<b>38%</b>
City of Lincoln	31%	25%	45%	77%	<b>41%</b>
East Lindsey	27%	22%	45%	76%	<b>32%</b>
North Kesteven	20%	17%	34%	71%	<b>25%</b>
South Holland	24%	20%	43%	75%	<b>30%</b>
South Kesteven	22%	18%	39%	72%	<b>29%</b>
West Lindsey	23%	20%	42%	73%	<b>29%</b>
Lincolnshire County	25%	21%	42%	75%	<b>32%</b>

**Map 8:** Percentage of private sector dwellings in Lincolnshire estimated to be occupied by low income households





### 3.3.7 SimpleSAP rating

The average SimpleSAP ratings for the County of Lincolnshire as a whole and broken down by local authority and tenure are shown in **Table 10**. For all stock, City of Lincoln has the best average SimpleSAP rating (57) and East Lindsey has the lowest average rating (47).

For the private sector stock, City of Lincoln has the best average SimpleSAP rating (56) and East Lindsey has the lowest (46). The average SimpleSAP rating for the county as a whole is 51 and the England average from the 2011 EHS is 55.

Overall the social stock has better average ratings compared to the other tenures.

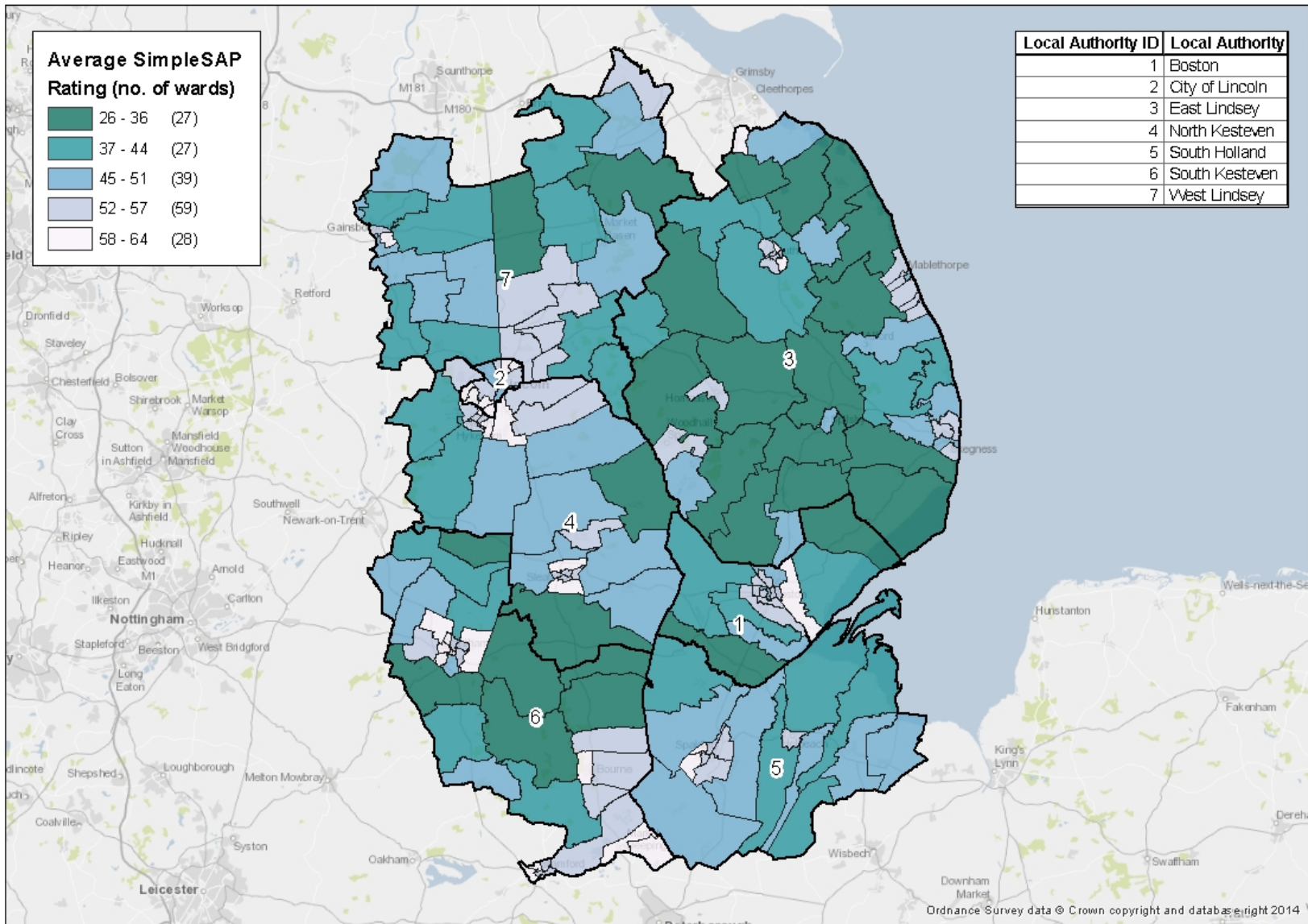
**Map 9** shows the geographical distribution of average SimpleSAP ratings. Rural areas with low population densities tend to have the lowest ratings. The size of the home itself is not a factor in SimpleSAP, and properties in these areas may be more likely to be semi-detached or detached, and therefore have larger heat loss areas. As they are in a rural location, properties in these wards may also not be connected to the mains gas network leading to a decrease in SimpleSAP score.

**Table 10:** Average SimpleSAP rating by local authority and by tenure

Local authority	Average SimpleSAP rating				
	Private sector stock			Social	All stock
	Total private sector	Owner occupied	Private rented		
Boston	50	50	49	57	<b>51</b>
City of Lincoln	56	58	51	61	<b>57</b>
East Lindsey	46	47	45	56	<b>47</b>
North Kesteven	52	52	50	55	<b>52</b>
South Holland	51	51	49	56	<b>52</b>
South Kesteven	53	54	49	57	<b>53</b>
West Lindsey	48	49	44	56	<b>49</b>
<i>Lincolnshire County</i>	<i>51</i>	<i>51</i>	<i>48</i>	<i>57</i>	<i>51</i>



**Map 9: Average SimpleSAP rating - private sector dwellings in Lincolnshire**





### 3.4 Comparison of information relating to LAHS reporting

The following sub-sections show the results for EPC ratings and the cost of mitigating category 1 hazards.

#### 3.4.1 EPC ratings

EPC ratings in the private sector stock

**Table 11** shows the Bands A – G and corresponding SAP scores in brackets. The columns show the percentage of private sector stock falling into each of the EPC rating bands for each local authority and for Lincolnshire County as a whole.

The percentage of private sector dwellings with an EPC rating below Band E for Lincolnshire County as a whole is 21.5%. East Lindsey has the highest percentage falling below Band E (30.3%) and City of Lincoln has the lowest (9.4%).

**Table 11:** Percentage of private sector stock falling into each of the EPC ratings bands (based on SimpleSAP) by local authority

Distribution of EPC rating bands by local authority - private sector								
EPC rating band	Boston	City of Lincoln	East Lindsey	North Kesteven	South Holland	South Kesteven	West Lindsey	Lincolnshire County
(92-100) A	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
(81-91) B	0.1%	0.1%	0.0%	0.0%	0.1%	0.1%	0.0%	0.1%
(69-80) C	11.6%	17.0%	9.0%	13.0%	12.5%	15.6%	9.5%	12.5%
(55-68) D	36.0%	41.7%	32.2%	40.7%	39.1%	40.9%	34.6%	37.7%
(39-54) E	29.6%	31.7%	28.5%	26.6%	27.7%	25.3%	29.6%	28.2%
(21-38) F	14.2%	7.4%	18.5%	12.9%	13.1%	11.9%	16.8%	13.8%
(1-20) G	8.5%	2.0%	11.8%	6.7%	7.5%	6.1%	9.5%	7.7%

Under the Energy Act 2011, new rules mean that from 2018 landlords must ensure that their properties meet a minimum energy efficiency standard, likely to be set at EPC Band E<sup>16, 17</sup>.

**Table 12** shows the breakdown of SimpleSAP results into the A – G Bands for the private rented stock only.

The percentage of private rented dwellings with an EPC rating below Band E for Lincolnshire County as a whole is 26.5%. East Lindsey has the highest percentage falling below Band E (34.1%) and City of Lincoln has the lowest (17.0%).

<sup>16</sup> <https://www.gov.uk/getting-a-green-deal-information-for-householders-and-landlords>

<sup>17</sup> Unless they have already installed the full range of measures possible under the Green Deal.



**Table 12:** Percentage of private rented stock falling into each of the EPC ratings bands (based on SimpleSAP) by local authority

Distribution of EPC rating bands by local authority - private rented sector								
EPC rating band	Boston	City of Lincoln	East Lindsey	North Kesteven	South Holland	South Kesteven	West Lindsey	Lincolnshire County
(92-100) A	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	<b>0.0%</b>
(81-91) B	0.2%	0.2%	0.1%	0.1%	0.2%	0.2%	0.1%	<b>0.1%</b>
(69-80) C	12.2%	11.7%	9.3%	13.5%	12.7%	12.6%	7.0%	<b>11.2%</b>
(55-68) D	30.7%	32.1%	28.6%	35.4%	33.0%	32.5%	26.4%	<b>31.1%</b>
(39-54) E	33.3%	39.0%	27.9%	26.7%	29.5%	28.8%	32.2%	<b>31.1%</b>
(21-38) F	13.9%	12.5%	19.6%	15.0%	15.3%	15.6%	19.8%	<b>16.1%</b>
(1-20) G	9.7%	4.5%	14.5%	9.2%	9.3%	10.3%	14.5%	<b>10.3%</b>

### 3.4.2 Cost of mitigating category 1 hazards

**Table 13** shows the total number of dwellings with HHSRS category 1 hazards in the private sector stock and the mitigation costs for each local authority and for the County of Lincolnshire as a whole. The costs are based on the average cost of mitigating category 1 hazards for East Midlands using EHS 2011 data<sup>18</sup>.

The total cost of mitigating category 1 hazards in the county as a whole is estimated to be £188 million. East Lindsey and West Lindsey have the highest percentage of private sector dwellings with hazards (27% and 25% respectively) and City of Lincoln has the lowest (15%).

**Table 13:** Total number and percentage of dwellings with category 1 hazards in private sector stock and cost of mitigation, by local authority

Local authority	Total no. of dwellings with cat 1 hazards	% of private stock with cat 1 hazards	Total cost of mitigating (£)
Boston	5,077	22%	16,548,657
City of Lincoln	4,843	15%	15,785,926
East Lindsey	15,342	27%	50,007,779
North Kesteven	7,773	18%	25,336,362
South Holland	6,444	19%	21,004,440
South Kesteven	9,471	18%	30,871,052
West Lindsey	8,887	25%	28,967,483
<b>Lincolnshire County</b>	<b>57,837</b>	<b>21%</b>	<b>188,521,698</b>

<sup>18</sup> Note that these costs are estimated based on standardised cost assumptions intended for comparison purposes. If available, local data on costs – such as grant or loan aided works – could be used; however, this type of data is usually biased. The estimates here are therefore considered as a useful starting point.



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## 4 Conclusion and recommendations

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### 4.1 Conclusion

The majority of local authorities within the County of Lincolnshire commissioned BRE to undertake a series of modelling exercises on their housing stock<sup>19</sup> – Boston, City of Lincoln, East Lindsey, West Lindsey, North Kesteven and South Kesteven. Separate reports were produced for each council describing the modelling work and providing details of the results obtained from the dwelling level models and database. Each council was also provided with their database to enable them to obtain specific information whenever required. This current report provides a high level summary for the County of Lincolnshire.

The stock models and databases for each of the separate local authorities have been used to provide the following, with a focus on private sector housing:

- The percentage of dwellings meeting each of the key indicators for Lincolnshire overall and broken down by tenure and then mapped by ward (private sector stock only)
- Information relating to LAHS reporting for the private sector stock – EPC ratings and category 1 hazards<sup>20</sup>

Such information will facilitate the decision making process for targeting resources to improve the condition of housing and to prevent ill health resulting from poor housing conditions. Furthermore, the results of this project provide the local authorities in Lincolnshire with information which will assist in health and housing policy and strategy development whether these are inspired locally, arise from obligations under the Housing Act 2004 or as responses to government initiatives such as DCLG's Housing Strategy Policy, Green Deal and ECO.

### 4.2 Recommendations

The current databases produced for each local authority could be enhanced to include the addition of various other sources of data (if they are available). If such data were available BRE are able<sup>21</sup> to integrate these 'local data sources' into the current database.

Examples of such data are:

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<sup>19</sup> The exception was South Holland, however high level results for this local authority have been included in this report to enable the provision of county-wide results and comparisons across the local authorities.

<sup>20</sup> City of Lincoln also commissioned BRE to supply information on Houses in Multiple Occupation (HMOs). As they were the only council to request this there is no scope for comparison with other councils, therefore HMO information has not been included in this summary report.

<sup>21</sup> Dependent on a successful feasibility assessment of the data.



- **Energy Performance Certificate (EPC) data**

EPCs contain data on key dwelling energy characteristics (e.g. energy demand, excess cold, SimpleSAP) and where these are available they can be used in preference to the modelled data (it should be noted that to comply with bulk EPC data licencing requirements the EPC data is only used to inform the energy efficiency aspects of the model).

- **Local Land and Property Gazetteer (LLPG) data**

The Unique Property Reference Number (UPRN) from the LLPG can be used to uniquely identify all properties, while the address details from the LLPG can be used to merge the BRE models and EPC data using address matching.

- **Households on benefits**

Data regarding any households in receipt of either Council Tax Support or Housing Allowance could be used to enhance the low income model, making the targeting of individual low income households more accurate.

- **Local repair schemes**

Data from any local repair schemes, including the use of repair grants, could be used to enhance the Disrepair model.

- **Local energy improvement schemes**

Any local schemes to improve the energy efficiency of dwellings, including national schemes for which local data has been made available, could be used to further enhance the energy models (SimpleSAP, Excess cold, Fuel Poverty).

Furthermore, it would be possible to provide local authorities with an analysis of the condition of the housing stock and its impact on health in terms of health outcomes, financial costs to the NHS of treatment costs, costs to wider society, and Quality Adjusted Life Years (QALYs) through a **Health Impact Assessment**. The report would also provide a cost benefit analysis of mitigating Housing Health and Safety Rating System hazards within the stock. An example proposal for this service was supplied to North Kesteven DC on 27<sup>th</sup> September 2014.

Further assistance could be provided in the form of a **Healthy Homes Advisory Service**. This involves assisting local authorities in using the data from the stock modelling and or the health impact assessment to proactively assist vulnerable residents living in the poorest quality housing in the local authority area. The service would help the local authorities in Lincolnshire to target the poorest quality housing and maximise the joint working opportunities with health and community groups in the area. The service could also advise on preferred methods of improving the energy efficiency in the private rented stock. NICE has recently published a Public Health Draft Guideline: Excess winter deaths, morbidity and the health risks associated with cold homes. Two of their key recommendations are:

- As a minimum properties should be raised to a SAP band D (55). Currently 50% of private sector dwellings in Lincolnshire are estimated to fail this standard; and
- A local health and housing referral service for people living in cold homes should be instigated by the Health and Wellbeing Board.



## Appendix A Definitions of the key indicators

### 1. House condition indicators

#### a. The presence of a category 1 hazard under the Housing Health and Safety Rating System (HHSRS<sup>22</sup>) – reflecting both condition and thermal efficiency

Homes posing a category 1 hazard under the HHSRS – the system includes 29 hazards in the home categorised into category 1 (serious) or category 2 (other) based on a weighted evaluation tool. Note that this includes the hazard of excess cold which is also included as one of the energy efficiency indicators.

The 29 hazards are:

1 Damp and mould growth	16 Food safety
2 Excess cold	17 Personal hygiene, Sanitation and Drainage
3 Excess heat	18 Water supply
4 Asbestos	19 Falls associated with baths etc.
5 Biocides	20 Falling on level surfaces etc.
6 Carbon Monoxide and fuel combustion products	21 Falling on stairs etc.
7 Lead	22 Falling between levels
8 Radiation	23 Electrical hazards
9 Uncombusted fuel gas	24 Fire
10 Volatile Organic Compounds	25 Flames, hot surfaces etc.
11 Crowding and space	26 Collision and entrapment
12 Entry by intruders	27 Explosions
13 Lighting	28 Position and operability of amenities etc.
14 Noise	29 Structural collapse and falling elements
15 Domestic hygiene, Pests and Refuse	

#### b. The presence of a category 1 hazard for falls (includes “falls associated with baths”, “falling on the level” and “falling on stairs”)

The HHSRS Falls Model includes the 3 different falls hazards where the vulnerable person is over 60 as listed above.

<sup>22</sup> The Housing Health and Safety Rating System (HHSRS) is a risk-based evaluation tool to help local authorities identify and protect against potential risks and hazards to health and safety from any deficiencies identified in dwellings. It was introduced under the Housing Act 2004 and applies to residential properties in England and Wales.



**c. Dwellings in disrepair (based on the former Decent Homes Standard criteria for Disrepair)**

The previous Decent Homes Standard states that a dwelling fails this criterion if it is not found to be in a reasonable state of repair. This is assessed by looking at the age of the dwelling and the condition of a range of building components including walls, roofs, windows, doors, electrics and heating systems).

**2. Energy efficiency indicators:**

**a. The presence of a category 1 hazard for excess cold (using SAP ratings as a proxy measure in the same manner as the English House Condition Survey)**

This hazard looks at households where there is a threat to health arising from sub-optimal indoor temperatures. The HHSRS assessment is based on the most low income group for this hazard – persons aged 65 years or over (note that the assessment requires the hazard to be present and potentially affect a person in the low income age group should they occupy that dwelling. The assessment does not take account of the age of the person actually occupying that dwelling at that particular point in time).

The English Housing Survey (EHS) does not measure the actual temperatures achieved in each dwelling and therefore the presence of this hazard is measured by using the SAP rating as a proxy. Dwellings with a SAP rating of less than 31.5 (SAP 2005 methodology) are considered to be suffering from a category 1 excess cold hazard.

**b. An estimate of the SAP rating which, to emphasise its origin from a reduced set of input variables, is referred to as “SimpleSAP”**

The Standard Assessment Procedure (SAP) is the UK Government's standard methodology for home energy cost ratings. SAP ratings allow comparisons of energy efficiency to be made, and can show the likely improvements to a dwelling in terms of energy use. The Building Regulations require a SAP assessment to be carried out for all new dwellings and conversions. Local authorities, housing associations, and other landlords also use SAP ratings to estimate the energy efficiency of existing housing. The version on which the Average SAP rating model is based is SAP 2005.

The SAP ratings give a measure of the annual unit energy cost of space and water heating for the dwelling under a standard regime, assuming specific heating patterns and room temperatures. The fuel prices used are averaged over the previous 3 years across all regions in the UK. The SAP takes into account a range of factors that contribute to energy efficiency, which include:

- Thermal insulation of the building fabric
- The shape and exposed surfaces of the dwelling
- Efficiency and control of the heating system
- The fuel used for space and water heating
- Ventilation and solar gain characteristics of the dwelling

**3. Household vulnerability indicators:**

**a. Fuel poverty - 10% definition**

This definition states that a household is said to be in fuel poverty if it spends more than 10% of its income on fuel to maintain an adequate level of warmth (usually defined as 21°C for the main living area, and 18°C for other occupied rooms). This broad definition of fuel costs also includes modelled spending on water heating, lights, appliances and cooking.



The fuel poverty ratio is defined as:

$$\text{Fuel poverty ratio} = \frac{\text{Fuel costs (usage * price)}}{\text{Full income}}$$

If this ratio is greater than 0.1 then the household is in fuel poverty.

The definition of full income is the official headline figure and in addition to the basic income measure, it includes income related directly to housing (i.e. Housing Benefit, Income Support for Mortgage Interest (ISMI), Mortgage Payment Protection Insurance (MPPI), Council Tax Benefit (CTB)).

Fuel costs are modelled, rather than based on actual spending. They are calculated by combining the fuel requirements of the household with the corresponding fuel prices. The key goal in the modelling is to ensure that the household achieves the adequate level of warmth set out in the definition of fuel poverty whilst also meeting their other domestic fuel requirements.

#### **b. Fuel poverty - Low Income High Costs definition**

The government has recently set out a new definition of fuel poverty which it intends to adopt under the Low Income High Costs (LIHC) framework<sup>23</sup>. Under the new definition, a household is said to be in fuel poverty if:

They have required fuel costs that are above average (the national median level)  
Were they to spend that amount they would be left with a residual income below the official poverty line

#### **c. Dwellings occupied by a low income household**

A household in receipt of:

Income support  
Housing benefit  
Attendance allowance  
Disability living allowance  
Industrial injuries disablement benefit  
War disablement pension  
Pension credit  
Child tax credit  
Working credit

For child tax credit and working tax credit, the household is only considered a low income household if it has a relevant income of less than £15,050.

The definition also includes households in receipt of Council Tax benefit and income based Job Seekers Allowance.

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<sup>23</sup> <https://www.gov.uk/government/collections/fuel-poverty-statistics>





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## Appendix B Methodology for the BRE Dwelling Level Housing Stock Modelling approach

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This Appendix provides a more detailed description of the models which make up the overall housing stock modelling approach and feed into the database. The process is made up of a series of data sources and models which, combined with various imputation and regression techniques and the application of other formulae, make up the final database. The database is essentially the main output of the modelling and provides information on the key indicators and other data requirements (e.g. energy efficiency variables). An overview of the approach and a simplified flow diagram are provided in Section 2 of this report.

The models making up the overall housing stock modelling approach are:

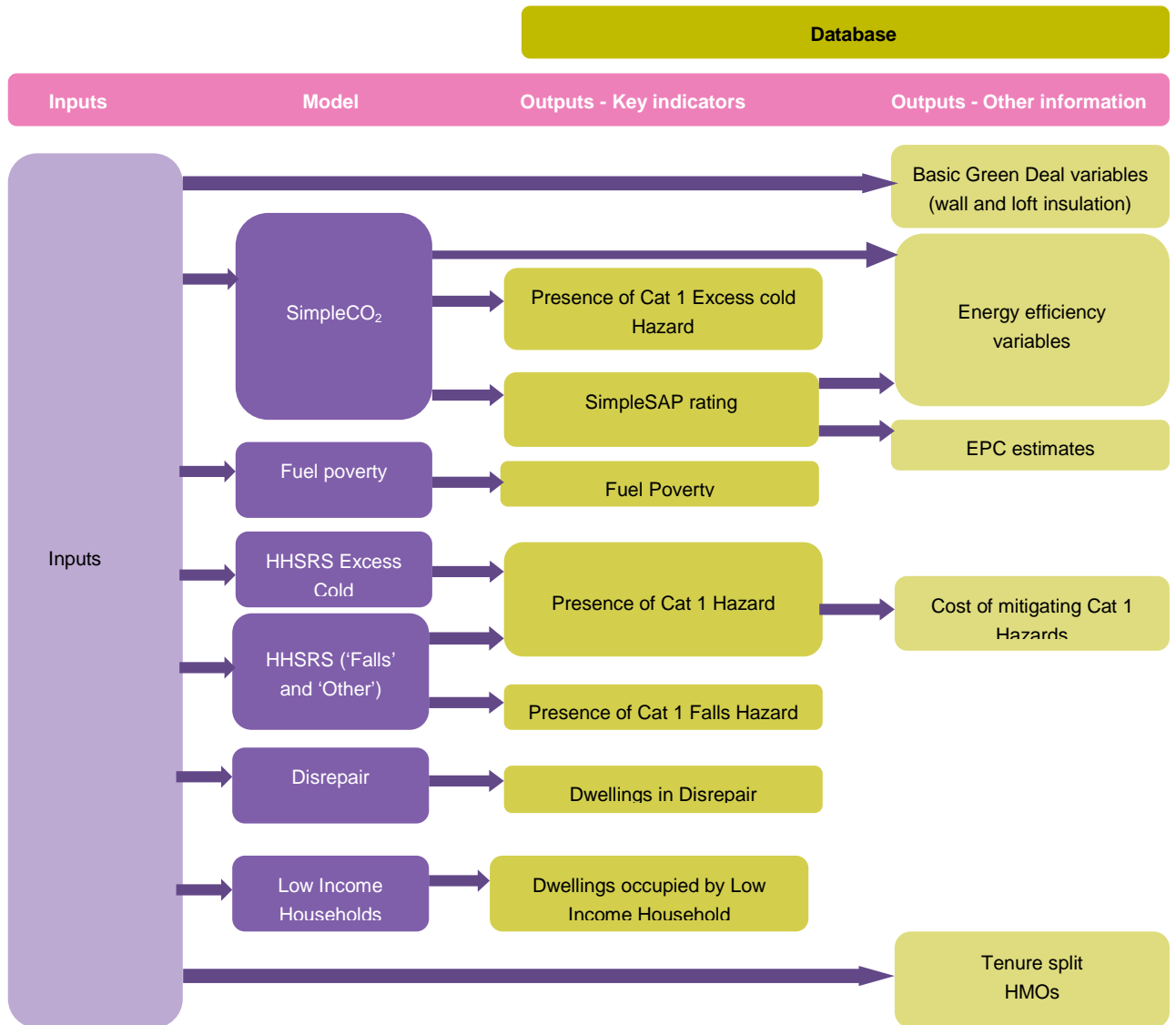
- SimpleCO<sub>2</sub> Model
- Fuel Poverty Model
- HHSRS (All Hazards, Falls Hazards and Excess Cold) Models
- Disrepair Model
- Low Income Households Model

**Figure B. 1** shows the data flows for the stock modelling approach, showing which models each of the outputs in the database (split into the key indicators and other information) come from. The exception is the Green Deal variables (if used) which come directly from the Energy inputs, and the tenure and HMO data (if used) which come directly from the other inputs.

Section B.1 describes the SimpleCO<sub>2</sub> Model in more detail, Section B.2 provides more information on the other four models and Section B.3 gives details of the OS MasterMap/geomodelling approach.



**Figure B. 1:** Simplified data flow for the housing stock modelling approach





## B.1 BRE SimpleCO<sub>2</sub> Model

BRE have developed a variant of the BREDEM software, named 'SimpleCO<sub>2</sub>', that can calculate outputs from a reduced set of input variables. These outputs are indicative of the full BREDEM outputs and the minimum set of variables the software accepts is information on:

- Dwelling type
- Dwelling age
- Number of bedrooms
- Heating fuel
- Heating system
- Tenure

The Experian UK Consumer Dynamics Database is used as a source of these variables and they are converted into a suitable format for the SimpleCO<sub>2</sub> software. However, these variables alone are insufficient for the software to calculate the 'SimpleSAP' rating or carbon emissions estimate (one of the outputs of the SimpleCO<sub>2</sub> model). Additional variables are required and as these values cannot be precisely inferred then a technique known as cold deck imputation is undertaken. This is a process of assigning values in accordance with their known proportions in the stock. For example, this technique is used for predicting heating fuels as the Experian data only confirms whether a dwelling is on the gas network or not. Fuel used by dwellings not on the gas network is unknown, so in most cases this information will be assigned using probabilistic methods. The process is actually far more complex e.g. dwellings with particular characteristics such as larger dwellings are more likely to be assigned with oil as a fuel than smaller dwellings.

The reason for taking this approach is to ensure that the national proportions in the data source are the same as those found in the stock nationally (as predicted by the EHS or other national survey). Whilst there is the possibility that some values assigned will be incorrect for a particular dwelling (as part of the assignment process has to be random) they ensure that examples of some of the more unusual types of dwelling that will be present in the stock are included.

Whilst this approach is an entirely sensible and commonly adopted approach to dealing with missing data in databases intended for strategic use, it raises issues where one of the intended uses is planning implementation measures. It must therefore be kept in mind at all times that the data provided represents the most likely status of the dwelling, but that the actual status may be quite different. That said, where EPC data has been used, the energy models (which use EPC data) are likely to be more accurate.

It is important to note that some variables have been entirely assigned using cold decking imputation techniques. These include presence of cavity wall insulation and thickness of loft insulation as there is no reliable database with national coverage for these variables.

The 'SimpleCO<sub>2</sub>' software takes the combination of Experian and imputed data and calculates the 'SimpleSAP' rating for each dwelling in the national database. The calculated 'SimpleSAP' ratings are the basis of the estimates of SAP and Excess cold. How the other key variables are derived is discussed later in this Appendix.

Because the estimates of 'SimpleSAP' etc. are calculated from modelled data it is not possible to guarantee the figures. They do, however, provide the best estimates that we are aware can be achieved



from a data source with national coverage and ready availability. The input data could, however, be improved in its:

- accuracy for example through correcting erroneous values,
- depth of coverage, for example by providing more detailed information on age of dwellings,
- breadth by providing additional input variables such as insulation.

Improving any of these would enhance the accuracy of the output variables and for this reason it is always worth considering utilising additional information sources where they are available. Using EPC data will go some way towards meeting these improvements by providing more accurate data.

## B.2 Housing Condition and Household Vulnerability Models

This section provides further information on the remaining four models – Fuel Poverty, HHSRS, Disrepair and Low Income Households. These models are discussed together since the approach used for each one is broadly the same.

These models are not based solely on the thermal characteristics of the dwelling, and in some cases are not based on these characteristics at all. A top down methodology has been employed for these models, using data from the EHS and statistical techniques, such as logistic regression, to determine the combination of variables which are most strongly associated with failure of each standard. Formulae have been developed by BRE to predict the likelihood of failure based on certain inputs. The formulae are then applied to the variables in the national Experian dataset to provide a likelihood of failure for each dwelling. Each individual case is then assigned a failure/compliance indicator based on its likelihood of failure and on the expected number of dwellings that will fail the standard within a given geographic area. Thus if the aggregate values for a census output area are that 60% of the dwellings in the area fail a particular standard then 60% of the dwellings with the highest failure probabilities will be assigned as failures and the remaining 40% as passes.

The presence of a category 1 hazard failure is the only exception to this as it is found by combining excess cold, fall hazards and other hazards such that failure of any one of these hazards leads to failure of the standard.

## B.3 OS MasterMap information ('geomodelling')

The OS data has been used to update a number of the SimpleCO2 model inputs. The most valuable use of the OS data is the ability to determine the dwelling type with much greater confidence.

The existing dwelling type is replaced with a new dwelling type derived from OS data. By looking at the number of residential address points it can be inferred whether the building is a house or block of flats (houses have one residential address point and blocks of flats have two or more).

**Houses** - where the dwelling is a house the number of other buildings it is attached to can be observed and the following assumptions made:

- If there are no other dwellings attached, the house is detached
- If two dwellings are joined to one another, but not to any other dwellings, they are semi-detached
- If they are attached to two or more other dwellings, they are mid terraced
- If they are attached to only one dwelling, but that dwelling is a mid-terrace, they are an end-terrace

**Flats** - if the building is a block of flats, its exact nature is determined by its age and the number of flats in the block and the following assumptions made:



- If there are between two and four flats in the block (inclusive) and the dwelling was built before 1980 then it is a conversion
- Otherwise it is purpose built

This information can also be used to reconcile discrepancies within blocks of flats, terraced and semi-detached houses. These discrepancies occur in variables such as dwelling age, location of flat in block, number of storeys, loft insulation, wall insulation, wall type and floor area.

Looking at dwelling age, although the OS data does not itself provide any information on age, it does allow reconciliation of age data within semi-detached, terraces and blocks of flats.

Where a group of buildings are all attached in some way, such as a terrace, it is logical to assume that they were built at the same time. Therefore the age of each building is replaced with the most common age among those present. Where the most common age occurs in equal numbers, this is resolved by looking at the average age of houses in the same postcode.

If one dwelling has an age that is notably newer than its neighbours, then the age is not changed, as it is assumed that the original dwelling was destroyed and rebuilt.

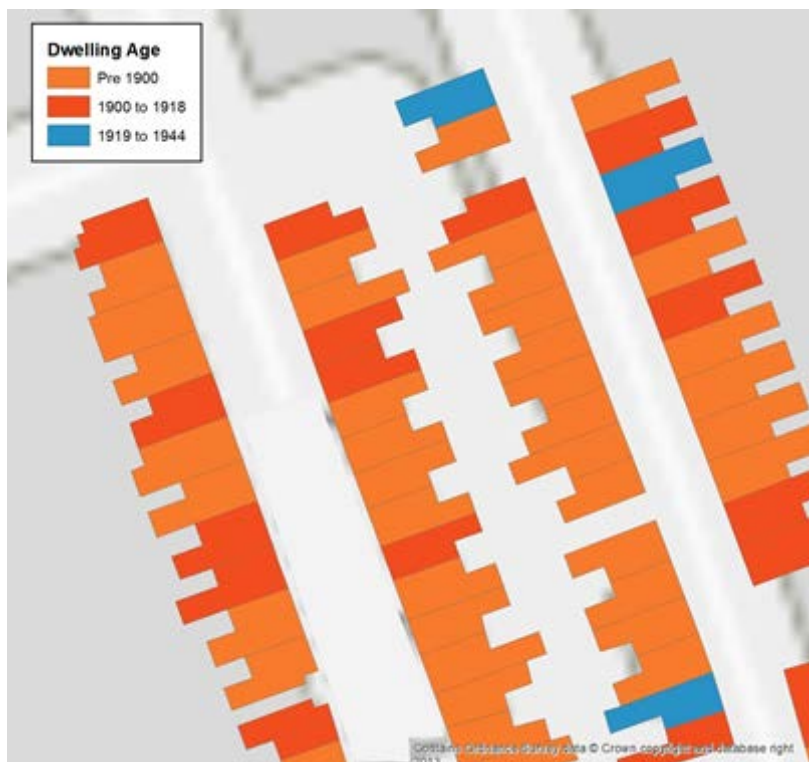
**Figure B. 2** and **Figure B. 3** below show how the initial base data is adjusted using the OS data to produce more consistent and reliable results.

Considering the number of storeys and the location of a flat in its block, if the OS data reveals that the dwelling type is significantly different from the original value – specifically if a house becomes a flat, or vice versa then the variables are adjusted. If this is the case a new location for the flat within the block or the number of storeys will be imputed using the same method as before, but taking into account the revised dwelling type.

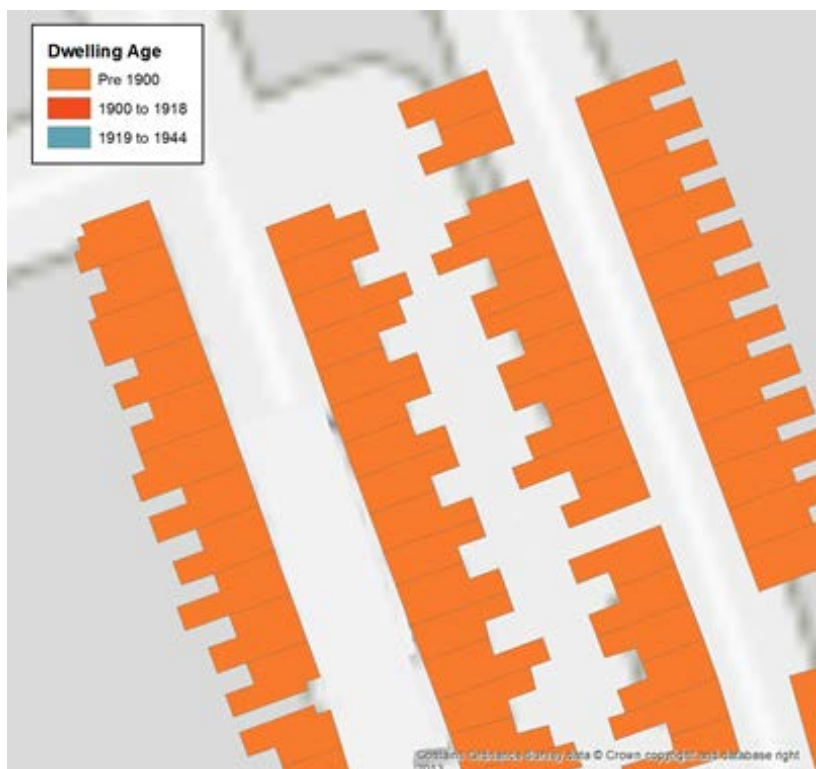
Similarly with floor area, loft insulation and wall type - if the dwelling type or location of a flat within a block changes as a result of OS data then the variables are calculated using the same method of imputation as the original models, but taking into account the new data.



**Figure B. 2:** Dwelling level map showing the base data, prior to using the OS data



**Figure B. 3:** Dwelling level map showing the OS updated data





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## Appendix C Policy background

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The detailed housing stock information provided in this report will facilitate the delivery of Lincolnshire's housing strategy and enable a targeted intervention approach to improving housing. This strategy needs to be set in the context of relevant government policy and legislative requirements. These policies either require reporting of housing-related data by local authorities, or the use of such data to assist in meeting policy requirements. The main policies and legislative requirements are summarised in the following subsections.

### C.1 Housing Act 2004

The Housing Act 2004 requires local housing authorities to review housing statistics in their district. The requirements of the Act are wide-ranging and also refer to other legislation which between them covers the following:

- Dwellings that fail to meet the minimum standard for housings (i.e. dwellings with HHSRS category 1 hazards)
- Houses in Multiple Occupation (HMOs)
- Selective licensing of other houses
- Demolition and slum clearance
- The need for provision of assistance with housing renewal
- The need to assistance with adaptation of dwellings for disabled persons

### C.2 Key housing strategy policy areas and legislation

In the report 'Laying the Foundations: A Housing Strategy for England' Chapters 4 and 5 focus on the private rented sector and empty homes.

#### Private rented sector

There has been significant growth in the private rented sector in recent years and new measures are being developed to deal with rogue landlords and to encourage local authorities to make full use of enforcement powers for tackling dangerous and poorly maintained dwellings. The report encourages approaches which work closely with landlords whilst still operating a robust enforcement regime (e.g. landlord forums and panels across the country).

#### Health inequalities

The government's white paper 'Choosing Health' states that the key to success in health inequalities will be effective local partnerships led by local government and the NHS working to a common purpose and reflecting local needs. Housing is a key determinant of health, and poor housing conditions continue to cause preventable deaths and contribute to health inequalities. An example in this area is the work carried out by Liverpool City Council in partnership with Liverpool Primary Care Trust – the 'Healthy Homes Programme'. This has identified over 3,800 hazards and led to an estimated £4.8 million investment by landlords, delivering sustainable health improvements and enhancing community wellbeing.



### Integrated care

It has been recognised by central government that to fully address the health needs of the population, services need to become more integrated and there needs to be better communication between different providers. Housing is a key aspect of this:

“Many people with mental and physical disabilities, complex needs, long-term conditions and terminal illness also need to access different health care, social care, housing and other services, such as education, and often simultaneously” .

It is therefore essential that departments providing or regulating housing work with other council departments and health organisations to provide services that are integrated and take full account of the needs of the individual.

### Public Health Outcomes Framework

The Public Health Outcomes Framework ‘Healthy lives, healthy people: Improving outcomes and supporting transparency’ sets out desired outcomes for public health and how they will be measured. Many of the measurements have links to housing, some of the more relevant being:

- Falls and injuries in over 65’s
- Fuel poverty
- Excess winter deaths

### Joint Strategic Needs Assessment (JSNA) and Joint Health and Wellbeing Strategies

The JSNA and joint health and wellbeing strategy allow health and wellbeing boards to analyse the health needs of their local population and to decide how to make best use of collective resources to achieve the priorities that are formed from these. The Department of Health document ‘Joint Strategic Needs Assessment and joint health and wellbeing strategies explained - Commissioning for populations’ says “This will ensure better integration between public health and services such as housing and education that have considerable impact on the wider determinants of health” .

### Energy Act 2011

The Energy Act 2011 requires that from 2016 reasonable requests by tenants for energy efficiency improvements will not be able to be refused. Furthermore, from 2018 it will be unlawful for landlords to rent out properties that do not reach a minimum standard of energy efficiency (likely to be set at Energy Performance Certificate rating E). While there will be various caveats to these powers, they will provide a new minimum standard for rented accommodation. Part of this current project includes provision of a private rented sector variable that should assist in identifying such dwellings.

### Empty homes

Empty homes brought back into use will qualify for the New Homes Bonus where, for the following 6 years, the government will match fund the Council Tax on long term empty properties brought back into use. In addition, from 2012-15, £100million of capital funding from within the Affordable Homes Programme will be available to tackle problematic empty homes. Whilst the data provided by this project cannot necessarily assist with the actual identification of empty homes, the database provided would be the logical place for such information to be stored should it be gathered from other sources.

## C.3 Other policy areas

The following policy areas, whilst not directly relating to environmental health services, will have an effect on demand and local authorities will need to be aware of the possible impact in their area.





### Welfare Reform Act 2012

The key parts of this Act for environmental health services are the sections relating to the under occupation of social housing, and the benefit cap. Whilst this will mainly affect tenants in the social rented sector it will undoubtedly have an impact on private sector services. Social tenants may find themselves being displaced into the private sector, increasing demand in this area, and the tenants of Registered Providers (RP's) and some private landlords may have greater trouble affording rent payments. If tenants are in arrears on their rental payments then authorities may be met with reluctance from landlords when requiring improvements to properties.

### Localism Act 2011

The Localism Act allows social housing providers to offer fixed term, rather than secure lifetime, tenancies. As with the Welfare Reform Act, this has a greater direct impact on the social rented sector, however, there is some concern this may lead to greater turnover of tenancies meaning that some 'traditional' social tenants may find themselves in the private rented sector.

Both of these policy changes above may increase the number of vulnerable persons in private sector properties. If this occurs any properties in this sector in poor condition are likely to have a far greater negative impact on the health of those occupiers

### Potential increase in private rented sector properties

Policies such as the Build to Rent and the New Homes Bonus are aimed at increasing the supply of properties. As the private rented sector is already growing, it is reasonable to assume that many of the new properties being built will be rented to private tenants. Local authorities will need to be aware of the potential impact on the demand for their services and how their perception of their local area may have to change if large numbers of properties are built.

## C.4 Local Authority Housing Statistics (LAHS)

The purpose of these statistics is twofold – firstly to provide central government with data with which to inform and monitor government strategies, policies and objectives as well as contributing to national statistics on housing, secondly, to the local authorities themselves to help manage their housing stock. Local authorities are required to complete an annual return which covers a wide range of housing-related issues. Of particular relevance to this current project is 'Section F: Condition of dwelling stock' which, amongst other things, requests the following information:

- Average EPC rating of the private sector stock and the proportion below a certain rating.
- Total number of dwellings and number of private sector dwellings with category 1 HHSRS hazards and the estimated costs of mitigating these
- Estimates of the number of HMOs and the number of mandatory licensable HMOs