INTEGRATED RISK MANAGEMENT PLAN

Modelling Methodology
2018/19

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Royal Berkshire Fire & Rescue Service www.rbfrs.co.uk

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Introduction

Integrated Risk Management Planning (IRMP) requires all fire and rescue services (FRSs) to consider how best to mitigate risk by a balance of Prevention, Protection and Response (PPR). To provide risk treatments by PPR requires a knowledge and understanding of the risks. Where and what are the risks?

This document outlines the methods of modelling and mapping that Royal Berkshire Fire and Rescue Service (RBFRS) uses to calculate risk and risk location within Berkshire. It supports the Fire Authority IRMP. The current IRMP, for 2015-2019, is published online.

The first version of this document was published under calculating risk on our website. This version is an evolution of our risk modelling methodology that will support the new IRMP 2019-2023. It updates various maps and tables, refines a number of items and develops the 'vulnerability index' concept that will enhance delivery to household level, especially alongside concurrent 'Webmaps' work.

Concepts

Risk

Risk[1] is commonly calculated by the equation:

Risk = Likelihood x Severity.

This basic principle is used throughout the model and is measured by geographic areas, down to household level, within Berkshire in terms of **societal risk** and **incident risk**. To give the greatest possible level of flexibility, a concept matrix was developed (appendix A) to illustrate how all risks can be combined, in any number of ways to form an assessment of risk.

In some cases, the model will give a score for **absolute risk**. For example, the number of incidents of a particular type maybe seen as the 'likelihood' and the number of fatalities and injuries maybe used as a measure of 'severity'. This enables the consistent calculation of changes in risk level over years. In most cases (especially for geographic areas), **relative risk** will be analysed, comparing one risk against another to find the most risky area compared to others.

Risk is also analysed at two levels. First, an overall **community risk** is derived. Second, this wider area community risk is drilled down into (households) for the more focused **vulnerability risk**.

[1] Risk here is 'public risk'. Other risks such as organisational (financial, legal etc) and staff (including firefighter risk) are not included. Further, risks to animals and the environment are only considered, if there has been harm caused to people.

Community risk

Community Risk is a calculated wider area risk 'profile'. Importantly at this stage, the output from the model (of all and any combined risks) compares areas of risk. It is a **relative risk** model. By this it is meant that one area will be measured as more (or less) risky than another area. This means that there will always be some mapped apparent high-risk areas, but they should usually be seen as high-risk compared to others.

The wider area can be of virtually any description, shape or size. For a Berkshire-wide approach to IRMP, **Lower Super Output Areas (LSOAs)** [2] are used as they enable a reasonable level of detail across the whole of Berkshire, thereby giving a sensible breakdown of risk, whilst not becoming so detailed that it is impossible to see the overall Berkshire risk picture[3]. Further, other FRSs are using LSOAs in their risk mapping[4].

In addition, LSOAs are used nationally. For example, the **Indices of Multiple Deprivation (IMD)** are issued by Government using LSOAs.

There are 537 LSOAs in Berkshire to which are added 'Motorway LSOAs'. Motorway LSOAs allow the extraction of motorway incident data from the geographical risk

[2] **LSOAs** (Lower-layer Super Output Areas) are small areas designed to be of a similar population size, with an average of approximately 1,500 residents or 650 households. There are 32,844 Lower-layer Super Output Areas (LSOAs) in England. They were produced by the Office for National Statistics for the reporting of small area statistics. Source: www.gov.uk/government/statistics/english-indices-of-deprivation-2015

[3] It is intended that by 2020 there will be an upgrade to Cadcorp 'Webmaps', which alongside other technological change, will enable staff to drill down into the data to any required level of detail.

[4] See for example: www.derbys-fire.gov.uk/files/1514/5941/3957/DFRS_Integrated_Risk_Management_Plan_2016-2017.pdf

areas and calculate them separately[5]. Using LSOAs allows RBFRS to calculate relative risk across Berkshire[6].

Having modelled and mapped the community risk profile, it is then possible to see those areas onto which RBFRS can **target risk treatments** by Prevention, Protection and/or Response most efficiently, effectively and economically. The targeting is aided by consideration of the focused vulnerability risk.

[5] This tool could be used to extract data from other facilities (for example an airport), where the risk is related to the infrastructure rather than the area.
[6] It would be possible to give relative risk across Thames Valley or all England. For 2019/23, it has been agreed to default to Thames Valley and all surrounding counties (and the three most westerly London Boroughs.) The data can then be filtered down to Authority areas. Currently, we can only show relative risk on a wider geographical basis for IMD scores, as this is the only dataset available. If all incident and social risk data become available nationally, then it would be possible to show relative risk nationally.

Predictive community risk

The modelling methodology may help target individual vulnerabilities by calculating a 'predictive' risk in a geographic area. Predictive risk is given in three themes:

- Fire and injury risk.
- Fire fatality risk.
- RTC risk.

The predictive risk calculation is also mapped by LSOA, but it is the first step towards identifying individual vulnerabilities.

Vulnerability risk analysis requires robust (that is complete and up-to-date) data which is sometimes problematic. Therefore, predictive community risk can be seen as a fall-back position, should relevant individual household data not be available.

Vulnerability risk

People are vulnerable due to a number of societal and personal factors. This can be very random and it is imperative that this is understood by those working 'on the ground'. It is their knowledge and experience that will be required to fully address individual household vulnerability.

Where data is available at household level, RBFRS can calculate a theoretical risk. At this time, the calculation is only for **fire vulnerability risk**.

RBFRS currently has access to Mosaic, SaFer and IBIS data down to household level. (See below for more dataset detail.) Every residential address (identified by their Unique Property Reference Number or UPRN) is listed and a fire vulnerability risk calculated.

The calculation maybe seen as an 'absolute' theoretical risk, but it is impossible to know every individual circumstance. Modelling in this way cannot replace, for example, individual referrals from partner agencies. However, it may guide PPR activity.

Datasets in the model

The need for relevant data is imperative and whilst relatively easily available for incidents, this is not necessarily the case for societal data, where there is likely to be greater reliance on partners and data sharing[7].

Incident data

Incident data is extracted from the mobilising system on a rolling six-year cycle (usually in April/May with the latest data year). The incident data is correlated to the incident types listed at appendix B and these are aligned with the incident types of the national Incident Recording System (IRS). Numbers of incidents by type and location are given, in addition to rescue, casualty and fatality data.

Societal data

As noted above, access to individual societal data is more problematic. Appendix F refers to extensive background research that attempts to identify which data it is that might give the best correlation to risk. However, even having done this, it doesn't mean the data is always available. Therefore, data – at least in part – has been selected based on availability and below the best data and availability potential are explained, to at least be a 'proxy' for the ideal data. (See also appendix C).

Indices of Multiple Deprivation (IMD) data[8]

This data is provided nationally by LSOA and gives local authority and population statistics mapped to societal risk data, as listed at appendix C. IMD data is a national risk calculation of various factors that indicate levels of societal deprivation. Correlations have been found to emergency incidents[9]. For 2018/19, RBFRS will primarily use the income and employment scores.

Deliberate fire data

At first sight, fire data appears to be an incident risk, but it springs from a particular crime – arson – within society. (It is recognised that not all deliberate fires may be

[7] Many FRSs have faced this issue. See for example 'An exploration of causal factors in unintentional dwelling fires' Taylor 2012 p115).
[8] All of the data files and supporting documents for the English Indices of Deprivation 2015 are available from:
www.gov.uk/government/statistics/english-indices-of-deprivation-2015
[9] See for example page 15 at:
www.gov.uk/government/uploads/system/uploads/attachment_data/file/7636/940448.pdf

deemed arson but, as an indicator, it is deemed worthy of inclusion). The number of deliberate fire incidents are counted by LSOA and indicates a level of societal risk.

Non-residential building risk score (fire protection data)

Fire protection officers and other fire service staff continuously visit and inspect non-residential premises, and score the risk level of those premises within IBIS (Integrated Building Information System). This score is captured and indicates a non-residential building risk by LSOA.

Demographic data (includes SaFer data)

SaFer data (also known as Exeter data) is an NHS list of people over 65 years of age by household. The number of households identified by SaFer data are counted by LSOA and indicates a risk. The data is also combined with age data from Mosaic within the vulnerability risk calculation.

Financial data

This relies on availability to data, such as disability allowance, carers allowance, pensions etc. Not currently available, so RBFRS uses a proxy data set, being a combined score of the IMD 'Income Deprivation Affecting Children' and Income Deprivation Affecting Older people' indices.

Health data

This relies on availability to data, such as for smokers and drinkers. Not currently available, so RBFRS uses a proxy data set, being the IMD Health Deprivation and Disability indices.

Property type data

The RBFRS Integrated Building Information System (IBIS) refers to residential property types that it is believed were based upon the original FSEC work.

For this IRMP, risk analysis of the latest Ordnance Survey (OS) Address Base, is used and it contains 563 property types. Of these, there are 266 different property types within Berkshire (plus 10km buffer).

At the highest level, properties are categorised as:

- Commercial (e.g. fire station, telephone exchange, builders yard).
- Land (e.g. park, lake, waterway, arboretum).

- Military.
- Other (e.g. rail signalling, road marker post, footbridge).
- Residential (e.g. dwelling, care home, caravan).
- Object of interest (e.g. abbey, monument, place of worship).

Tenure data

Mosaic refers to three types of tenure:

- Owner occupied.
- Privately rented.
- Council/housing association.

The risks of tenure are calculated and used for the vulnerability score for each residential property.

Mosaic data

RBFRS has access to Mosaic data[10] down to household level, and uses this data within both the calculation of community risk and vulnerability risk.

Risk calculation methodology

To map and model[11] risk data, it is necessary to calculate the risks. These calculations are within a series of worksheets with all relevant calculating worksheets being independently validated[12].

For community risk, these include a worksheet[13] that is data extracted from the mobilising system. This is cascaded into a second[14] worksheet, which is a very large file populated with relevant incident and societal data. Although this can be filtered to analyse local, regional or national LSOAs, it has been decided for this year that, due to size limitations, this latter worksheet will be for Thames Valley and surrounds (appendix G).

[10] www.experian.co.uk/assets/marketing-services/brochures/mosaic-ps-brochure.pdf
[11] RBFRS uses Cadcorp Workload Modeller that is an application built into the Cadcorp Geographical Information System (GIS).
[12] Risktec Solutions Ltd. 22/2/16 …"we believe that the methodology and its implementation are robust for the purpose for which it is to be used (i.e. looking at relative risk levels across RBFRS and to allow prioritisation of resources to be made"). And 16/7/18 - "updates have been positive…and help with focusing risk mitigation strategies down to household level."
[13] Currently called – "Incidents_2012-2017 for incident type risk analysis GC 20-05-18" (2018 development includes the use of live SQL feeds for the incident severity score.)
[14] Currently called – "LSOA Risk 2012-17 - Soc and Inc Risk RBFRS MASTER- GC7-5-18"

For vulnerability risk, there are separate calculation worksheets for Mosaic, age and property that cascade into a final worksheet ready for mapping[15].

Incident community risk

A rolling six years of incident data is exported from the mobilising system to the relevant incident data spreadsheet. It is sorted into incident types (for modelling) and gives incident location, rescues, casualties and fatalities by incident type.

The incident location data is input into Cadcorp and Cadcorp Calcinterior is used to calculate how many incidents of each type are in each LSOA. The totals are input into the LSOA risk spreadsheet.

The numbers of fatalities, casualties and rescues inform the 'severity' tab of the LSOA Risk spreadsheet, where a severity score for each incident type is calculated, using the following formula:

$$\text{Incident type severity} = \frac{\#[16]\text{rescues}[17] + (\#\text{casualties} \times 10) + (\#\text{fatalities} \times 100)}{(\#\text{incidents of type})}$$

In this way, we ascertain the severity of the incident if you, as a member of public, are involved in an incident of this type[18] (appendix D).

If we again use the formula: risk = likelihood x severity, and the likelihood of an incident is the number of incidents of type within, say, Berkshire, we can calculate an overall risk assessment for each incident type (appendix E).

Now, the number of incidents of each type in each LSOA is known and the severity of each incident type is known, the severity score is input into the LSOA risk spreadsheet. The **incident risk score** for each incident type is then calculated for each LSOA.

[15] Currently called – "Vulnerability Fire Risk 2012-17 - RBFRS - MASTER GC17-7-18" (Updated on recommendation from Ristec validation report to use Normal Distributions rather than risk scores to avoid 'age skew'.)

[16] # = 'number of'

[17] Risktec advised analysis of impact of rescues due to numbers of lift and effecting entry 'rescues' that have little inherent risk. Having done the comparison it was found that, although there is difference between the calculation with and without rescues (appendix E), the effect is small (due to the x10 and x100 factors for casualties and fatalities respectively) and it is thought we should not lose the positive impact of 'non injury' rescues in, say, dwelling fires or RTCs. Therefore, 'rescues' remain in the calculation.

[18] 2018 development includes the use of live SQL feeds for the incident severity score. This removed the need for "+1" in the divisor of the equation.

Each **incident risk rated score** by LSOA is rated by population:

Incident type risk rate in LSOA = incident risk in LSOA/LSOA population.

Then standard deviation is used to give the **incident risk rank score**. Formula given as:

LSOA Incident Risk Rank = Standard Deviation of (LSOA incident type nnn risk)

So, the risk for each incident type is ranked and may be mapped:

Risk rank 1 = <-1 s.d. (Dark Green)

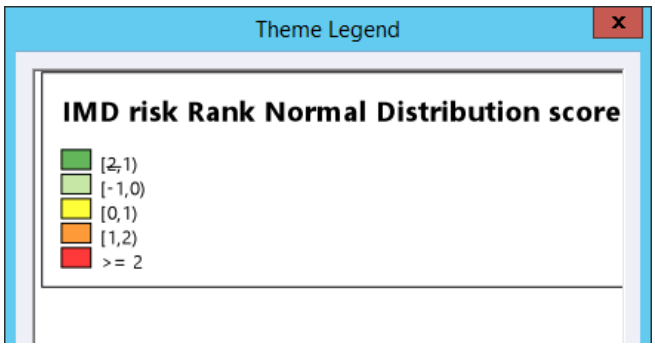
Risk rank 2 = >-1 s.d. to <0 s.d. (Light Green)

Risk rank 3 = >0 s.d. to <1 s.d. (Yellow)

Risk rank 4 = >1 s.d. to <2 s.d. (Orange)

Risk rank 5 = >2 s.d. (Red)

(where s.d. = standard deviation)



This is the **relative** risk rank – compared to all other LSOAs 'normalised'[19], allowing incident types to be mapped (individually or collectively) on a five-colour map.

To combine one, two, many, or all incident risks, the following formula is used: Total Incident Risk Rate[20] in LSOA =

(Risk 1 rate) + (Risk 2 rate) + (Risk 3 rate) etc.

[19] By filtering on the local authority area in the LSOA risk spreadsheet, it is possible to normalise the risk ranks by the filtered areas. This applies to all normalisations here.

[20] Following advice from the independent validation, suicides were removed from this total incident risk calculation. Further, the evolving work for co-responding is having a major impact on risk calculations (even considering only one wholetime pump is involved.) Therefore, co-responding is also removed, as this is a risk being dealt with by Health Trusts.

The total incident risk rank is given as:

LSOA Rank = Standard Deviation of (Total Incident Risk rate in LSOA)

And, this risk ranking score may be mapped similarly to above.

Societal community risk

A list of risks under consideration is in appendix C.

Each societal risk is scored by LSOA. This score is rated by population 21. Then standard deviation is used to give a 'rank'. Formula given as:

LSOA Rank = s.d. of (LSOA societal risk rate nnn score/LSOA population)

Then, similarly to the individual incident risks, each societal risk maybe ranked in the following way:

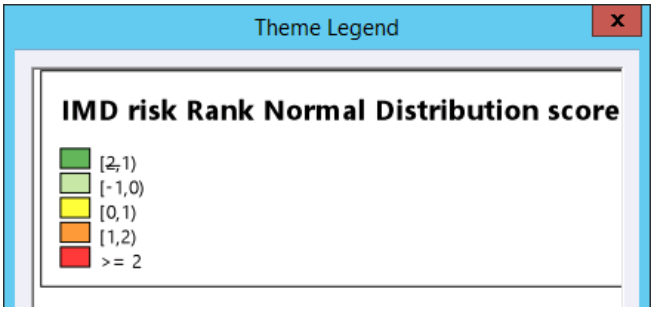
Risk rank 1 = <-1 s.d. (Dark Green)

Risk rank 2 = >-1 s.d. to <0 s.d. (Light Grn)

Risk rank 3 = >0 s.d. to <1 s.d. (Yellow)

Risk rank 4 = >1 s.d. to <2 s.d. (Orange)

Risk rank 5 = >2 s.d. (Red)



(where s.d. = standard deviation)

This is the **relative risk** rank – compared to all other LSOAs 'normalised'[22], allowing societal risk types to be mapped (individually or collectively) on a five-colour map.

To combine one, two, many, or all societal risks, the following formula is used:

Total societal risk in LSOA =

(Risk 1 rank x weight) + (Risk 2 rank x weight) + (Risk 3 rank x weight) etc.

(Using the sum of 'ranks' avoids an 'orders of magnitude' data problem[23].)

[21] IMD data is most often already given by population rate and therefore, the IMD risk rate is given by the IMD score.
[22] By filtering on the local authority area in the LSOA risk spreadsheet, it is possible to normalise the risk ranks by the filtered areas. This applies to all normalisations here.
[23] The validation noted that calculated IMD risk rates were many orders of magnitude larger than other societal risks considered and therefore recommended use of ranks and weighting.

The weights sum to ‘1’ and are given by professional judgement. The weightings currently used are given in the table at the next section.

The total societal risk rank to give the relative societal risk is given as:

LSOA Rank = Standard Deviation of (Total Societal Risk in LSOA)

And, this risk score ranking may be mapped similarly to above.

Combining community societal and incident risk

Total risk in each LSOA is calculated by the following:

Total LSOA risk =

(Total Societal risk rank x weighting) + (Total incident risk rank x weighting)

The weightings sum to 1. The current weighting used is 0.5/0.5, given by professional judgement.

And, again, this score can be ranked by standard deviation and then mapped.

(Although any weighting may be used (for example, to give precedence to incidents, 0.1 / 0.9 could be used), it is felt that to fully reflect the broader agenda (across all of PPR), requires a higher weighting for societal risk. In any event, this weighting is only used when totalling risk and any one, two, more or all risks can be combined, mapped and used to indicate appropriate treatments, prior to this weighting being needed.)

Predictive community risk

In addition to incident, societal and the total relative risk scores, it is also possible to predict incident risk by LSOA for three broad risk aspects:

- Fire and injury risk.
- Fire fatality risk.
- RTC risk.

Incident and societal risk factors have been selected for appropriateness, having considered the risk factors giving the greater risk correlations (appendix F). Then, in a similar manner, as for total risk, weightings are applied using professional judgement to these factors. The weightings currently in consideration are in the table on the next page.

Risk factor score in LSOA	Total risk	Total social risk	Total incident risk	Fire and injury predictive risk	Fire fatality predictive risk	RTC predictive risk
Social factors						
Demographic	0.5	0.2		0.1	0.4	0
Finance		0.05		0.025	0.05	0
Health		0.2		0.1	0.2	0
Property		0.1		0.05	0.05	0
Non-residential buildings		0.05		0.025	0	0
Mosaic		0.2		0.1	0.2	0.2
Arson		0.05		0.025	0	0
IMD income deprivation		0.1		0.05	0.05	0.2
IMD employment deprivation		0.05		0.025	0.05	0.1
Incident factors						
Fires in dwellings	0.5		1	0.25		
Fires in other residential				0.25		
RTC advice only						0.025
RTC extrication						0.225
RTC make safe						0.05
RTC medical						0.1
RTC release						0.05
RTC standby						0.05
All other incidents						

All the above risk calculations give an output by geographical area, in the case of RBFRS, by LSOA. Vulnerability risk needs another more detailed level of analysis.

Vulnerability risk

To target household risk requires that RBFRS knows about individuals and individual properties. This can be sensitive data and appropriate data security is in place within RBFRS. Within mapping systems, Unique Property Reference Numbers (UPRN) are often applied. If data is matched to UPRNs, then it is possible to give a vulnerability risk score by household.

The following data is currently available to RBFRS at household (UPRN/address) level:

- Mosaic Type (also includes age, property type and tenure).
- SaFer Data (Exeter data).
- Property type.
- Incidents (used as a risk flag – not currently as part of calculation).

These individual datasets are analysed for risk levels and combined within an overall fire vulnerability risk assessment.

Mosaic type vulnerability analysis

Appendix H contains the Mosaic Dwelling Fire (DWF) vulnerability risk analysis for RBFRS[24]. This risk score is included in the vulnerability analysis.

The score is calculated:

$$\text{Mosaic Severity} = \frac{\#DWFs+(\#rescues \times 10)+(\#casualties \times 100)+(\#fatalities \times 1000)}{(\#households\ of\ Mosaic\ type)}$$

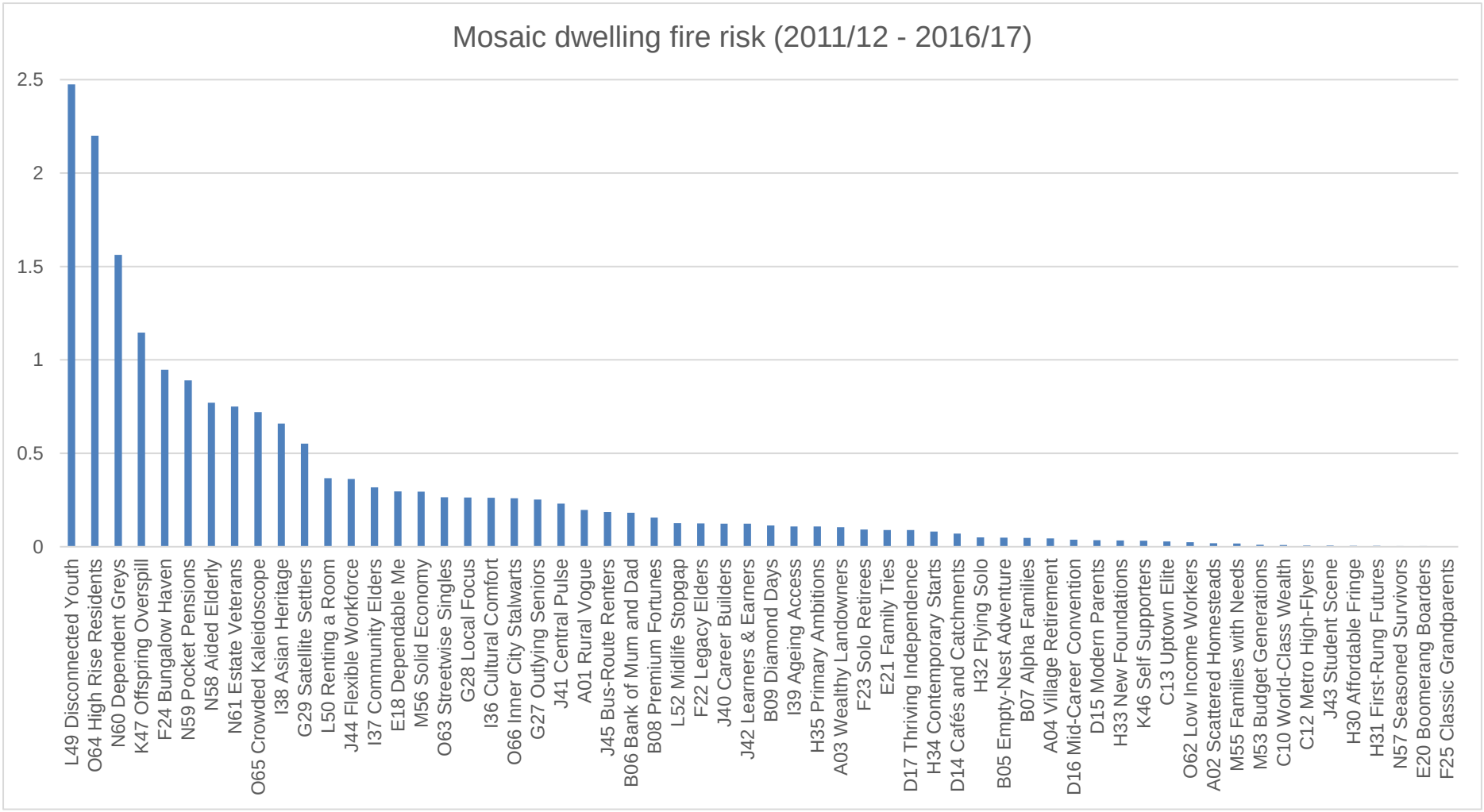
For example, with the riskiest Mosaic type found, the data is as follows:

Mosaic Classification	# of household type in RBFRS	%of type in RBFRS	# of DWF incidents 2011/17	# of DWF Rescues 2011/17	# of DWF Casualties 2011/17	# of DWF Fatalities 2011/17	Mosaic DWF risk score per household
L49 Disconnected Youth	573	0.156287	8	1	4	1	2.474695

[24] Current Mosaic analysis within "MAP030_2011-16 Incidents for Mosaic risk GC14-2-18.xlsx"

(8 + (1 x 10) + (4 x 100) + (1 x 1000)) / 573 = 2.474695

The chart on the next page shows Mosaic types in descending order of dwelling fire risk.

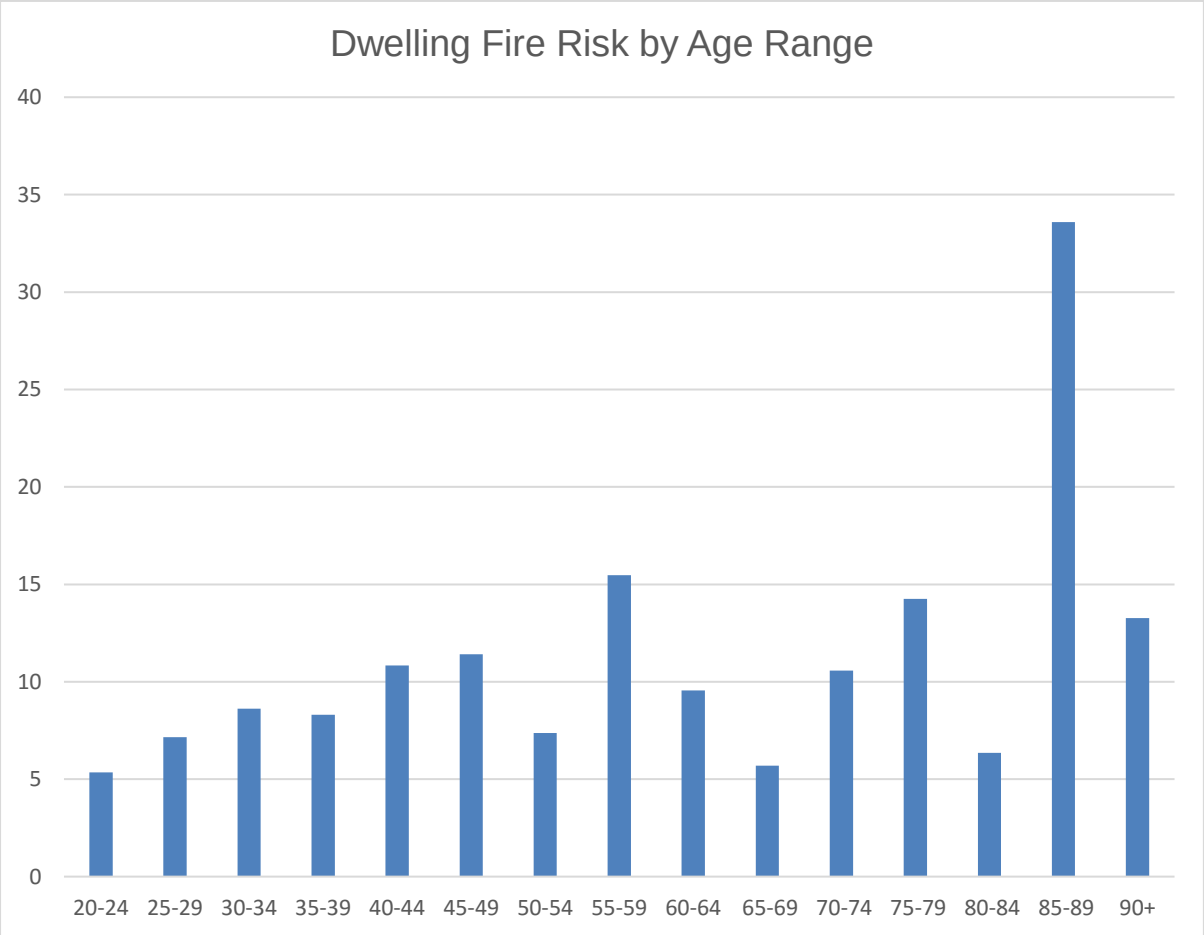

Mosaic dwelling fire risk (2011/12 - 2016/17)
2.5
2
1.5
1
0.5
0
L49 Disconnected Youth
O64 High Rise Residents
N60 Dependent Greys
K47 Offspring Overspill
F24 Bungalow Haven
N59 Pocket Pensions
N58 Aided Elderly
N61 Estate Veterans
O65 Crowded Kaleidoscope
I38 Asian Heritage
G29 Satellite Settlers
L50 Renting a Room
J44 Flexible Workforce
I37 Community Elders
E18 Dependable Me
M56 Solid Economy
O63 Streetwise Singles
G28 Local Focus
I36 Cultural Comfort
O66 Inner City Stalwarts
G27 Outlying Seniors
J41 Central Pulse
A01 Rural Vogue
J45 Bus-Route Renters
B06 Bank of Mum and Dad
B08 Premium Fortunes
L52 Midlife Stopgap
F22 Legacy Elders
J40 Career Builders
J42 Learners & Earners
B09 Diamond Days
I39 Ageing Access
H35 Primary Ambitions
A03 Wealthy Landowners
F23 Solo Retirees
E21 Family Ties
D17 Thriving Independence
H34 Contemporary Starts
D14 Cafés and Catchments
H32 Flying Solo
B05 Empty-Nest Adventure
B07 Alpha Families
A04 Village Retirement
D16 Mid-Career Convention
D15 Modern Parents
H33 New Foundations
K46 Self Supporters
C13 Uptown Elite
O62 Low Income Workers
A02 Scattered Homesteads
M55 Families with Needs
M53 Budget Generations
C10 World-Class Wealth
C12 Metro High-Flyers
J43 Student Scene
H30 Affordable Fringe
H31 First-Rung Futures
N57 Seasoned Survivors
E20 Boomerang Boarders
F25 Classic Grandparents

Age analysis

To calculate age related fire risk, every fire incident from 2011/12 to 2016/17 was mapped to the UPRN and either, the SaFer data age (if known) or, if not, the Mosaic age range for that UPRN was appended to the incident[25]. Appendix I contains the RBFRS analysis[26] for age related fire vulnerability risk and uses the following equation:

$$\text{Age Severity} = \frac{\#\text{DWFs}+(\#\text{rescues} \times 10)+(\#\text{casualties} \times 100)+(\#\text{fatalities} \times 1000)}{(\%\text{ of Berkshire population of that age})}$$

Giving the following result:

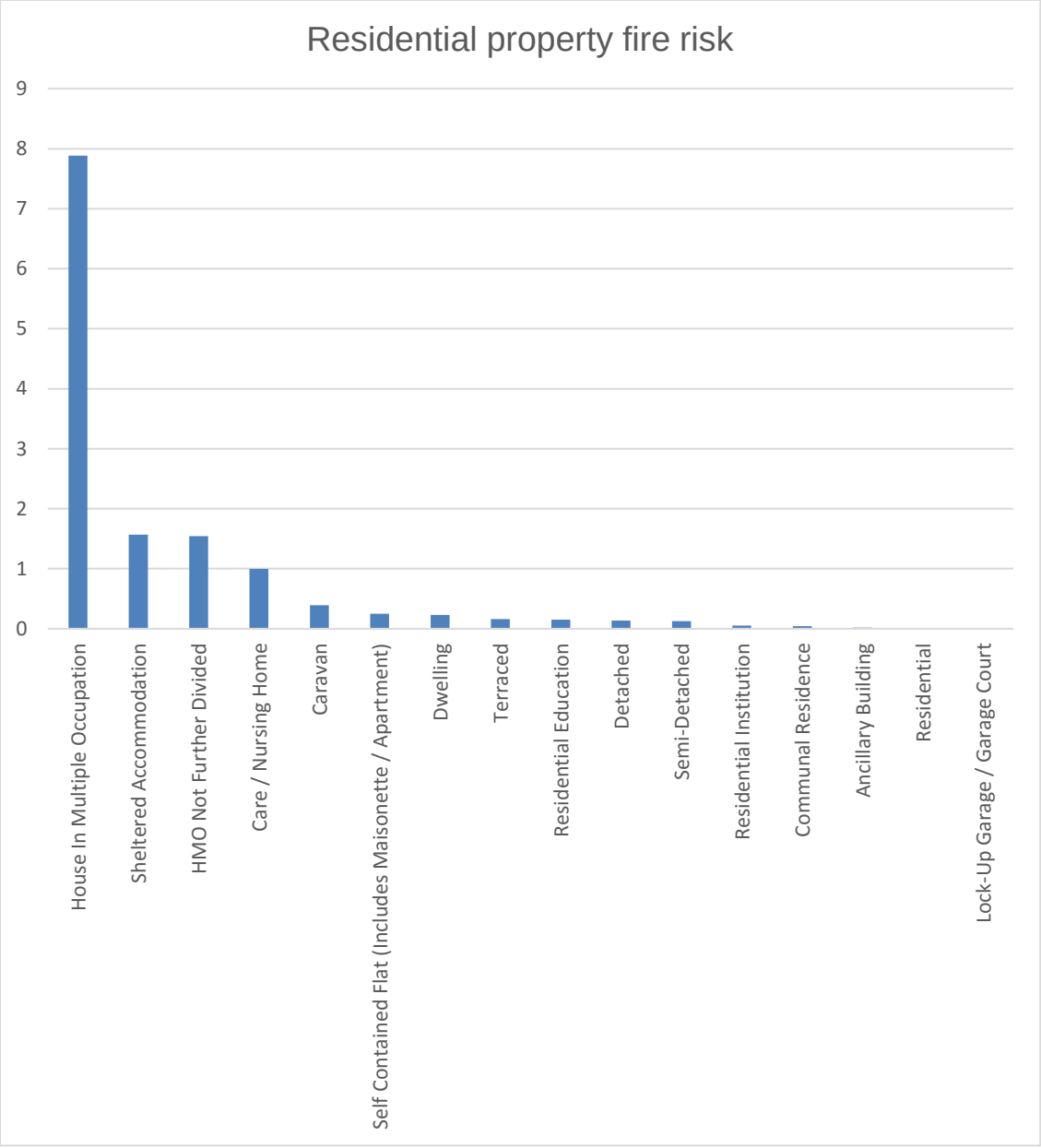


[25] Currently calculated in: "MAP030_2011-16 Incidents for Berkshire Age risk GC14-2-18"

[26] It should be noted that different datasets, give different age ranges, so the best interpretation was required.

Property type analysis

In a similar way, property types were appended to every incident for the six years of 2011/12 – 2016/17. The Ordnance Survey (OS) Address Base, contains 563 property types. Of these, 124 types had at least one fire. Appendix J gives the full analysis. Moreover, of the 25 residential property types, there are 16 mapped to fire risk, as seen below:



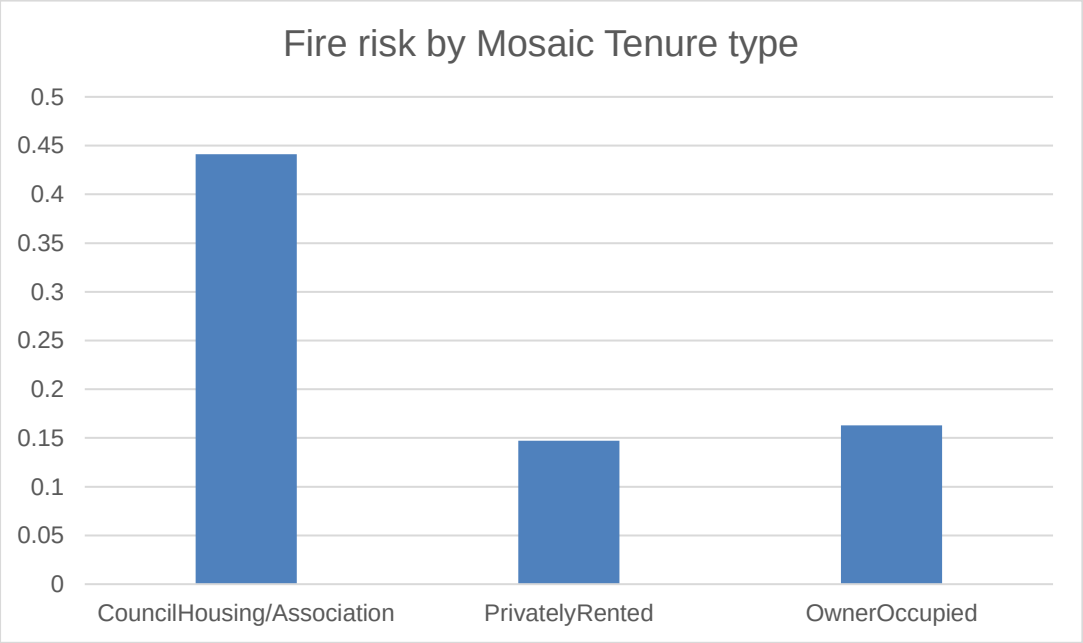
Tenure analysis

Mosaic describes three types of tenure which were mapped to all incidents for 2011/12 – 2016/17. Appendix K contains the RBFRS analysis for tenure related fire vulnerability risk and uses the following equation:

Tenure DWF risk = #DWFs+(#rescues x 10)+(#casualties x 100)+(#fatalities x 1000)

(#properties of tenure type in Berkshire)

Giving the following result:



Combining vulnerability risks

As well as calculating these risks individually, in the same way as for community risk, it is possible to combine risk scores by using normal distribution/standard deviations.

This creates ranking:

Risk rank 1 = <-1 s.d. (Dark Green)

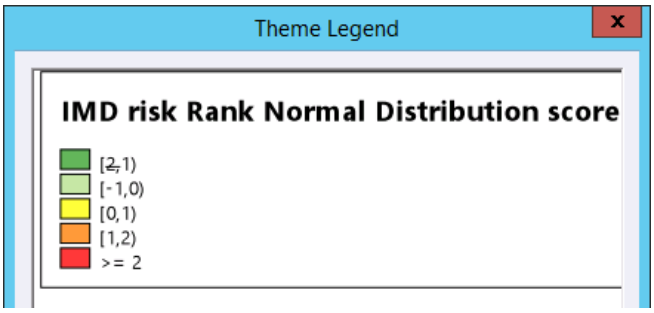
Risk rank 2 = >-1 s.d. to <0 s.d. (Light Grn)

Risk rank 3 = >0 s.d. to <1 s.d. (Yellow)

Risk rank 4 = >1 s.d. to <2 s.d. (Orange)

Risk rank 5 = >2 s.d. (Red)

(where s.d. = standard deviation)



And, **total vulnerability** is calculated as the sum of the standard deviations:

Total vulnerability risk in each household =

(Mosaic ND[27] x weight) + (Age ND x weight) + (Property ND x weight) + (Tenure ND x weight)

Currently, weighting is not needed so all are weighted as 'one'.

As noted above, it is possible to 'flag' each household that has had an incident but, currently, this risk is not included in the vulnerability score. The intention is that all these items will be seen 'live' by all relevant staff within a Web Maps environment 'online' and that any referrals or other interventions (be it Prevention, Protection or Response) will adjust the risk score.

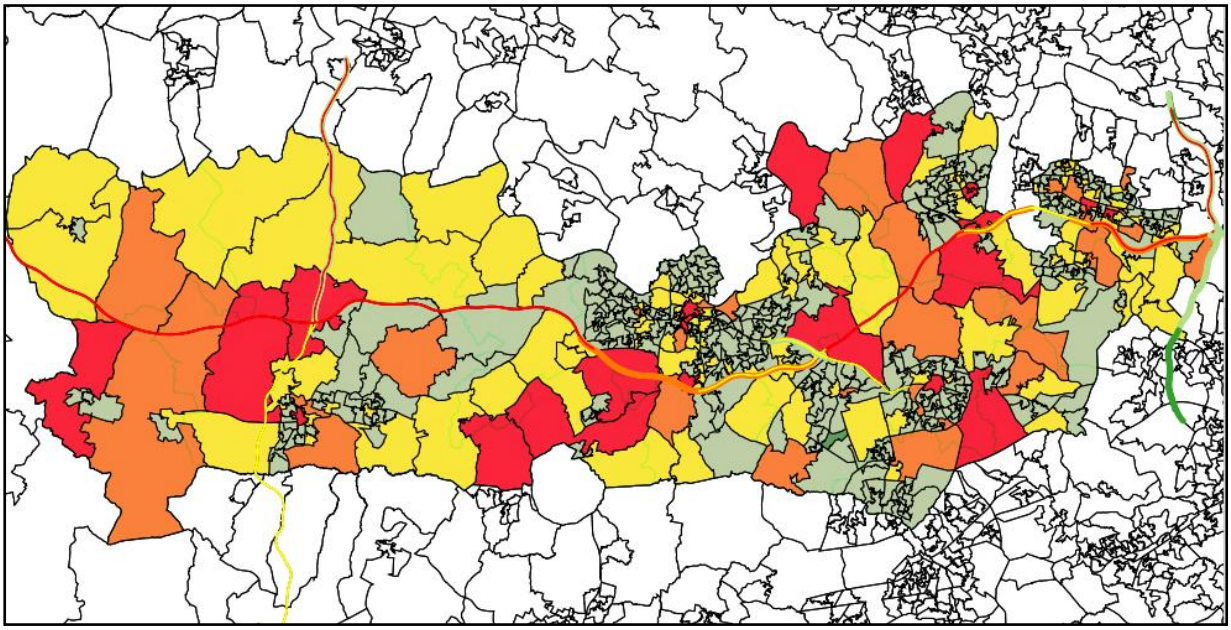
Risk mapping and modelling

The above calculation methodology is to ensure that the correct data are input into the Cadcorp mapping (GIS) and modelling (Cadcorp Workload Modeller) system. Once data is input, there are two basic operations, 'risk mapping' and 'risk modelling'.

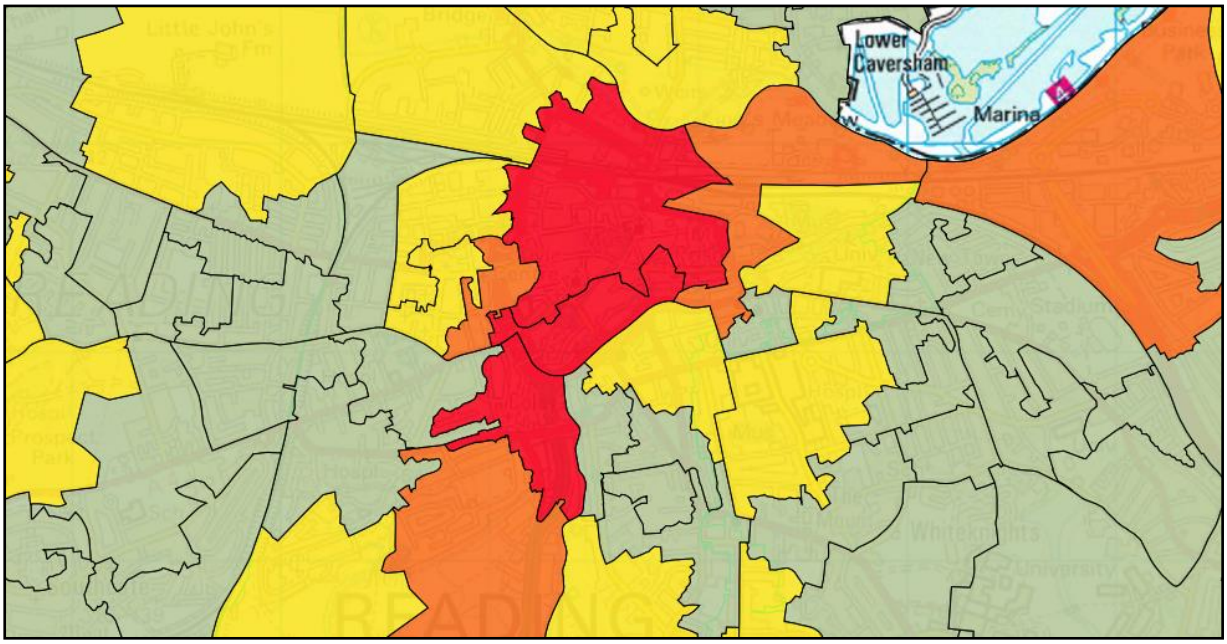
Community risk mapping

It is possible to see a community risk map of any one, two, more or all risks in any combination. The following are examples:

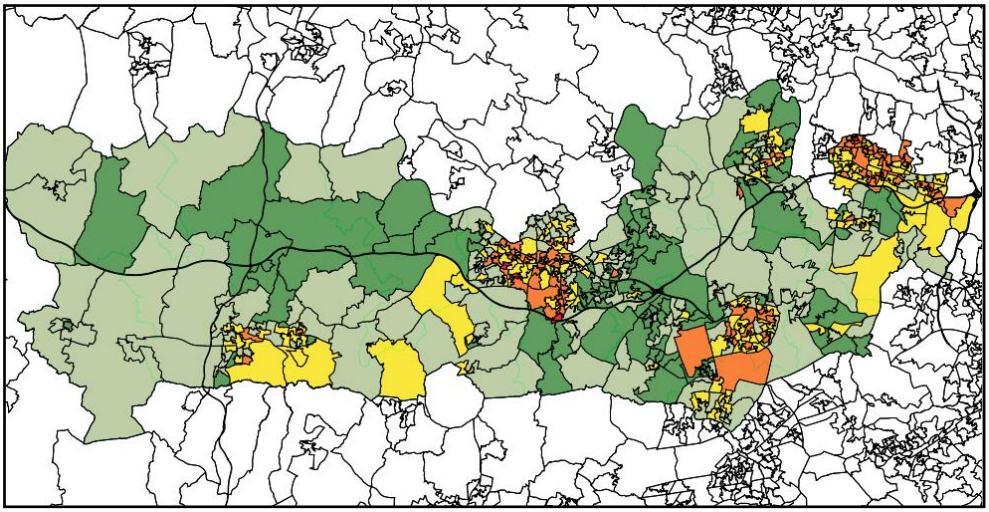
[27] Normal Distribution



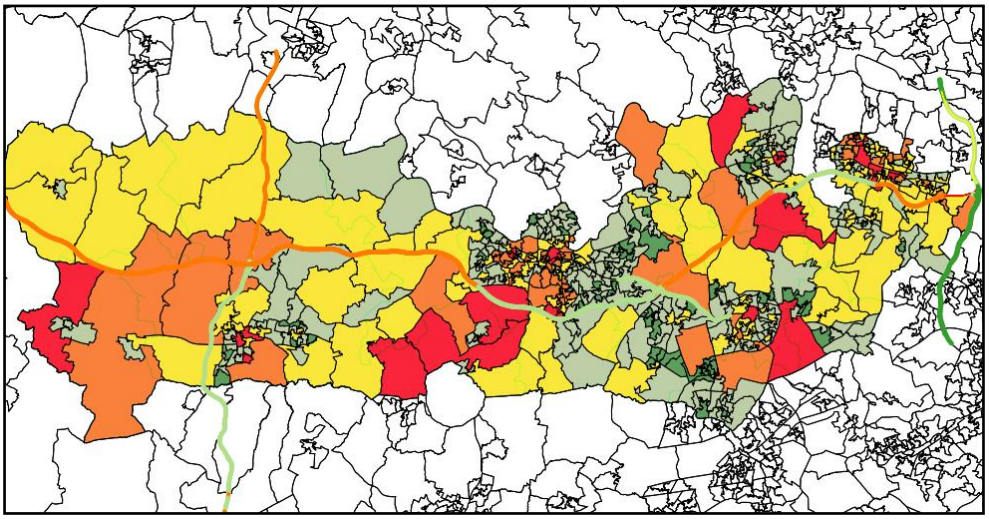
Total incident relative risk (includes motorways) (ranked by LSOA)



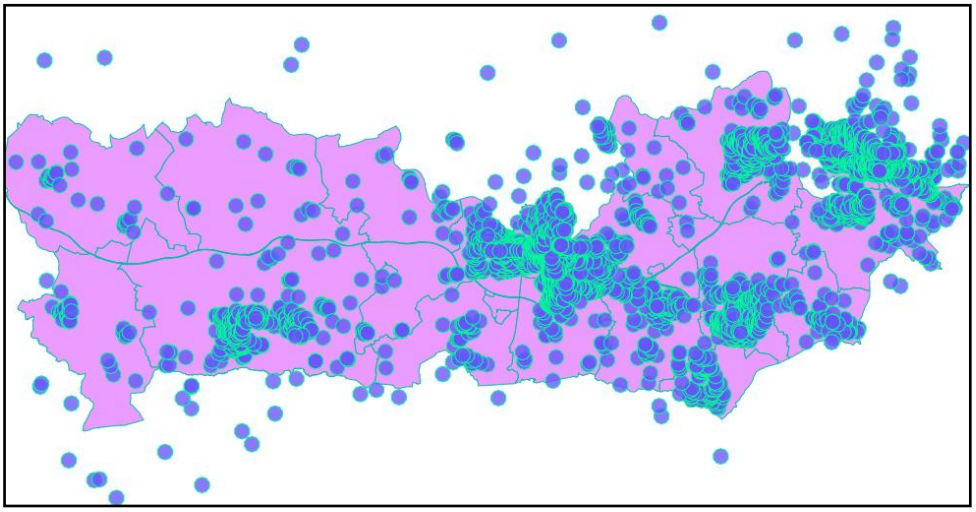
Total incident relative risk – central Reading (ranked by LSOA)



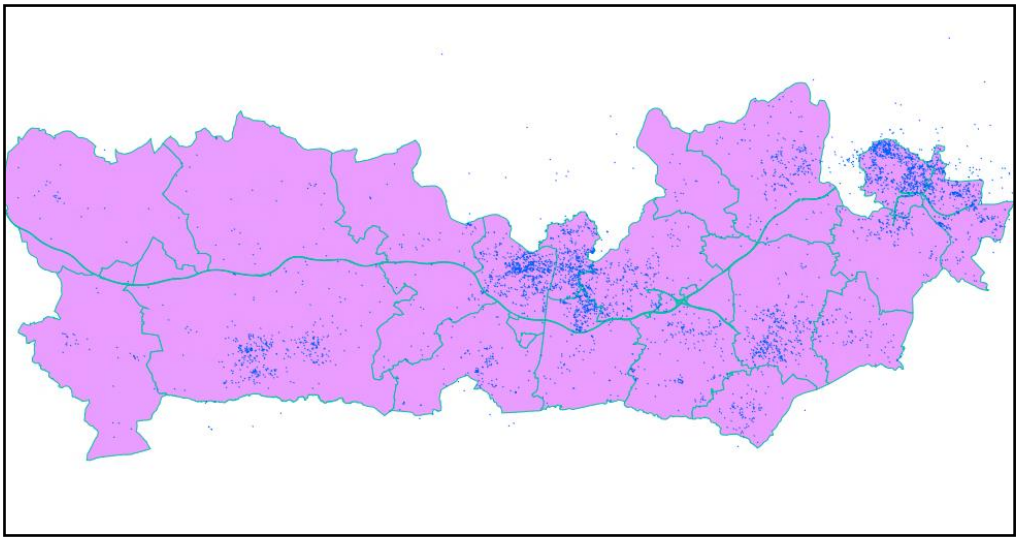
Total societal relative risk (ranked by LSOA)



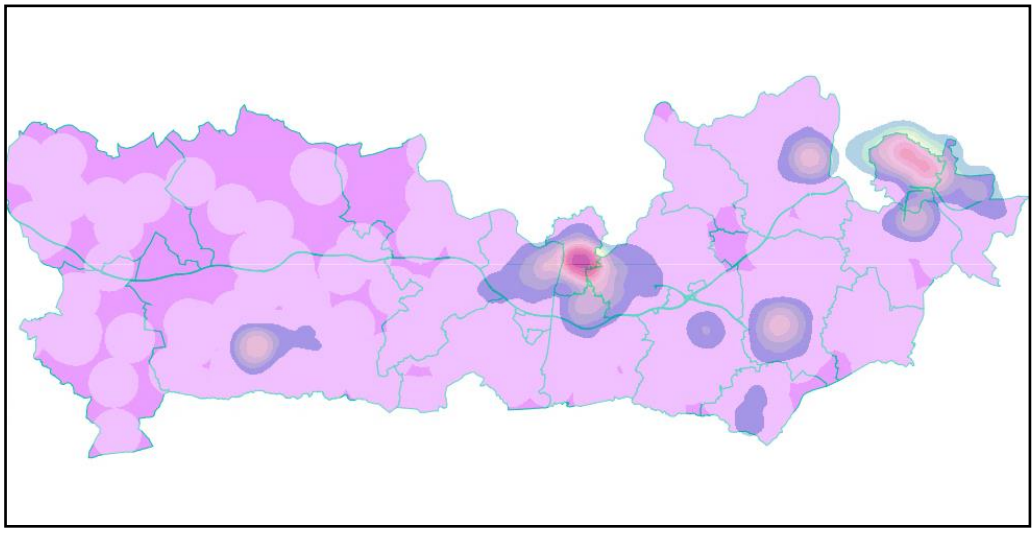
Total combined incident and societal relative risk (ranked by LSOA)



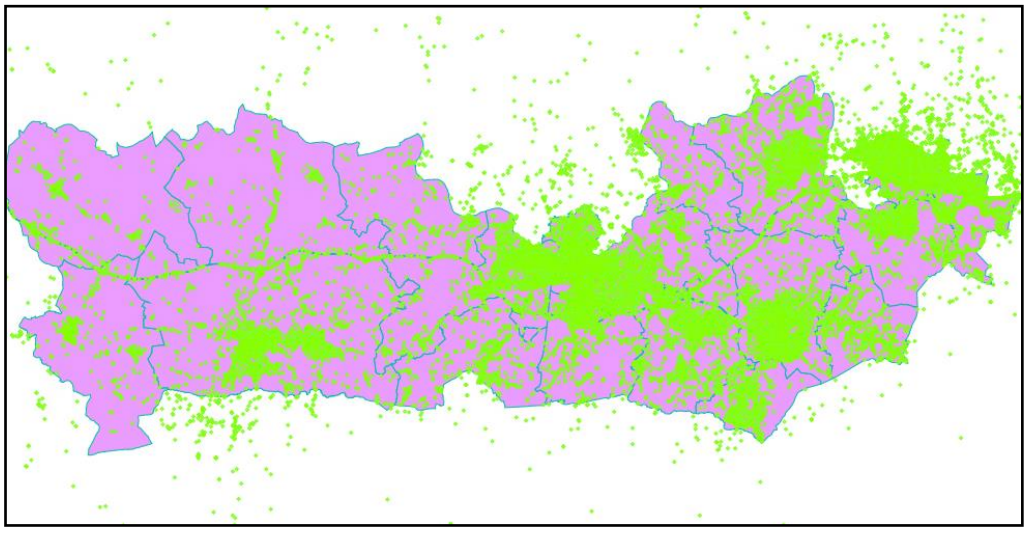
Incident type risk – dwelling fire locations 2010/11 – 2015/16



Incident cause risk - deliberate fire locations 2010/11 – 2015/16



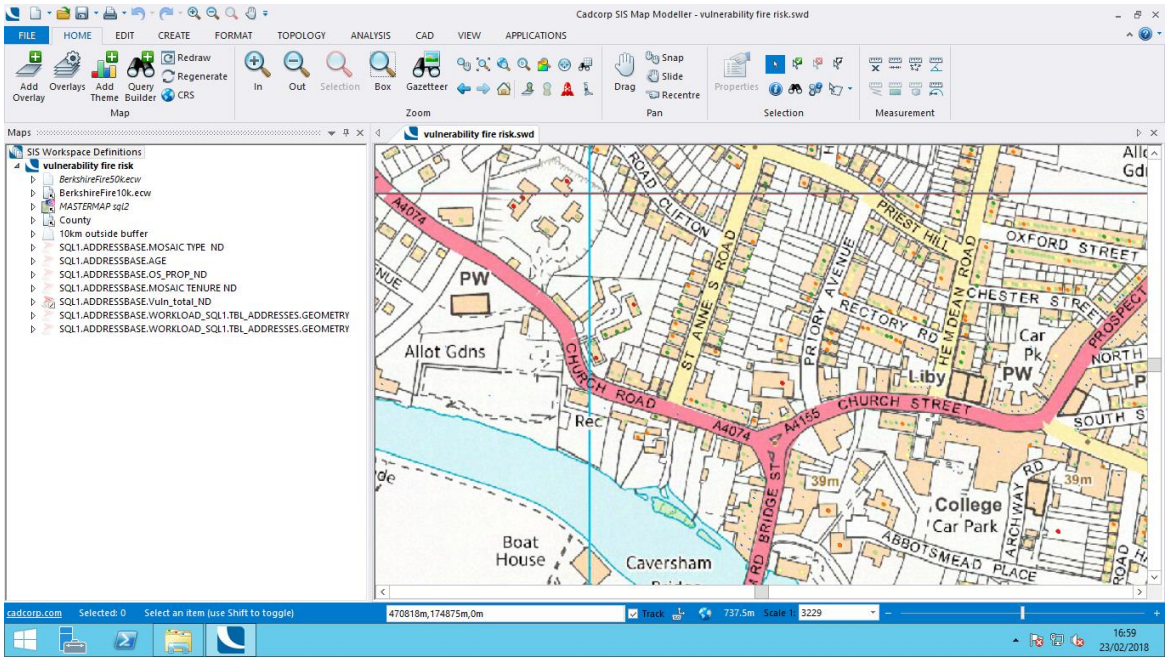
Incident type risk - non-residential fire hotspots 2010/11 – 2015/16



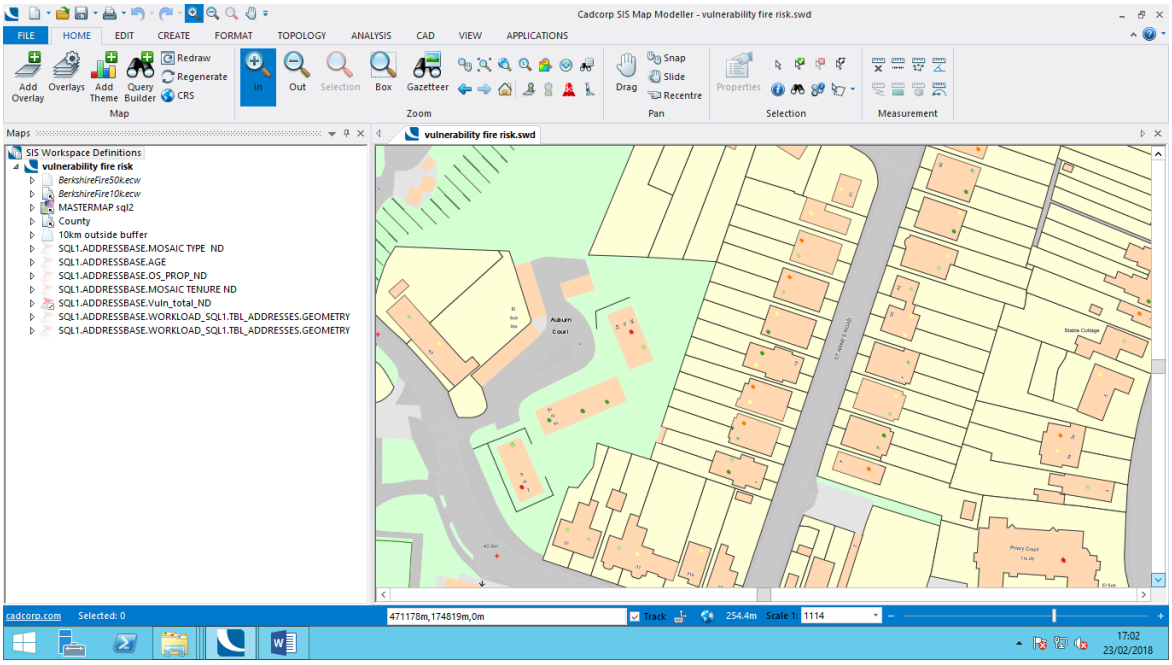
All incident locations 2010/11 – 2015/16

Vulnerability risk mapping

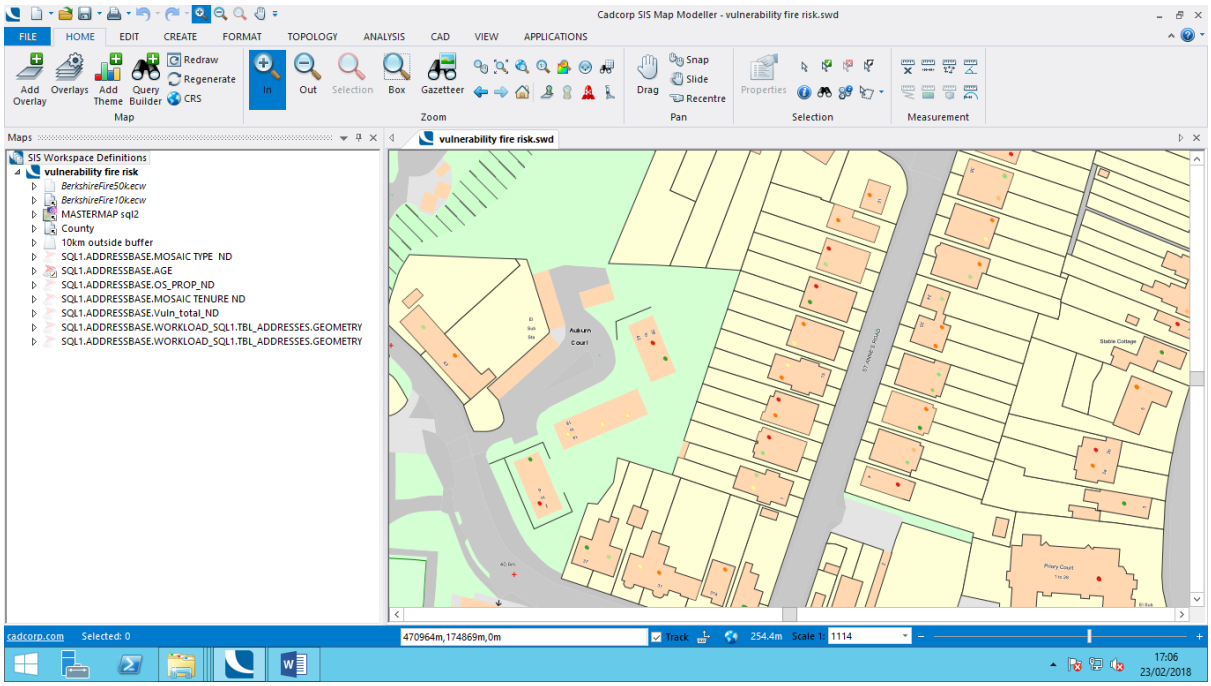
It is possible to see a vulnerability risk map of any one, two, more or all risks in any combination. The following are examples:



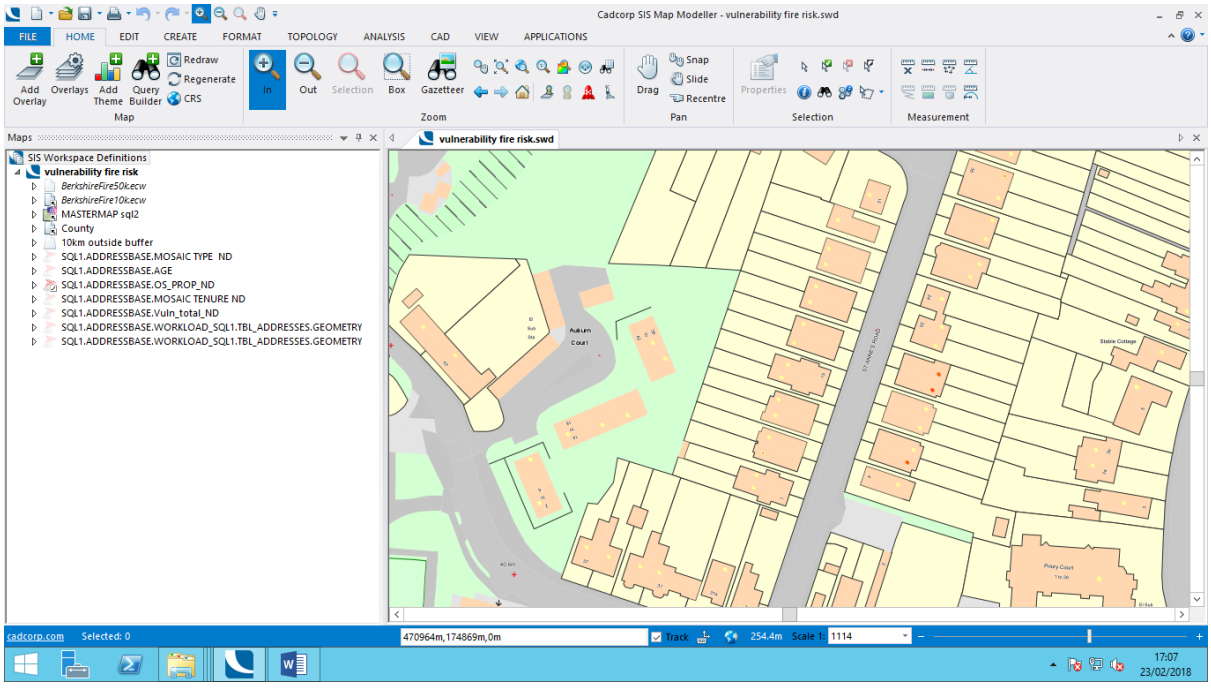
Total vulnerability risk map (10k map level) 2011/12 – 2016/17



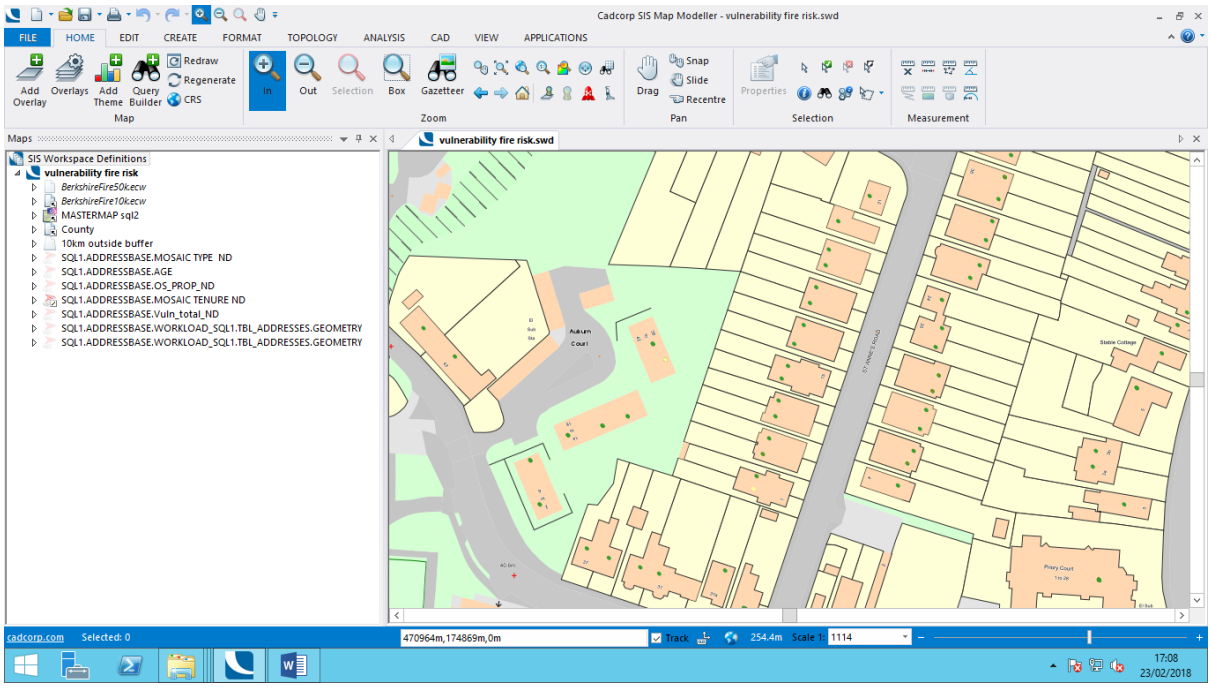
Total vulnerability risk map (master map level) 2011/12 – 2016/17



Age vulnerability risk map (master map level) 2011/12 – 2016/17



Property vulnerability risk map (master map level) 2011/12 – 2016/17



Tenure vulnerability risk map (master map level) 2011/12 – 2016/17

Web Maps development

The dissemination of all Cadcorp Workload Modeller mapping shown above, is possible in an online 'live' environment for staff (and potentially the public – with suitable redaction). This work is in development.

Risk modelling

Modelling is used in Cadcorp Workload Modeller (CWM) to consider resource location and redistribution in order to be efficient and cost effective. CWM is a powerful modelling tool able to compare virtually limitless changes and options, one against the other, and display the data in a number of ways.

Two general risk parameters are modelled: response risk and life risk. It is only possible here to give an indication of the output from the model as the variables are virtually limitless. The model outputs are generally collated into spreadsheet reports. Some extracts are given below. (Any modelling here is to give example and not necessarily to be seen as possible scenarios).

Response risk modelling

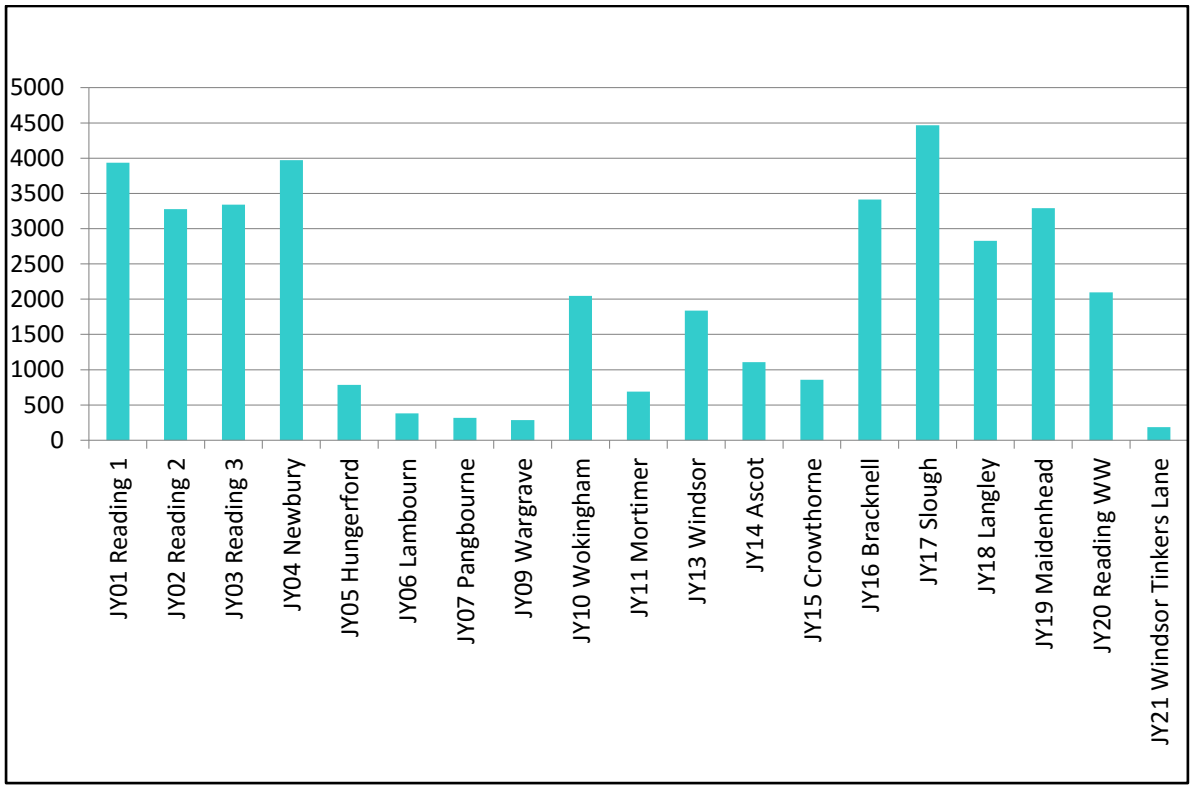
The model will compare performance, in terms of response to incidents, in a number of ways for each projected scenario. The scenarios may include items such as:

- Removal, addition and/or change of resources (such as pumps).

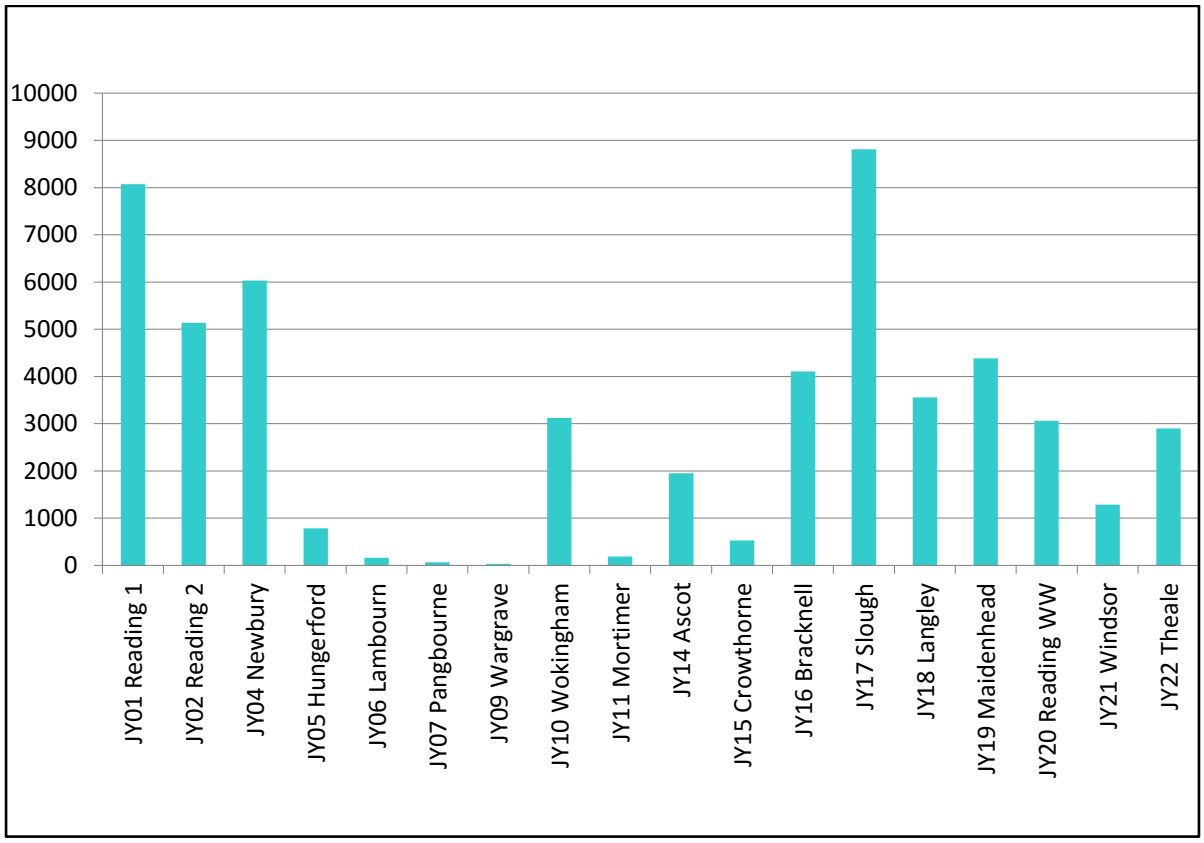
- Change in shift systems and/or times of work.
- Change in call handling times, reaction times and/or travel times.
- Adjustment of response standards by incident type/s.

And, these may be seen by models using, for example:

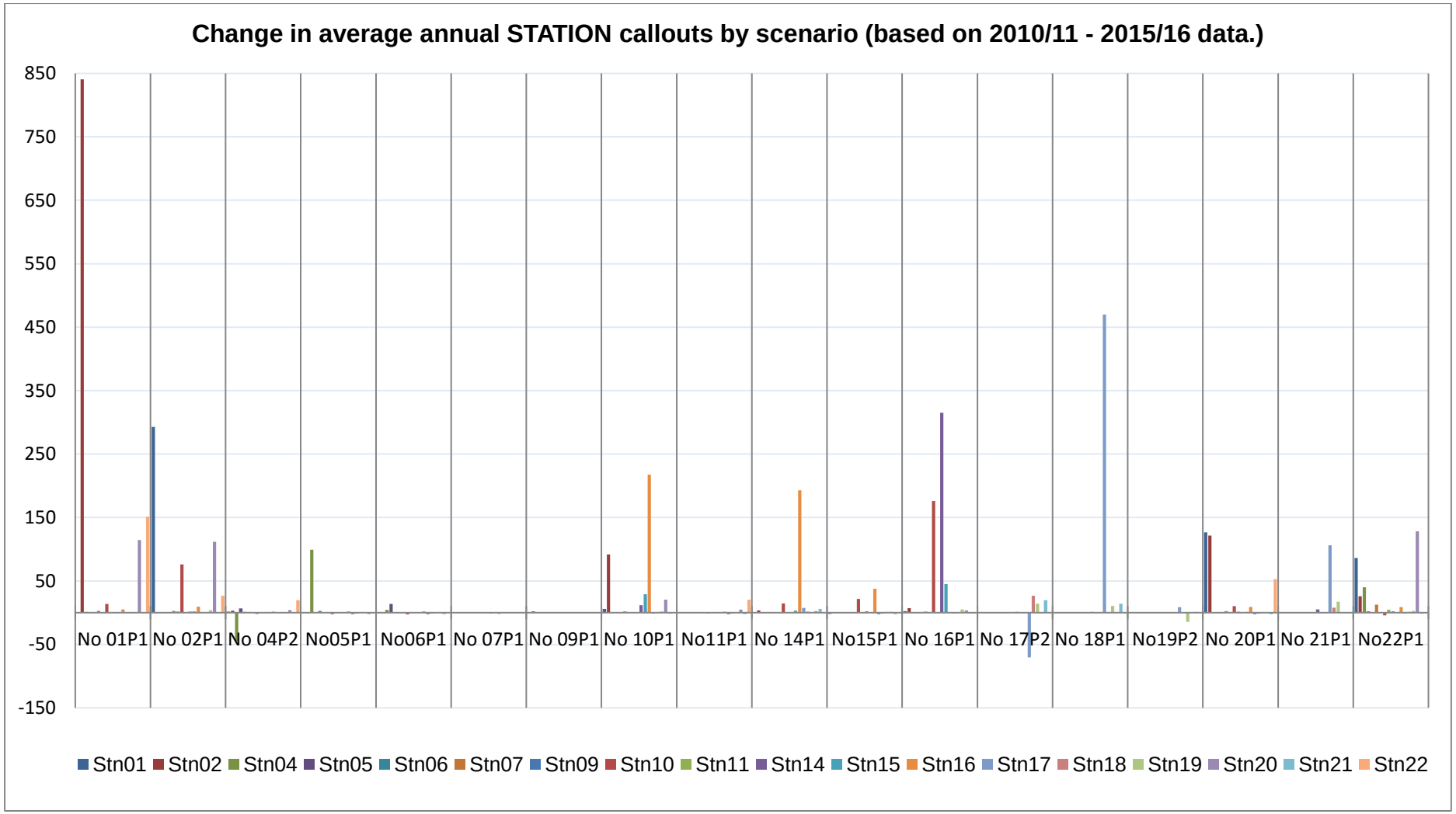
- Number of incidents by station ground.
- Number of call outs by station.
- Number of pumps used by day, week, year.
- Change in response times (in absolute and percentage terms).
- Pass and fail mapping for any change.
- Impact on other pumps.
- Impact on officer cover (currently in development).



Number of incidents assigned to station grounds - 2010/11 – 2015/16



Number of modelled callouts by station (based on 2010/11 – 2015/16 data)


Change in average annual STATION callouts by scenario (based on 2010/11 - 2015/16 data.)
850
750
650
550
450
350
250
150
50
-50
-150
No 01P1
No 02P1
No 04P2
No05P1
No06P1
No 07P1
No 09P1
No 10P1
No11P1
No 14P1
No15P1
No 16P1
No 17P2
No 18P1
No19P2
No 20P1
No 21P1
No22P1
Stn01
Stn02
Stn04
Stn05
Stn06
Stn07
Stn09
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Stn15
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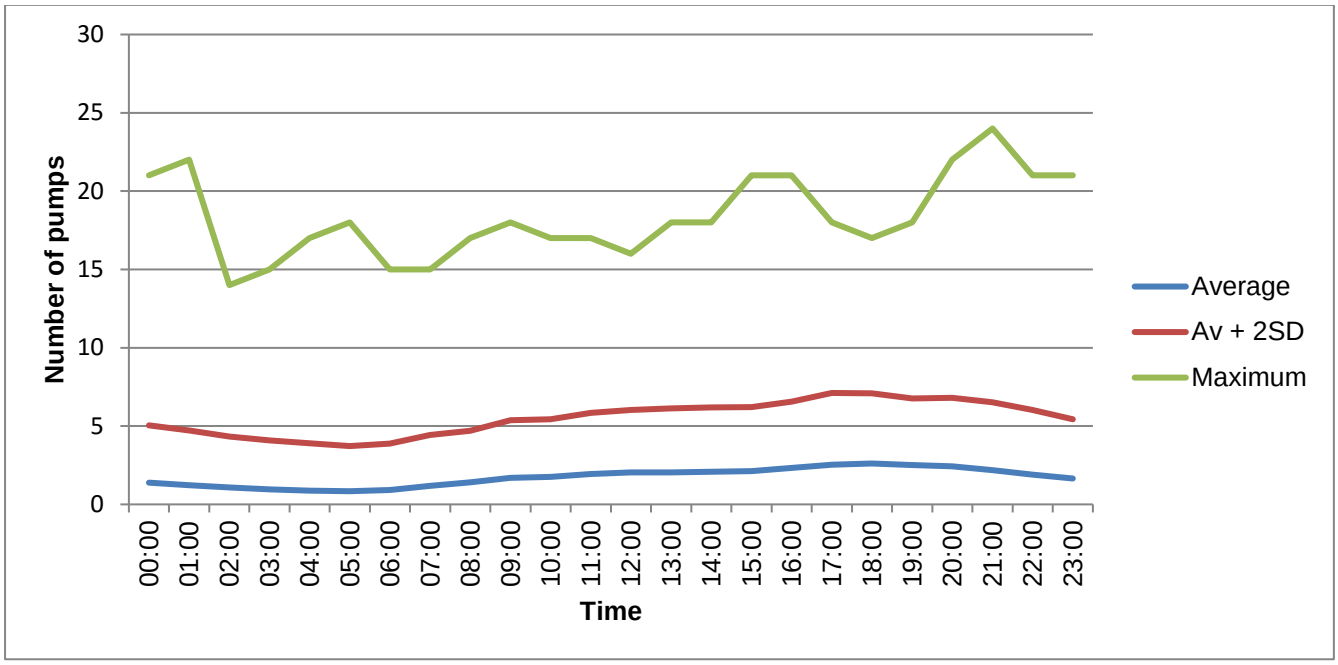
Stn17
Stn18
Stn19
Stn20
Stn21
Stn22



Pumps in use by hour of day in the modelled base case – weekly composite 2015/16 (Swinley incident removed).

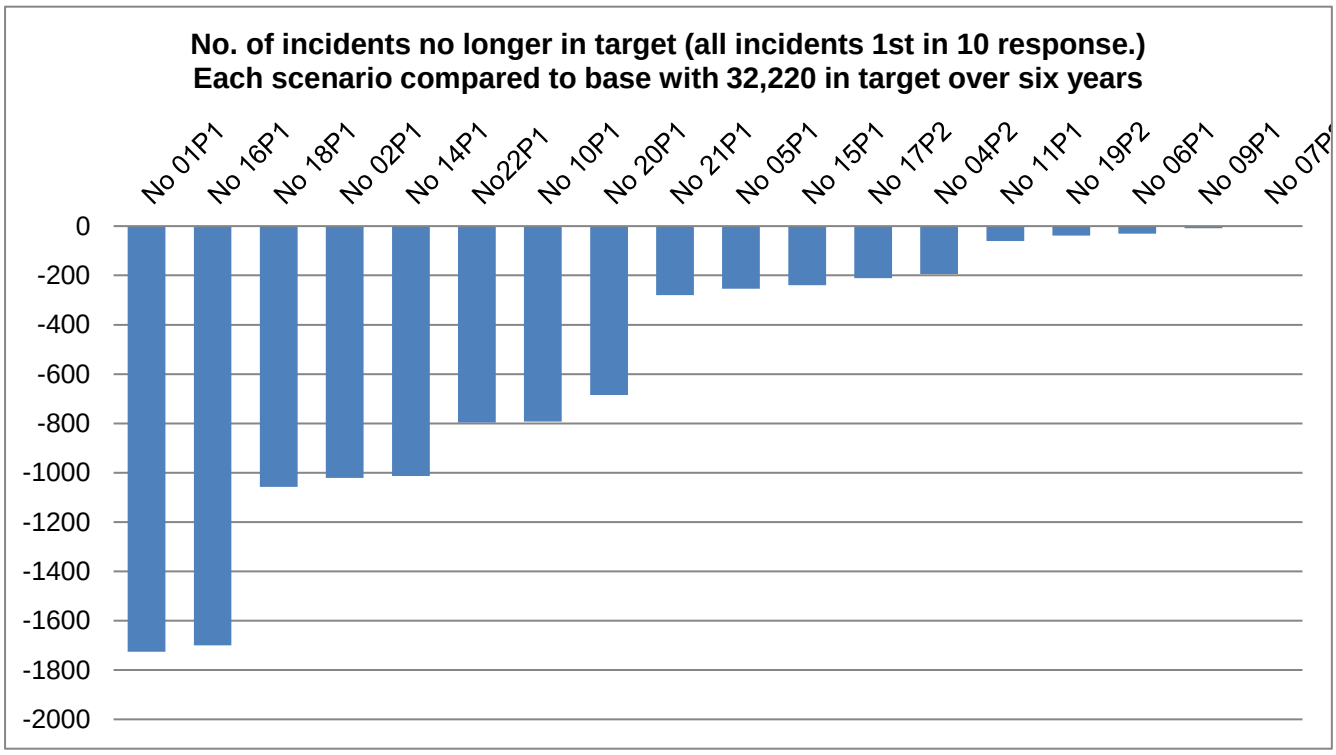
The 'compare' function in CWM allows a comparison across a number of scenarios. The table below is exported to a spreadsheet report and shows worsening of performance of the scenarios relative to each other. This example removes one pump at a time.

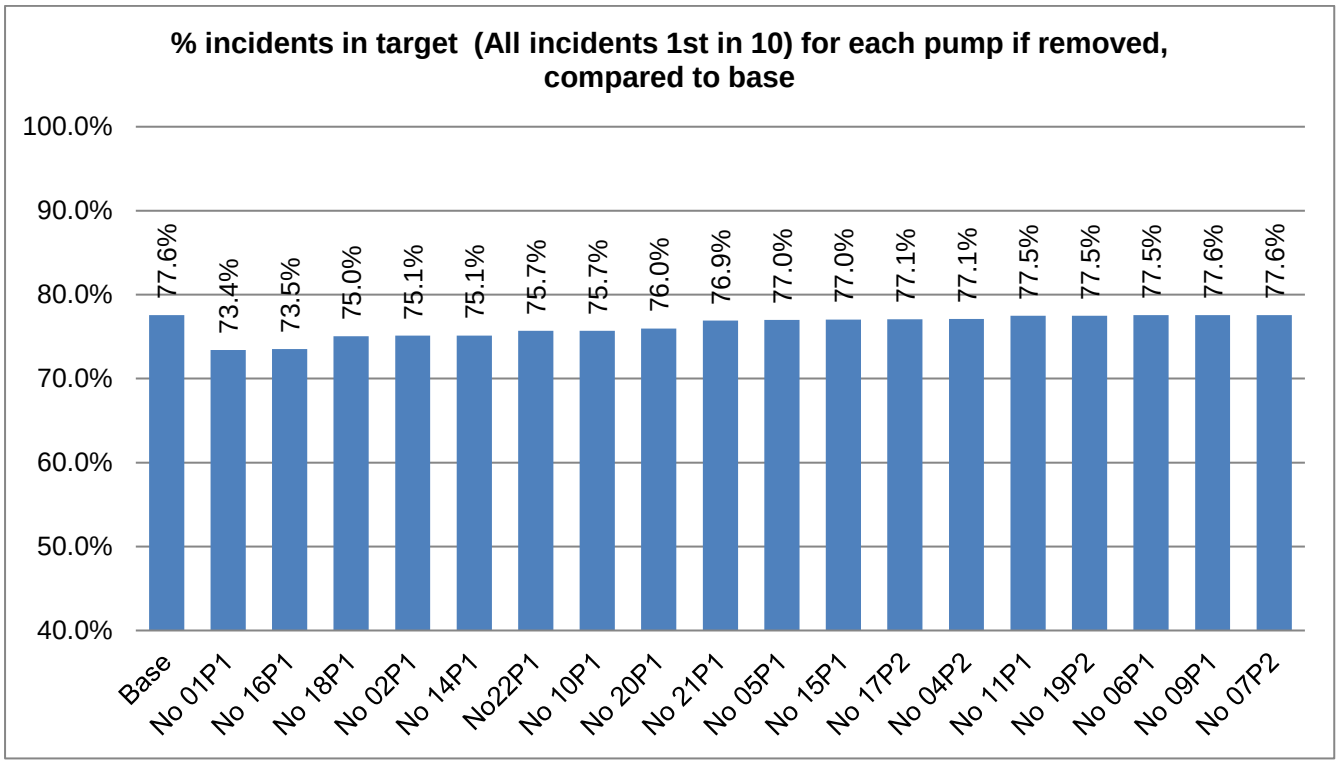
Scenario	Number of incidents no longer in target (1 in 10)	%incidents in target	% drop in target
Base	0	77.6%	0
No 01P1	-1726	73.4%	-4.16%
No 16P1	-1700	73.5%	-4.06%
No 18P1	-1057	75.0%	-2.55%
No 02P1	-1021	75.1%	-2.46%
No 14P1	-1013	75.1%	-2.44%
No22P1	-797	75.7%	-1.9%
No 10P1	-792	75.7%	-1.87%
No 20P1	-685	76.0%	-1.61%

No 21P1	-280	76.9%	-0.67%
No 05P1	-254	77.0%	-0.57%
No 15P1	-240	77.0%	-0.54%
No 17P2	-211	77.1%	-0.51%
No 04P2	-194	77.1%	-0.47%
No 11P1	-60	77.5%	-0.11%
No 19P2	-39	77.5%	-0.09%
No 06P1	-30	77.5%	-0.03%
No 09P1	-8	77.6%	-0.02%
No 07P1	-3	77.6%	-0.01%

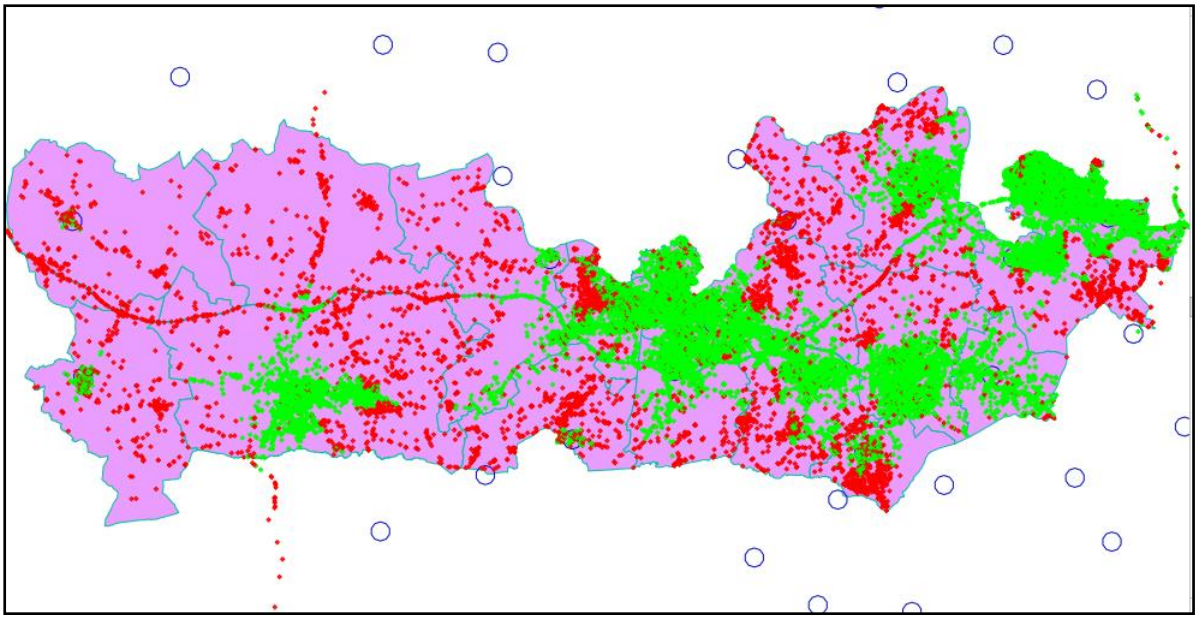
So, in the table above, it is predicted that removing 07P1, reduces the number of incidents not attended within our 10-minute response standard by three incidents (modelled across six years' data). Whereas, removing 01P1, reduces these by 1,726.

And, the same data is represented as graphs below.

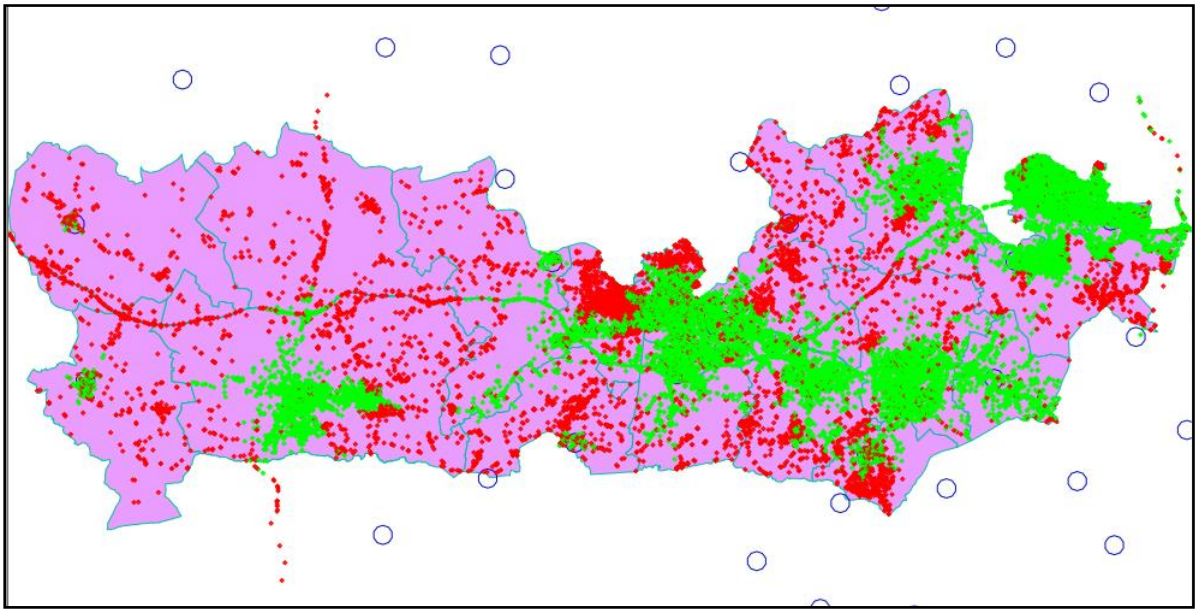




The data can also be modelled onto a map by individual incident:

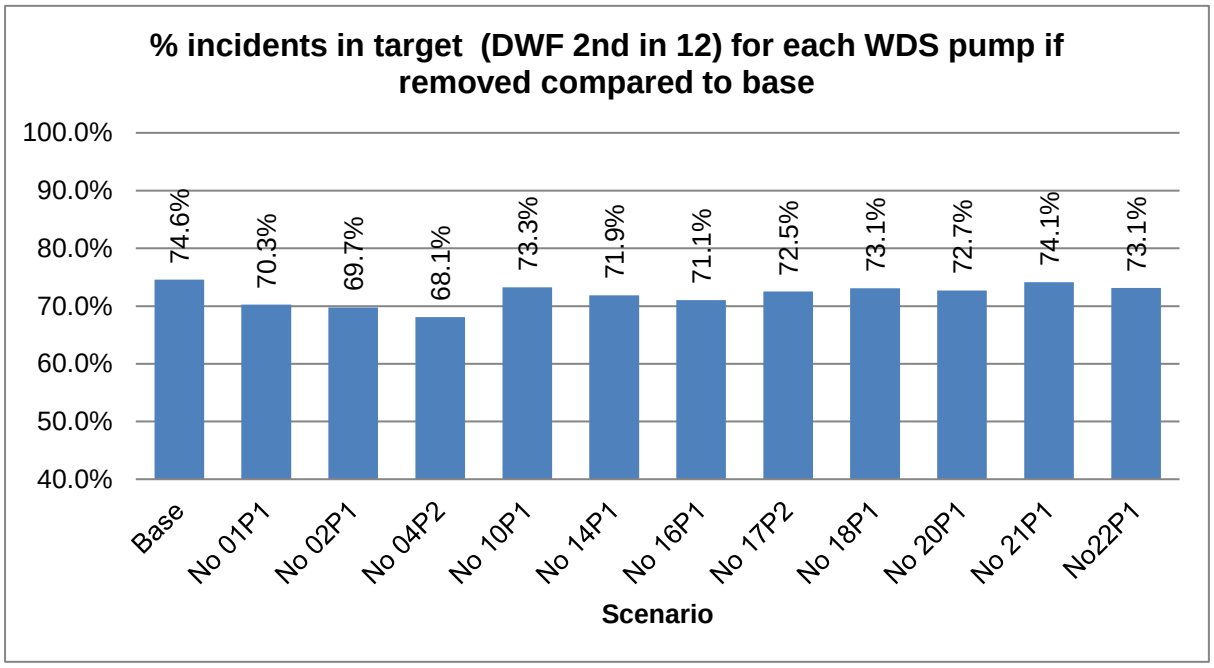


Base case pass and fails (1st in 10 response standard – based on data 2010/11 – 2015/16)



Pass and fails if Caversham Road, Reading, removed (1st in 10, response standard – based on data 2010/11 – 2015/16)

We can also analyse the impact on other appliances, in this case the 2nd WDS pump in 12 minutes to dwelling fires:

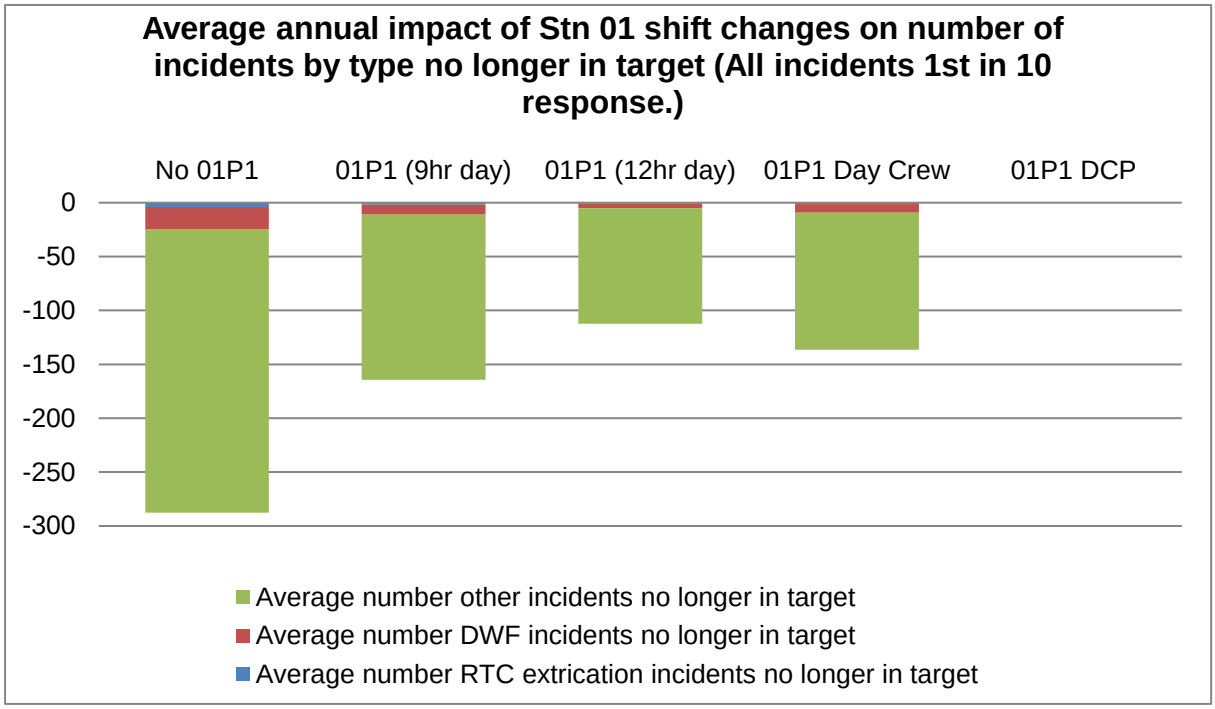


And, it is possible to model different shift systems. This example indicates what happens to our 1st in 10-minute response standard if alternative shift systems are deployed at Caversham Road, Reading (01P1):

Scenario	Number of incidents no longer in target (1 in 10)	% incidents in target	% drop in target

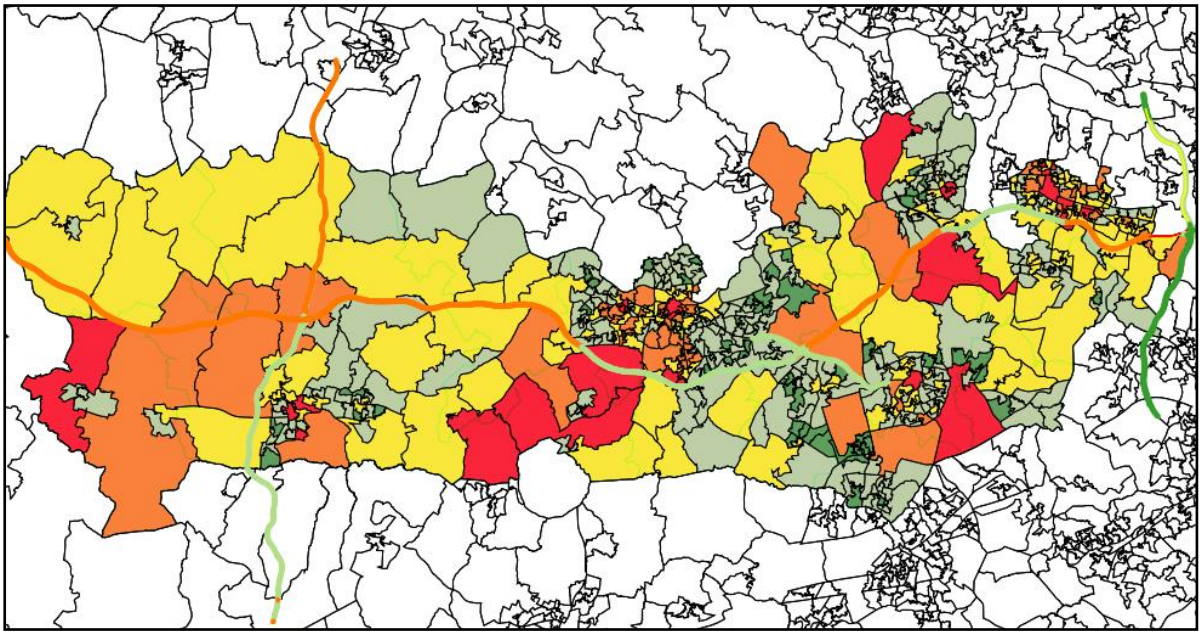
Base	0	77.6%	0
No 01P1	-1726	73.4%	-4.16%
01P1 (9hr day)	-986	75.2%	-2.34%
01P1 (12hr day)	-675	76.0%	-1.59%
01P1 Day Crew	-819	75.6%	-1.93%
01P1 DCP	0	77.6%	0.00%

The above is a prediction based on six years of data. The following analyses the impact as an average year by incident type:

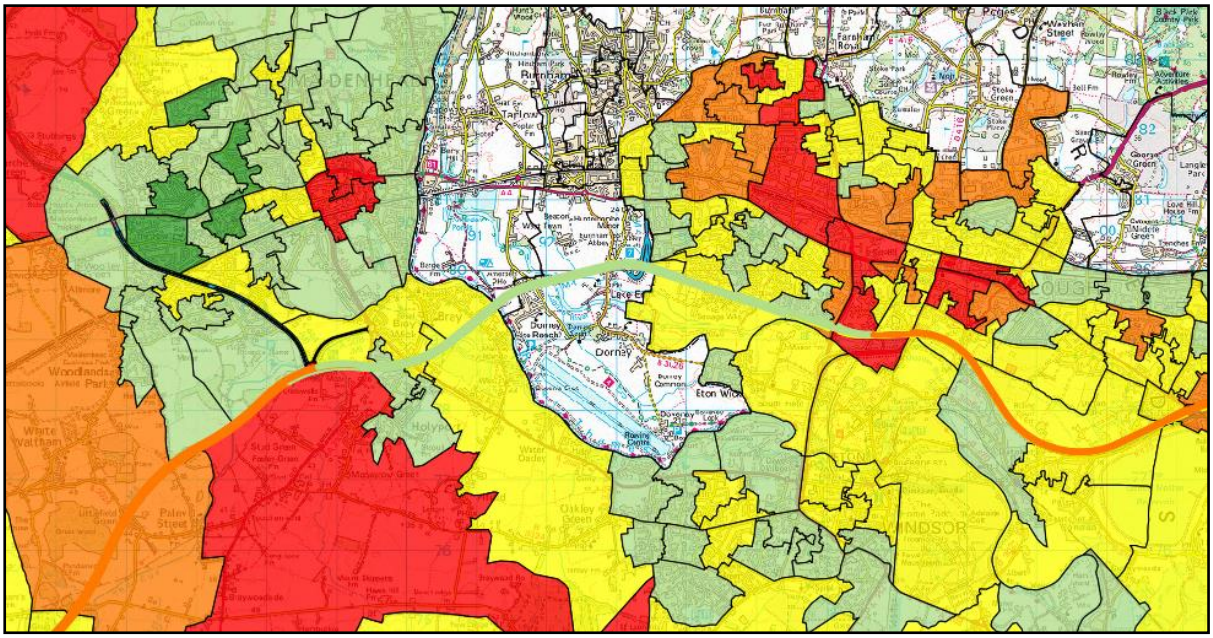


Life risk modelling

It is also possible to model the impact on designated life risks. RBFRS modelling defines life risks, by LSOA area, as being 50% social risk and 50% incident risk. It is a measurement of how much life risk there is within a defined geographical area, in terms of the numbers and severity of incidents and the defined social risks affecting the lives of people within that area.

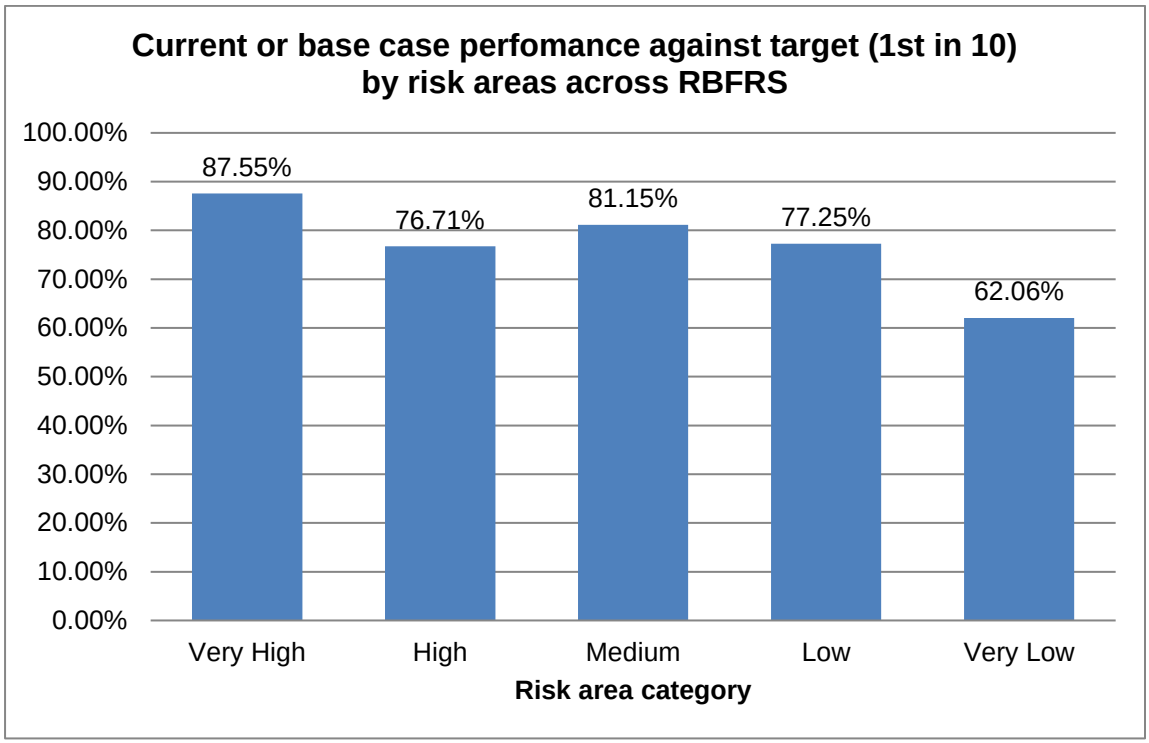


Total combined incident and societal relative risk (ranked by LSOA) – giving ‘Life Risk’.

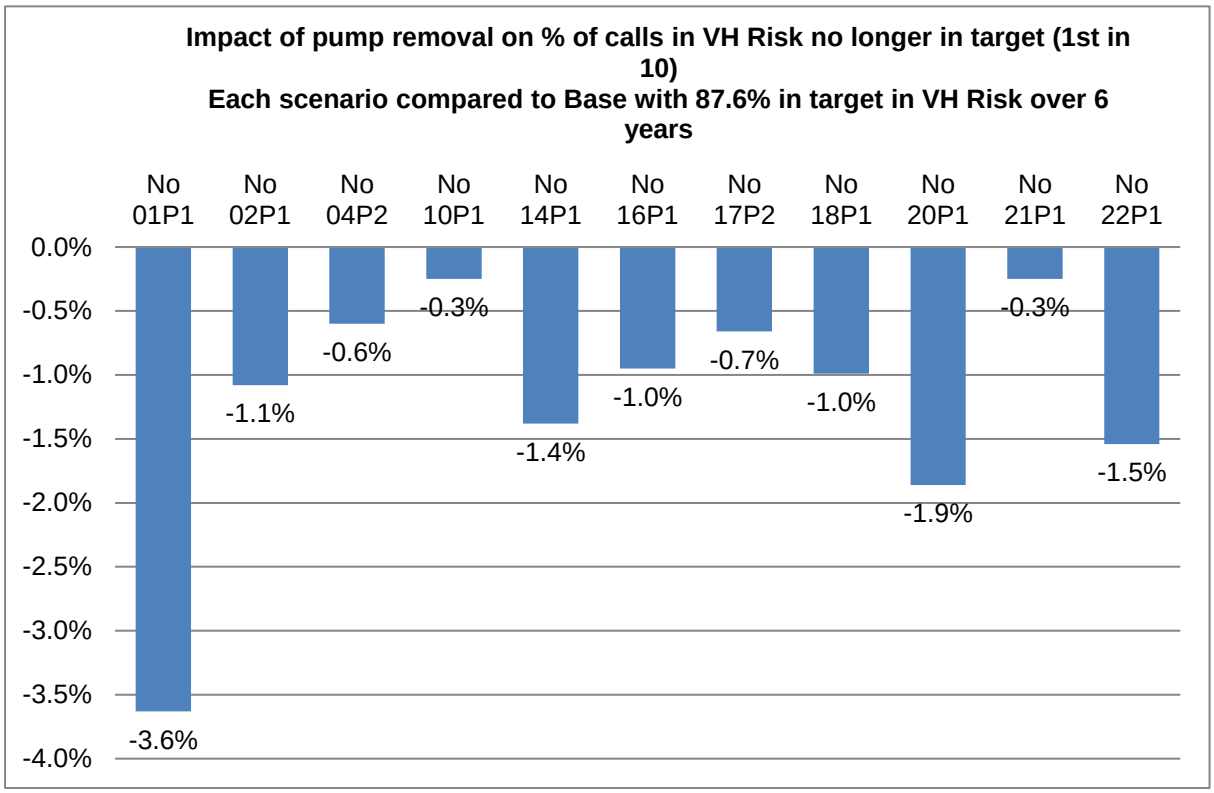


Life risk LSOAs – detail for Maidenhead, Slough and Windsor.

In the same way as before, any change can be modelled in terms of the impact on life risk areas. For example, in the current base model our performance is:



And if, say, Wokingham Road Fire Station (02P1) were closed, then our performance to very high life risk areas would worsen by 1.1%:



Whilst risk mapping is able to show all risks, it is probably fair to say that the model aspect of CWM concentrates on changes in performance by re-distribution of resources – primarily Response resources. However, the mapping aspect allows a more focused targeting of treatments across all of Prevention, Protection and Response.

Methodology Validation

The overall methodology has been externally validated by Risktec Solutions Ltd28. In 2016 Risktec reported “we believe that the methodology and its implementation are robust for the purpose for which it is to be used (i.e. looking at relative risk levels across RBFRS and to allow prioritisation of resources to be made)”.

It was agreed to re-validate the methodology due to the evolution of the work into two streams (Community Risk and Vulnerability Risk) and, very recently, the Risktec report of 2018 states:

- The risk model approach represents an evolution from the previous model which was considered appropriate for its intended use of estimating relative risk across Berkshire.
- ...updates have been positive additions to the model which can add granularity of the output and help with focusing risk mitigation strategies down to household level.
- The overall approach and use of data appears appropriate for the intended use...
- A key strength of the adopted approach is that the model outputs can be used to present a significant number of risk maps, tailored to RBFRS requirements which assists in the communication and understanding of risks in decision making within RBFRS and wider stakeholders.

Both reports have been of benefit, giving recommendations that RBFRS has considered and acted upon where appropriate.

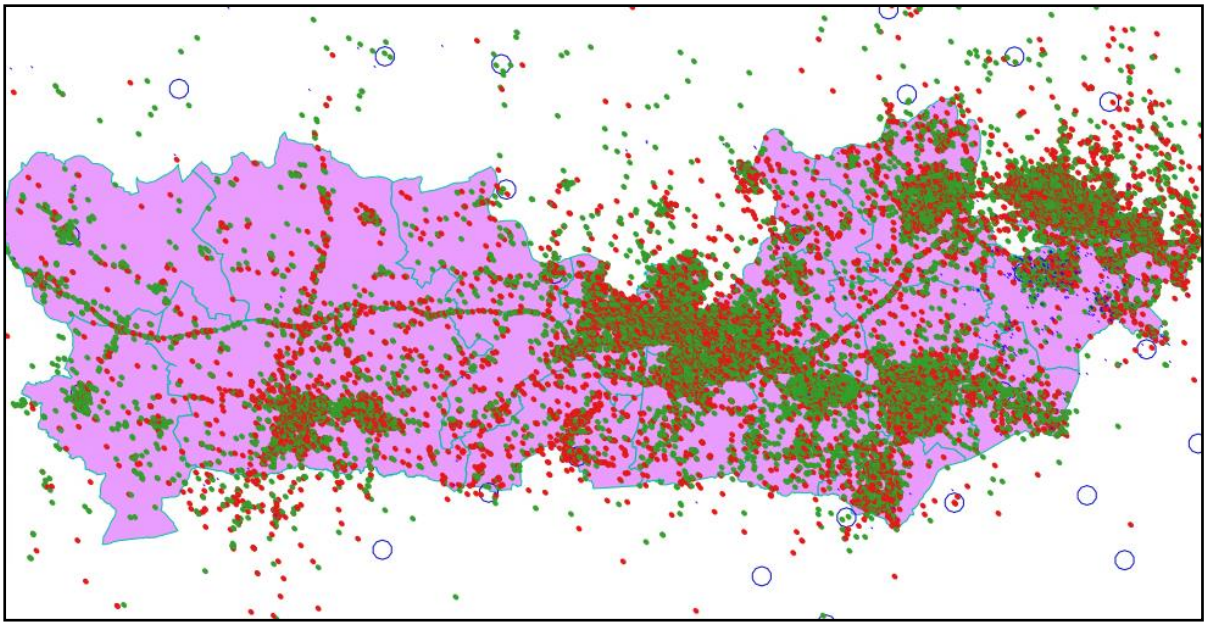
[28] http://www.risktec.tuv.com/

Model Validation

Every year the model is checked against actual performance by comparing model performance against the set response times[29] with actual performance. (All relevant times are considered within the model for the response standard: call handling time; reaction time and travel time).

In this way, items such as the road speeds used within the model are confirmed as correct.

For example, reaction times are tested for pass/fail (the model allows a difference in reaction times for WDS, RDS and OTB):



Pass and fails – reaction times (based on data 2010/12 - 2015/16)

The actual[30] response performance for 2016/17 was reported as 73.8%.

The model[31] gave 75.75%for 2016/17 and, as such, is deemed to be within the expected parameters of such a model.

[29] RBFRS response standard is: **RBFRS aims to arrive with the first fire appliance at all emergency incidents within 10 minutes on 75% of occasions**
[30] Performance Report 2016-17 V11 FINAL.pdf (NB – only two quarters reported due to change in standard that year)
[31] Model report: 2017 Cadcorp compare report - base minus WDS pumps 10mins - GC8-9-17.xlsx

Summary

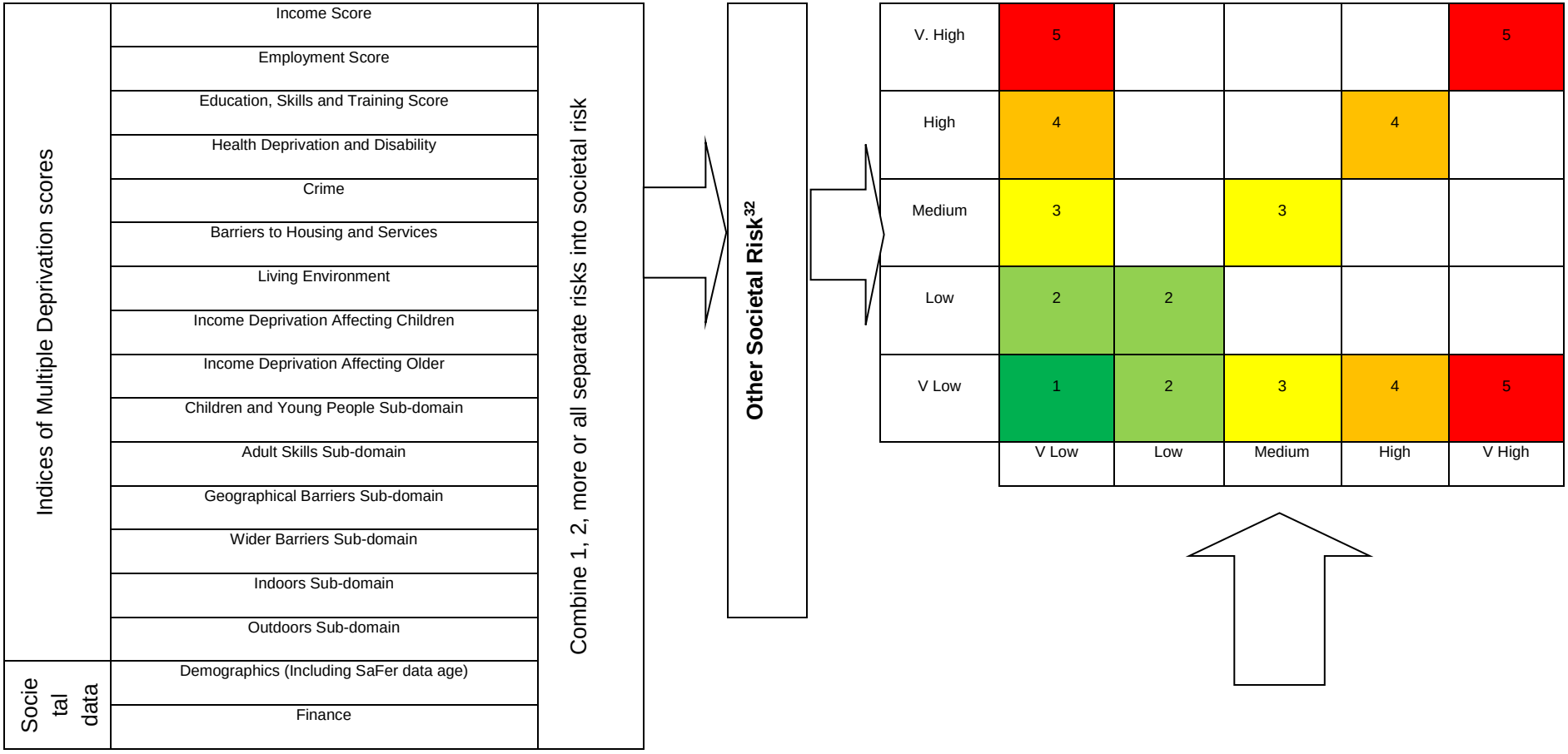
An extensive and complicated methodology is described within this report and, even so, it is only possible to give an indication of the whole process. In brief:

1. Six years of rolling data is extracted from the mobilising system, including incident locations and all rescues, casualties and fatalities.
2. The incident data is collated into a manageable number of incident types that mirror the IRS incident types.
3. An incident type severity is calculated.
4. Likelihood and severity are used to calculate incident risk by LSOA.
5. IMD data is combined with other societal risk data by LSOA (including weighting).
6. Incident and societal risk data is also combined by LSOA (including weighting) and can give a 'predictive' element to incidents.
7. Any risk or combination of risks may be 'normalised' by LSOA across any geographical range, up to all England (providing all England data is available - as it is for IMD).
8. Various datasets are mapped by UPRN and used to analyse and map vulnerability risk by household, in terms of Mosaic, age, tenure and property.
9. Cadcorp GIS is used to map any one, two, more or all risks by LSOA (also considering motorway LSOAs) and/or UPRN.
10. The risk maps may be used to target treatments.
11. Cadcorp Workload Modeller can model two basic risk types – Response Risk and Life Risk.
12. Cadcorp Workload Modeller is used to model resource changes and the outputs are given by comparison (table, graph or map.) generally combined in worksheet reports.
13. Further to the external methodology validation, the Cadcorp model is validated annually against actual incident performance.

Thereby, a very flexible, accurate and powerful set of modelled outputs is possible.

Appendix A: Risk modelling concept matrix

Each LSOA (Lower Super Output Areas) will have an incident risk, a societal risk, a dwelling fire fatality predictive risk and a total public risk score between 1 and 5, based on data normalisation and standard deviation.



32 Excludes Organisational Risk (and environmental and animal risk unless people have been involved).

	Health	
	Property type (Including Mosaic and IBIS)	
	Non-residential building scores (in IBIS)	
	Mosaic (Including Age and Tenure)	
	Deliberate Fires	

Incident Risk (Types based on IRS)

Appendix B: List of incident types

As used in Cadcorp Workload Modeller and collated from IRS data. This list has been updated in 2018 to better align with Thames Valley.

1	False Alarm
2	FireAircraft
3	FireBoat
4	Fire Chimney
5	FireDwelling
6	FireNonResidential
7	FireOtherResidential
8	FireOutdoor
9	FireOutdoorStructure
10	FireRailVehicle
11	FireRoadVehicle
12	Special Service Advice Only
13	Special Service Animal Assistance
14	Special Service Assist other agencies
15	Special Service Effecting entry/exit
16	Special Service Evacuation (no fire)
17	Special Service Flooding
18	Special Service Hazmat
19	Special Service Lift release
20	Special Service Making safe (not RTC)
21	Special Service Medical (Co-Responder)
22	Special Service Medical (First Responder)
23	SpecialService No action (not false alarm)
24	Special Service Other Rescue/Release of persons (not RTC)
25	Special Service Other transport incident
26	SpecialService Person in water or at immediate risk of entering water
27	SpecialService Person not in water or at imminent risk of entering water (NB water not flowing)
28	SpecialService Removal of objects from people
29	SpecialService Rescue from below ground
30	SpecialService Rescue from height
31	SpecialService RTC Advice only
32	SpecialService RTC Extrication of person/s
33	SpecialService RTC Make scene safe
34	SpecialService RTC Make vehicle safe
35	SpecialService RTC Medical assistance only (e.g. First Aid)
36	SpecialService RTC Other
37	SpecialService RTC Release of person/s
38	SpecialService RTC Stand by - no action
39	SpecialService RTC Wash down road
40	Special Service Spills and Leaks (not RTC)

41	Special Service Standby (not RTC)
42	Special Service Suicide/attempt
43	SpecialService Unknown
44	Special Service Water provision

Appendix C: Societal risks

List of IMD social data available in the community risk calculation

- Income Score.
- Employment Score[33].
- Education, Skills and Training Score.
- Health Deprivation and Disability Score.
- Crime Score.
- Barriers to Housing and Services Score.
- Living Environment Score.
- Income Deprivation Affecting Children Index (IDACI) Score.
- Income Deprivation Affecting Older People (IDAOPI) Score.
- Children and Young People Sub-domain Score.
- Adult Skills Sub-domain Score.
- Geographical Barriers Sub-domain Score.
- Wider Barriers Sub-domain Score.
- Indoors Sub-domain Score.
- Outdoors Sub-domain Score.

List of additional societal risks currently in the community risk calculation

- Arson (Deliberate fire) data.
- Non-residential building score (Protection score from IBIS).
- Mosaic data (15 classifications A to O; 1 – 66 ‘types’).

List of societal risk data currently in the vulnerability risk calculation

- Mosaic data (15 classifications A to O; 1 – 66 ‘types’).
- Age (from Mosaic and SaFer data).
- Property type (from Mosaic and IBIS).
- Tenure (from Mosaic).

Incident data (currently used as a ‘flag’ against each household)

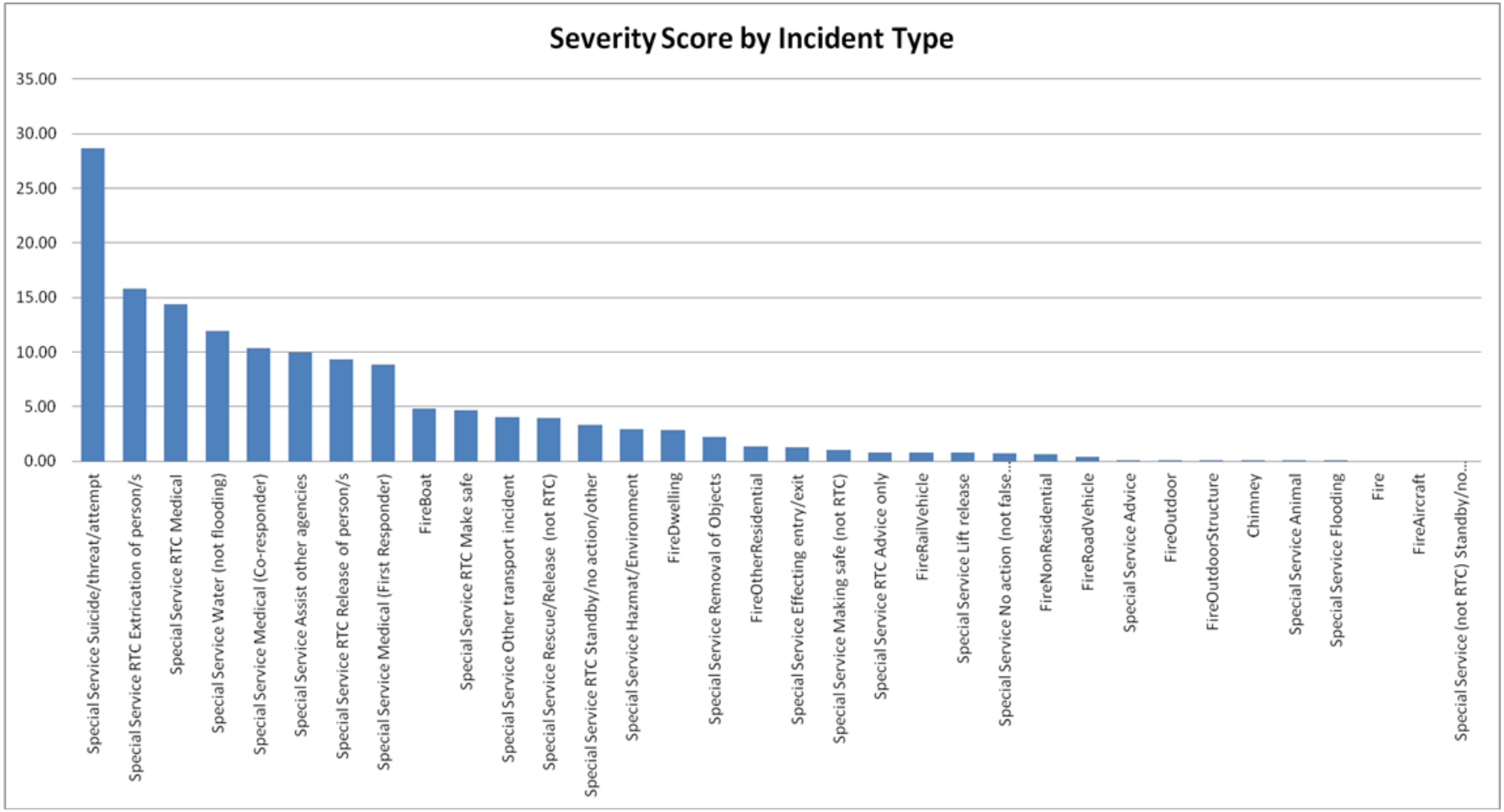
[33] A research report from 2016 (Socio-economic and demographic predictors of accidental dwelling fire rates – Hastie 2016 p.6), explains some difficulty with using IMD data and suggests only using income and employment ‘scalar’ data rather than all the other data that is ‘ordinal’. For 2020/25, RBFRS will primarily use these first two IMD data. (See also research section of this paper).

List of societal risk data to be included – as and if data permits.

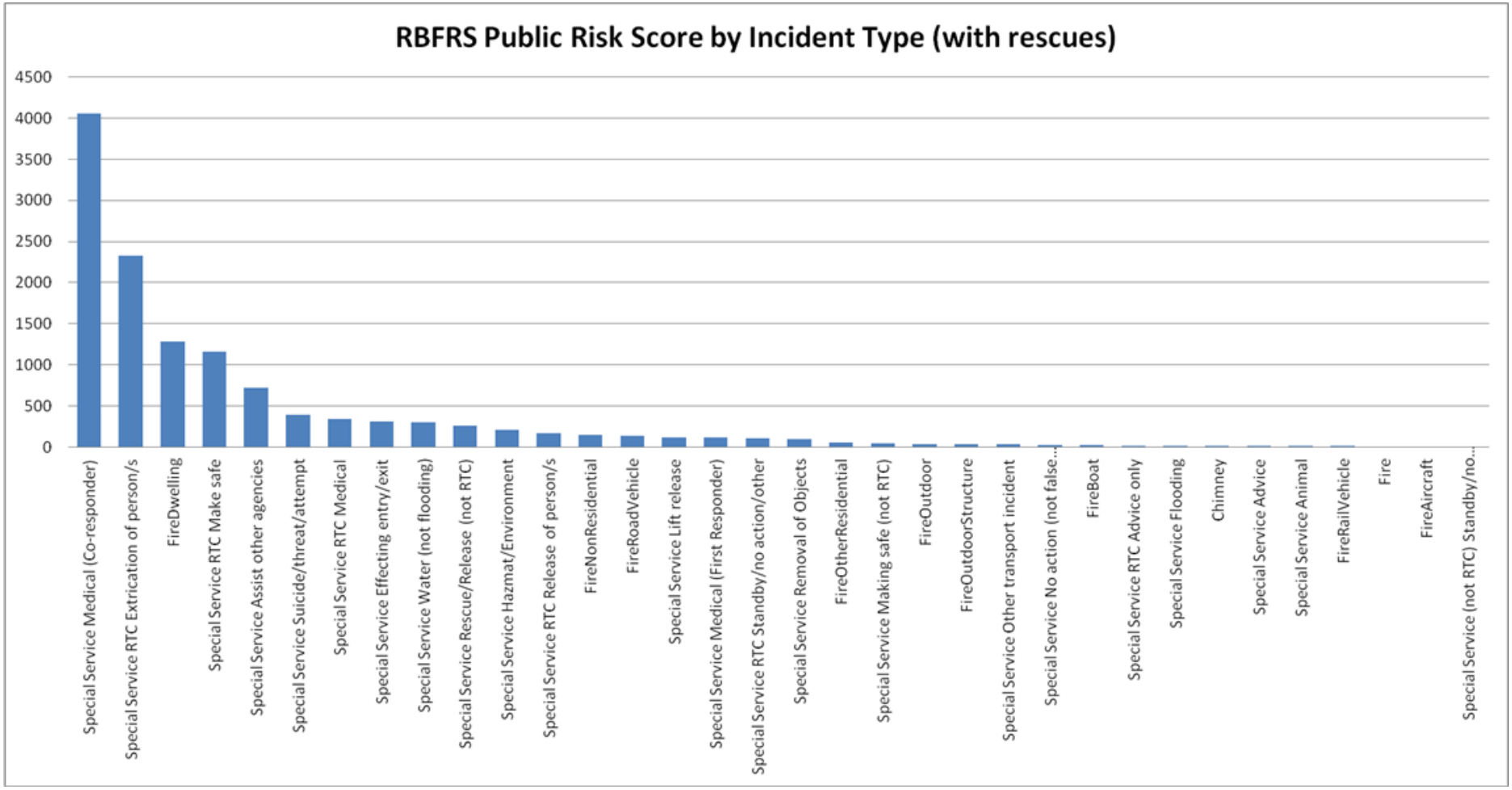
Finance		
	Benefit claimants (adults)	State Pension
	Benefit claimants (adults)	Disability Living Allowance
	Benefit claimants (adults)	Incapacity Benefit / Severe Disability Allowance
	Benefit claimants (adults)	Pension Credit
	State benefits received	Pension Credit
	State benefits received	Carer's Allowance
	State benefits received	Disability Living Allowance
	State benefits received	Incapacity Benefit
Health		
	Parking permits	Disabled parking permit (Blue Badge)
	Care providers	Provides 1-19 hours unpaid care a week
	Care providers	Provides 20-49 hours unpaid care a week
	Care providers	Provides 50+ hours unpaid care a week
	Health status	Bad health
	Health status	Very bad health
	Activity limited	Health problem or disability limits activities / work
	Smoking	Heavy smokers
	Smoking	Medium smokers
	Smoking	Light smokers
	Alcohol consumption	Drink alcohol once a day or more
	Alcohol consumption	Drink alcohol 2 or 3 times a week
	Alcohol consumption at home	Drink alcohol once a day or more
	Alcohol consumption at home	Drink alcohol 2 or 3 times a week
	Visits to GP	More than once a month
	Visits to GP	About once a month

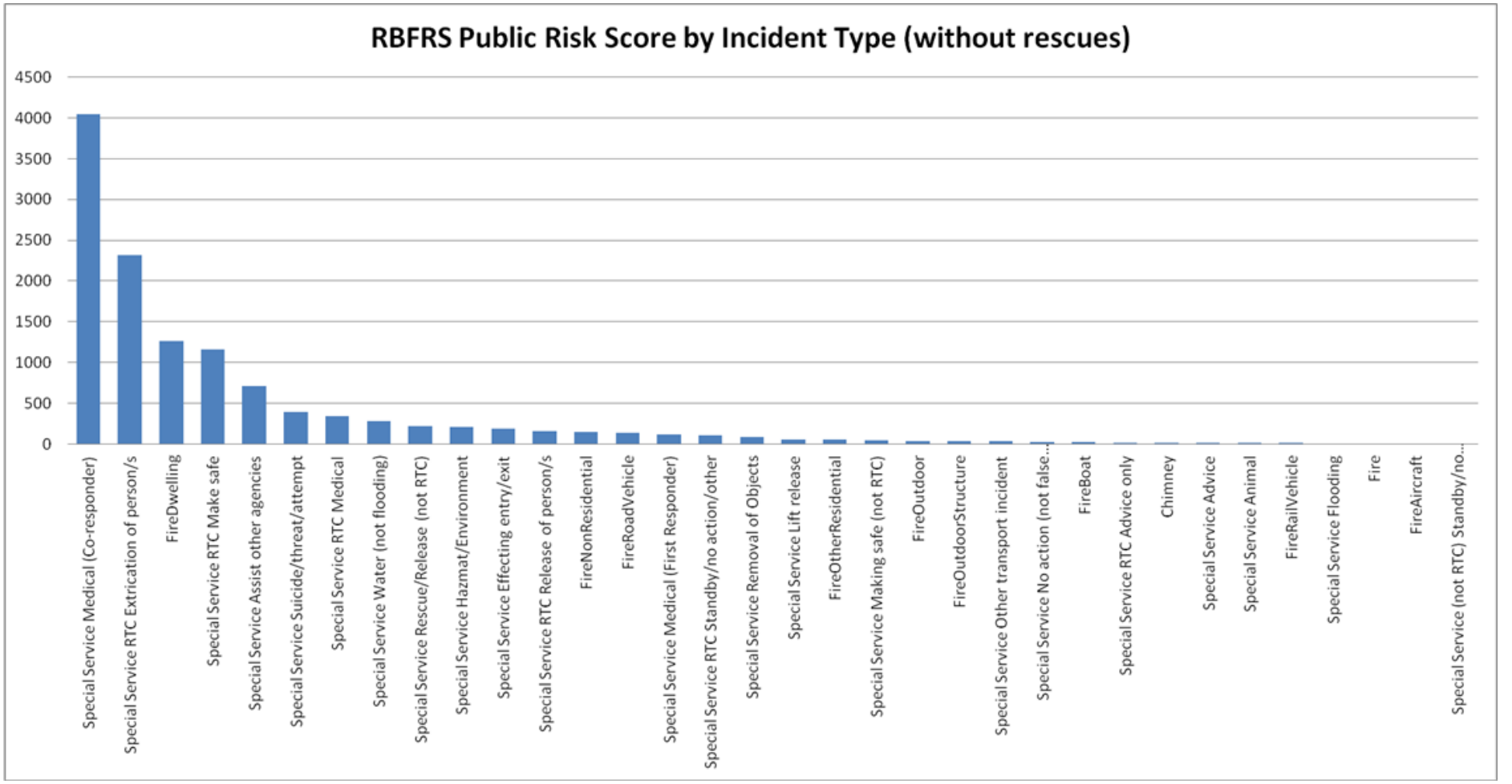
- Police Stats19 data.
- MAST RTC data.
- SCAS co-responder data.
- Water Safety data WAID.

Appendix D: Incident type severity score (2011- 2016)



Appendix E: Berkshire public risk scores (2011- 2016)





The ‘without rescues’ graph is included for completeness. It can be seen that not including rescues in the calculation, moves both ‘effecting entry’ and ‘lift rescues’ to the right (less risk), but that the impact is small and, therefore, rescues remain in the calculation. (This will be kept under review in the light of recent agreement to ‘effect entry’ for other services).

Appendix F: Fire and fire fatality risk factors

Over years, researchers have attempted to correlate various societal risk factors with frequency of fire, fire injuries and fire fatalities, to try to predict where fire may occur. Not surprisingly, this is a complex area, but the following is a synopsis of the more recent research and thereby influences the data selected by RBFRS for inclusion into the model.

Analysis of fire and rescue service performance and outcomes with reference to population socio-demographics (CLG - Fire Research Series 9/2008)

This extensive research used Census data, IMD and also briefly considered Mosaic and found Census or combined Census and IMD data to be the better indicator. It found weak correlations for IMD alone. Mosaic was not considered in much detail as it 'will not support the production of a regression formula'.

Key findings:
"Thus, being a **single parent, never worked, single adult** and **deprived** are the top factors associated with higher rates of fire." And, this generally applied to dwelling fire injuries. In this case 'deprived' was given by the overall IMD score.

Additionally, from census data, **'Sick disabled, socially rented** and **single person** households were all moderate predictors.'

Interestingly, **'lone pensioners** and **privately rented explained very little** of the variance in rate of dwelling fire.'

An exploration of causal factors in unintentional dwelling fires (Taylor M – Merseyside 2012)

Looked at Merseyside and the region and noted that 'one of the major difficulties when developing an unintentional dwelling fire risk model is the availability of detailed data to allow such modelling.' Also, found 'a significant proportion of the fire fatalities did not occur in areas that were categorised as high risk areas by the unintentional dwelling fire risk model.'

This latter is a common problem, perhaps due to the very few numbers of fire fatalities, and supports the **parallel approach** to prevention.

Key findings:
For dwelling fire fatalities - **mental health issues, disability** and **living alone**.
Additionally for dwelling fires - **smoking** and **binge drinking** were also significant."

Understanding community fire risk - A spatial model for targeting fire prevention activities (Higgins – Merseyside 2013)

Building upon the research above, identified two levels of risk – 'community profile' and 'vulnerability index'. Again, this work noted the difficulty of obtaining data for the latter index.

Socio-economic and demographic predictors of accidental dwelling fire rates (Hastie – Fire Safety Journal 2016).

Working in West Midlands and noting the need to take care if transferring to non-similar areas, this research found three groups of factors were important.

First, multiple aspects of **deprivation**, particularly **worklessness** but also **income, health** and **housing**.

Second, groups identifying as **black** - which still featured even though having controlled for deprivation, lone parents and unemployment.

Third, **single person households**, particularly those aged 35-54.

"In contrast, a high concentration of those **living alone and 65 or over** shows a **negative association** with rates of fire."

Appendix G: Local authorities within the model

Counties of Thames Valley and surrounds

	Local authority Areas within counties
Berkshire	West Berkshire
	Reading
	Bracknell Forest
	Wokingham
	Windsor & Maidenhead
	Slough
Buckinghamshire	Aylesbury Vale
	Chiltern,
	Wycombe
	South Bucks
	Milton Keynes
Oxfordshire	Cherwell District Council
	West Oxfordshire District Council
	Oxford City Council
	South Oxfordshire District Council
	Vale of White Horse District Council
London	Hillingdon (most western)
	Harrow (next to east and North)
	Ealing (next to east)
	Hounslow (next to east and south)

Surrey	Elmbridge Borough Council
	Epsom and Ewell Borough Council
	Guildford Borough Council
	Mole Valley District Council
	Reigate and Banstead Borough Council
	Runnymede Borough Council
	Spelthorne Borough Council
	Surrey Heath Borough Council
	Tandridge District Council
	Waverley Borough Council
	Woking Borough Council
Hampshire	Basingstoke and Deane Borough Council
	East Hampshire District Council
	Eastleigh Borough Council
	Fareham Borough Council
	Gosport Borough Council
	Hart District Council
	Havant Borough Council
	New Forest District Council
	Rushmoor Borough Council
	Test Valley Borough Council
	Winchester City Council
Wiltshire	Wiltshire Council
	Swindon Borough Council.

Gloucestershire	Cheltenham Borough Council
	Cotswold District Council
	Forest of Dean District Council
	Gloucester City Council
	South Gloucestershire Council
	Stroud District Council
	Tewkesbury Borough Council
Warwickshire	North Warwickshire
	Nuneaton and Bedworth
	Rugby,
	Stratford,
	Warwick
Northamptonshire	Corby Borough Council
	Daventry District Council
	East Northamptonshire District Council
	Kettering Borough Council
	Northampton Borough Council
	South Northamptonshire District Council
	Borough Council of Wellingborough
Bedfordshire	Bedford
	Central Bedfordshire,
	Luton.
Hertfordshire	Broxbourne
	Dacorum

East Hertfordshire

Hertsmere

North Hertfordshire

St Albans

Stevenage

Three Rivers

Watford

Welwyn Hatfield

Appendix H: Mosaic analysis within RBFRS

Mosaic Classification	# of household type in RBFRS	%of type in RBFRS	# of DWF incidents 2011/17	# of DWF Rescues 2011/17	# of DWF Casualties 2011/17	# of DWF Fatalities 2011/17	Mosaic DWF risk score per household
A01 Rural Vogue	2300	0.627329	44	1	4	0	0.197391
A02 Scattered Homesteads	157	0.042822	3	0	0	0	0.019108
A03 Wealthy Landowners	9186	2.505496	157	0	8	0	0.10418
A04 Village Retirement	2974	0.811163	32	0	1	0	0.044385
B05 Empty-Nest Adventure	4502	1.227928	19	0	2	0	0.048645
B06 Bank of Mum and Dad	14199	3.8728	70	2	5	2	0.182407
B07 Alpha Families	21929	5.981169	120	1	9	0	0.04697
B08 Premium Fortunes	10803	2.946535	79	1	6	1	0.156345
B09 Diamond Days	11245	3.067091	83	0	12	0	0.114095
C10 World-Class Wealth	221	0.060278	2	0	0	0	0.00905
C11 Penthouse Chic	0	0	0	0	0	0	0
C12 Metro High-Flyers	1711	0.466678	12	0	0	0	0.007013
C13 Uptown Elite	4308	1.175014	22	0	1	0	0.028319
D14 Cafés and Catchments	21138	5.765423	88	0	14	0	0.070395
D15 Modern Parents	6995	1.907897	37	1	2	0	0.035311
D16 Mid-Career Convention	5943	1.620963	26	0	2	0	0.038028
D17 Thriving Independence	27721	7.560946	139	3	23	0	0.089066
E18 Dependable Me	2421	0.660332	17	0	7	0	0.296159
E19 Fledgling Free	103	0.028093	0	0	0	0	0
E20 Boomerang Boarders	1839	0.50159	7	0	0	0	0.003806
E21 Family Ties	7198	1.963266	44	0	6	0	0.089469
F22 Legacy Elders	14085	3.841706	52	0	7	1	0.124388
F23 Solo Retirees	4597	1.253839	25	0	4	0	0.092452
F24 Bungalow Haven	2438	0.664968	9	0	3	2	0.947088
F25 Classic Grandparents	1954	0.532957	5	0	0	0	0.002559
G26 Far Flung Outposts	0	0	0	0	0	0	0
G27 Outlying Seniors	873	0.238112	11	1	2	0	0.25315
G28 Local Focus	2024	0.552049	32	0	5	0	0.262846
G29 Satellite Settlers	3896	1.06264	52	0	11	1	0.552361
H30 Affordable Fringe	367	0.1001	2	0	0	0	0.00545

H31 First-Rung Futures	741	0.202109	4	0	0	0	0.005398
H32 Flying Solo	2259	0.616146	12	0	1	0	0.049579
H33 New Foundations	3050	0.831892	2	0	1	0	0.033443
H34 Contemporary Starts	9102	2.482585	34	0	7	0	0.080642
H35 Primary Ambitions	25407	6.929799	143	0	26	0	0.107962
I36 Cultural Comfort	15093	4.116639	129	3	28	1	0.262307
I37 Community Elders	9757	2.661237	84	2	20	1	0.318131
I38 Asian Heritage	2305	0.628692	19	0	15	0	0.659002
I39 Ageing Access	5020	1.369213	18	3	5	0	0.109163
J40 Career Builders	24006	6.547674	122	5	28	0	0.123802
J41 Central Pulse	5850	1.595597	44	1	3	1	0.231453
J42 Learners & Earners	2635	0.7187	24	0	3	0	0.12296
J43 Student Scene	316	0.086189	2	0	0	0	0.006329
J44 Flexible Workforce	17219	4.696509	177	8	50	1	0.363378
J45 Bus-Route Renters	8454	2.305842	67	1	15	0	0.186539
K46 Self Supporters	374	0.102009	2	1	0	0	0.032086
K47 Offspring Overspill	2373	0.647239	19	0	7	2	1.145807
K48 Down-to-Earth Owners	13	0.003546	0	0	0	0	0
L49 Disconnected Youth	573	0.156287	8	1	4	1	2.474695
L50 Renting a Room	292	0.079643	7	0	1	0	0.366438
L51 Make Do & Move On	0	0	0	0	0	0	0
L52 Midlife Stopgap	2781	0.758522	19	3	3	0	0.125494
M53 Budget Generations	198	0.054005	2	0	0	0	0.010101
M54 Childcare Squeeze	60	0.016365	0	0	0	0	0
M55 Families with Needs	336	0.091645	6	0	0	0	0.017857
M56 Solid Economy	23455	6.397388	270	16	55	1	0.295459
N57 Seasoned Survivors	244	0.066551	1	0	0	0	0.004098
N58 Aided Elderly	6070	1.655602	70	1	26	2	0.771005
N59 Pocket Pensions	2898	0.790434	42	4	15	1	0.890959
N60 Dependent Greys	1107	0.301936	20	1	7	1	1.562782
N61 Estate Veterans	2059	0.561595	25	2	5	1	0.750364
O62 Low Income Workers	125	0.034094	3	0	0	0	0.024
O63 Streetwise Singles	1703	0.464496	21	3	4	0	0.264827
O64 High Rise Residents	665	0.18138	23	4	14	0	2.2

O65 Crowded Kaleidoscope	1301	0.35485	27	1	9	0	0.720215
O66 Inner City Stalwarts	1666	0.454404	22	1	4	0	0.259304
Total households	366634	100					

Appendix I: Age fire risk analysis within RBFRS

Age*	Fire Incidents	Fire Rescues	Fire Injuries	Fire Fatalities	Fire risk by age Berkshire
20-24	80	2	18	1	534.796
25-29	170	1	24	2	715.699
30-34	240	8	48	1	862.635
35-39	258	9	55	1	830.003
40-44	326	4	57	2	1084.38
45-49	339	6	51	3	1140.37
50-54	312	11	38	1	736.967
55-59	287	10	50	4	1546.89
60-65	188	6	35	1	955.169
66	3	0	0	0	0.21468
67	37	2	8	0	139.545
68	35	0	6	0	135.466
69	63	0	10	0	293.596
70	28	0	7	0	203.087
71	40	1	8	0	236.609
72	37	1	3	0	96.3755
73	22	0	5	0	89.6711
74	46	3	2	2	635.24
75	31	0	9	0	305.188
76	32	3	6	0	243.706
77	22	0	9	0	302.966
78	27	0	1	0	45.1856
79	29	1	4	1	528.153
80	23	1	2	0	106.118
81	22	0	4	0	205.391
82	15	0	2	0	104.162

83	20	0	1	0	57.2159
84	27	1	3	0	162.356
85	18	0	4	0	327.923
86	24	1	9	0	655.058
87	12	0	3	1	1033.43
88	13	0	1	0	7.0945
89	85	2	17	0	1336.13
90	9	0	2	0	140.647
91	13	2	1	0	172.491
92	8	1	0	0	22.5566
93	13	0	2	0	278.64
94	13	1	3	0	291.909
95	7	0	2	0	274.66
96	7	0	2	0	137.993
97	2	0	0	0	1.32686
98	1	0	0	0	1.32686
99	2	0	0	0	1.32686
100	5	0	1	0	2.65372
101	1	0	0	0	1.32686
102	1	0	1	0	0
103	1	0	0	0	0
104	0	0	0	0	0
105	1	0	0	0	0
106	0	0	0	0	0
107	0	0	0	0	0
108	0	0	0	0	0

* SaFer data is given by individual age and applies at over 65 years old. Below that age only Mosaic age ranges are known.

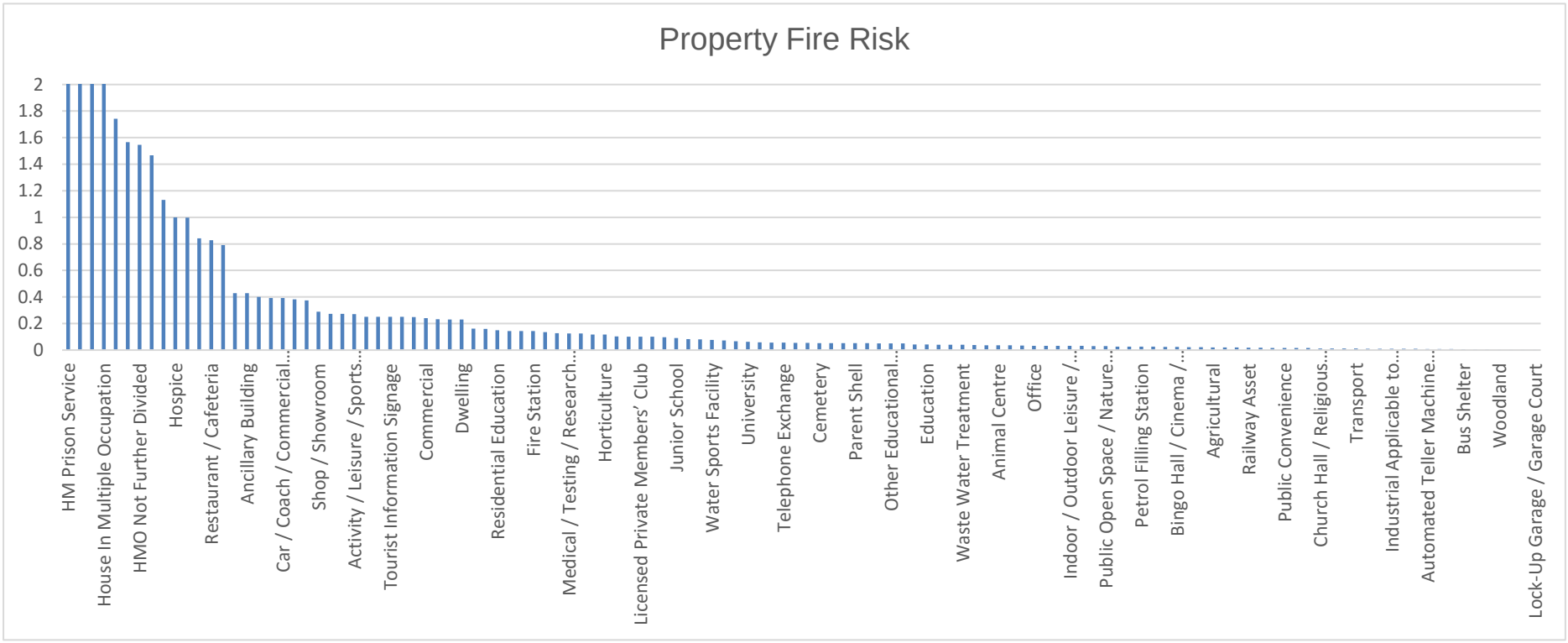
Appendix J: Property risk analysis within RBFRS

	#in Berks (+10km buffer)	#incidents	fire incidents	fire rescues	fire casualties	fire fatalities	Property fire risk
HM Prison Service	1	14	13	1	1	0	123
Power Station / Energy Production	17	2	2	0	6	0	35.41176
First School	10	24	1	0	1	0	10.1
House In Multiple Occupation	51	3	2	0	4	0	7.882353
Boarding / Guest House / Bed And Breakfast / Youth Hostel	58	14	1	0	1	0	1.741379
Sheltered Accommodation	143	471	4	2	2	0	1.566434
HMO Not Further Divided	66	12	2	0	1	0	1.545455
Public House / Bar / Nightclub	559	260	100	2	7	0	1.466905
Fast Food Outlet / Takeaway (Hot / Cold)	184	13	8	0	2	0	1.130435
Hospice	1	5	1	0	0	0	1
Care / Nursing Home	528	484	27	0	5	0	0.998106
Hotel/Motel	157	248	32	0	1	0	0.840764
Restaurant / Cafeteria	773	132	40	0	6	0	0.827943
Secondary / High School	143	241	13	0	1	0	0.79021
Waste Management	7	7	3	0	0	0	0.428571
Ancillary Building	7	11	3	0	0	0	0.428571
Broadcasting (TV / Radio)	5	10	2	0	0	0	0.4
Caravan	3360	81	21	0	3	1	0.393155
Car / Coach / Commercial Vehicle / Taxi Parking / Park And Ride Site	265	38	4	0	1	0	0.392453
Property Shell	8145	2617	159	15	28	0	0.381707
Hospital / Hospice	32	97	2	1	0	0	0.375
Shop / Showroom	5053	1047	113	5	3	1	0.289531
Ancillary Building	11	11	3	0	0	0	0.272727
Telecommunication	1112	24	3	0	3	0	0.272482
Activity / Leisure / Sports Centre	37	124	10	0	0	0	0.27027
Zoo / Theme Park	4	2	1	0	0	0	0.25
Garden Centre	12	4	3	0	0	0	0.25
Tourist Information Signage	4	1	1	0	0	0	0.25
Defence Estates	4	4	1	0	0	0	0.25
Self Contained Flat (Includes Maisonette / Apartment)	63293	3448	460	23	111	4	0.249475
Commercial	1814	201	26	1	4	0	0.240353

Development	453	27	5	10	0	0	0.231788
Hospital	13	117	3	0	0	0	0.230769
Dwelling	138815	5003	1189	40	224	8	0.230443
Terraced	46134	1337	308	3	51	2	0.161226
Police / Transport Police / Station	25	32	4	0	0	0	0.16
Residential Education	689	111	3	0	1	0	0.149492
Special Needs Establishment.	7	37	1	0	0	0	0.142857
Chemical Works	7	10	1	0	0	0	0.142857
Fire Station	21	133	3	0	0	0	0.142857
Detached	67934	2250	500	5	46	4	0.13469
Semi-Detached	60855	1684	425	2	63	1	0.12727
Medical / Testing / Research Laboratory	8	7	1	0	0	0	0.125
Castle / Historic Ruin	8	1	1	0	0	0	0.125
Retail	909	118	7	0	1	0	0.117712
Horticulture	34	8	4	0	0	0	0.117647
Golf Facility	29	16	3	0	0	0	0.103448
Law Court	10	13	1	0	0	0	0.1
Licensed Private Members' Club	20	6	2	0	0	0	0.1
Horse Racing / Breeding Stable	10	2	1	0	0	0	0.1
Station / Interchange / Terminal / Halt	41	29	4	0	0	0	0.097561
Junior School	22	11	2	0	0	0	0.090909
Chapel	12	2	1	0	0	0	0.083333
Mineral / Ore Working / Quarry / Mine	37	6	3	0	0	0	0.081081
Water Sports Facility	13	6	1	0	0	0	0.076923
Preparatory / First / Primary / Infant / Junior / Middle School	165	158	12	0	0	0	0.072727
Community Services	136	83	9	0	0	0	0.066176
University	225	175	14	0	0	0	0.062222
Factory/Manufacturing	202	97	12	0	0	0	0.059406
Vet / Animal Medical Treatment	54	7	3	0	0	0	0.055556
Telephone Exchange	18	10	1	0	0	0	0.055556
Library	55	31	3	0	0	0	0.054545
Local Government Service	37	40	2	0	0	0	0.054054
Cemetery	19	2	1	0	0	0	0.052632
Infant School	19	21	1	0	0	0	0.052632
Health Centre	38	32	2	0	0	0	0.052632
Parent Shell	19	7	1	0	0	0	0.052632
Workshop / Light Industrial	2114	104	10	0	1	0	0.052034

Community Service Centre / Office	39	22	2	0	0	0	0.051282
Other Educational Establishment	40	27	2	0	0	0	0.05
Residential Institution	20	2	1	0	0	0	0.05
Playground	166	23	7	0	0	0	0.042169
Education	72	16	3	0	0	0	0.041667
Primary School	122	108	5	0	0	0	0.040984
Communal Residence	197	77	8	0	0	0	0.040609
Waste Water Treatment	25	2	1	0	0	0	0.04
Public Park / Garden	51	2	2	0	0	0	0.039216
Place Of Worship	135	17	5	0	0	0	0.037037
Animal Centre	28	1	1	0	0	0	0.035714
Animal Services	28	1	1	0	0	0	0.035714
Health Care Services	87	28	3	0	0	0	0.034483
Office	1144	242	27	1	0	0	0.032343
Wholesale Distribution	31	10	1	0	0	0	0.032258
Other Licensed Premise / Vendor	126	16	4	0	0	0	0.031746
Indoor / Outdoor Leisure / Sporting Activity / Centre	446	120	14	0	0	0	0.03139
Lock	32	2	1	0	0	0	0.03125
Children's Nursery / Crèche	225	65	7	0	0	0	0.031111
Public Open Space / Nature Reserve	196	16	6	0	0	0	0.030612
Manufacturing	37	5	1	0	0	0	0.027027
Public Car Parking	111	26	3	0	0	0	0.027027
Petrol Filling Station	117	52	3	0	0	0	0.025641
Army	39	1	1	0	0	0	0.025641
Leisure - Applicable to recreational sites and enterprises	122	20	3	0	0	0	0.02459
Bingo Hall / Cinema / Conference / Exhibition Centre / Theatre / Concert Hall	42	38	1	0	0	0	0.02381
Bank / Financial Service	182	68	4	0	0	0	0.021978
Holiday Let/Accomodation/Short-Term Let Other Than CH01	47	36	1	0	0	0	0.021277
Agricultural	49	1	1	0	0	0	0.020408
Farm / Non-Residential Associated Building	392	24	8	0	0	0	0.020408
Ancillary Building	153	11	3	0	0	0	0.019608
Railway Asset	53	1	1	0	0	0	0.018868
Professional Medical Service	57	6	1	0	0	0	0.017544
Retail Service Agent	247	23	4	0	0	0	0.016194
Public Convenience	65	3	1	0	0	0	0.015385

Ancillary Building	196	11	3	0	0	0	0.015306
Warehouse / Store / Storage Depot	1505	268	23	0	0	0	0.015282
Church Hall / Religious Meeting Place / Hall	79	12	1	0	0	0	0.012658
Recycling Site	85	1	1	0	0	0	0.011765
Agricultural - Applicable to land in farm	89	2	1	0	0	0	0.011236
Transport	180	8	2	0	0	0	0.011111
Office / Work Studio	4775	674	52	0	0	0	0.01089
Water Controlling / Pumping	185	3	2	0	0	0	0.010811
Industrial Applicable to manufacturing, engineering, maintenance, storage /	736	107	7	0	0	0	0.009511
Residential	983	148	9	0	0	0	0.009156
Utility	112	8	1	0	0	0	0.008929
Automated Teller Machine (ATM)	122	6	1	0	0	0	0.008197
Public / Village Hall / Other Community Facility	389	82	3	0	0	0	0.007712
Dentist	131	10	1	0	0	0	0.007634
Bus Shelter	341	2	2	0	0	0	0.005865
Equestrian	229	17	1	0	0	0	0.004367
Transport Related Infrastructure	684	14	2	0	0	0	0.002924
Woodland	616	5	1	0	0	0	0.001623
Land	1289	9	2	0	0	0	0.001552
Electricity Sub-Station	2302	7	3	0	0	0	0.001303
Lock-Up Garage / Garage Court	982	5	1	0	0	0	0.001018


Property Fire Risk
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
HM Prison Service
House In Multiple Occupation
HMO Not Further Divided
Hospice
Restaurant / Cafeteria
Ancillary Building
Car / Coach / Commercial...
Shop / Showroom
Activity / Leisure / Sports...
Tourist Information Signage
Commercial
Dwelling
Residential Education
Fire Station
Medical / Testing / Research...
Horticulture
Licensed Private Members' Club
Junior School
Water Sports Facility
University
Telephone Exchange
Cemetery
Parent Shell
Other Educational...
Education
Waste Water Treatment
Animal Centre
Office
Indoor / Outdoor Leisure /...
Public Open Space / Nature...
Petrol Filling Station
Bingo Hall / Cinema /...
Agricultural
Railway Asset
Public Convenience
Church Hall / Religious...
Transport
Industrial Applicable to...
Automated Teller Machine...
Bus Shelter
Woodland
Lock-Up Garage / Garage Court

Appendix K: Tenure risk analysis within RBFRS

Tenure Types that have had a fire incident	# Instances in Mosaic	Fire Incidents	Fire Rescues	Fire Injuries	Fire Fatalities	Fire risk by Mosaic Tenure type
Council Housing/Association	54431	706	31	160	7	0.441219
Privately Rented	29889	265	13	40	0	0.147044
Owner Occupied	283659	2001	32	309	13	0.162946

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