Management options for PM_{10} - target burner numbers in Napier and Hastings 2012

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Executive Summary

Regulatory measures to reduce concentrations of PM_{10} have been introduced for the Napier and Hastings airsheds to reduce concentrations of PM_{10} to comply with National Environmental Standards (NES). The NES specify a limit of 50 µg m^{-3} (24-hour average) which can only be exceeded on one occasion per year. Compliance with the NES for PM_{10} is required by 2016 in Napier and 2020 in Hastings.

In January 2012 the Resource Regional Management Plan Change 2 – Air Quality became operative. The regulations in the plan change target domestic home heating, as the main source of PM_{10} in both Napier and Hastings and prohibit domestic outdoor rubbish burning. Measures adopted in the plan include bans on open fires and older wood and multi fuel burners in Napier and Hastings and are aimed at reducing concentrations of PM_{10} to meet the NES.

The impact of these regulatory measures in reducing PM_{10} was evaluated regularly throughout the plan change process as timeframes, scientific understanding and proposed rules changed. The reductions in PM_{10} concentrations required in Napier and Hastings were based on a Golder (2009) report detailing modelling of 2006 emissions and meteorological conditions. The reduction required for Hastings was estimated at 71% and in Napier it was 47% of 2006 emissions. In addition to the regulatory measures proposed, around 40% of households replacing phased burners in Hastings needed to select non solid fuel heating options to achieve the required reductions.

An update of the airshed modelling (Gimson, 2012) incorporating current modelling methods, 2010 emissions and meteorological data from 2005 to 2010 found a reduction of 48% (relative to 2010 data) was required in Hastings and 44% for Napier. A 50% reduction in domestic heating emissions was necessary to achieve an overall reduction of 48% in Hastings and in Napier reducing domestic heating emissions by 47% was estimated to result in compliance with the NES (Gimson, 2012).

This report evaluates the impact of the updated reduction scenarios on regulatory options and the number of wood burners that require removal/ replacement in Napier and Hastings. Results indicate that current regulatory measures are still required but that fewer households in Hastings may need to convert to non-solid fuel at the time their burners are replaced.

In Napier around 9000 households using solid fuel need to upgrade to NES compliant wood burners or clean heating alternatives. In Hastings around 7100 households need to upgrade to NES compliant wood burners or clean heating alternatives. The minimum number for converting to clean heating alternatives is 940.

Contents

1 Introduction

Air quality management measures have been introduced in Napier and Hastings to reduce concentrations of PM_{10} to comply with National Environmental Standards (NES) which specify a limit of 50 µg m^{-3} (24-hour average) which can only be exceeded on one occasion per year. Compliance with the NES is required by 2016 in Napier and 2020 in Hastings.

The management measures, introduced via the Resource Regional Management Plan Change 2 – Air Quality Plan (operative 1 January 2012), primarily target domestic home heating, as the main source of PM_{10} in both Napier and Hastings. Measures adopted in the plan include bans on the following solid fuel heating methods in Napier and Hastings:

- open fires: 1 Jan 2012
- pre 96 burners: 1 Jan 2014
- 96 – 2005 burners: 1 Jan 2016
- post 2005 non-complying burners & multi fuels: 1 Jan 2020 (Napier) 1 Jan 2018 (Hastings).

2 Air quality monitoring in Napier and Hastings

2.1 Napier

Air quality monitoring for PM_{10} has been carried out in Napier since 1998, initially at Nelson Park and since 2005 at Marewa Park. From 1998 to 2004, the method of measurement was gravimetric high volume sampling, which involves the collection and subsequent weighing of PM_{10} on a filter. From 2005 a beta attenuation monitor provided hourly average PM_{10} concentrations at Marewa. The BAM is an NES compliant PM_{10} monitoring method.

Table 2.1 shows summary statistics for PM_{10} monitoring in Napier from 2000 (note results are reported for two sites).

The NES for PM_{10} has been exceeded at the Marewa monitoring site since continuous monitoring began in 2005. It is also probable that the NES was breached on earlier years but was just not detected because of the high number of non-sample days. Table 2.1 shows annual average PM_{10} concentrations of around 16 µg m^{-3}. These are less than the annual average guideline for PM_{10} of 20 µg m^{-3} (MfE, 2000).

Table 2.1: Summary statistics for air quality monitoring in Napier from 2000 to 2011

Nelson Park - Napier	**PM_{10} 2000**	**PM_{10} 2001**	**PM_{10} 2002**	**PM_{10} 2003**	**PM_{10} 2004**	**PM_{10} 2005**	**PM_{10} 2006**	**PM_{10} 2007**	**PM_{10} 2008**	**PM_{10} 2009**	**PM_{10} 2010**	**PM_{10} 2011**
"Good" 0-33% of guideline	69%	81%	85%	82%	81%	67%	69%	65%	65%	68%	72%	71%
"Acceptable" 33-66% of guideline	19%	19%	9%	12%	13%	27%	28%	30%	29%	27%	23%	26%
"Alert" 66-100% of guideline	4%	0%	6%	6%	4%	4%	3%	4%	5%	4%	4%	2%
"Action" >Guideline	8%	0%	0%	0%	2%	2%	1%	1%	1%	1%	1%	1%
Percentage of valid data	7%	7%	15%	19%	23%	79%	100%	99%	99%	99%	100%	100%
Annual average (µg m-3)	14	11	11	12	13	16	16	16	16	16	15	15
Guideline exceedences (*extrapolated based seasonal variations)	14*	0	0	0	8*	5	3	5	4	3	3	4
99.7 %ile concentration (µg m-3)	64	33	43	44	69	65	70	62	59	53	60	53
Second highest concentration (µg m^{-3})							70	62	59	53	61	53
Annual maximum (µg m-3)	64	33	44	44	70	67	72	86	64	68	71	64
Number of records	26	26	53	68	83	288	364	361	362	362	365	364

2.2 Hastings

Air quality monitoring for PM_{10} has been carried out in Hastings since August 2003. The monitoring site is located at St Johns College, Jervois Street. Until 2006, the method of measurement was gravimetric high volume sampling, which involves the collection and subsequent weighing of PM_{10} on a filter. The sampling frequency was one day in three, with filters being exposed for the period from midnight to midnight on sample days. Since February 2006 continuous monitoring has been carried out using a Thermo Scientific FH 62 model beta attenuation monitor (BAM).

Table 2.2 shows summary results of PM_{10} monitoring in Hastings from 2004 to 2011.

Air quality monitoring for Hastings suggests that the annual average PM_{10} concentration in Hastings is around 17-19 µg m^{-3}. This compares with an annual average guideline for PM_{10} of 20 µg m^{-3}.

Table 2.2: Summary statistics for PM_{10} monitoring in Hastings from 2004 to 2011

St Johns College - Hastings	PM_{10} 2004	PM_{10} 2005	PM_{10} 2006	PM_{10} 2007	PM_{10} 2008	PM_{10} 2009	PM_{10} 2010	PM_{10} 2011
"Good" 0-33% of guideline	65%	40%	64%	62%	63%	65%	66%	67%
"Acceptable" 33-66% of guideline	22%	22%	24%	26%	26%	25%	23%	24%
"Alert" 66-100% of guideline	7%	15%	8%	8%	4%	7%	7%	6%
"Action" >Guideline	6%	23%	5%	4%	7%	3%	4%	3%
Percentage of valid data	32%	21%	100%	99%	99%	100%	100%	98%
Annual average (µg m-3)	17	25	19	18	19	18	17	17
Guideline exceedences	7	18	18	13	27	11	13	12
99.7 %ile concentration (µg m-3)	79	138	96	80	93	73	81	65
Second highest PM_{10} concentration			96	80	93	74	81	65
Annual maximum (µg m-3)	84	145	112	81	105	80	85	68
Number of records	116	78	365	362	363	364	365	357

3 Reductions required in PM_{10} concentrations – 2006 calculations

The reductions required in PM_{10} concentrations to meet the NES was estimated using a combination of existing air quality monitoring data and airshed modelling. The latter was used to predict concentrations under worst-case meteorological conditions.

The maximum PM_{10} concentration measured in Napier from 1998 to 2004 was 72 µg m^{-3} (24-hour average), measured in May 2006. In Hastings, the maximum measured PM_{10} concentrations was 144 (24-hour average) and was measured in June 2005. Air quality modelling, however, indicates higher concentrations are likely to occur under worst-case meteorological conditions (Gimson, 2006). Starting points for the straight line path of 95 and 170 µg m^{-3} are recommended for Napier and Hastings respectively by Gimson (2006).

The reduction required in PM_{10} concentrations to meet an air quality target of 50 μgm^{-3} (24-hour average), can be calculated using Equation 2.1.

$$R = 100(1 - \frac{t}{c}) \qquad \text{Equation 2.1}$$

where

R = the percentage reduction

t = the air quality target (e.g., 50 μgm^{-3})

c = the percentile concentration (e.g., 99.7 percentile concentrations for one allowable breach)

Based on Equation 2.1 the required reduction if the air quality target of 50 μgm^{-3} is to be met is 47% in Napier and 71% in Hastings.

4 Reductions required in PM_{10} concentrations – 2012 calculations

The reductions required in PM_{10} concentrations were re-evaluated in 2012 by Golder Associates (Gimson, 2012). The Golder and Associates report indicates that the peak modelled PM_{10} concentration at Marewa Park from 2005 to 2010 was 74 µg m^{-3}, of which 69 µg m^{-3} was from domestic home heating, 4 µg m^{-3} from natural sources and 1 µg m^{-3} from other sources. Reducing domestic heating emissions by 47% was predicted to result PM_{10} concentrations of 44 µg m^{-3} from this source and compliance with the NES of 50 µg m^{-3} at Marewa. However, a higher concentration of 89 µg m^{-3} was predicted a distance of two kilometres from the monitoring site in Pirimai (Gimson, 2012). Of this 83 µg m^{-3} was predicted from domestic heating with 4 µg m^{-3} coming from natural sources and 2 µg m^{-3} from other sources. The estimated reduction required in emissions from domestic home heating to achieve compliance with the NES in Pirimai was estimated at 47% (Gimson, 2012).

Based on Equation 2.1 the overall required reduction if the air quality target of 50 µgm^{-3} is to be met in Napier at Pirimai is 44%. This compares with a value of 47% used in previous management options assessments (Wilton, 2007) based on modelling carried out by Golder Associates (Gimson, 2006).

In Hastings, the peak modelled PM_{10} at St Johns College was 91 µg m^{-3}, comprising 88 µg m^{-3} from domestic heating, 2 µg m^{-3} from natural sources and 1 µg m^{-3} from other sources (Gimson, 2012). The highest concentrations were estimated to occur one kilometre to the north west of the St Johns monitoring site in the Mahora census area unit. The highest modelled concentration at this location was 96 µg m^{-3} of which 92 µg m^{-3} were from domestic heating, 2 µg m^{-3} from natural sources and 2 µg m^{-3} from other sources. The estimated reduction required in emissions from domestic home heating to achieve compliance with the NES at this site was estimated at 50% (Gimson, 2012).

Based on Equation 2.1 the overall required reduction if the air quality target of 50 µgm^{-3} is to be met in Hastings is 48%. This compares with a value of 66% used in previous management options assessments (Wilton, 2007) and an earlier assessment of 71% based on modelling carried out by Golder Associates which estimated maximum PM_{10} concentrations of around 145 µg m^{-3} (Gimson, 2006).

The Golder Associates report (Gimson, 2012) makes the following comments with respect to the previous (Gimson, 2006) modelled estimates of PM_{10} concentrations in Napier and Hastings:

"They incorporated some conservative assumptions and were somewhat higher than concentrations observed before 2006 at Marewa Park and St Johns College. A repeat of the calculation now would yield lower start points."

5 Management options assessment

The approach taken in this evaluation differs to the previous management options assessment (Wilton, 2007) which used the relative contribution of sources based on emission inventory emission estimates and projected changes in emissions.

In this evaluation, the emission estimates have been revised based on their relative contribution to worst case PM_{10} concentrations based on the updated Golder and Associates airshed modelling (Gimson, 2012). In the latter assessment, which is based on 2010 emission estimates, the contribution of domestic home heating to worst case PM_{10} concentrations is higher than estimated using an emission inventory approach. This, combined with the difference in reductions required, will influence the effectiveness of management options in meeting the NES.

The contributions of different sources to PM_{10} based on 2010 emission estimates were as follows:

- Napier – domestic heating 93%, natural sources 4% and other sources 2%.
- Hastings – domestic heating 96%, natural sources 2% and other sources 2%.

5.1 Napier

Figure 5.1 shows the previous projection of the effectiveness of management options included in the Resource Regional Management Plan Change 2 – Air Quality Plan in reducing PM_{10} concentrations in Napier. The revised effectiveness based on integrating results of modelling for 2010 are shown in Figure 5.2. Whilst it may seem intuitive that the lesser reduction in PM_{10} concentrations required based on the updated modelling (44% compared with 47% previously) would bring the projections line further below the NES this is not the case. This is because the 47% related to the 2006 emission levels whereas the 44% relates to 2010 emissions, which are estimated to be around 10% lower than 2006 emissions as a result of households replacing older burners at the end of their useful life and a prohibition on outdoor rubbish burning.

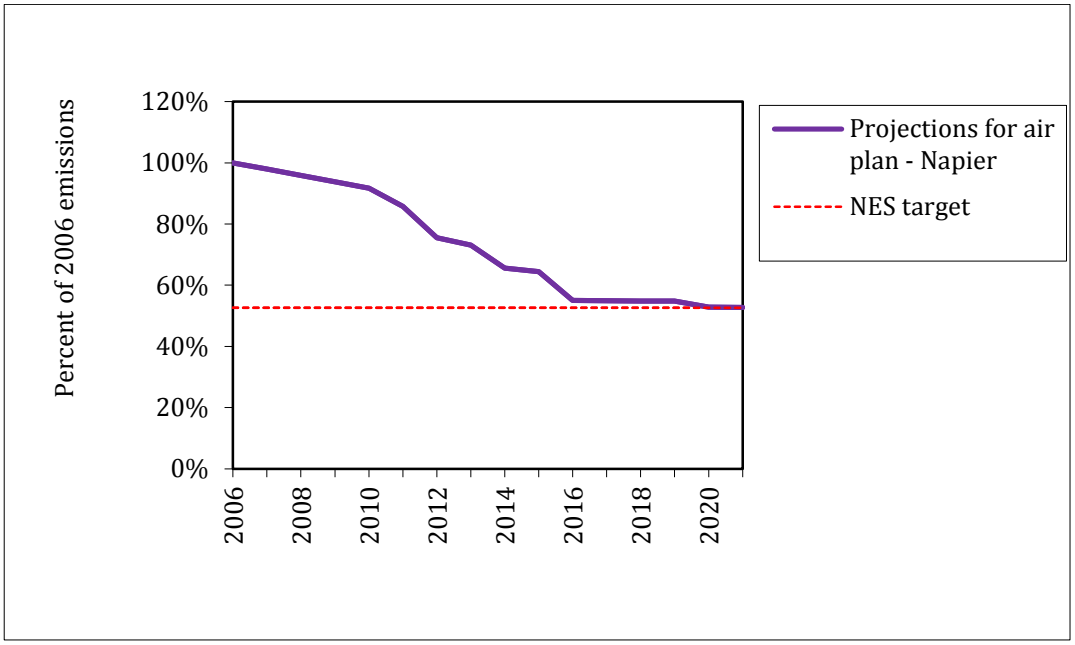

Figure 5-1: Previous assessment of the effectiveness of management options for Napier

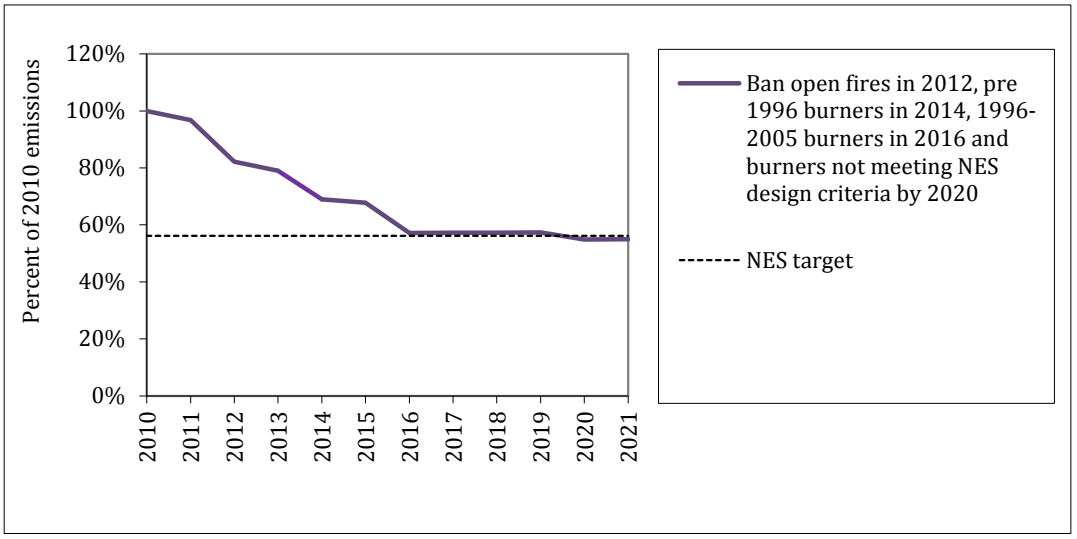

Figure 5-2: Revised assessment of the effectiveness of management options for Napier

5.2 Hastings

Figure 5.3 shows the previous projection of the effectiveness of management options included in the Resource Regional Management Plan Change 2 – Air Quality Plan in reducing PM_{10} concentrations in Hastings. The revised effectiveness based on integrating

results of modelling for 2010 are shown in Figure 5.4. Unlike the Napier scenario, the difference between the original reduction required (66%) and the 2012 evaluation of a 48% reduction is not outweighed by changes in emissions from 2006 to 2010. Thus the impact of the revised modelling is significant in that the proposed management options are now predicted to comfortably meet the NES by 2016. It is noted however that the assessment is based on the assumption that 40% of households currently using solid fuel heating methods will convert to non-solid fuel options. Figure 5.5 suggests that this percentage may be lowered to around 10% of households and the NES may still be achieved.

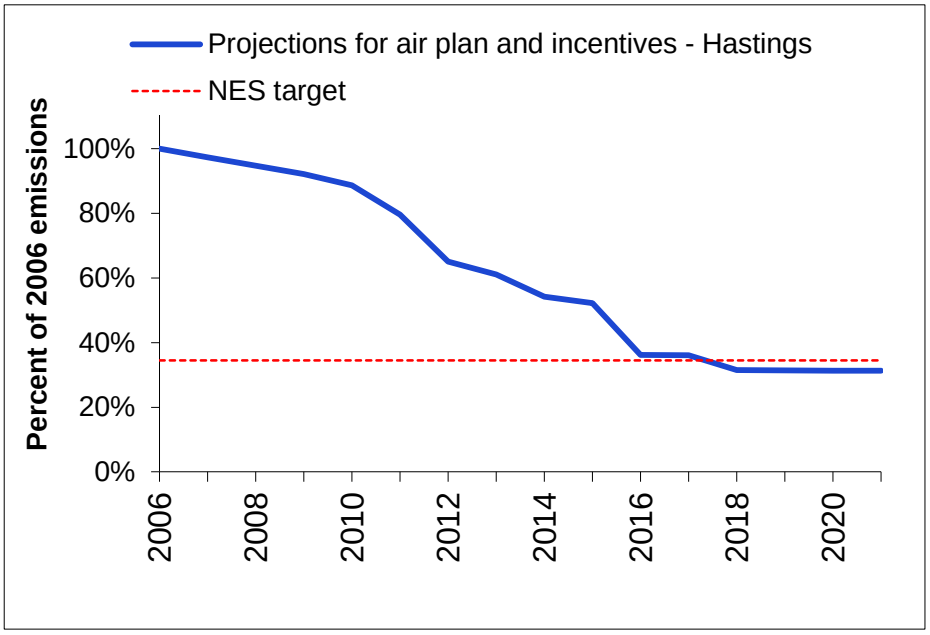

Figure 5-3: Previous assessment of the effectiveness of management options for Hastings

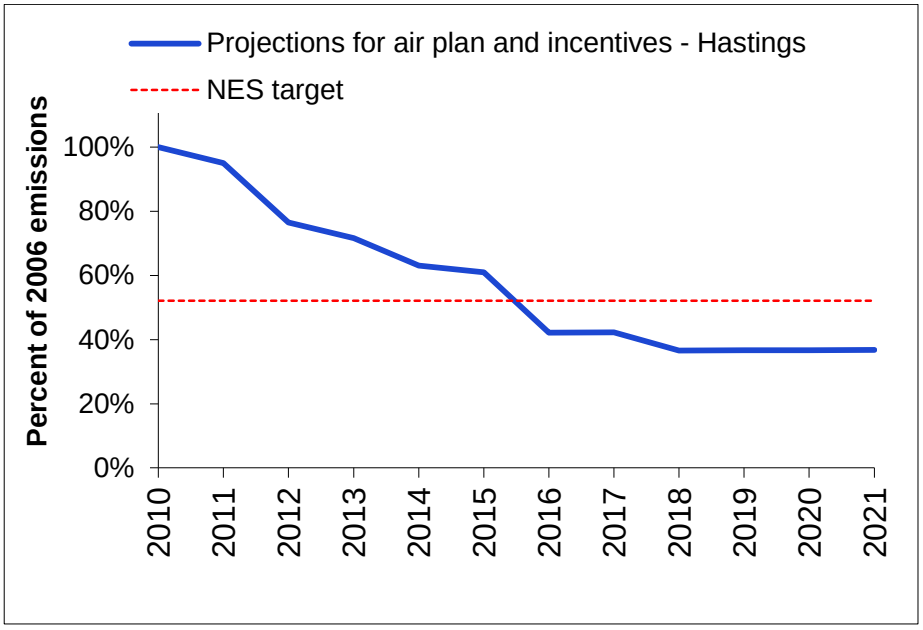

Figure 5-4: Revised assessment of the effectiveness of management options for Hastings

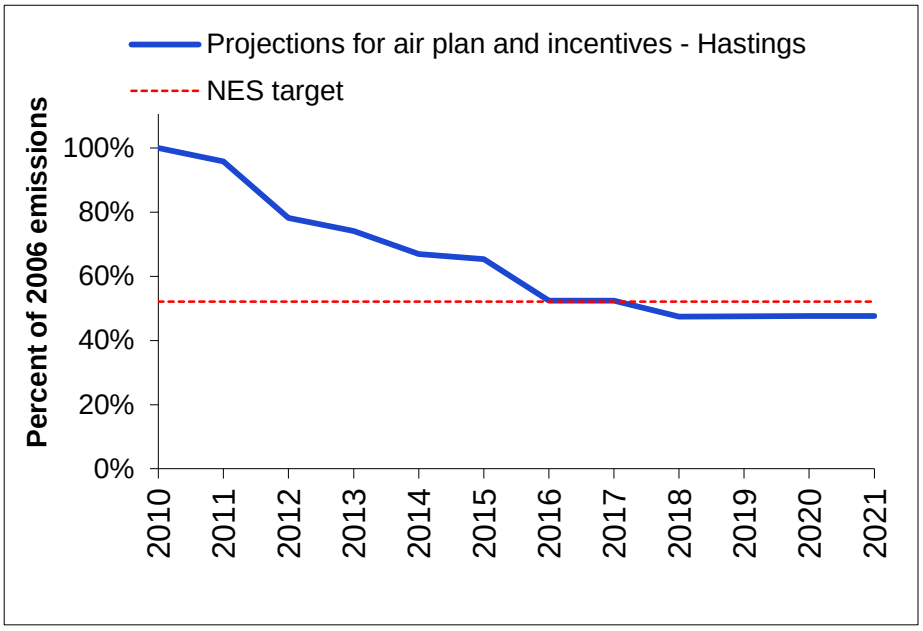

Figure 5-5: Revised assessment of the effectiveness of management options for Hastings assuming only 10% of households convert to non-solid fuel alternatives.

6 Wood burner removals in Napier and Hastings

6.1 Napier

There were an estimated 11000 households using solid fuel burners in 2010 in Napier. Of these around 1800 are estimated to be compliant with the NES design criteria for wood burners. To meet the NES all households using solid fuel burners but not complying with the NES design criteria for wood burners (around 9000) would need to upgrade (from open fires, multi fuel burners or older wood burners) to NES compliant wood burners or cleaner heating options. Modelling has been done based on the assumption that all households can convert to wood burners. However, some households converting to non-solid fuel heating options would increase the certainty of compliance with the NES.

This is based on the assumption that all NES compliant burners installed have not been tampered with (for example, to reduce the oxygen supply) and result in an average real life emission of around 4 grams of particulate per kilogram of fuel burnt.

Figure 6.1 shows the likely distribution of older wood burners, open fires and multi fuel burners in Napier.

6.2 Hastings

In Hastings there were an estimated 8700 households using solid fuel burners in 2010. Of these around 1500 are estimated to be compliant with the NES design criteria for wood burners. To meet the NES around 7100 households would need to upgrade (from open fires, multi fuel burners or older wood burners) to NES compliant wood burners or clean heat alternatives. The minimum number for converting to clean heating alternatives is 940.

This is based on the assumption that all NES compliant burners installed have not been tampered with (for example, to reduce the oxygen supply) and result in an average real life emission of around 4 grams of particulate per kilogram of fuel burnt.

Figure 6.1 shows the likely distribution of older wood burners and open fires and Figure 6.2 shows the distribution of households using coal in Hastings and Napier. High density wood burning areas could be targeted for incentives to encourage upgrading and the replacement of wood burners with non-solid fuel alternatives.

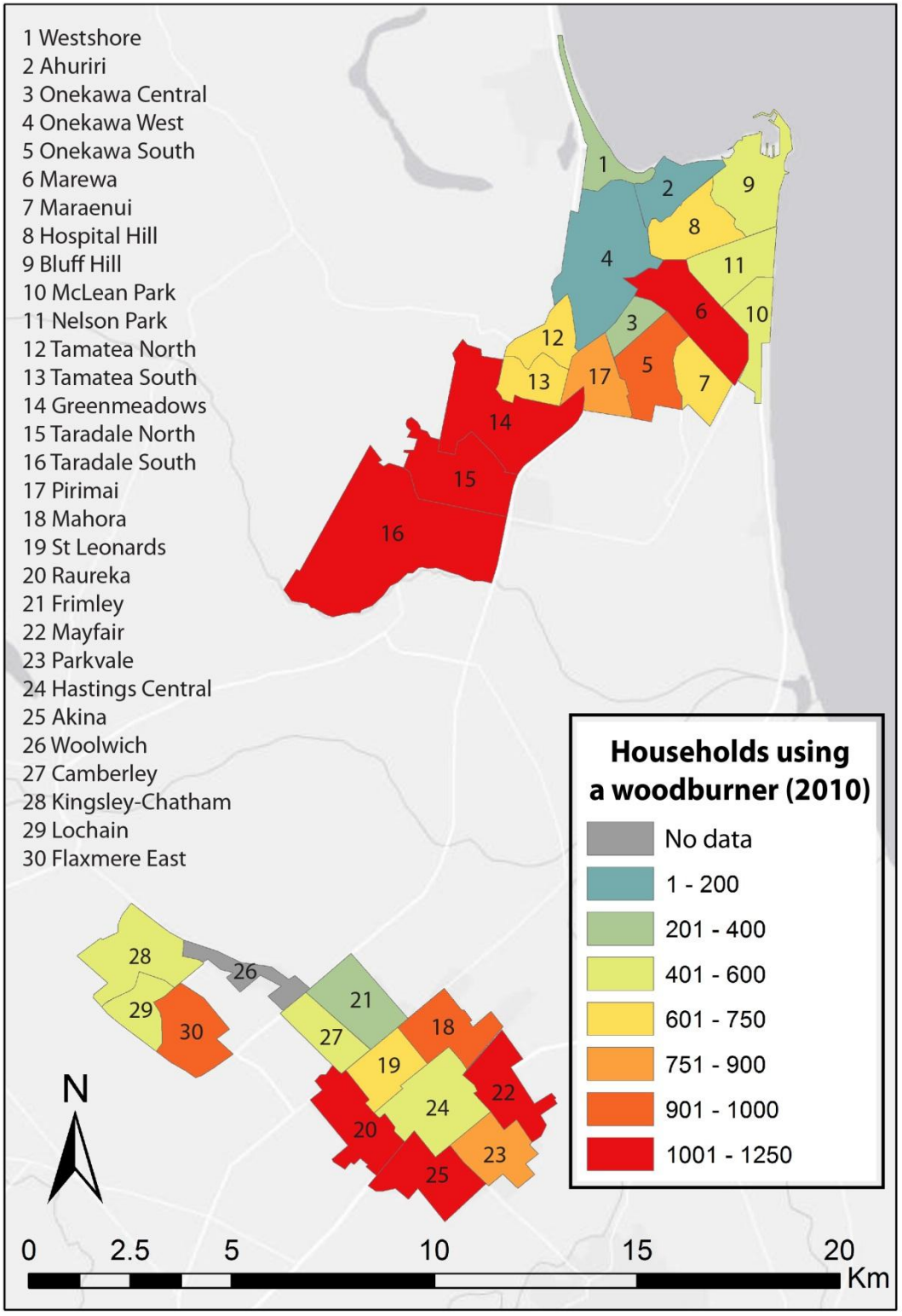

Figure 6-1: Spatial distribution of wood burning in Napier and Hastings

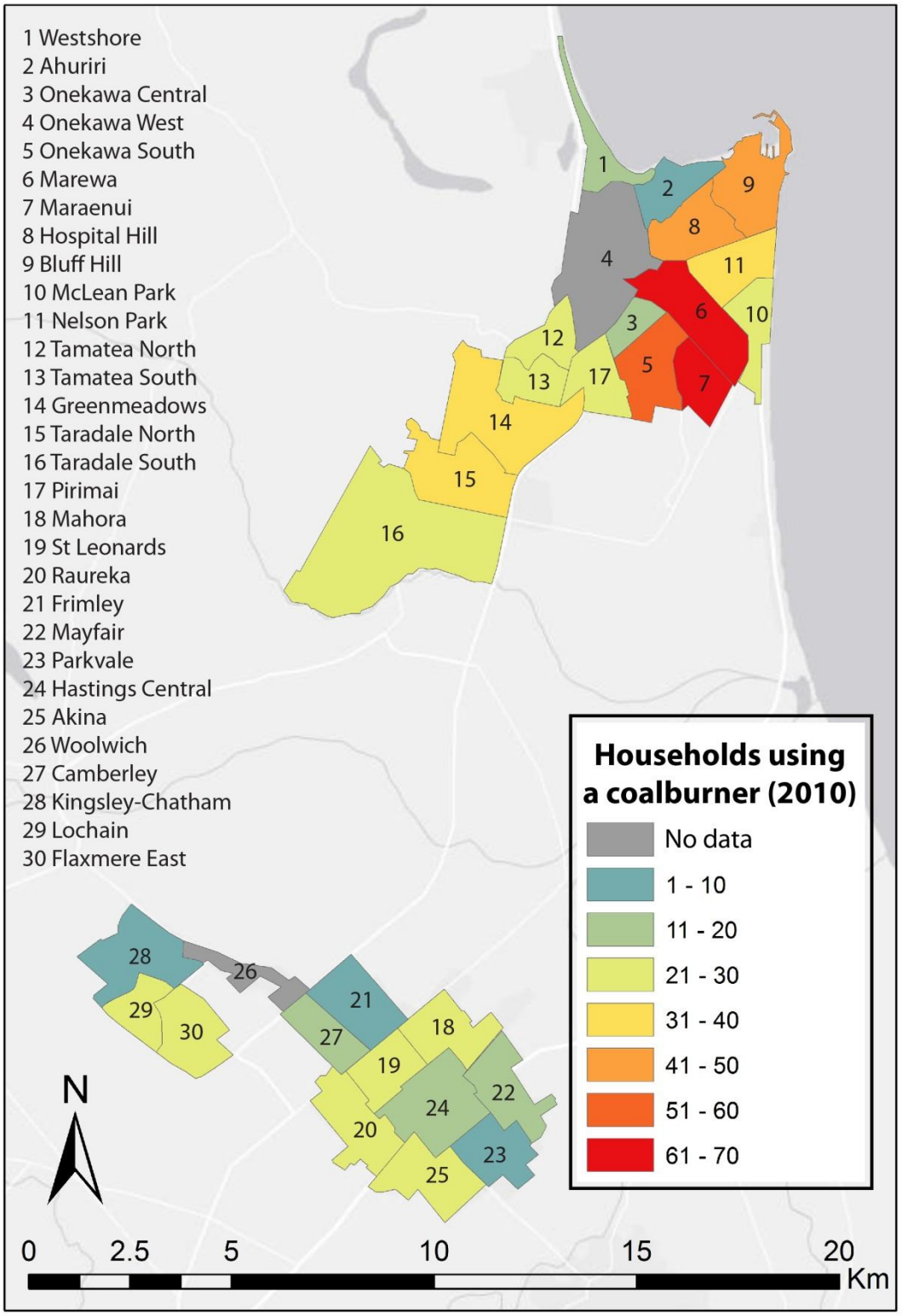

Figure 6-2: Spatial distribution of coal burning in Napier and Hastings

7 Summary

The NES for PM_{10} is breached in both Napier and Hastings and management measures have been introduced to reduce PM_{10} from domestic heating and outdoor rubbish burning. Previously reductions of 47% (Napier) and 71% (Hastings) established through earlier modelling were updated based on 2010 emissions and meteorology from 2005 to 2010 (Gimson, 2012). Based on that modelling, overall reductions of 44% (Napier) and 50% (Hastings) were identified.

The assessment of the effectiveness of management options in reducing PM_{10} concentrations in Napier and Hastings was updated to integrate changes to the reductions required (and the 2010 baseline) and the relative contribution of sources based on modelled contributions to concentrations. Results show management measures may be marginal in terms of meeting the NES for PM_{10} in Napier by 2016. However, in Hastings fewer households than originally estimated may need to convert to non-solid fuel alternatives when replacing burners.

In Napier around 9000 households would need to upgrade (from open fires, multi fuel burners or older wood burners) to NES compliant wood burners or clean heating alternatives to meet the NES by 2016. It may be possible for all households to convert to NES compliant burners in Napier although there would be greater certainty of meeting the NES if some households convert to cleaner heating options.

In Hastings around 7100 households need to upgrade (from open fires, multi fuel burners or older wood burners) to NES compliant wood burners or clean heating alternatives to meet the NES by 2016. Of these the minimum number for converting to clean heating alternatives is 940.

References

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