## Appendix 2: Summary of science informationto give context for domestic emission reduction goals

*Science gives context for New Zealand's contribution to global climate goals*

1. Under the Paris Agreement, countries set a collective goal of "holding the increase in the global average temperature to well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 degrees Celsius" and aim "to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century". Each country determines its own contribution to these goals.
2. These goals aim to avoid "dangerous anthropogenic interference with the climate system" (as agreed in the 1992 UN Framework Convention on Climate Change) and are based on scientific evidence about the expected effects of climate change.
3. Science also provides a great deal of information about how to achieve these goals. This Appendix summarises some of this: the global requirement to reduce greenhouse gas (GHG) emissions; the distribution between countries of the required effort; and the behaviour of different gases. It also informs development of technologies to reduce emissions and methods of assessing their effectiveness.
4. However, many important decisions about New Zealand's overall ambition and the nature of the Target depends on our national circumstances and cannot be informed by scientific evidence alone.

*Alignment of global emissions with temperature goals*

5. Scenarios of future global emissions have been developed using economic models, under various assumptions of global social and economic development. These have been assessed by the Intergovernmental Panel on Climate Change (IPCC) for their ability to meet global temperature goals.
6. Pathways likely to limit warming to below 2 degrees Celsius relative to pre-industrial levels would require substantial emissions reductions over the next few decades and near zero emissions of $CO_2$ and other long-lived GHGs by the end of the century.
7. Work since the Paris Agreement has identified pathways that limit global warming to the more stringent goal of 1.5 degrees Celsius, and these have been assessed in an IPCC Special Report completed in October 2018:
   - global $CO_2$ emissions in these pathways reach net-zero around mid-century
   - non-$CO_2$ emissions show deep reductions that are similar to those in pathways limiting warming to 2 degrees Celsius
   - global agricultural methane emissions in 2050 are 24 − 47 per cent below 2010 levels
   - global GHG emissions (including methane) reach net zero around 2070.

*The global effort will be distributed between countries*

8. The global emissions scenarios are subdivided into five country groups, and New Zealand sits in the OECD90 group of developed countries. The year net zero $CO_2$ emissions is reached by the OECD90 group is not significantly different to that for the world as a whole.
9. In scenarios that limit global warming to 1.5 degrees Celsius, OECD90 countries make cuts to methane emissions more stringent than the global average (about 60 per cent below 2010 levels by 2050, compared to 50 per cent cuts globally). Agricultural methane emissions reduce less than total methane, but in this sector too, OECD90 countries make greater reductions than the global average. For context, it should be noted that in regard to

emissions of methane from agriculture, New Zealand is a highly atypical member of the OECD90 group.

*Short-lived and long-lived greenhouse gases have different effects on the climate*

10. Different GHGs have different potency and atmospheric lifetimes, and therefore different impacts on the climate. For mitigation purposes, including setting targets and policies, it is useful to compare the effects of different gases.

11. Methane is a short-lived GHG. More than half the methane in the atmosphere decays after 12 years, and after 50 years about 98 per cent is gone. In contrast, about half of each carbon dioxide emission is removed within a few decades, but the remainder stays in the atmosphere for much longer. About 15 to 40 per cent is still in the atmosphere after 1000 years.

12. To limit warming, emissions of long-lived gases must be reduced to net zero, and emissions of short-lived GHGs must stabilise at a ‘sustainable’ level. There is no consensus on what that ‘sustainable’ level is, and it is not a purely scientific question - it depends on political, economic and social choices, as well as technological developments and progress on reducing long-lived GHGs. However, as described above, scenarios consistent with the Paris Agreement temperature goals entail methane emission reductions of around 50 per cent.