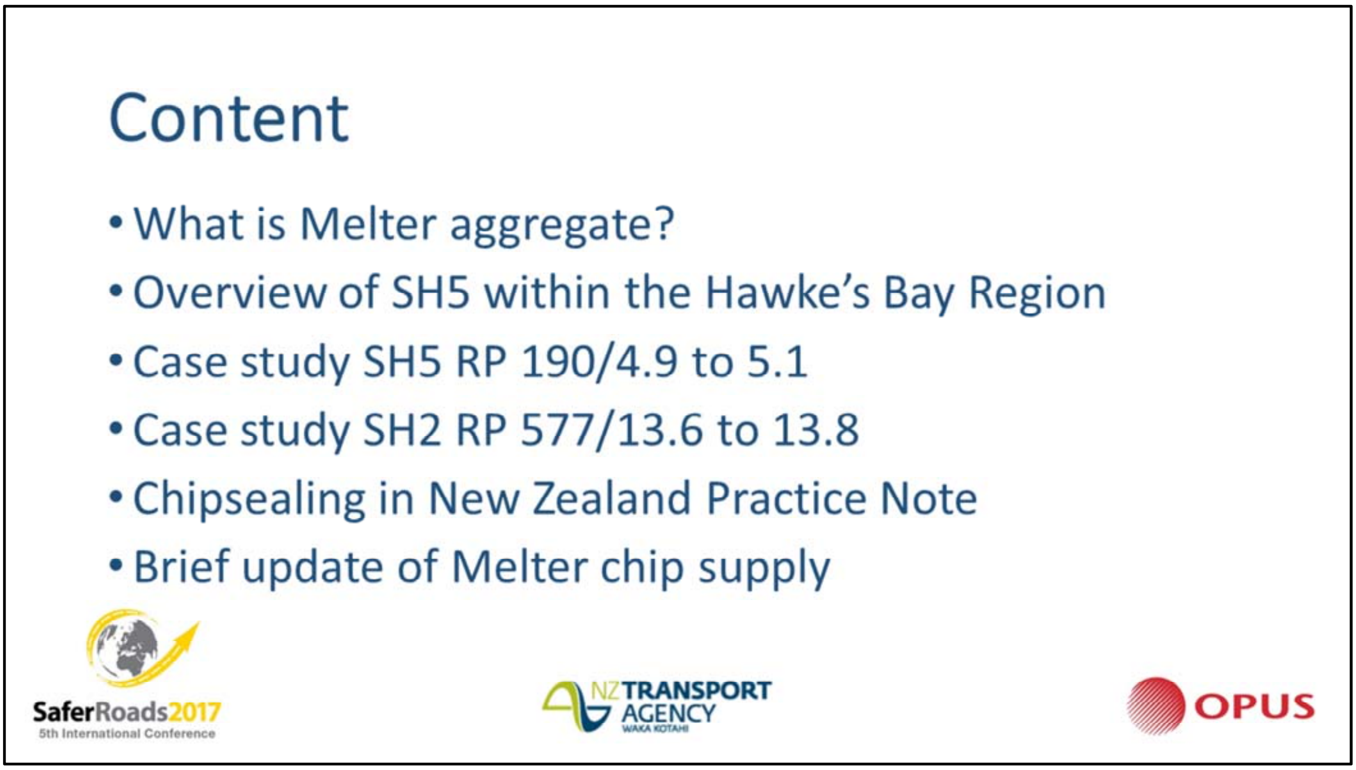
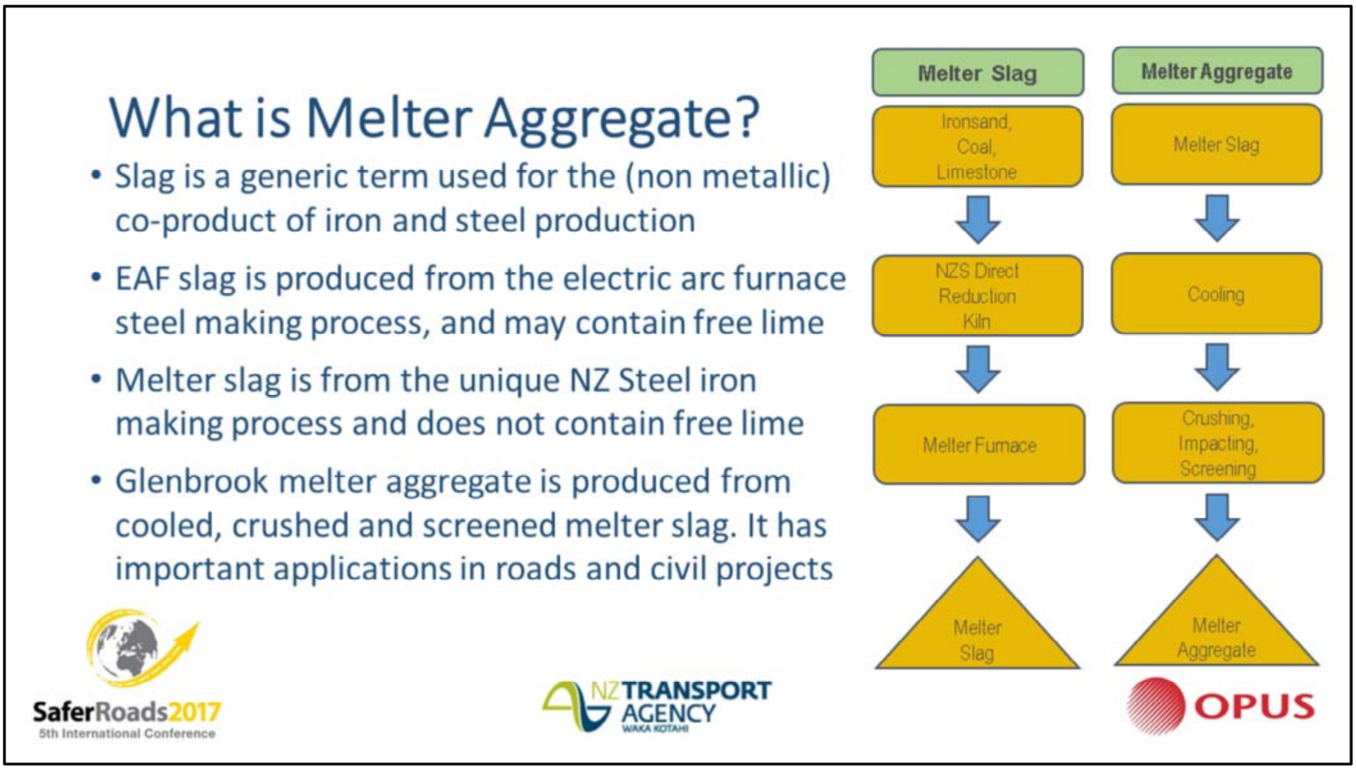
1. This presentation is an opportunity to bring you a brief update on the use of melter aggregate in chip seals on New Zealand State Highways.

2. Melter chip has been shown to provide consistent skid performance on high demand sites resulting in a decrease in wet Loss of Control (LOC) vehicle accidents.

3. As a result chip seal lives can be extended until replacement is required for distress other than polishing.



1. Briefly look at how melter chip is produced in New Zealand.
2. Look at the successful use of melter chip for reseals on SH5 (part of the National state highway roading network) within the Hawke's Bay region.
3. We will look at two specific accident sites where melter chip seals have been constructed to reduce wet LOC accidents.
4. Site 1, on SH5 between Napier and Taupo.
5. Site 2, on SH2 between Napier and Wairoa.
6. I will talk about Chipsealing in New Zealand and the melter aggregate practice note.
7. And will finish with a quick update on the availability of melter chip for use in chip seals throughout New Zealand.



1. Excellent material on the New Zealand Steel website www.nzsteel.co.nz.

2. "The steelmaking operation at New Zealand Steel's site at Glenbrook is a unique process that uses ironsand found on the local coast and turns it into iron and steel – no other steelmaking operation in the world makes steel in the same way."

3. "The main by-product of steelmaking is slag (known as steel aggregate). Slag is non-metallic residue from the iron and steelmaking processes. It contains minerals such as silica, alumina and titania from the ironsand and other combinations of calcium and magnesium oxides, derived from other raw materials. It is produced in four different processes of the steelmaking operation. In the iron melters, iron slag is formed by fusion of limestone, ash and other fluxes added to the original ironsand (silica, aluminium, titanium). Iron slag is less dense than the molten iron in the large melters and so floats on top of the iron. This allows the slag to be tapped (poured) from the melter separately."

4. Melter aggregate is crushed from melter slag and is used for constructing pavements, filter materials, asphalt (asphaltic concrete / hot mix) production and more recently as sealing chip.

Melter Chip?

- Is crushed from melter slag to meet the NZ Transport Agency specification for sealing chip
- Generally has a rough, porous (vesicular) appearance
- Is hard and durable with good crushing resistance
- Provides good on-road skid performance

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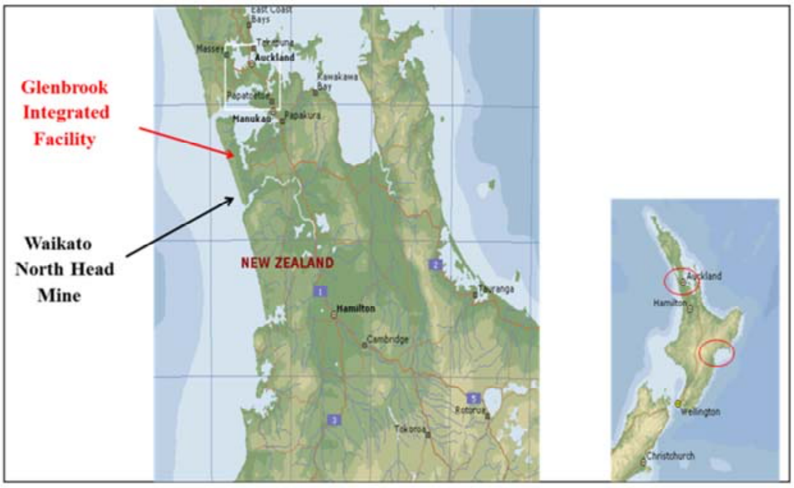
1. All sealing chip used on New Zealand’s state highways and most local authority roads must be crushed to meet the NZTA M6 specification for sealing chip.

2. This specification sets out the material requirements including strength, durability, polishing value, cleanness, size and shape for sealing chip.

3. While melter chip is hard and durable the vesicular nature of the stone means that additional fines can be generated in the crushing test as material is broken from the thin walls of the vesicles. This was a possible stumbling block early in the use of melter chip so an amendment to NZTA M6 allowed for an additional 3% of fines to be generated above the 9% limit specified for natural aggregates.

4. Annual SCRIM testing has shown melter chip maintains acceptable on-road skid performance where chip from natural aggregates have traditionally polished. So the evidence to date is that melter chip will extend chip seal lives by maintaining acceptable skid resistance on high demand sites.

Melter Chip Production



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1. The New Zealand Steel mill is located at Glenbrook approximately 50km south of Auckland city and just west of Pukekohe.

2. The Iron sand is mined at a number of sites from Port Waikato to as far south as Taharoa on the west coast of the North Island.

3. The cart distance from Glenbrook to the regional state highway boundary on SH5 is approximately 320km.

4. All of the local Hawke's Bay sealing chip is crushed from hard river worn greywacke stone extracted from local rivers. While this aggregate is very hard and extremely durable it polishes quite quickly to low SCRIM values on sites with high traffic stresses.

5. Since the introduction of the NZTA T10 skid resistance management specification all high polish stone value (PSV) sealing chip calculated to meet the traffic stresses of high demand sites in Hawke's Bay has needed to be imported from outside of the region.

6. This and the poor performance of some imported high PSV chip reinforced the need to look at other possible aggregates and so the trials using melter chip on SH5

began.

Hawke's Bay History using Slag Aggregate

- 1999 EAF slag trials in NZ – three sites were constructed in the Hawke's Bay region
- 2006 saw the introduction of melter chip reseals
- Originally limited to low risk sites on SH5
- 2010 Specified for use on **ALL** SH5 reseals
- Prioritised for use on high demand sites

throughout the Hawke's Bay region

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1. Hawke's Bay (HB) history applies to the State Highway network under the control of the NZ Transport Agency and not the various other local authority roading networks.

2. In 1999 trials using sealing chip crushed from electric arc furnace (EAF) slag were constructed around the country. Three trial sites were constructed on the Hawke's Bay SH network. SCRIM measurements recorded following the construction of these trial sites showed an unacceptably low skid performance so further use of EAF chip was banned.

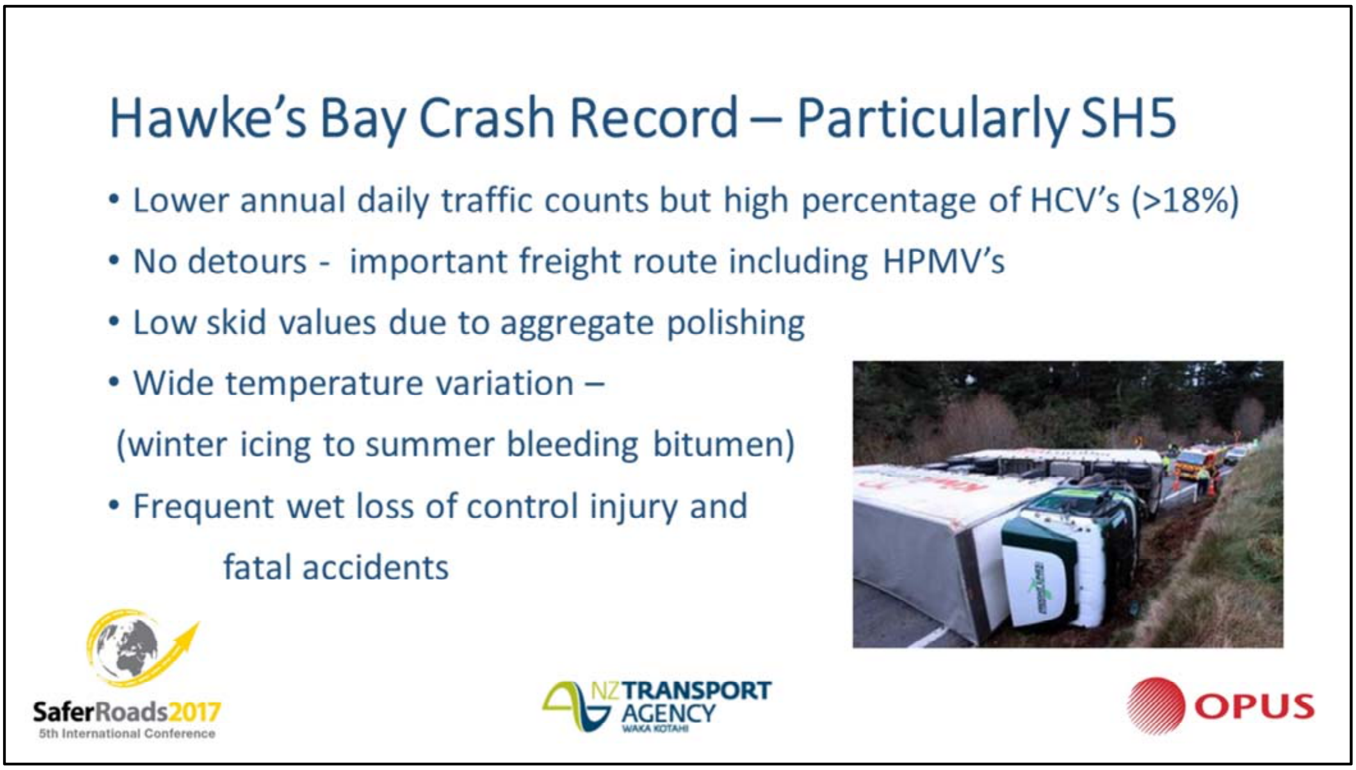
3. So when we looked to trial melter slag chip seals we initially choose relatively low demand sites just in case it did not perform as well as we were hoping.

4. Initial SCRIM testing showed very good skid performance so melter chip seals were constructed on high demand sites. SCRIM testing of these sites also showed good skid resistance.

5. As the melter chip continued to provide good skid resistance on high demand sites and there were high numbers of wet loss of control (LOC) accidents on SH5 the 2010 maintenance contract specified all chip seals on SH5 were to be constructed using melter chip. However this requirement changed in subsequent years so that melter chip could be used on other high demand sites throughout the HB region

particularly where there were wet LOC accidents.

6. Note the road marker is yet to paint the edge lines in the photograph on the right where the site has been resealed using melter chip.



1. SH5 is the main route between Napier and Taupo in the centre of the North Island. In fact it is the only route between these two centres unless you take a significant detour on local roads not designed for the weight and volume of traffic that SH5 carries.

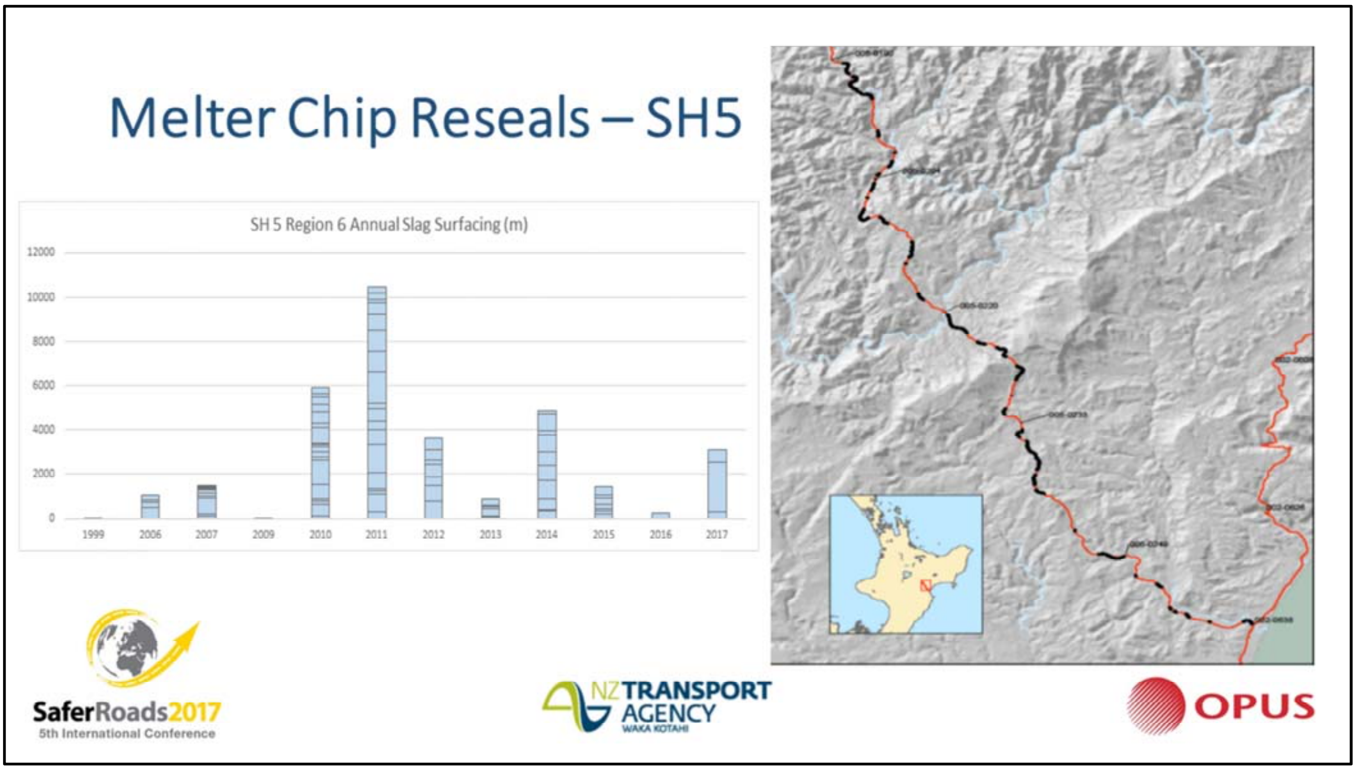
2. While the annual average daily traffic is relatively low with approximately 2,600 vehicles travelling between Napier and Taupo there is a significant percentage of heavy commercial vehicles.

3. There is no direct rail link to Hawke's Bay from the north so significant freight is moved across this road by heavy vehicles including high productivity motor vehicles (HPMV's) permitted to carry longer and heavier loads than normal heavy commercial vehicles. There are also large pine plantations between Napier and Taupo so there can be significant changes in logging truck counts depending on log prices and harvesting programmes.

4. The alignment of SH5 is curvilinear and has some significant changes in elevation from sea level at the coast to three summits at around 720m. The weather variation between summer and winter is significant with a range in pavement surface temperatures between +55 to -3 degrees Celsius. So there are sections of the road that will be treated for bleeding bitumen in summer and treated for ice in the

winter. There can also be long periods of dry weather in the summer and very heavy rainfall in the winter.

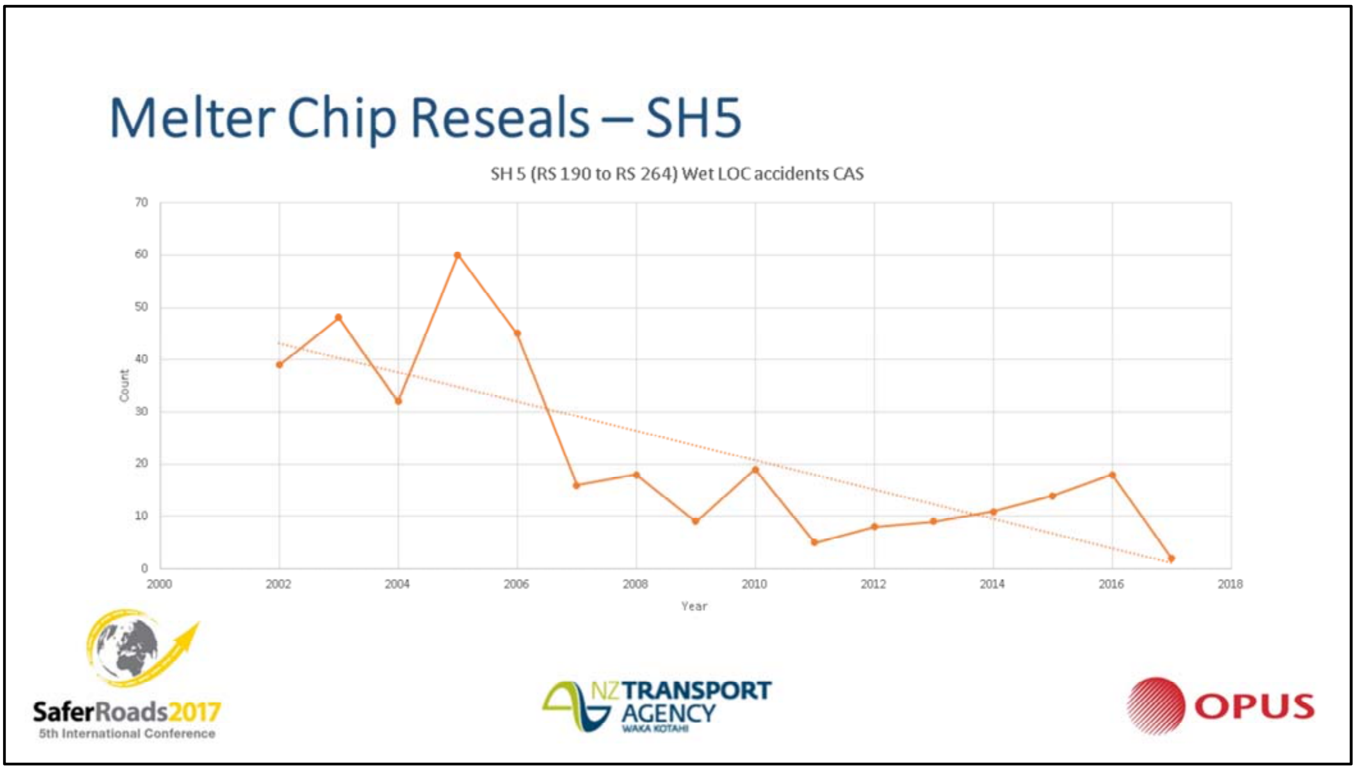
5. From a safety perspective the major concern was the high number of wet LOC injury and fatal accidents.



1. The chart on the left shows the number and length of chip seals using slag based chip since the trials of EAF chip in 1999.

2. From 2006 the melter chip seals were being trialled and you can see the large increase from 2010 when melter chip seals were specified in the maintenance contract. From 2012 the number and length of melter chip seals reduced as other high demand skid sites throughout the remainder of the network were resurfaced using melter chip.

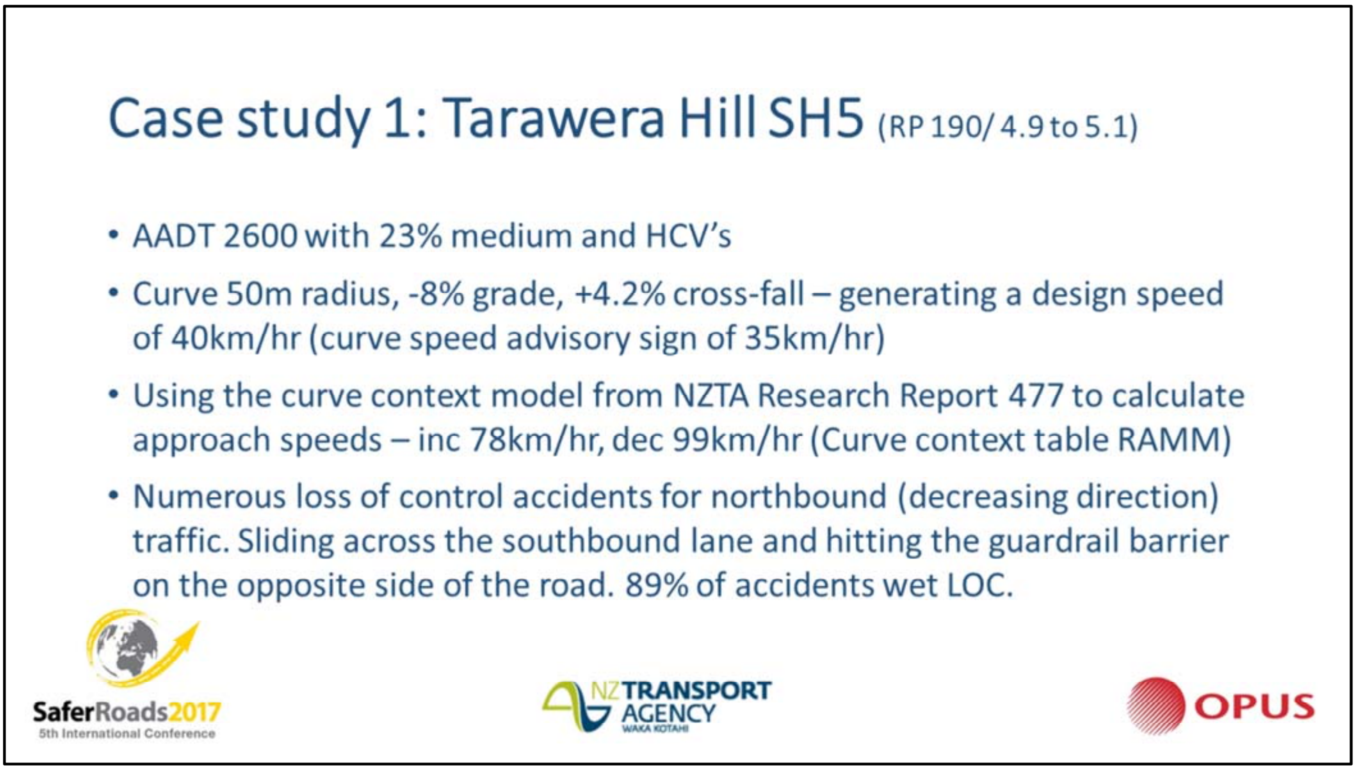
3. The map to the right shows the curvilinear alignment of SH5 and where melter chip seals have been completed, particularly on the higher demand curves.



1. This graphs shows that there has been a significant drop in wet road LOC accidents on SH5.

2. We believe that this significant reduction is in part due to the progressive sealing of high demand skid sites with melter chip.

3. The introduction of the T10 skid resistance specification, completion of safety improvements, education, Policing and ABS will also have contributed to the reduction in wet road LOC accidents.

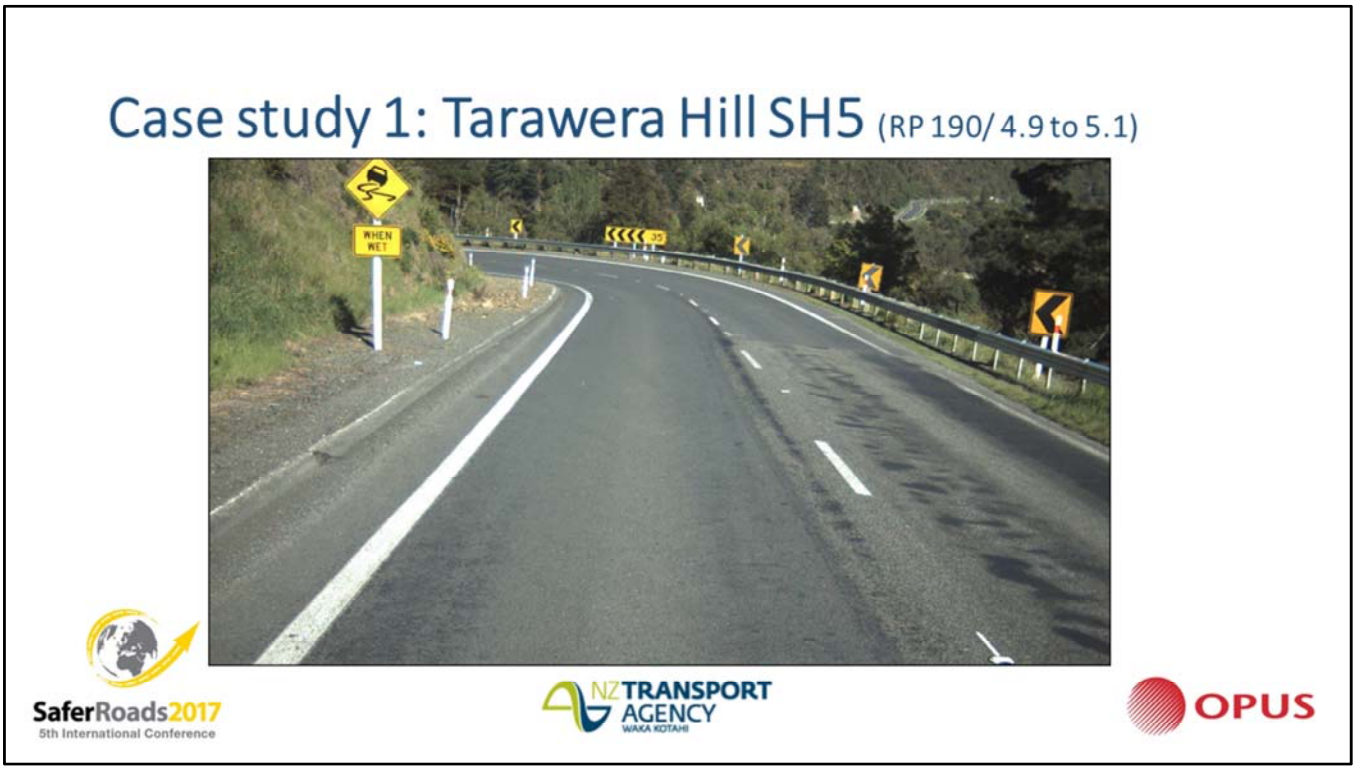


Case study 1

1. Site 1, is located on SH5 close to the Hawke's Bay regional boundary. This section of the highway is in hilly (some would call mountainous) terrain and is a particularly curvilinear alignment.

2. The curve context data in the RAMM data base has been calculated using the curve context model published in NZ Transport Agency Report 477. This calculates the design speed of the curve to be 40km/hr and the down hill approach speed to the curve to be 99km/hr.

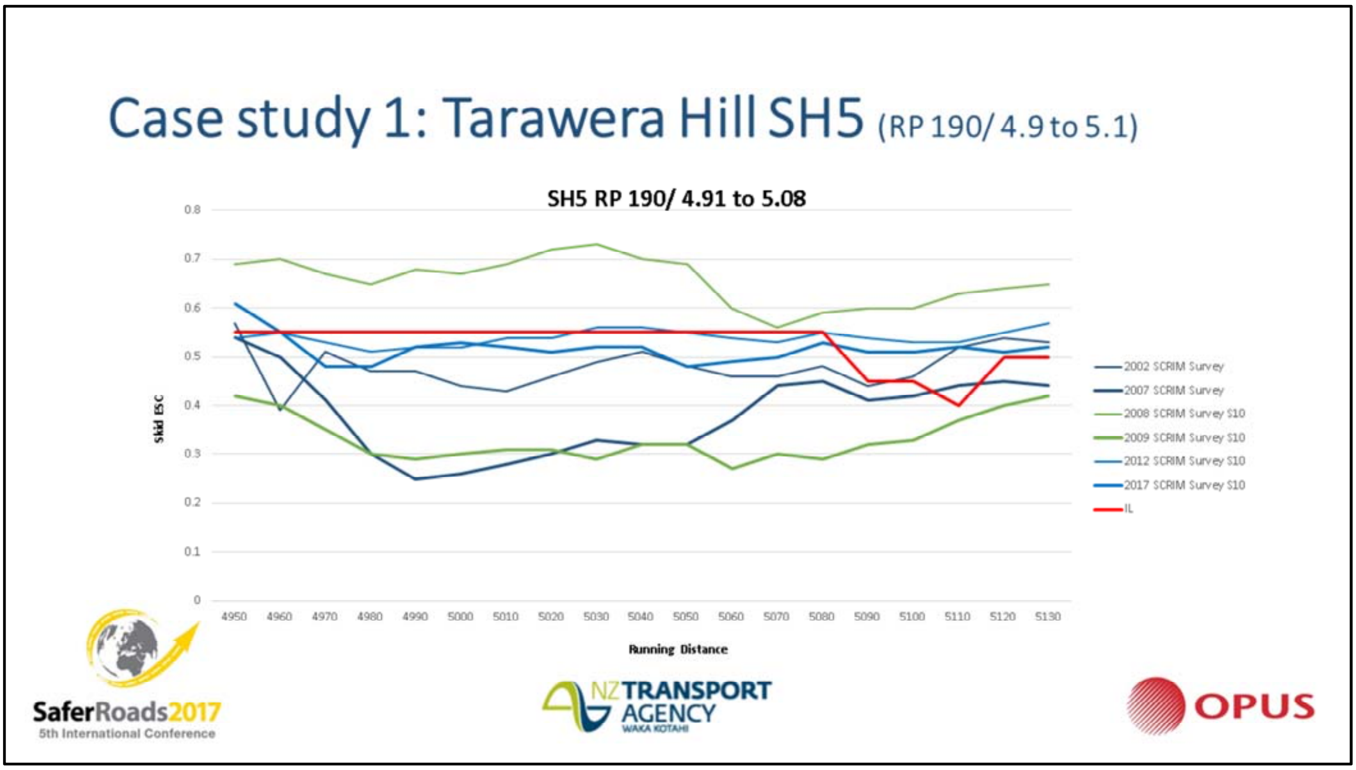
3. The general nature of the accidents was north bound vehicles coming over the crest of the hill would increase speed on the 220m down hill gradient and then realise they were travelling to quickly to negotiate the tight 50m radius curve. This would cause them to brake heavily which caused a number of vehicles to lose control and slide across the southbound lane hitting the guardrail on the opposite side of the road particularly when the road surface was wet.



1. This photograph taken from the November 2016 high speed data collection video gives some idea of the terrain and road alignment. There is a reasonable back drop of foliage beyond the curve and signage highlighting the curve and advisory sign of a slippery road surface when wet.

2. However none of that helps when you are travelling too quickly and need to brake heavily to negotiate the very tight curve ahead and the surface is providing very little in the way of skid resistance.

3. The melter chip seal was almost 7years old when this photograph was taken. Visually it appears to be performing well for northbound traffic.



1. This curve is a site category 2 high which has a Investigatory Level (IL,ESC) of 0.55 shown by the red line.

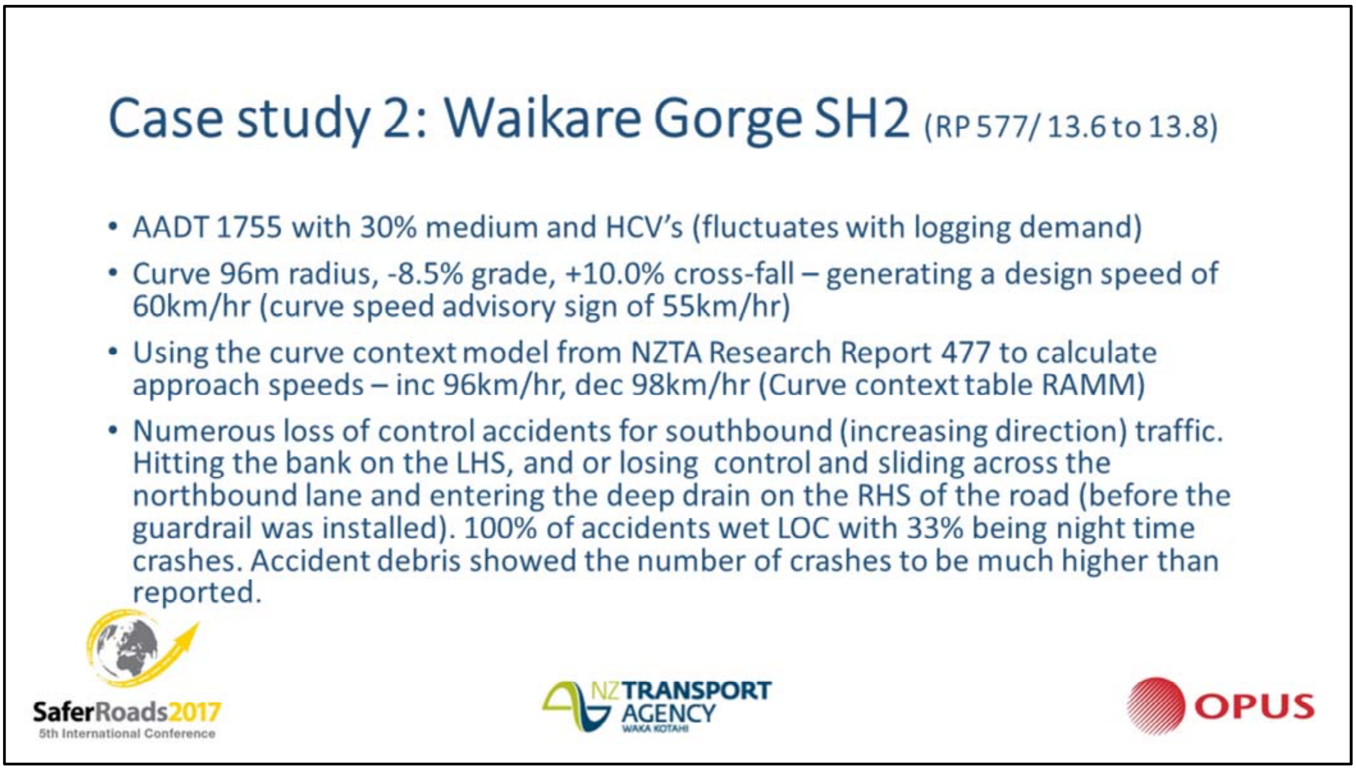
2. In 2001 a Poplar Lane (~58 PSV) 3/5 two coat seal was constructed. The 2002 SCRIM survey was the first following construction and shows that the skid values had already polished to near the Threshold level (TL) which is 0.10 below the IL. Over a period of five years the skid values dropped significantly to below 0.30 ESC over a 40m length.

3. In 2007 a Linton Quarry (~58-60 PSV) 3/5 two coat seal was constructed. The 2008 survey show excellent skid values but the skid values dropped quickly and significantly as shown in the 2009 survey. The results of the 2009 survey are likely to have been affected by chip embedment as the pavement was recycled in late 2009.

4. In 2011 a Glenbrook melter chip 3/5 two coat seal was constructed. The 2012 SCRIM survey shows the skid values provided by the melter chip to sit just below the investigatory level at an average of 0.54 ESC. The 2017 survey shows that the melter chip although it has polished slightly is maintaining good skid values at an average of 0.52 ESC. The life of the melter chip seal already exceeds the lives of the previous two chip seals.

5. The crash data shows no wet LOC accidents recorded on this curve since the construction of the melter chip seal and is supported by the absence of accident debris and damage to the guard rail.

6. Note:- ESC is Equilibrium SCRIM Coefficient which is skid values that have been adjusted for within year and between year variations.



Case study 2

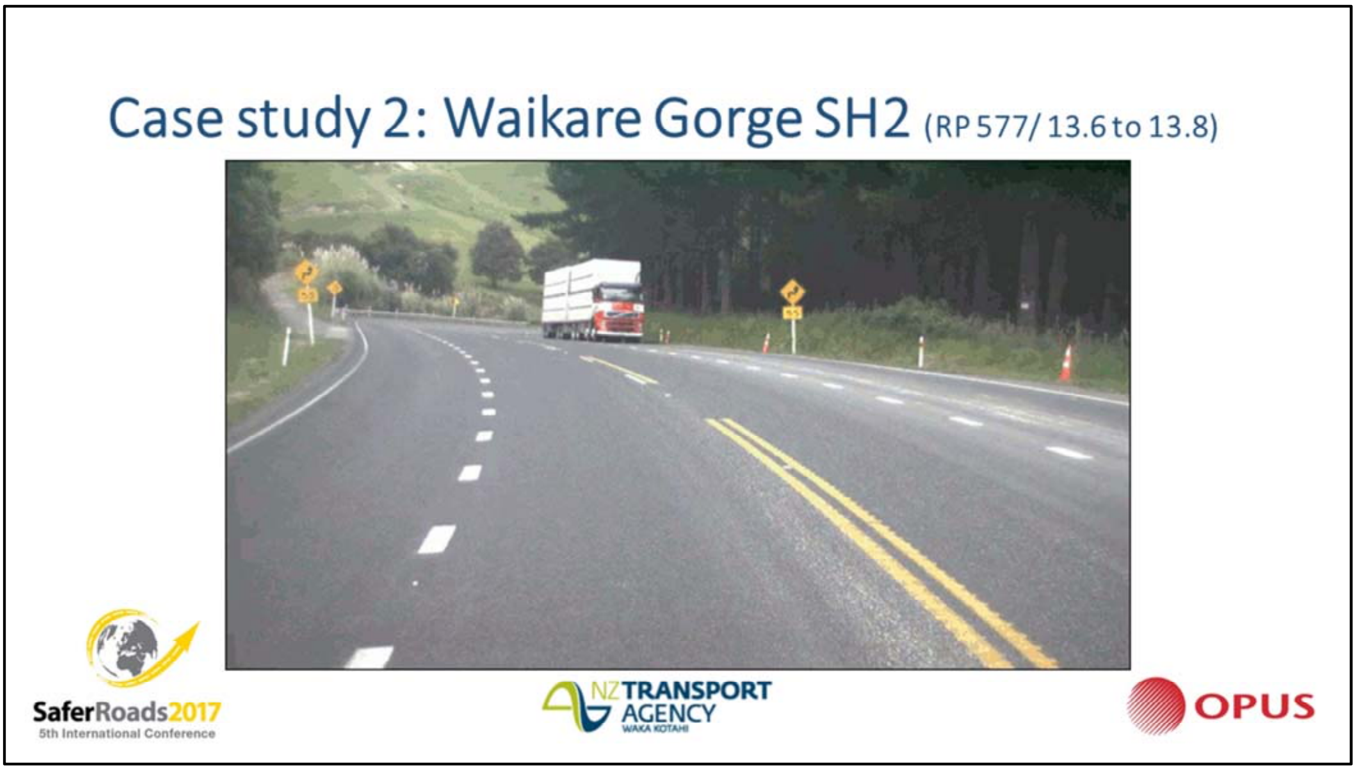
1. Site 2, is located on SH2 between Napier and Wairoa. This site is on the northern side of the Waikare gorge and is in hilly terrain with curvilinear alignment.

2. The rail link between Napier and Wairoa has been closed for some years. There are large pine forests north of Napier so while the annual daily traffic count is low there is a high percentage of heavy freight and logging trucks.

3. The site has three back to back curves that start the decent into the Waikare river valley. The curve context data in the RAMM data base states the design speed of the curve to be 60km/hr and the down hill approach speed to be 96km/hr.

4. The general nature of the crashes was vehicles entering the down hill curves at speed (particularly if they were passing vehicles using the slow vehicle passing bay) losing control and either hitting the bank on the left side of the road or sliding across the road into the deep drain on the RHS of the road.

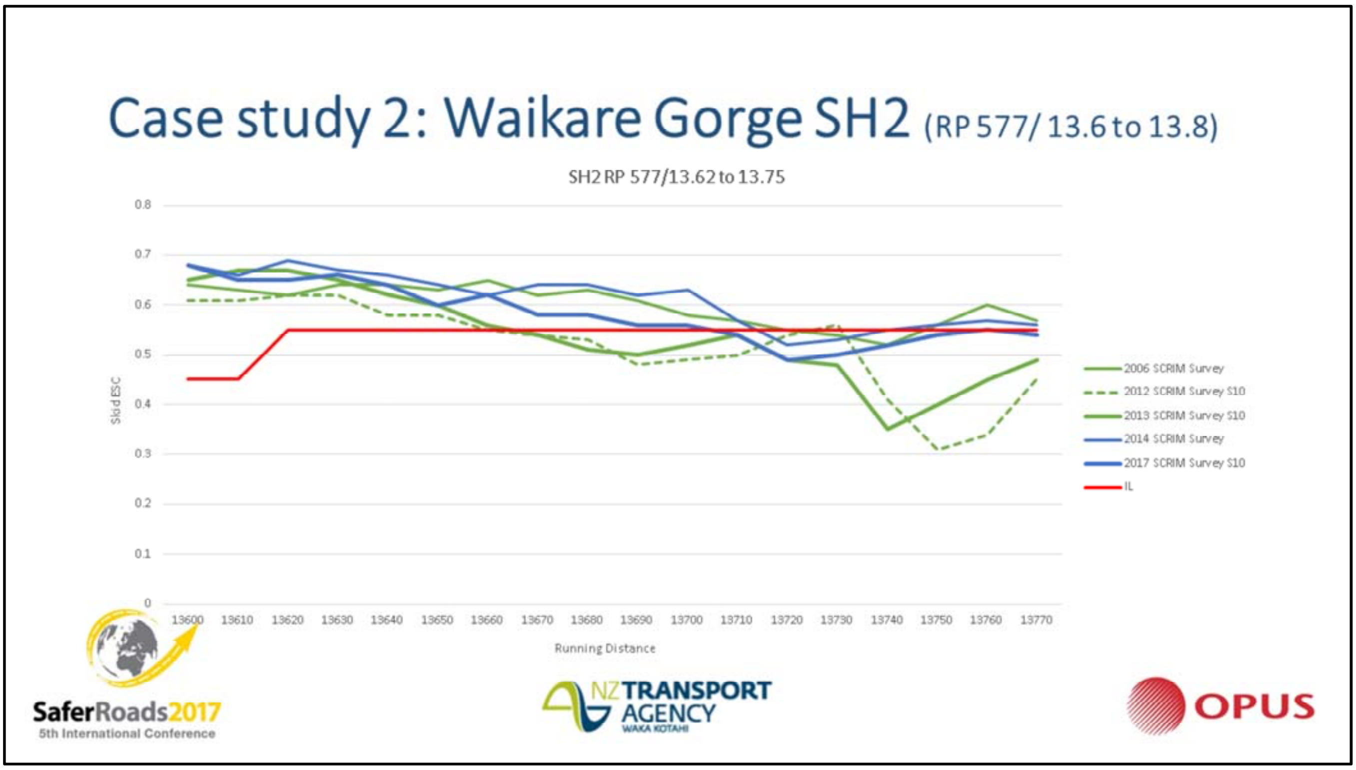
5. All LOC accidents recorded happened when the road surface was wet.



1. This short video shows the gradient and curvilinear alignment of the site.

2. It also shows the slow vehicles bays for both the increasing and decreasing directions. It is possible that the south bound slow vehicle bay has increased the approach speed to the curve as motorists attempt to pass slow vehicles close to the end of the slow vehicle bay.

3. You can also see that the guard rail at the south end of the site on the RHS was extended to stop vehicles from ending up in the deep side drain.



1. This is a category 2 high curve with an IL of 0.55 ESC.

2. A Poplar Lane chip seal was constructed in 2005 (15/02/2005). The 2006 survey (17/11/2005) shows good skid performance with most skid readings above IL. The 2012 and 2013 surveys show that polishing has occurred in the high demand section of the curve and for 20m is well below TL (which is 0.1 ESC below IL).

3. A Glenbrook melter chip seal was constructed in 2012 (25/01/2012). The 2014 survey shows initial skid values generally above IL for most of the site and while the 2017 skid values have dropped slightly below IL they remain reasonably consistent particularly through the area of high demand.

4. Although the initial skid values of the melter chip are not any higher on average than the initial skid values of the natural aggregate the melter chip appears more resistant to polishing particularly in areas of high traffic stress.

5. Along with the minor safety improvements completed at this site the use of melter chip has almost completely eliminated all of the wet LOC accidents with only one accident recorded since the 2012 resurfacing using melter chip. The lack of accident debris and damage to the guard rail would support this accident reporting.

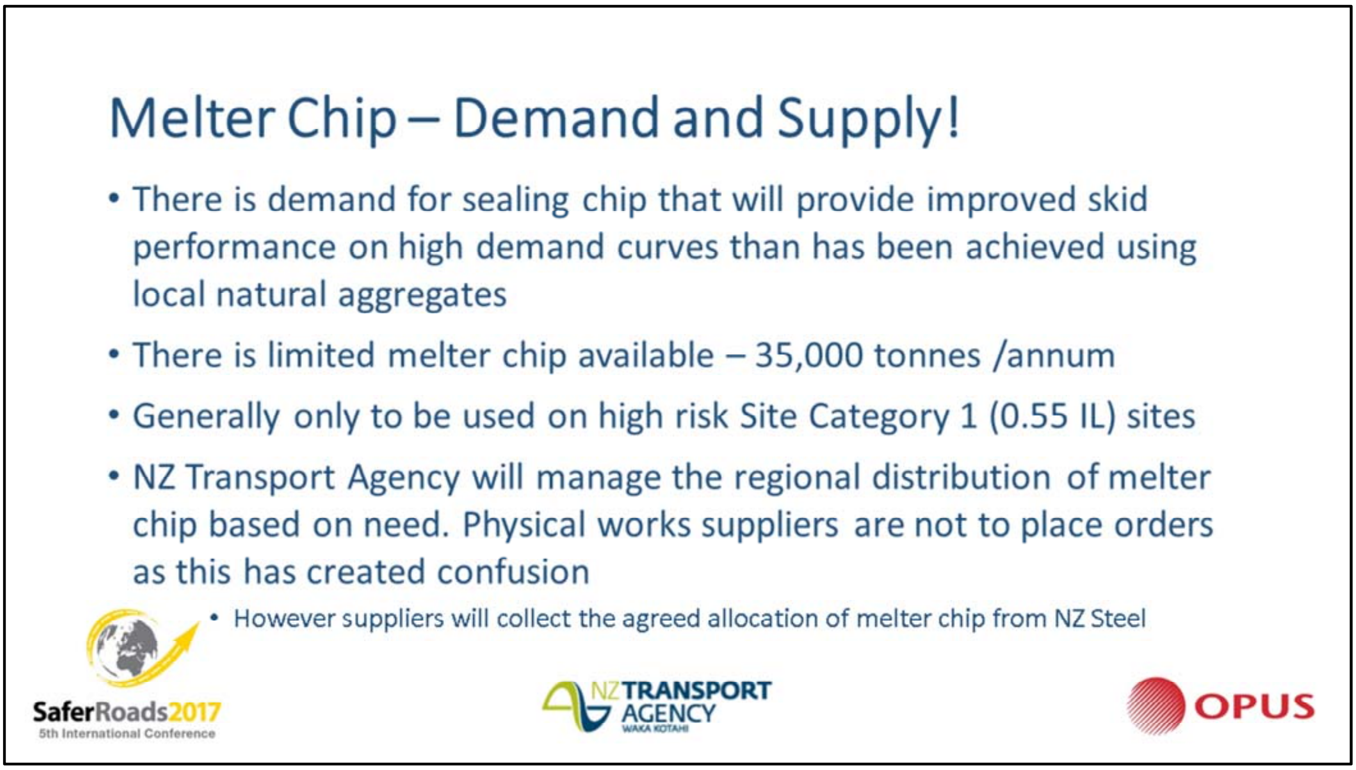
6. The melter chip seal is currently just over 5yrs old and is showing good skid performance compared to the previous natural aggregate at a similar life.

1. Chipsealing in New Zealand is a textbook compiled and printed in 2005 that covers all aspects of chip sealing in New Zealand.

2. In order to keep this textbook as current as possible changes and additions are added through practice notes. Each practice note is captioned with the topic to be covered and the chapter in the textbook to which it applies.

3. Constructing melter chip seals in Hawke's Bay has taught us that there are a number of differences from sealing with natural aggregates that need to be considered when designing and constructing melter chip seals.

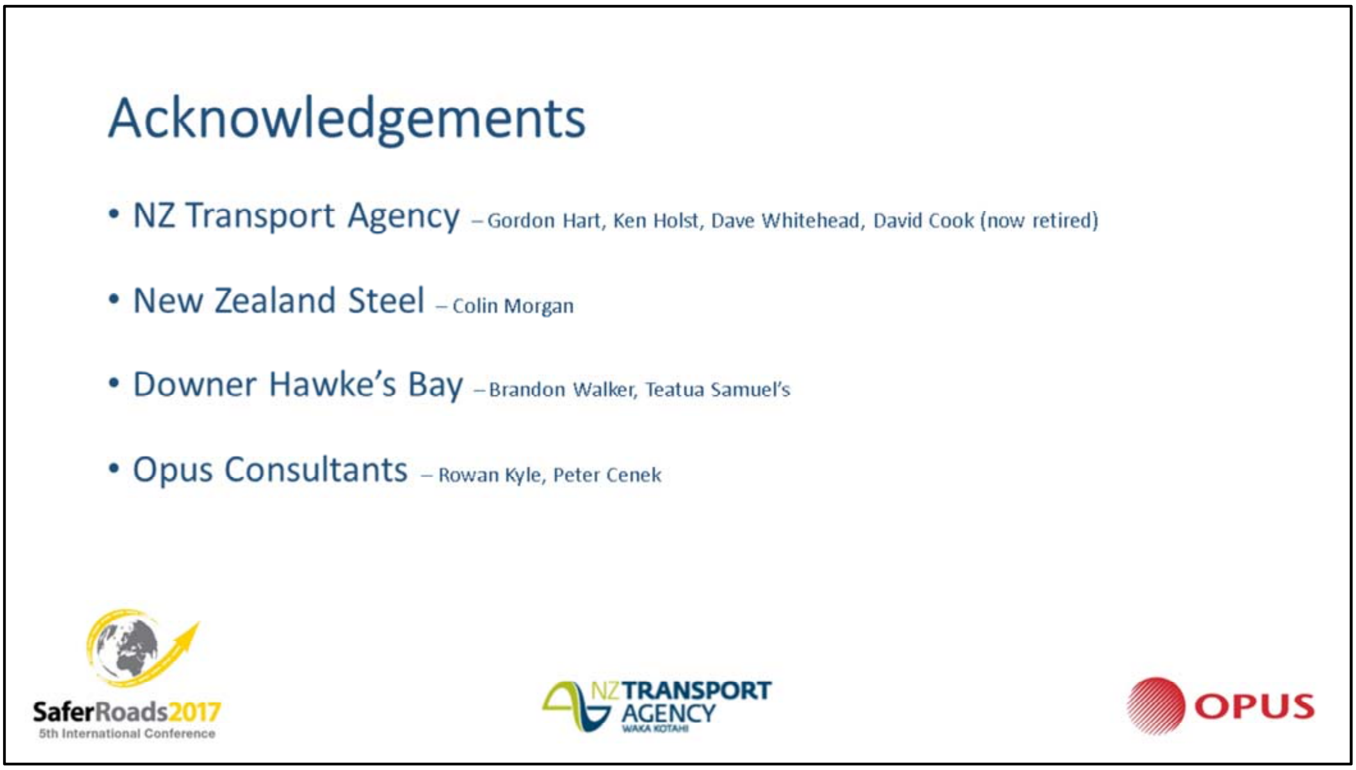
4. A Chipsealing in New Zealand Practice Note has been written to assist seal practitioners to design and construct successful melter chip seals. This information is now available on the NZ Transport Agency web site as both a Technical Note and a Chipsealing in New Zealand Practice Note.



1. Demand for melter chip to improve skid performance on high demand skid sides has increased significantly as the on road performance of melter chip has been proven over time.

2. It has been shown to extend chip seals lives by maintaining good skid resistance for more years than can be achieved by most natural aggregates we have available to us in New Zealand.

3. As there is a limited supply of melter chip available, to ensure it is distributed to the networks of greatest need, Dave Whitehead of NZ Transport Agency who is responsible for the SCRIM budget, has provided these guidelines.

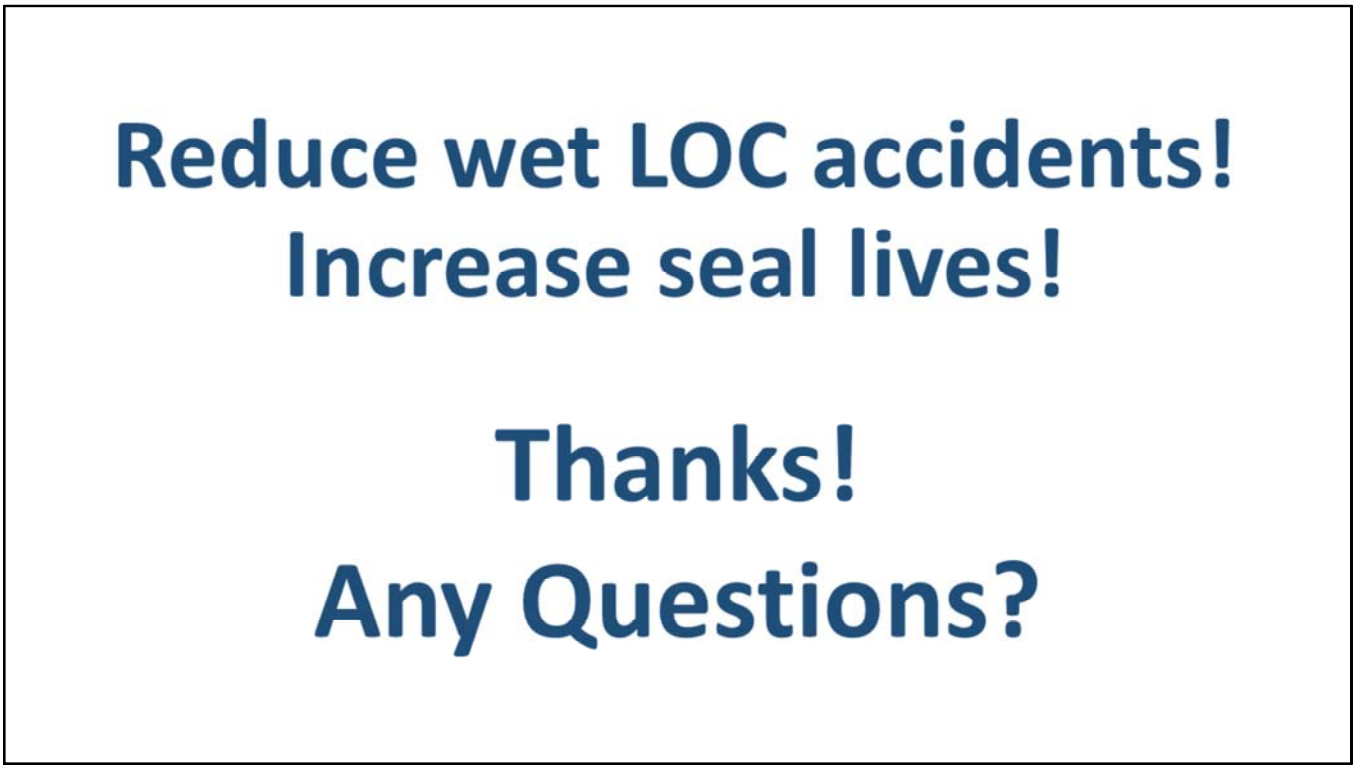


1. The introduction of melter aggregate for chip sealing on SH5 was influenced by a number of people shown in the acknowledgements.

2. I would like to specifically acknowledge Gordon Hart, NZ Transport Agency, who was the Hawke's Bay regional network manager and provided the initial impetus and allowance for the melter chip seal trials to go ahead.

3. Brandon Walker and Teatua Samuel's of Downer Hawke's Bay were particularly helpful in working through the contractual planning and construction challenges and learnings that happened along the way.

4. In particular I would like to give credit to the late Bill Bourke who was so passionate about seeing what he believed to be a great product used on the State Highway and worked through the issues with us to ensure its success. Bill has been proven right. It is a great product.



1. All round – Better lives!
2. Thanks!
3. Questions?