Memo					
To	Waka Kotahi NZ Transport Agency				
CC					
From	s 9(2)(a)				
Project	SH2 Remutaka Hills – Scope Confirmation Courtesy Bay Assessment				
Rev. No.	Date	Description	Prepared By	Reviewed By	Approved By
A	31-01-23	Courtesy Bay Assessment for Waka Kotahi Reference	s 9(2)(a)	s 9(2)(a)	s 9(2)(a)

1 Purpose

The purpose of this technical assessment is to confirm the feasibility of providing either a slow vehicle bay or courtesy bay facilities and to evaluate the safety issues of the proposed locations for use by all road users.

This technical information is intended for Waka Kotahi to help them make decisions whether to fund and undertake the physical works as part of a Low-Cost-Low-Risk (LCLR) funded project.

2 Executive Summary

Waka Kotahi New Zealand Transport Agency (Waka Kotahi) has commissioned Manu Taiko to undertake the detailed design of safety improvements on the SH2 Remutaka corridor. As a part of the previous Feasibility Phase closeout, additional analysis has been requested to determine the suitability of existing locations for use as either a courtesy bay or slow vehicle bay on Remutaka Hill.

The assessment carried out leverages off a previous assessment undertaken by GHD in 2020 and the proposed locations were appraised based on various criteria such as road curvature, available length, visibility, and presence of unprotected hazards.

Recommendations

Only three locations are suitable for use as a courtesy bay without any additional significant physical works being required. The remaining locations would need further consideration during the detailed design phase before being acceptable for use.

The recommended treatment for each location is summarised in Table 1

Table 1 Summary of treatment recommendations

Location Reference	Recommended Treatment	Physical works required
1	Courtesy bay	Moderate
2	Courtesy bay (small vehicles only)	Moderate
3	Courtesy bay	Moderate

4	Slow vehicle /courtesy bay	None
5	Courtesy bay	None
6	Courtesy bay	Moderate
7	Courtesy bay	Moderate
8	Courtesy bay	Moderate
9	Slow vehicle /courtesy bay	None
10	Courtesy bay (small vehicles only)	Moderate
11	Courtesy bay (small vehicles only)	Moderate
12	Courtesy Bay	Moderate

In order to fully design the courtesy bays, it is recommended that further analysis be undertaken to determine the optimum bay interval. The trial results, including any variations in the number and types of crashes, should also be examined to determine the efficacy of the proposed modifications.

The relatively minor nature of this work is likely to meet the requirements of a LCLR funded project.

3 Background

In 2020, GHD conducted a study entitled "Remutaka Trial Application". The purpose of this trial was to examine the impact of modifications to line markings and signage on reducing 'driver frustration' crashes, decreasing the formation of platoons of vehicles and improve travel-time reliability, while not increasing the frequency of injury-crashes.

As part of the trial, the impact of new line marking and sign system on Remutaka Hill was monitored. The two methods of monitoring have been employed, including a) discrete volume and speed counts and b) continuous crash monitoring. The details of both methods and the related processes are described in the report supplied by the client (The Remutaka Trial Assessment has been included in **Attachment 1** for reference). However, to date, no conclusive results from the trial have been supplied.

Manu Taiko has utilised trial report as the basis for this assessment and the proposed locations for courtesy bays have been evaluated against set criteria.

4 Base Assessment Criteria and Assumptions

4.1 Assessment Criteria

Potential slow vehicle bay/courtesy bay locations were assessed against the following criteria.

- **Presence of accessways** Accessways coinciding with courtesy bays should be avoided as it increases the number of potential conflict points and prolong the decision-making time for drivers. The presence of accessways is considered a drawback for the installation of a courtesy bay.
- **Road curvature** The installation of a courtesy bay on tight curves presents potential difficulties, as heavy vehicles tend to occupy a wider section of the road to complete their manoeuvres. A vehicle tracking assessment has been carried out for each location.

Available length The proposed bays must have sufficient length to accommodate the necessary approach and departure tapers and the full width section for courtesy and /or slow vehicle bays. The appropriate length of the proposed bays will be evaluated based on the following assumptions:

Suitability for use as a Courtesy Bay. The tracking requirements of 17.0m semi-trailer on a straight portion of the road necessitate a minimum length of 20m for both the approach and departure tapers, resulting in a total length requirement of 60m for the courtesy bay when used for heavy vehicles. This length may vary based on the curvature of the road. The total required length for a 90% car is estimated to be 35m.

Suitability for use as a Slow Vehicle Bay. Slow Vehicle Bay requires a minimum length of 150m to accommodate for 15m and 30m approaching and departure tapers, respectively, and 100m minimum length requirement for the full width of slow vehicle bay, given that the mean traffic speed is 70 km/h [1].

- **Visibility** Visibility is a crucial consideration in the location of the designated courtesy bays. The following sight distances are considered when evaluating the location of a bay:

A minimum sight distance of 40m to determine the availability of the courtesy bay (SD=40m)

  - A minimum sight distance of 150m for visibility to the exit taper of the courtesy bay (SISD=150m)
  - A minimum sight distance of 100m from Courtesy Bay's end to the main traffic lane (MGSD=100m)

- **Presence of any unprotected hazards.** courtesy/slow vehicle bays should be safe to use. The presence of any unprotected hazards at the site may necessitate the implementation of safety measures such as side barriers, pavement widening, and other construction considerations, thereby increasing the overall project costs. As a result, the presence of unprotected hazards is considered a drawback for the location of the bay.

[1] MOTSAM, Part 2 - Section 2: Pavement Marking

4.2 Assumptions

- **Operating Speed**
  - 70km/h is adopted as an operating speed for evaluating visibility at courtesy bays. This speed is 10 km/h above[2] the recommended future posted speed limit.
  - For visibility checks on curves with a radius less than 50 metres, the operating speed will be reduced to 50 km/h.
- **Visibility**
  - The calculation of required sight distance to determine the availability of a courtesy bay will be based on the greater of two distances: (1) the distance required to reduce the speed from 70 km/h to 30 km/h at the start of the bay, or (2) the distance travelled in three seconds while indicating at an average speed of 35 km/h.
  - The visibility from the end of the courtesy bay to the main traffic lane must be sufficient for the driver to observe the approaching vehicle's headlights and have a five-second gap before deciding to re-enter the lane. Although the existing barrier, which has an average height of approximately 1.0m, may obstruct the view, it is assumed that the driver will observe the approaching headlights well before the vehicle is placed toward the exit taper.
  - The visibility at the exit taper of the courtesy bay must allow an oncoming driver to observe the indicator light of a waiting vehicle. The existing barriers may obstruct the view from the driver's eye to the indicator light.
  - Existing longitudinal slope and vertical curves have not been considered for visibility checks.
  - Intervisibility to the bay can be blocked by the platoon of vehicle travelling in the opposite direction.
- **Vehicle tracking**
  - The appropriate tracking scenario must be checked for each bay. It is noted that semi-trailers occupy a wider portion of the pavement when travelling on curves. For example, they will sweep 2.0m wider on curves with a radius less than 50m.
- **Courtesy bay and slow vehicle bay definition**
  - The proposed lengths are based on this assumption that there is not requirement for vehicles using slow vehicle bay to stop and other drivers should demonstrate courtesy by allowing the vehicle that has slowed back into the traffic flow. However, it is assumed

[2] Austroad, Guide to Road Design Part 3: Geometric Design - 2021

that vehicles must halt at the designated Courtesy Bay location and re-enter the traffic lane once a safe gap in the flow of traffic has been identified.

5 Assessment Discussion

Evaluation has been conducted at twelve designated locations within the SH2 Remutaka corridor as per previous GHD assessments and the results are summarised in the tables below. The green row with checkmark (✓) indicates compliance with the assessment criterion, while the red row with a cross (X) indicates non-compliance.

Assessments have been made for slow vehicle bays and courtesy bays at each location.

The Remutaka Trial Assessment has been included in **Attachment 1 and Attachment 2** for reference.

Location #1 RS/RP: 931/4200 (Ch. 4200)		
Item	**Slow vehicle bay**	**Courtesy bay**
1- Presence of accessways	X	
2- Sharp curves – Widening is required	✓	
3- Length, including tapers Courtesy Bay Min 35m for cars and 60m for heavy vehicles. Slow vehicle Bay Min 150m	X	✓
4- Width Min. 3.5m	✓	
5- Visibility to Courtesy Bay to determine if it is available (SD=40m)	✓	
6- Visibility to the courtesy bay exit taper (SISD=150m)	Not enough	
7- Visibility from courtesy bay end to the main traffic lane (MGSD=100m)	Not enough	
8- Presence of unprotected hazard	Culvert Headwall on taper	✓

Location #2 RS/RP: 931/3550 (Ch. 3550)		
Item	**Slow vehicle bay**	**Courtesy bay**
1- Presence of accessways	✓	
2- Sharp curves – Widening may be required	X	
3- Length, including tapers Courtesy Bay Min 35m for cars and 60m for heavy vehicles. Slow vehicle Bay Min 150m	X	Enough for cars

4- Width Min. 3.5m	✓
5- Visibility to Courtesy Bay to determine if it is available (SD=40m)	✓
6- Visibility to the courtesy bay exit taper (SISD=100m)	✓
7- Visibility from courtesy bay end to the main traffic lane (MGSD=70m)	✓
8- Presence of unprotected hazard	Culvert Opening

Location #3 RS/RP: 931/2200 (Ch. 2200)		
Item	**Slow vehicle bay**	**Courtesy bay**
1- Presence of accessways	✓	
2- Sharp curves – Widening may be required	X	
3- Length, including tapers Courtesy Bay Min 35m for cars and 60m for heavy vehicles. Slow vehicle Bay Min 150m	X	✓
4- Width Min. 3.5m	✓	
5- Visibility to Courtesy Bay to determine if it is available (SD=40m)	✓	
6- Visibility to the courtesy bay exit taper (SISD=150m)	X	
7- Visibility from courtesy bay end to the main traffic lane (MGSD=100m)	✓	
8- Presence of unprotected hazard	✓	

Location #4 RS/RP: 931/900 (Ch. 900)		
Item	**Slow vehicle bay**	**Courtesy bay**
1- Presence of accessways	✓	
2- Sharp curves – Widening may be required	✓	
3- Length, including tapers Courtesy Bay Min 35m for cars and 60m for heavy vehicles. Slow vehicle Bay Min 150m	✓	
4- Width Min. 3.5m	✓	
5- Visibility to Courtesy Bay to determine if it is available (SD=40m)	✓	
6- Visibility to the courtesy bay exit taper (SISD=150m)	✓	

7- Visibility from courtesy bay end to the main traffic lane (MGSD=100m)	✓
8- Presence of unprotected hazard	✓

Location #5 RS/RP: 931/700 (Ch. 700)		
Item	**Slow vehicle bay**	**Courtesy bay**
1- Presence of accessways	✓	
2- Sharp curves – Widening may be required	✓	
3- Length, including tapers Courtesy Bay Min 35m for cars and 60m for heavy vehicles. Slow vehicle Bay Min 150m	X	✓
4- Width Min. 3.5m	✓	
5- Visibility to Courtesy Bay to determine if it is available (SD=40m)	✓	
6- Visibility to the courtesy bay exit taper (SISD=150m)	✓	
7- Visibility from courtesy bay end to the main traffic lane (MGSD=100m)	✓	
8- Presence of unprotected hazard	✓	

Location #6 RS/RP: 921/9400 (Ch. 9450)		
Item	**Slow vehicle bay**	**Courtesy bay**
1- Presence of accessways	✓	
2- Sharp curves – Widening may be required	X	
3- Length, including tapers Courtesy Bay Min 35m for cars and 60m for heavy vehicles. Slow vehicle Bay Min 150m	X	✓
4- Width Min. 3.5m	✓	
5- Visibility to Courtesy Bay to determine if it is available (SD=40m)	✓	
6- Visibility to the courtesy bay exit taper (SISD=150m)*	✓	
7- Visibility from courtesy bay end to the main traffic lane (MGSD=100m)	✓	
8- Presence of unprotected hazard	✓	

*There is an upgrade slope approaching to the bay

Location #7 RS/RP: 921/8800 (Ch. 8800)		
Item	**Slow vehicle bay**	**Courtesy bay**
1- Presence of accessways	✓	
2- Sharp curves – Widening may be required	X	
3- Length, including tapers Courtesy Bay Min 35.0m for cars and 60m for heavy vehicles. Slow vehicle Bay Min 150m	X	✓
4- Width Min. 3.5m	✓	
5- Visibility to Courtesy Bay to determine if it is available (SD=40m)	✓	
6- Visibility to the courtesy bay exit taper (SISD=100m)	✓	
7- Visibility from courtesy bay end to the main traffic lane (MGSD=70m)	✓	
8- Presence of unprotected hazard	CULVERT OPENING	

Location #8 RS/RP: 921/8200 (Ch. 8200)		
Item	**Slow vehicle bay**	**Courtesy bay**
1- Presence of accessways	✓	
2- Sharp curves – Widening may be required	X	
3- Length, including tapers Courtesy Bay Min 35.0m for cars and 60m for heavy vehicles. Slow vehicle Bay Min 150m	X	Enough for cars
4- Width Min. 3.5m	✓	
5- Visibility to Courtesy Bay to determine if it is available (SD=40m)	✓	
6- Visibility to the courtesy bay exit taper (SISD=100m)	X	
7- Visibility from courtesy bay end to the main traffic lane (MGSD=70m)	✓	
8- Presence of unprotected hazard	CULVERT OPENING	

Location #9 RS/RP: 921/5600 (Ch. 5600)		
Item	**Slow vehicle bay**	**Courtesy bay**
1- Presence of accessways	✓	

2- Sharp curves – Widening may be required	✓
3- Length, including tapers Courtesy Bay Min 35m for cars and 60m for heavy vehicles. Slow vehicle Bay Min 150m	✓
4- Width Min. 3.5m	✓
5- Visibility to Courtesy Bay to determine if it is available (SD=40m)	✓
6- Visibility to the courtesy bay exit taper (SISD=150m)	✓
7- Visibility from courtesy bay end to the main traffic lane (MGSD=100m)	✓
8- Presence of unprotected hazard	✓

Location #10 RS/RP: 921/5350 (Ch. 5350)		
Item	**Slow vehicle bay**	**Courtesy bay**
1- Presence of accessways	✓	
2- Sharp curves – Widening may be required	X	
3- Length, including tapers Courtesy Bay Min 35m for cars and 60m for heavy vehicles. Slow vehicle Bay Min 150m	X	Enough for cars
4- Width Min. 3.5m	✓	
5- Visibility to Courtesy Bay to determine if it is available (SD=40m)	✓	
6- Visibility to the courtesy bay exit taper (SISD=100m)	X	
7- Visibility from courtesy bay end to the main traffic lane (MGSD=70m)	✓	
8- Presence of unprotected hazard	✓	

Location #11 RS/RP: 921/4350 (Ch. 4350)		
Item	**Slow vehicle bay**	**Courtesy bay**
1- Presence of accessways	✓	
2- Sharp curves – Widening may be required	X	
3- Length, including tapers Courtesy Bay Min 35m for cars and 60m for heavy vehicles. Slow vehicle Bay Min 150m	X	Enough for cars
4- Width Min. 3.5m	✓	
5- Visibility to Courtesy Bay to determine if it is available (SD=40m)	✓	

6- Visibility to the courtesy bay exit taper (SISD=100m)	✓
7- Visibility from courtesy bay end to the main traffic lane (MGSD=70m)	✓
8- Presence of unprotected hazard	✓

Location #12 RS/RP: 921/4200 (Ch. 4200)		
Item	**Slow vehicle bay**	**Courtesy bay**
1- Presence of accessways	Maintenance accessway	
2- Sharp curves – Widening may be required	Intermediate Radius 100m	
3- Length, including tapers Courtesy Bay Min 35m for cars and 60m for heavy vehicles. Slow vehicle Bay Min 150m	✓	
4- Width Min. 3.5m	✓	
5- Visibility to Courtesy Bay to determine if it is available (SD=40m)	✓	
6- Visibility to the courtesy bay exit taper (SISD=100m)	✓	
7- Visibility from courtesy bay end to the main traffic lane (MGSD=700m)	✓	
8- Presence of unprotected hazard	✓	

6 Summary and Recommendations

This memo has provided an evaluation of potential slow vehicle/courtesy bays which were included in the previous study. The recommendations from of the assessment are summarised in the following table.

Location Reference	Recommended Treatment	Comments	Physical works required
1	Courtesy Bay	• Accessways located at the designated bay would require careful consideration in the detailed design phase to ensure adequate intervisibility between the accessways and through traffic. Sufficient observation and reaction times must be provided to avoid any unsafe conflicts.	• Set back of existing cut or closing accessways • Installing edge barrier and/or culvert headwall be relocated away from the edge of bay

		• Minimise the effect of culvert opening and its headwall on traffic • The length of the bay is insufficient for slow vehicle bay	
2	Courtesy bay (small vehicles only)	• road widening will be required to allow installation at corner for tracking • The length of the bay is insufficient to accommodate semi-trailers, hence, appropriate signage must be used to indicate this limitation. • Minimise the effect of culvert opening and its headwall on traffic.	• Road widening • Signage to limit vehicle usage. • Installing edge barrier
3	Courtesy Bay	• Sufficient width must be provided to accommodate the adopted tracking scenario on the curve. • The length of the bay is insufficient for slow vehicle bay. • Review intervisibility of the bay.	• Road widening • Set back of existing cut
4	Slow Vehicle /courtesy Bay	• This is an appropriate location for both slow vehicle bay and courtesy bay	
5	Courtesy Bay	• The length of the bay is insufficient for slow vehicle bay.	
6	Courtesy Bay	• Sufficient width must be provided to accommodate the adopted tracking scenario on the curve. • The length of the bay is insufficient for slow vehicle bay.	• Road widening
7	Courtesy Bay	• Sufficient width must be provided to accommodate the adopted tracking scenario on the curve. • The length of the bay is insufficient for slow vehicle bay. • Minimise the effect of culvert opening on traffic.	• Road widening • Installing edge barrier
8	Courtesy Bay	• Sufficient width must be provided to accommodate	• Road widening

		the adopted tracking scenario on the curve. • The length of the bay is insufficient to accommodate semi-trailers, hence, appropriate signage must be used to indicate this limitation. • Minimise the effect of culvert opening on traffic. • Review intervisibility of the bay.	• Signage to limit vehicle usage • Installing edge barrier • Set back of existing cut
9	Slow Vehicle /courtesy Bay	• This is an appropriate location for both slow vehicle bay and courtesy bay	
10	Courtesy bay (small vehicles only)	• Sufficient width must be provided to accommodate the adopted tracking scenario on the curve. • The length of the bay is insufficient to accommodate semi-trailers, hence, appropriate signage must be used to indicate this limitation. • Review intervisibility of the bay.	• Road widening • signage to limit vehicle usage. • Set back of existing cut
11	Courtesy bay (small vehicles only)	• Sufficient width must be provided to accommodate the adopted tracking scenario on the curve. • The length of the bay is insufficient to accommodate semi-trailers, hence, appropriate signage must be used to indicate this limitation.	• Road widening • Signage to limit vehicle usage.
12	Courtesy Bay	• Maintenance accessways located at the designated bay require careful consideration in the detailed design phase to ensure adequate intervisibility between the accessways and through traffic. Sufficient observation and reaction times must be provided to avoid any unsafe conflicts. • Sufficient width must be provided to accommodate the adopted tracking scenario on the curve.	• Road widening • Set back of existing cut or closing accessways

Some of the proposed bays are insufficient in length to accommodate heavy vehicles. It is recommended that modification of courtesy bay signage be considered to reflect this. Although there is not a type diagram available for this, existing signage could be modified to display the relevant information. **Figure 1** illustrates the potential modifications.

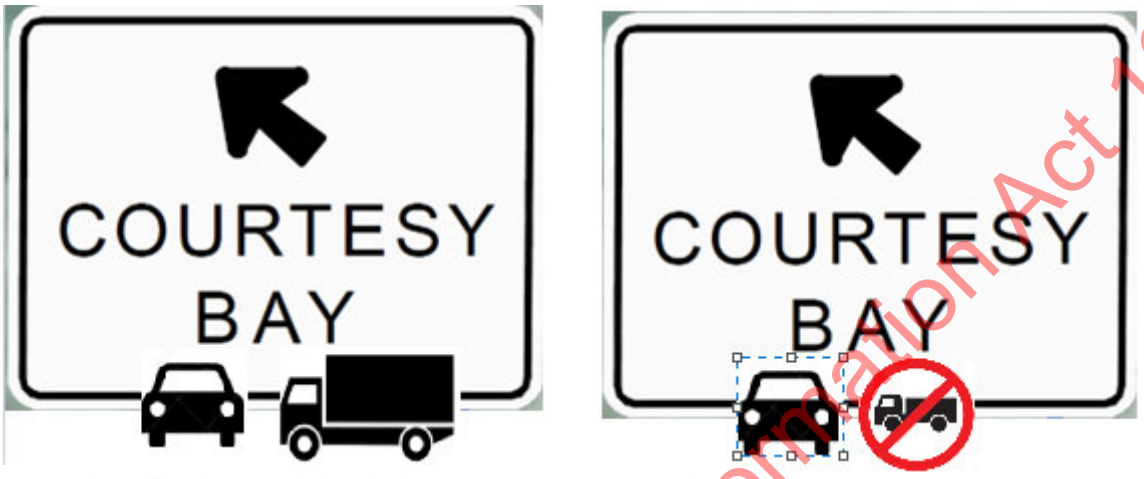

Figure 1 Example of modifications to existing signing

Attachment 1

Remutaka Sign trial
Remutaka Sign Trial Monitoring Report

NZ Transport Agency

Remutaka Sign Trial

Remutaka Sign Trial Monitoring Report

February 2020

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1. Introduction

1.1 Purpose of this report

The New Zealand Transport Agency (NZTA) has commissioned GHD to develop a sign and line marking trial on Remutaka Hill for replacing stopping bays, slow vehicle lanes, and passing lanes with Courtesy Lanes. The Remutaka Trial Application outlined that the main purpose of the trial is to test whether changes in line markings and additional signage have the potential to reduce 'driver frustration' crashes, reduce platooning of vehicles and to improve travel-time reliability without an increase in injury-crashes.

This report will detail the proposed monitoring of the trial to evaluate the effectiveness.

1.2 Scope

The report outlines how the changes on Remutaka Hill in relation to the courtesy lane sign and line marking trial will be monitored. The report details the type of monitoring, the units of measure, the location, lane occupancy, speed and the timing of the monitoring activity.

Two types of monitoring will be used - discrete volume and speed counts, and continuous crash monitoring. These will be discussed further in Section 2 and Section 3.

1.3 Limitations

This report: has been prepared by GHD for NZ Transport Agency and may only be used and relied on by NZ Transport Agency for the purpose agreed between GHD and the NZ Transport Agency as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than NZ Transport Agency arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

GHD has prepared this report on the basis of information provided by NZ Transport Agency and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report

2. Volume and speed count monitoring

This section of the report will outline the monitoring of the lane utilisation (effectiveness) of the trial modifications once installed and will take into account volume and speed count measurements. Site monitoring will use two different collection methods; tube counters, and video cameras.

In order to determine the effectiveness of the trial modifications implemented, a comparison of pre and post installation measurements on the Remutaka Hill Road will be assessed.

2.1 Monitoring outcomes

Monitoring seeks to record;

- Lane occupancy
- Vehicle speed
- Vehicle type (as per NZTA 2011 classifications)
- Driver behaviour

2.1.1 Monitoring devices

Tube Counter

Tubes will be installed at the start of the courtesy lane and in the middle of the proposed courtesy lanes (locations in Table 1). Tube counters cannot be installed on curves, so only suitable straight sections will be monitored with tube counters.

The tubes located prior to modified sites will measure entry speeds for all users, while tubes located within the lane or bay will measure vehicle lane occupancy, vehicle class, and changes in speed. The lane occupancy data will be used to measure changes in lane utilisation, and whether more road users are using the facilities under the trial layout.

Speed data from the tube counters will be used to help identify driver behaviour in the additional lane and the through lane; if road users are stopping, reducing, or maintaining their speed in the additional lane, and if users in the through lane are maintaining or increasing speed. Speed data will be compared to the tube counts at the start of the additional lane to compare numbers (tube counters are inaccurate at recording very slow moving vehicles and so stopping vehicles might not be recorded) and speeds.

Table 1 Tube counting location information

RSRP	Direction of travel	Number and split of lanes	Lane of interest	Modified or prior to lane
002-0931-4.232	Southbound	2	Southbound	Modified
002-0931-4.145	Southbound	1	Southbound	Prior to modification
002-0931-2.350	Both	2 (1 each)	Northbound	Prior to modification
002-0931-2.150	Both	2 Northbound 1 Southbound	Northbound	Modified
002-0931-1.020	Northbound	1	Northbound	Prior to modification
002-0931-0.850	Both	2 Northbound 1 Southbound	Northbound	Modified
002-0921-8.840	Both	1 Northbound 2 Southbound	Southbound	Modified
002-0921-5.660	Both	1 Northbound 2 Southbound	Southbound	Modified
002-0921-5.530	Both	2 (1 each)	Southbound	Prior to modification

Video Cameras

Video footage will be recorded at key locations (see Table 2) to determine road user behaviour, record lane occupancy, and validate tube counter data. The cameras will capture lane usage, lane changing and will assist in verifying vehicle classes and counts due to their close location to modified lanes. Video cameras will be use to record lane occupancy during daylight hours at two sites where tube counters are inappropriate due to the road alignment.

Video footage recorded will used to observe driver behaviour within the additional lane (stopping duration, departing the vehicle, or other behaviour).

Table 2 Video recording location information

RSRP	Direction Facing	Lane of interest	Number of Lanes used
002-0931-3.601	Southwest	Southbound	2
002-0931-0.870	East	Northbound	3
002-0921-8.800	West	Southbound	3
002-0921-4.200	Southwest	Northbound	3

2.1.2 Monitoring periods

Active site monitoring will occur:

- Two weeks prior to installation to establish a baseline.
- Three months following installation to measure effectiveness.
- One year following installation to observe long-term effectiveness.

Tube counts and video data will collected during a week without statutory or school holidays, or other extreme flow event days such as the Martinborough Fair to avoid counts that are not representative of typical flows. NZTA will be provided with the raw data files and analysis of the

processed data assessing the effectiveness of the trial installations in achieving the desired benefits.

The method of assessment and a description of the analysis follows.

2.1.3 Monitoring Timeframes

Tube counters will be installed for a one-week period.

Video footage will record 48 hours of continuous 1-second time-lapse images for the same weekdays during each monitoring period (for behaviour consistency).

2.2 Outputs

The tube count data collected will include vehicle speed (prior to and within modified areas), lane occupancy (within modified areas) and vehicle types.

Lane occupancy data will enable an understanding of whether courtesy bays and lanes are being utilised by slower vehicles (or specific vehicle types) to enable other vehicles (or vehicle types) to pass. An analysis of the time between vehicles passing a tube counter within and prior to a modified site should inform whether platooning is occurring. This will be confirmed through video footage analysis.

The video recordings collected will, as stated above, identify whether the lanes and bays are being used as expected and will enable validation of the tube data.

All future outputs will be added to this report to maintain one document for all three monitoring periods.

2.3 Deliverables

At the end of each post- monitoring period (3-month post installation and 1-year post installation) a monitoring data report will be provided to NZTA comparing the pre-installation monitoring data with all post installation monitoring data. The following sets of information will be provided to NZTA:

1. Lane occupancy and speeds on the new Courtesy bays.
2. Road user behaviour change observed through video surveillance.

3. Crash monitoring

Information from NZ Transport Agency Crash Analysis System (CAS) will be used to monitor crashes. Crashes are low probability events, and so long term monitoring of the highway between two defined locations will be the major measure of changes.

The purpose of this monitoring is to observe changes in crash numbers and type.

Non-injury crashes are excluded from monitoring due to the delays in these crashes entering the system as well as the completeness in reporting these crash events.

3.1 Measures

3.1.1 Extent

The Remutaka Hill trial study zone will include SH2 between the rest area immediately west of Featherston on the true left hand side of the highway (SH2 RS 921 RP 1.0) and the Pakuratahi River bridge (SH2 RS 931 RP 6.5). These locations are beyond the "hill" section of the route and are definable locations. The trial study zone has been saved and is publically sharable within CAS.

3.1.2 Period

During the trial, injury crash numbers will be exported from CAS and rates compared monthly to existing baseline data. These crash patterns will be reported to the NZTA regional safety engineer for review.

3.1.3 Units

Crash Numbers:

- 3-month rolling injury crashes
- 12-month rolling fatal and serious injury crashes

As crashes are discrete events, it can be hard to judge any significant change in crash patterns on a month-by-month basis. As fatal crashes are prominent but extremely rare events, a long rolling average will be used along with serious injury crashes to monitor any changes.

Crash Type:

- 12-month rolling injury crashes by CAS movement codes categories

3.1.4 Crash Numbers

Between 2009 and 2019, 4% of 3-monthly periods had no reported injury crashes, and no 3-month period had more than 12 reported injury crashes. On "average" there are three or fewer injury crashes per 3-monthly period, and 95% of the 3-month periods between 2009 and 2019 have six or fewer injury crashes.

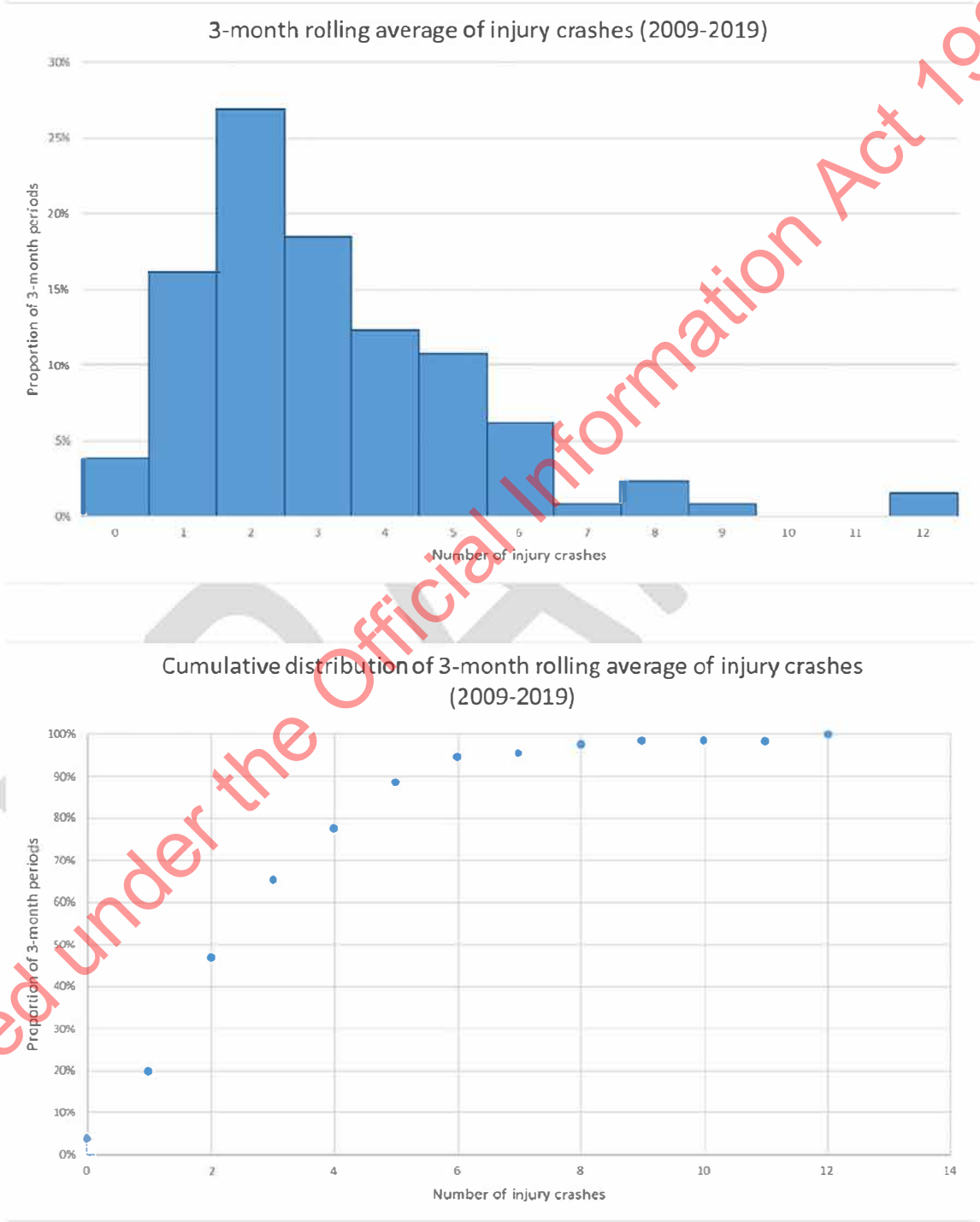
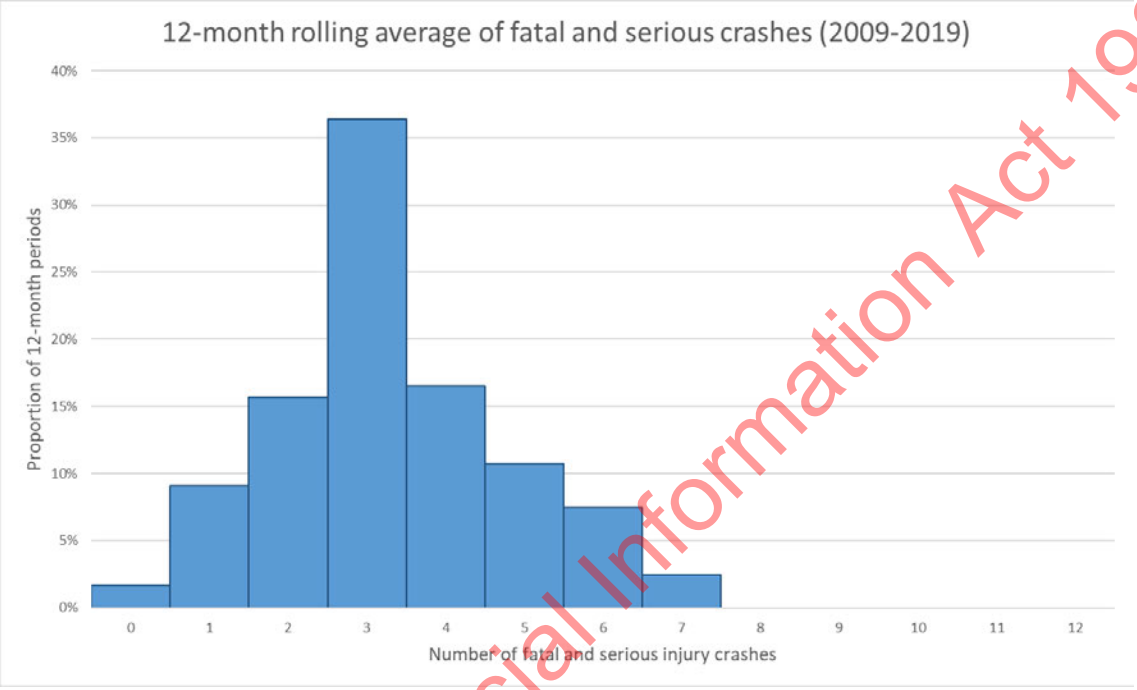


Figure 1: 3-month rolling injury crash numbers

Between 2009 and 2019, only 2% of 12-monthly periods had no reported fatal or serious injury crashes, and no 12-month period had more than seven. On “average”, there are three or fewer fatal and serious injury crashes per 12-month period, and 90% of 12-monthly periods have five or fewer fatal and serious injury crashes.



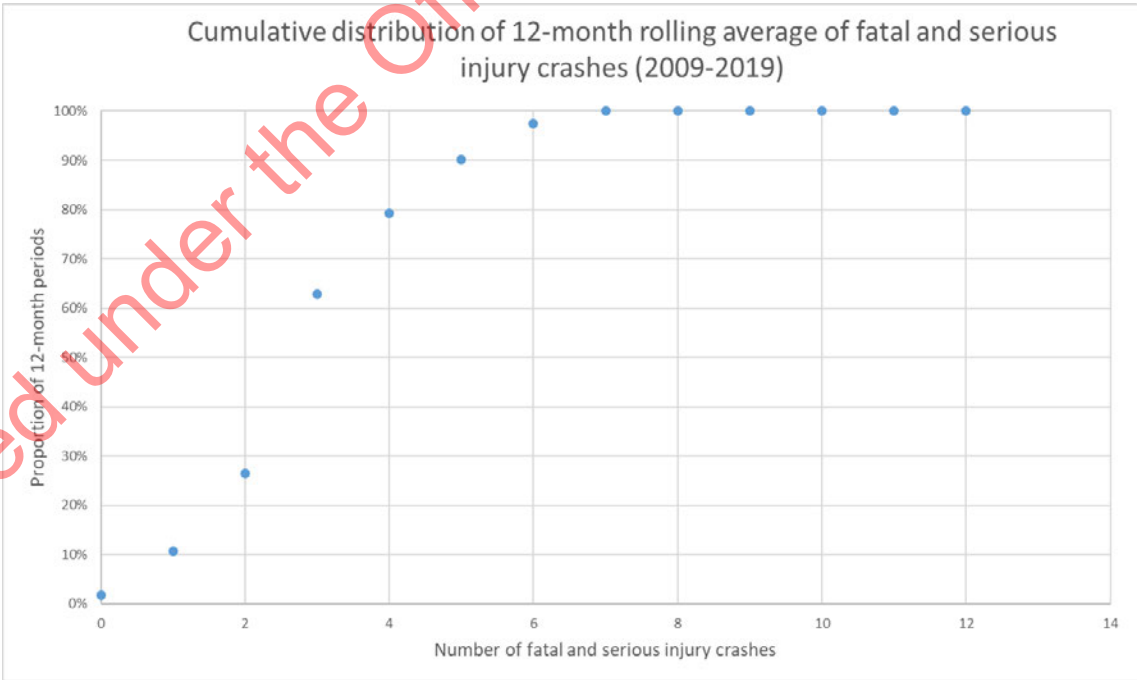


Figure 2 12-month rolling fatal and serious crash numbers

There is variation in the number of injury crashes by month. Figure 3 shows the average number of crashes per month as well as the 30th, 60th and 90th distribution of injury crashes by month between 2009 and 2019. This shows that injury crashes in June / July are unusual and more common in January to March and September to December. Consideration of the distribution will be considered when assessing the sign trial on a month-by-month basis. If there are more injury crashes in a month than the historical 90th percentile, each crash should be reviewed to determine if the signs and marking of the trial were a factor in the crash.

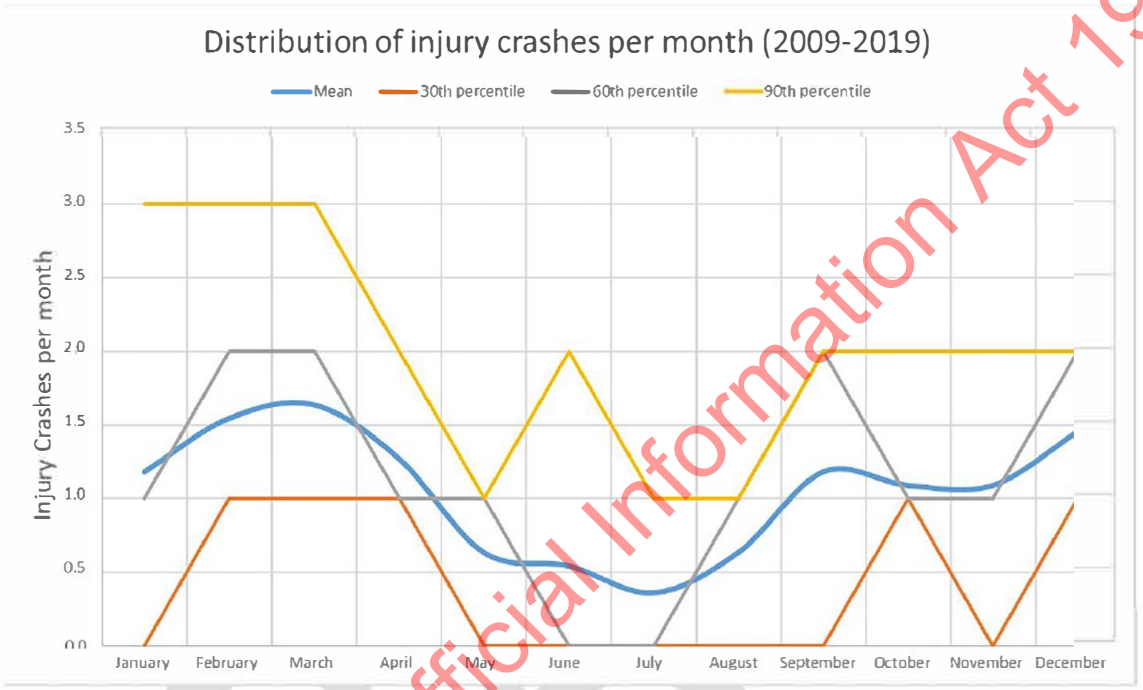


Figure 3 distribution of injury crashes by month

3.1.5 Crash types

This trial is looking to reduce 'driver frustration' related crashes. CAS does not incorporate a systematic approach for identifying 'driver frustration' as a contributing crash cause. CAS reports the movement of vehicles in crashes; these are grouped into simplified movement code categories. The vast majority of crashes are lost control bend with a large proportion of fatal and serious crashes being head on crash types (see Table 3). Overtaking group includes crashes relating to the merging movement as well as occurring while passing. The majority of crashes were an overtaken or overtaking vehicle losing control.

Without a directly measurable and attributable factor, overtaking and Head-on crash numbers will be used as a proxy to represent reckless actions that result in an unavoidable crash. Overtaking crashes are crashes typically resulting in impacts to avoid another road user approaching in the opposite direction where a road user has not adequately judged an overtaking opportunity, while head-on crashes (other than bend loss-of-control head-on) occur when collision was unavoidable.

Table 3 Crash severity and type (2009-2019)

Movement code categories	Fatal crash	Serious crash	Minor crash	% injury crashes	Injury Crashes per year
Overtaking	0	3	6	6%	0.8
Head On	2	13	19	24%	3.1
Lost Control Bend	3	17	67	63%	7.9
Lost Control Straight	0	0	2	1%	0.2
Rear End	0	0	4	3%	0.4
Manoeuvring	0	0	1	1%	0.1
Crossing One Turning	0	0	1	1%	0.1
Merging (turning)	0	0	1	1%	0.1
Total	**5**	**33**	**101**		

3.2 Reporting

The subsequent reports produced will aim at reporting the following trends via email to cover but not limited to the following:

- Injury crashes per rolling 3-month period
- Fatal and serious crashes per rolling 12-month period
- Overtaking and Head-on crashes per year.

Crash data reporting will also be included in the post implementation 3 month and 1 year report. All supplementary reporting will be added to this report.

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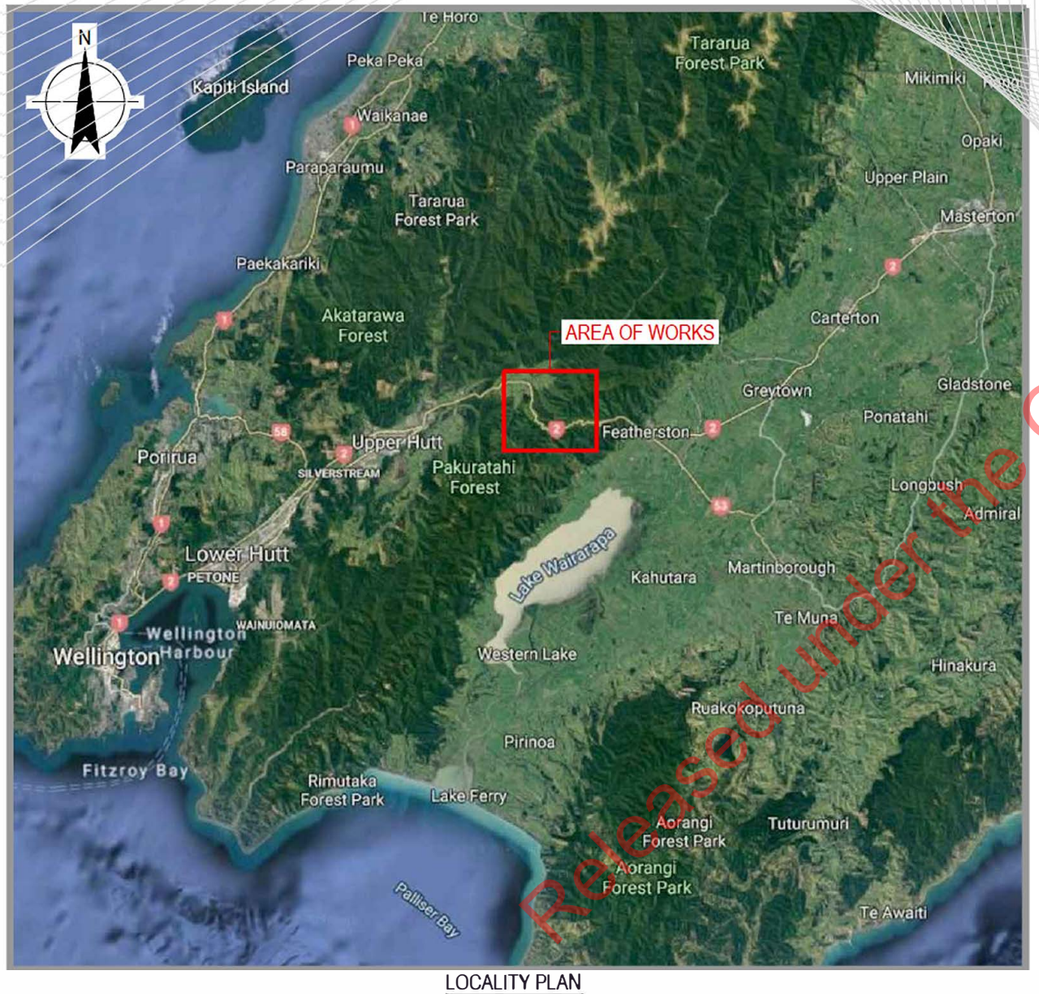
Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	s 9(2)(a)					

Attachment 2

Remutaka Hill Sign Trial

NZ TRANSPORT AGENCY
STATE HIGHWAY 2
REMUTAKA HILL SIGN TRIAL
51-0908375-03



LOCALITY PLAN
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51-0908375-03-G002	SHEET INDEX		A
51-0908375-03-C001	STATE HIGHWAY 2 - REMUTAKA HILL SIGN TRIAL - SHEET 1 OF 15		A
51-0908375-03-C002	STATE HIGHWAY 2 - REMUTAKA HILL SIGN TRIAL - SHEET 2 OF 15		A
51-0908375-03-C003	STATE HIGHWAY 2 - REMUTAKA HILL SIGN TRIAL - SHEET 3 OF 15		A
51-0908375-03-C004	STATE HIGHWAY 2 - REMUTAKA HILL SIGN TRIAL - SHEET 4 OF 15		A
51-0908375-03-C005	STATE HIGHWAY 2 - REMUTAKA HILL SIGN TRIAL - SHEET 5 OF 15		A
51-0908375-03-C006	STATE HIGHWAY 2 - REMUTAKA HILL SIGN TRIAL - SHEET 6 OF 15		A
51-0908375-03-C007	STATE HIGHWAY 2 - REMUTAKA HILL SIGN TRIAL - SHEET 7 OF 15		A
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51-0908375-03-C009	STATE HIGHWAY 2 - REMUTAKA HILL SIGN TRIAL - SHEET 9 OF 15		A
51-0908375-03-C010	STATE HIGHWAY 2 - REMUTAKA HILL SIGN TRIAL - SHEET 10 OF 15		A
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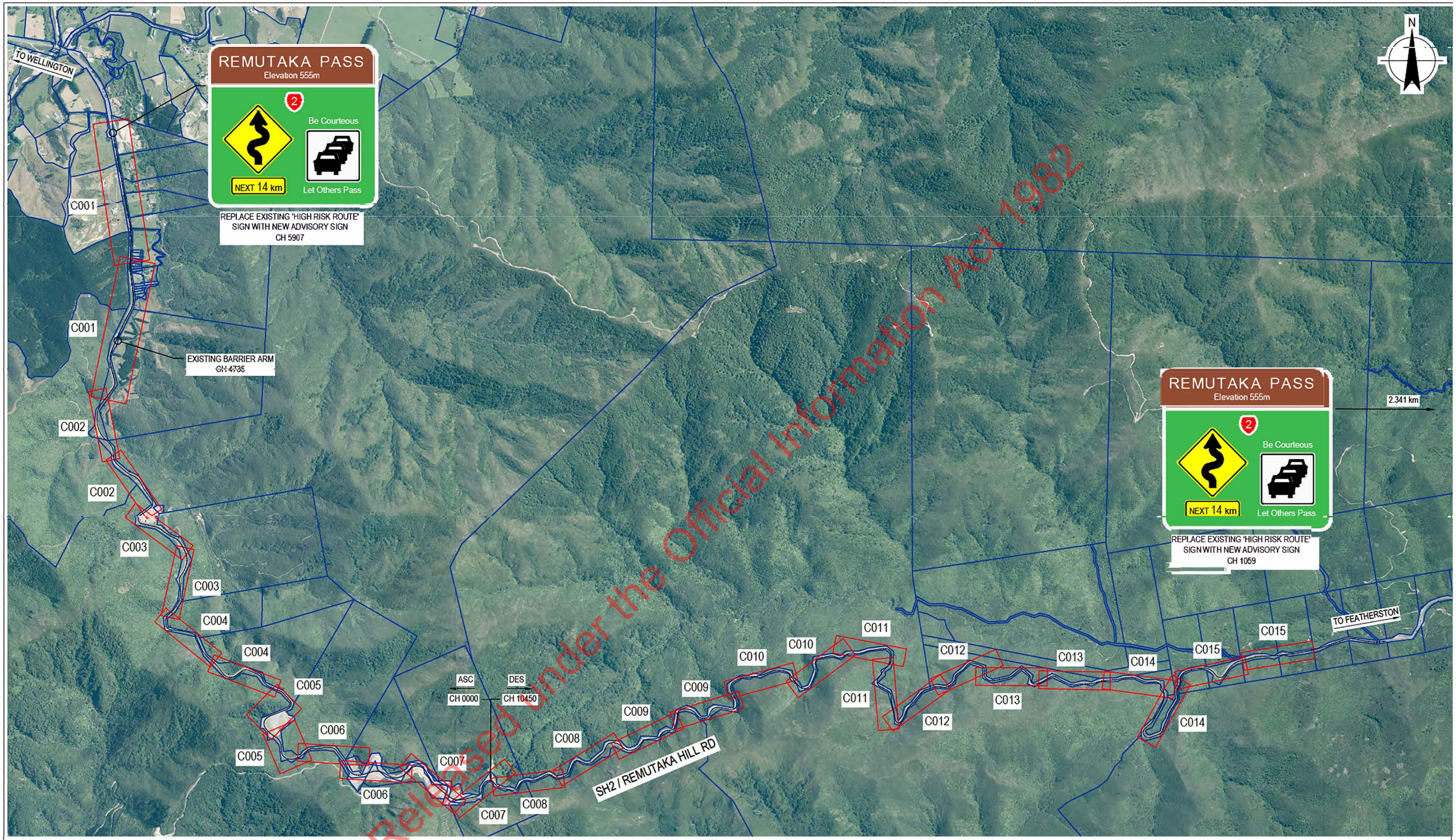

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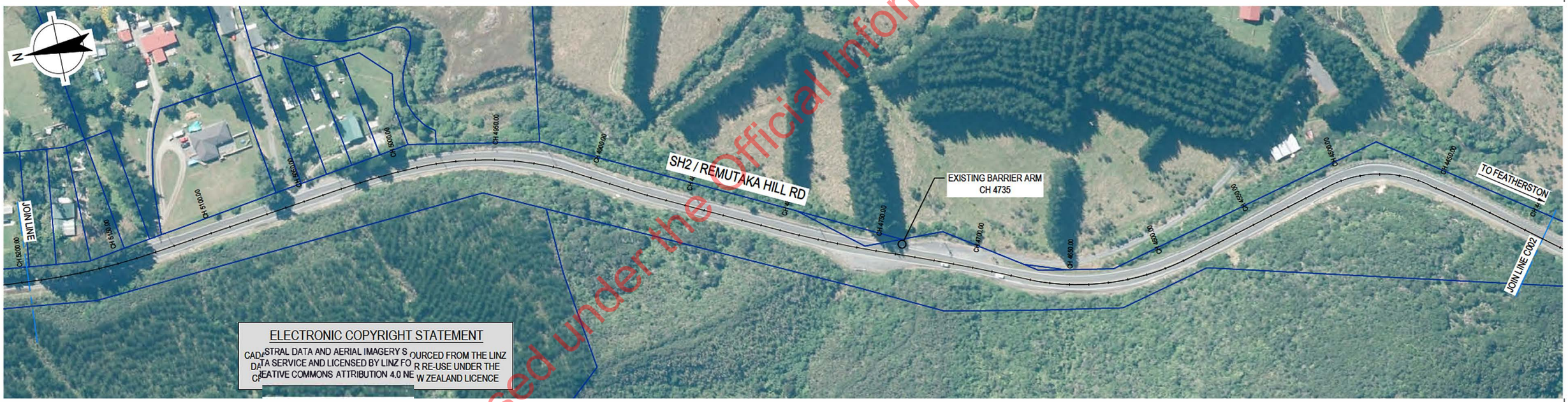

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- NEW WHITE DASHED LANELINE (3 / 7)
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- REMOVE LANEMARKING
- REMOVE HATCH
- NEW WHITE HATCH
- NEW SIGN

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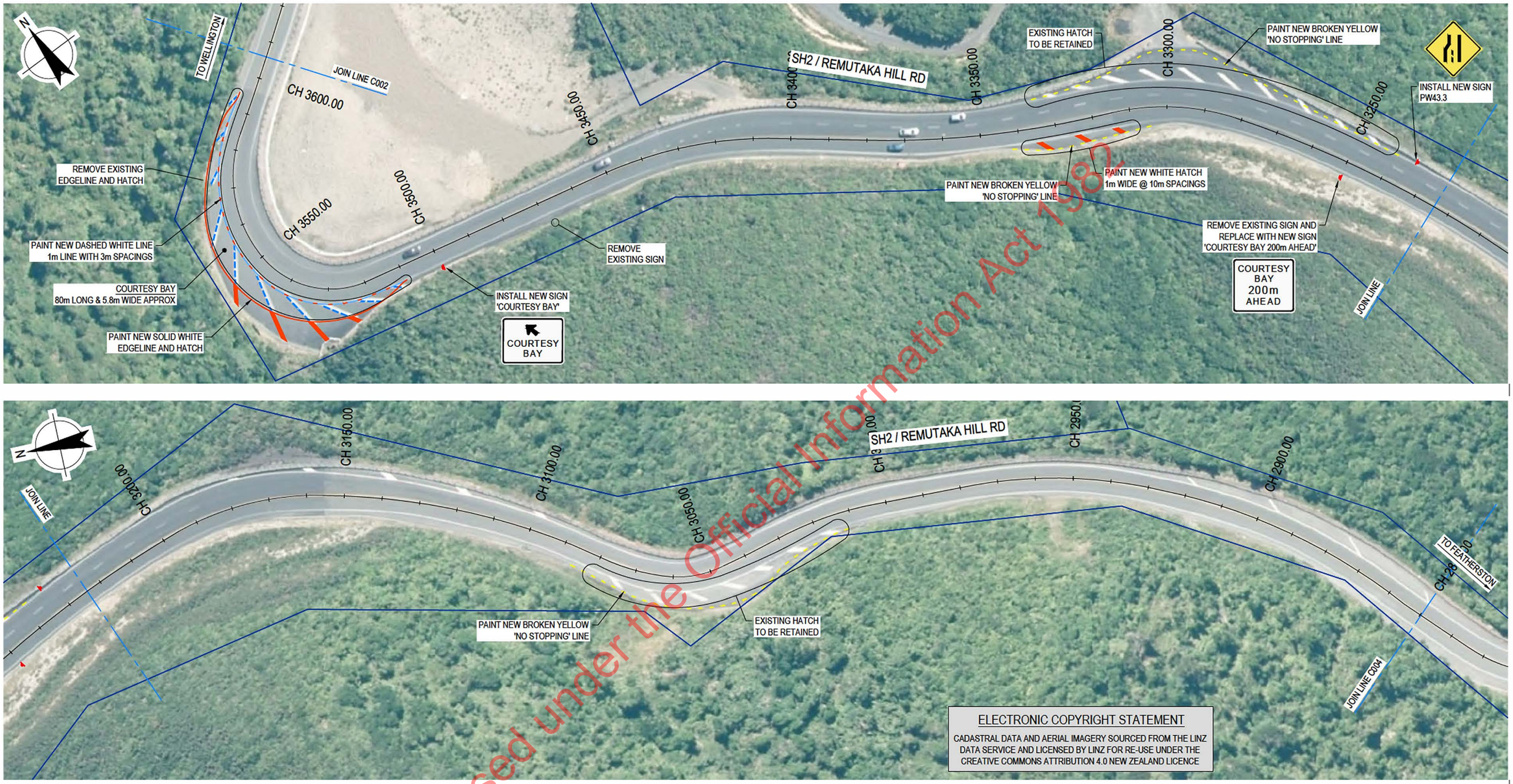

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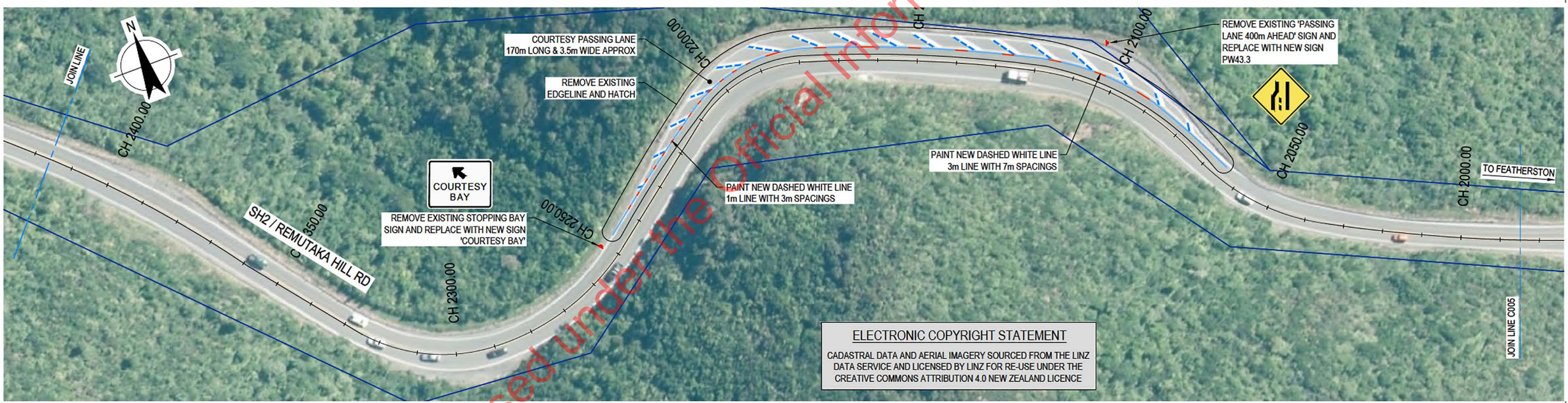

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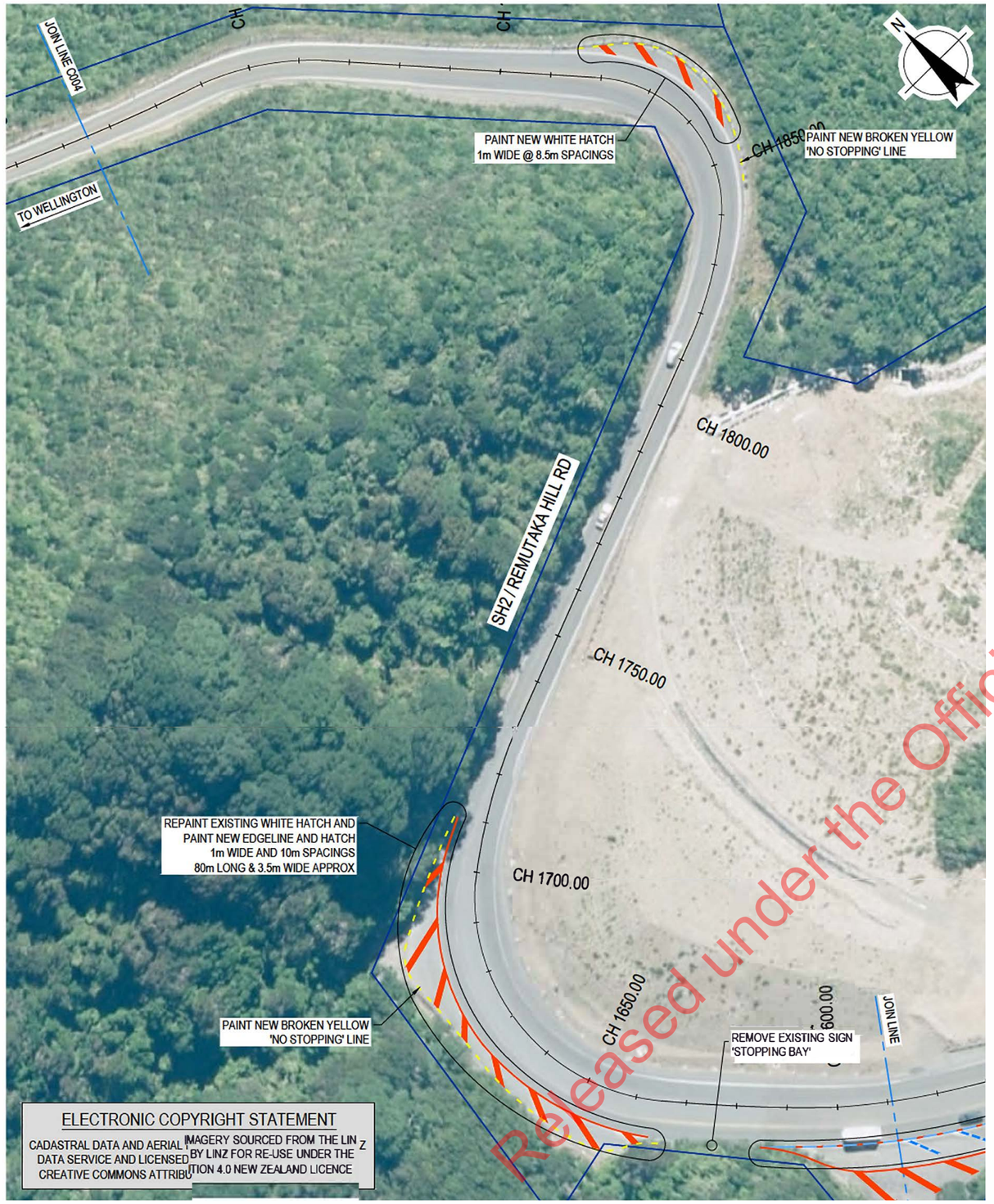

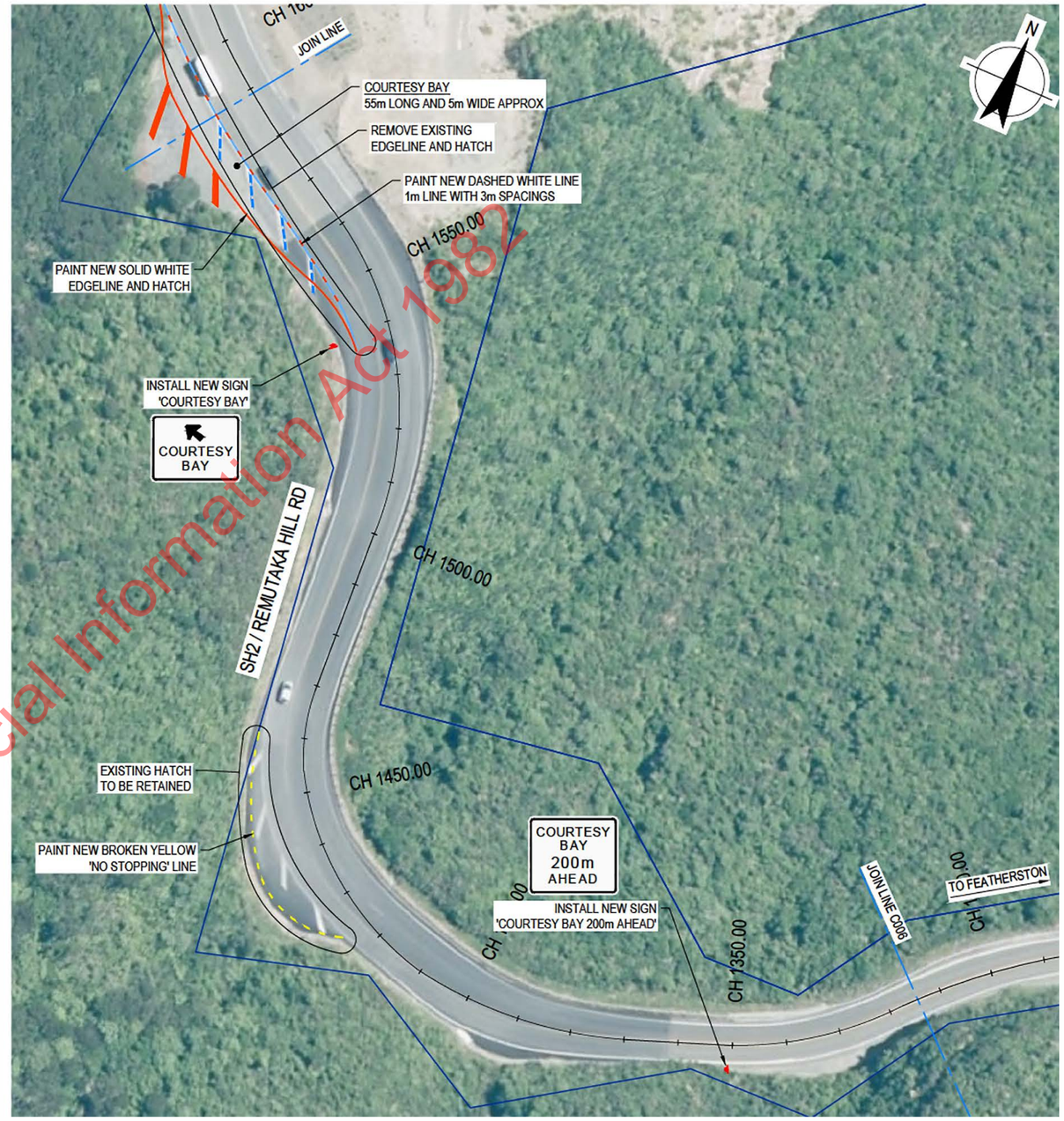

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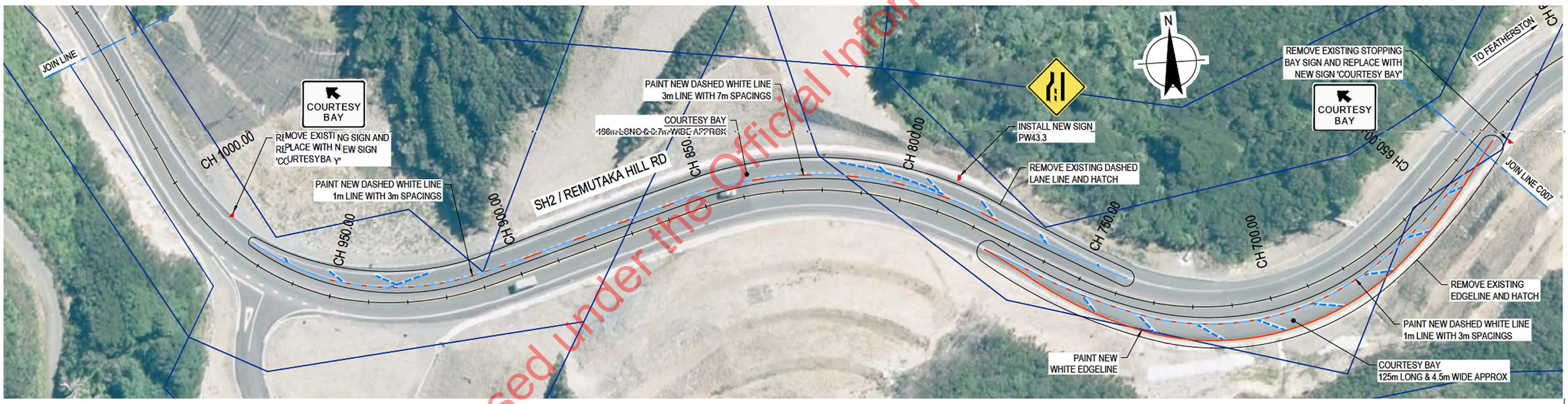

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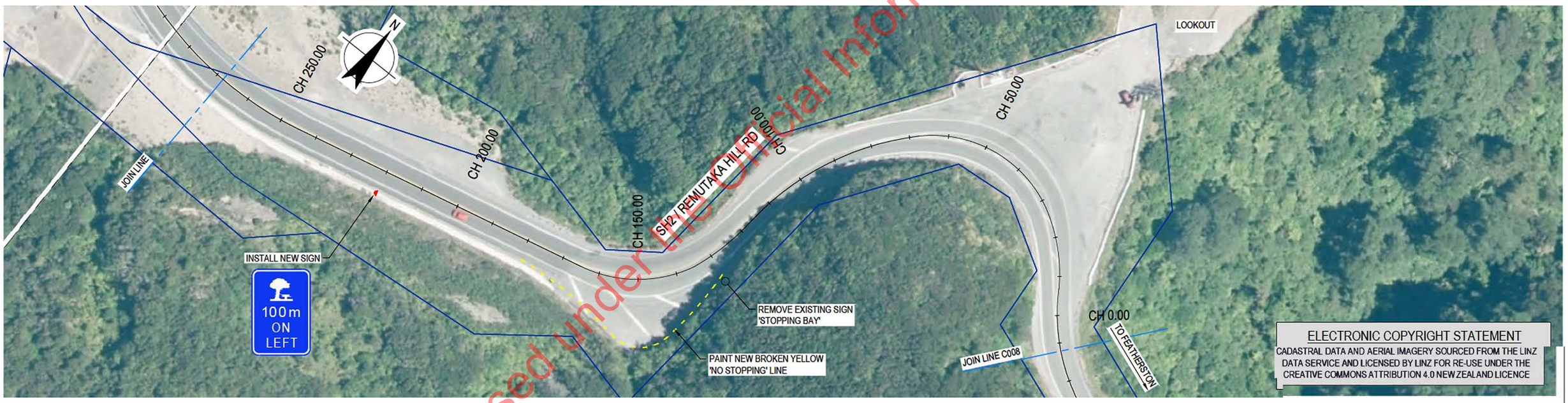

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- NEW WHITE HATCH
- NEWSIGN

0 5 10 15 20 25m
SCALE 1:500 AT ORIGINAL SIZE

NOTE

ALL ROADMARKING TO COMPLY WITH MOTSAM SPECIFICATIONS OR WHERE SUPERCEDED, BY TCDM (TRAFFIC CONTROL DEVICES MANUAL)

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
A	PRELIMINARY		s 9(2)(a)			25/07/19

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Drawn	s 9(2)(a)	Designer	s 9(2)(a)
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Approved (Project Director)	s 9(2)(a)		
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Scale	1:500 @ A1	This Drawing must not be used for Construction unless	

Client	NZ TRANSPORT AGENCY
Project	STATE HIGHWAY 2
Title	REMUTAKA HILL SIGN TRIAL
	SHEET 8 OF 15
Original Size	A1
Drawing No:	51-0908375-03-C008
Rev:	A

PAINT NEW BROKEN YELLOW 'NO STOPPING' LINE
EXISTING HATCH TO BE RETAINED
TO WELLINGTON
JOIN LINE C008
COURTESY BAY 100m AHEAD
INSTALL NEW SIGN 'COURTESY BAY 100m AHEAD'
COURTESY BAY
REMOVE EXISTING SIGN AND REPLACE WITH NEW SIGN 'COURTESY BAY'
PAINT NEW WHITE EDGELINE
COURTESY BAY 70m LONG AND 3.5m WIDE APPROX
REMOVE EXISTING EDGELINE AND HATCH
PAINT NEW DASHED WHITE LINE 1m LINE WITH 3m SPACINGS
SH2 / REMUTAKA HILL RD
JOIN LINE
PAINT NEW BROKEN YELLOW 'NO STOPPING' LINE
PAINT NEW BROKEN YELLOW 'NO STOPPING' LINE
REMOVE EXISTING STOPPING BAY SIGN
PAINT NEW BROKEN YELLOW 'NO STOPPING' LINE
JOIN LINE
JOIN LINE C010
TO FEATHERSTON
PAINT NEW BROKEN YELLOW 'NO STOPPING' LINE
EXISTING HATCH TO BE RETAINED
SH2 / REMUTAKA HILL RD
PAINT NEW DASHED WHITE LINE 1m LINE WITH 3m SPACINGS
PAINT NEW DASHED WHITE LINE 3m LINE WITH 7m SPACINGS
REMOVE EXISTING EDGELINE AND HATCH
REMOVE EXISTING STOPPING BAY SIGN
REMOVE EXISTING PASSING LANE SIGN
PAINT NEW WHITE HATCH 1m WIDE @ 8.5m SPACINGS
PAINT NEW BROKEN YELLOW 'NO STOPPING' LINE
INSTALL NEW SIGN PW43.3
COURTESY BAY 160m LONG & 4.0m WIDE APPROX

LEGEND
- NEW SOLID WHITE EDGELINE
- NEW WHITE DASHED LANELINE (3 / 1)
- NEW WHITE DASHED LANELINE (3 / 7)
- NEW BROKEN YELLOW LINE
- REMOVE LANEMARKING
- REMOVE HATCH
- NEW WHITE HATCH
- NEWSIGN

NOTE
ALL ROADMARKING TO COMPLY WITH MOTSAM SPECIFICATIONS OR WHERE SUPERCEDED, BY TCDM (TRAFFIC CONTROL DEVICES MANUAL)

0 5 10 15 20 25m
SCALE 1:500 AT ORIGINAL SIZE

PRELIMINARY

No	Revision	Drawn	Job Manager	Project Director	Date
A	PRELIMINARY	s 9(2)(a)			25/07/19

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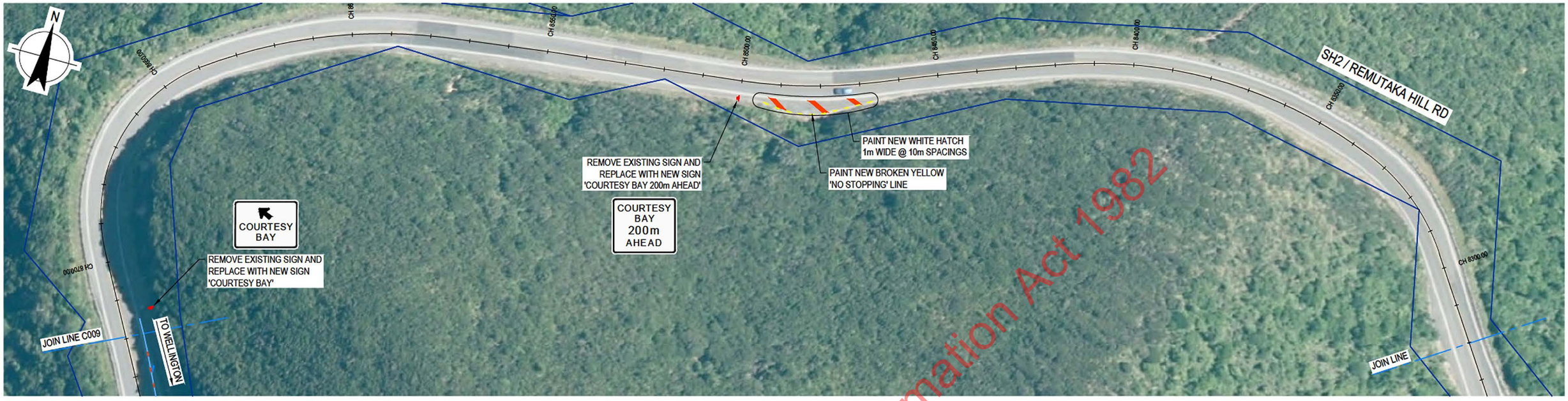
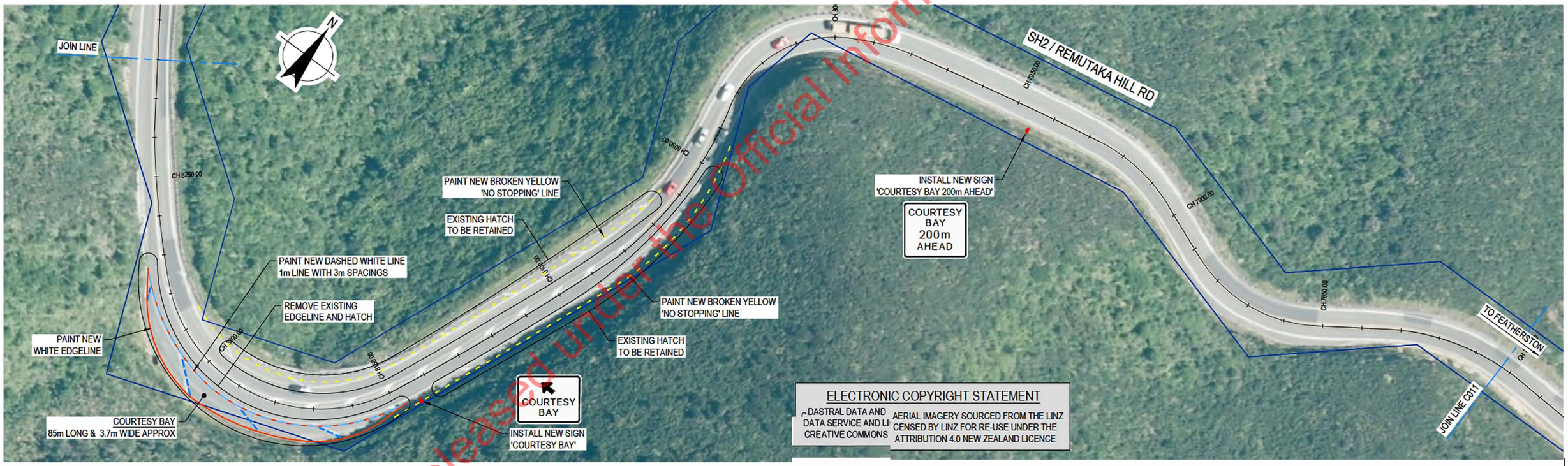
Project: STATE HIGHWAY 2
Title: REMUTAKA HILL SIGN TRIAL
SHEET 9 OF 15

Original Size: A1
Drawing No: 51-0908375-03-C009
Rev: A





LEGEND

- NEW SOLID WHITE EDGELINE
- NEW WHITE DASHED LANELINE (3 / 1)
- NEW WHITE DASHED LANELINE (3 / 7)
- NEW BROKEN YELLOW LINE
- REMOVE LANEMARKING
- REMOVE HATCH
- NEW WHITE HATCH
- NEW SIGN

0 5 10 15 20 25m
SCALE 1:500 AT ORIGINAL SIZE

NOTE

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Approved (Project Director)	s 9(2)(a)		
Date	16/07/2019		
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Project: STATE HIGHWAY 2
Title: REMUTAKA HILL SIGN TRIAL
SHEET 10 OF 15

Original Size: A1 | Drawing No: 51-0908375-03-C010 | Rev: A

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LEGEND

- NEW SOLID WHITE EDGELINE
- NEW WHITE DASHED LANELINE (3, 1)
- NEW WHITE DASHED LANELINE (3, 7)
- NEW BROKEN YELLOW LINE
- REMOVE LANEMARKING
- REMOVE HATCH
- NEW WHITE HATCH
- NEW SIGN

0 5 10 15 20 25m
SCALE 1:500 AT ORIGINAL SIZE

NOTE

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Client	NZ TRANSPORT AGENCY
Project	STATE HIGHWAY 2
Title	REMUTAKA HILL SIGN TRIAL
	SHEET 11 OF 15
Original Size	A1
Drawing No:	51-0908375-03-C011
Rev:	A

Plot Date: 25 July 2019 - 9:37 AM
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LEGEND

- NEW SOLID WHITE EDGELINE
- NEW WHITE DASHED LANELINE (3 / 1)
- NEW WHITE DASHED LANELINE (3 / 7)
- NEW BROKEN YELLOW LINE
- REMOVE LANEMARKING
- REMOVE HATCH
- NEW WHITE HATCH
- NEWSIGN

NOTE

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0 5 10 15 20 25m
SCALE 1:500 AT ORIGINAL SIZE

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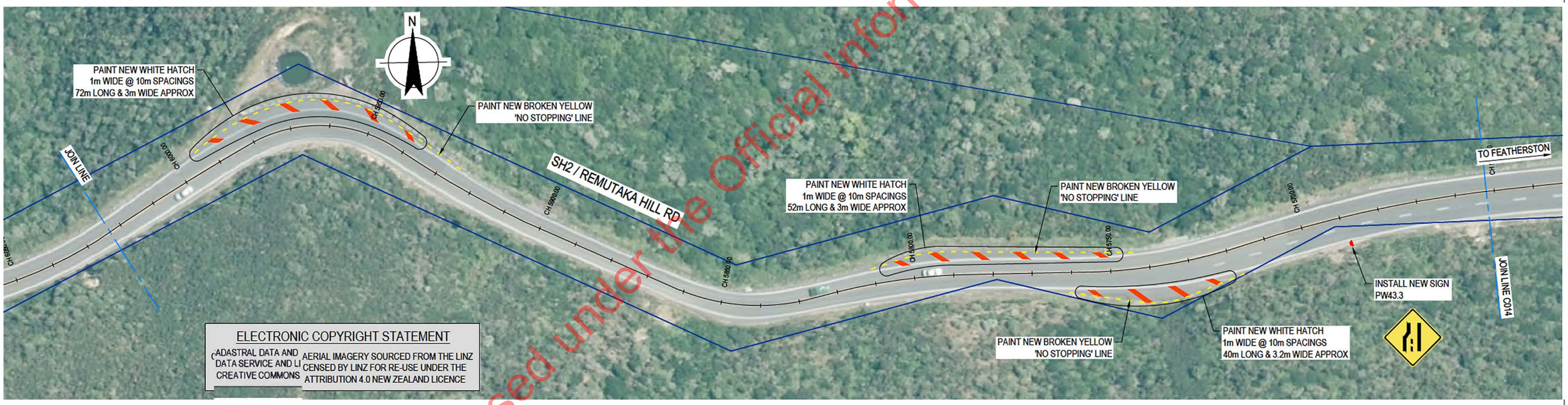
Client	NZ TRANSPORT AGENCY
Project	STATE HIGHWAY 2
Title	REMUTAKA HILL SIGN TRIAL SHEET 12 OF 15
Original Size	A1
Drawing No:	51-0908375-03-C012
Rev:	A



LEGEND

- NEW SOLID WHITE EDGELINE
- NEW WHITE DASHED LANELINE (3 / 1)
- NEW WHITE DASHED LANELINE (3 / 7)
- NEW BROKEN YELLOW LINE
- REMOVE LANEMARKING
- REMOVE HATCH
- NEW WHITE HATCH
- NEWSIGN

NOTE

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Date	16/07/2019		
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Client	NZ TRANSPORT AGENCY
Project	STATE HIGHWAY 2
Title	REMUTAKA HILL SIGN TRIAL
	SHEET 13 OF 15
Original Size	A1
Drawing No:	51-0908375-03-C013
Rev:	A

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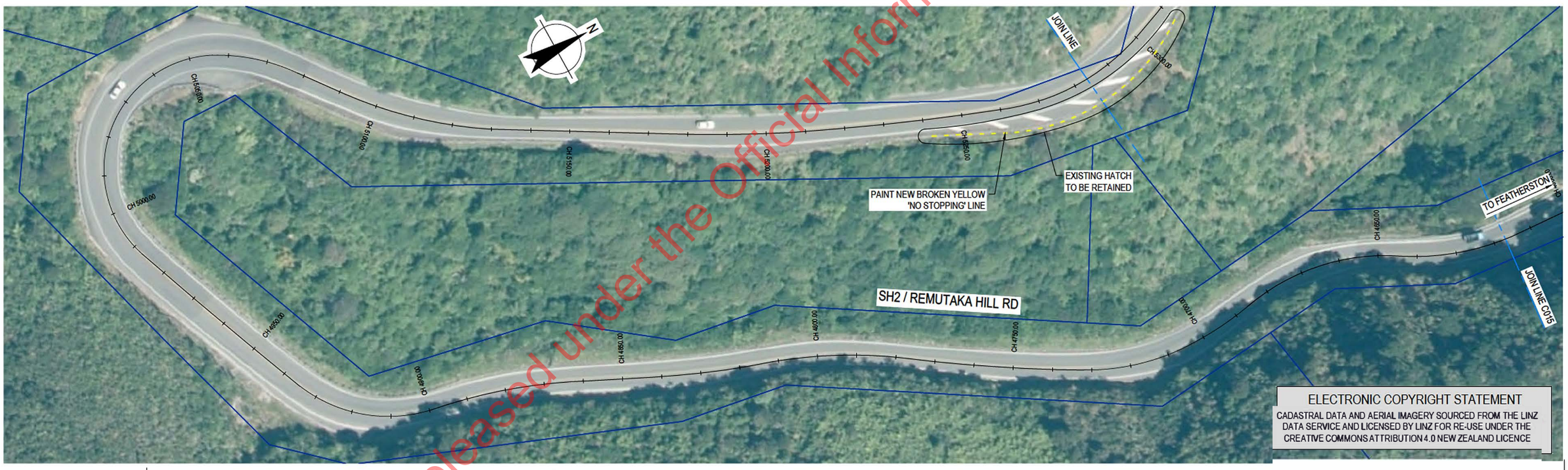

LEGEND

- NEW SOLID WHITE EDGELINE
- NEW WHITE DASHED LANELINE (3, 1)
- NEW WHITE DASHED LANELINE (3, 7)
- NEW BROKEN YELLOW LINE
- REMOVE LANEMARKING
- REMOVE HATCH
- NEW WHITE HATCH
- NEW SIGN

0 5 10 15 20 25m
SCALE 1:500 AT ORIGINAL SIZE

NOTE
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Date	16/07/2019		
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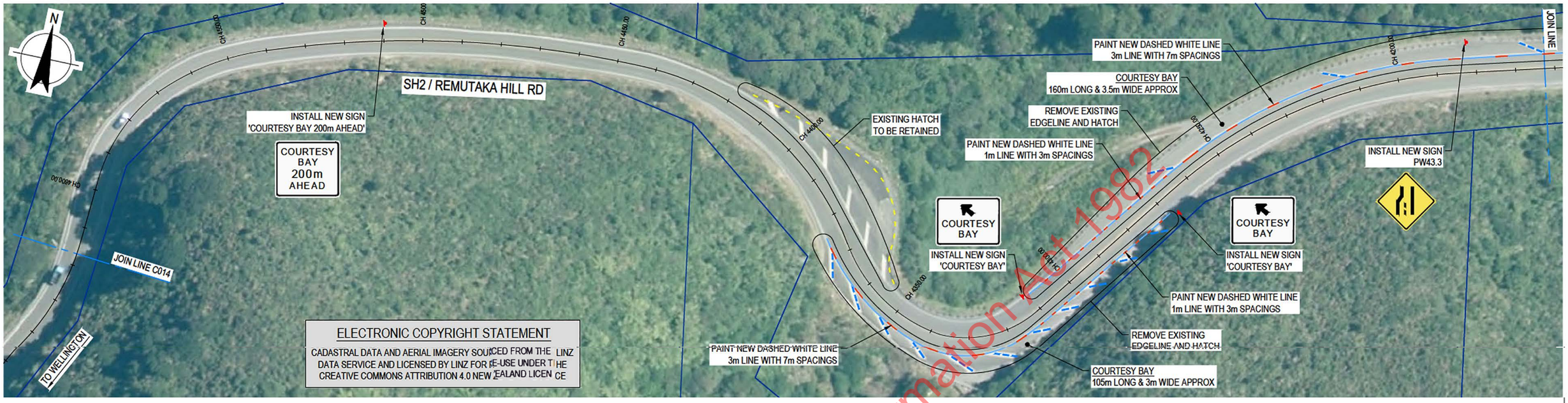
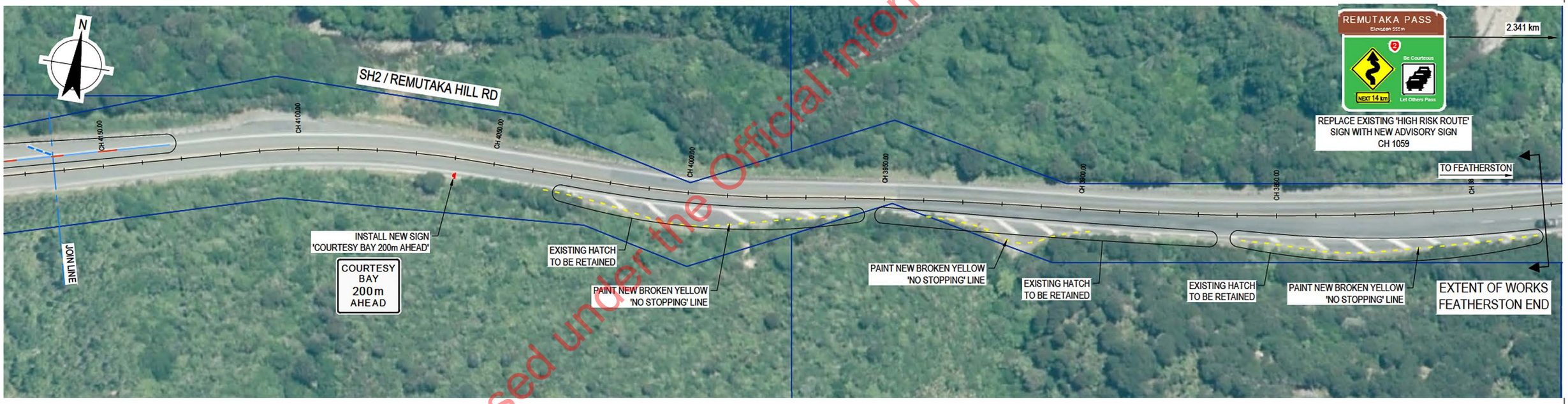
Client: NZ TRANSPORT AGENCY
Project: STATE HIGHWAY 2
Title: REMUTAKA HILL SIGN TRIAL
SHEET 14 OF 15

Original Size: A1
Drawing No: 51-0908375-03-C014
Rev: A





LEGEND

- NEW SOLID WHITE EDGELINE
- NEW WHITE DASHED LANELINE (3 / 1)
- NEW WHITE DASHED LANELINE (3 / 7)
- NEW BROKEN YELLOW LINE
- REMOVE LANEMARKING
- REMOVE HATCH
- NEW WHITE HATCH
- NEWSIGN

0 5 10 15 20 25m
SCALE 1:500 AT ORIGINAL SIZE

NOTE

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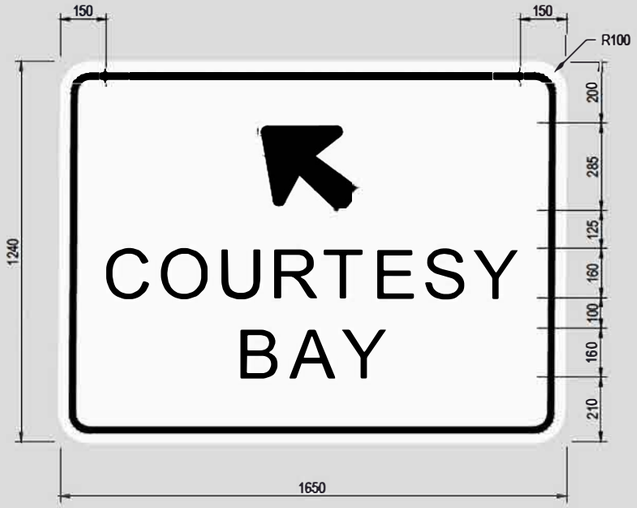
Client: NZ TRANSPORT AGENCY
Project: STATE HIGHWAY 2
Title: REMUTAKA HILL SIGN TRIAL
SHEET 15 OF 15

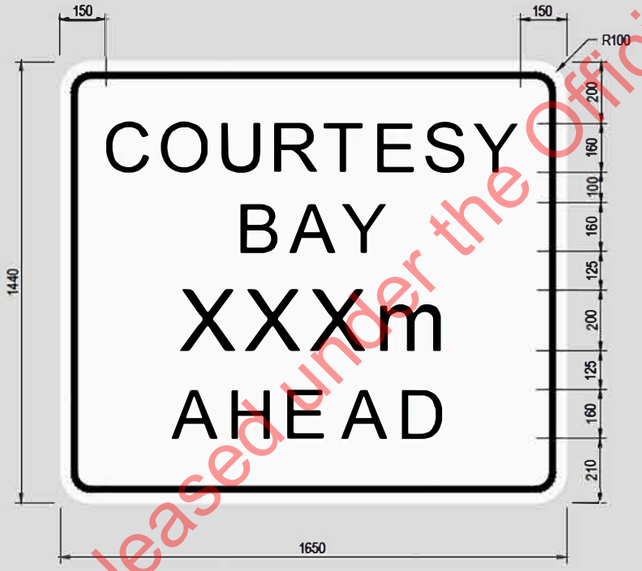
Original Size: A1
Drawing No: 51-0908375-03-C015
Rev: A

PROPOSED SIGN
NOT TO SCALE



PROPOSED SIGN
SCALE 1:10 @ A1

PROPOSED SIGN
NOT TO SCALE



PROPOSED SIGN
SCALE 1:10 @ A1

PROPOSED SIGN
NOT TO SCALE

0 100 200 300 400 500mm
SCALE 1:10 AT ORIGINAL SIZE

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Client	NZ TRANSPORT AGENCY
Project	STATE HIGHWAY 2
Title	REMUTAKA HILL SIGN TRIAL NEW SIGN LAYOUTS
Original Size	A1
Drawing No:	51-0908375-03-C016
Rev:	A