

POROUS ASPHALT SURFACE NOISE TRIALS

Summary of CPX testing results

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Introduction

A number of porous asphalt trials sections were constructed in Christchurch during 2017 and 2018 as part of the low noise road surface programme. Additionally, several epoxy modified porous asphalt trials already existed on the Christchurch Southern Motorway and those trial sections have been incorporated into the surface noise programme.

Intermittent CPX testing has been performed on each trial section since commissioning of the Waka Kotahi CPX noise measurement trailer in February 2017.

This report presents the CPX testing results for the Christchurch porous asphalt trial sections as at December 2020 and follows on from the previous summary prepared by Altissimo¹.

Trial section details

The porous asphalt trial sections are located on SH1 and SH73 in Christchurch. Table 1 to Table 4 provide details of the trial sections.

¹ Altissimo (2019). Road surface noise research: Porous asphalt variability study – final report. Appendix B: Porous asphalt trial results.

Table 1 High void trial sections – Sawyers Arms Rd to Greywacke Rd ("S2G")

Mix	Thickness	Carriageway	Rs	Start	End	Length	Lanes	Contractor	Construction date	Notes
EPA10	30 mm	Northbound	01S-0333 (D)	3,640 m	3,880 m	240 m	Both	Downer	Feb 2017	
EPA10HV	30 mm			3,320 m	3,630 m	310 m				
EPA14	30 mm			3,040 m	3,300 m	260 m				

Table 2 Small chip trial sections

Mix	Thickness	Carriageway	Rs	Start	End	Length	Lanes	Contractor	Construction date	Notes
EPA7	40 mm	Northbound	01S-0333 (D)	518 m	1,007 m	489 m	Both	Fulton Hogan	Oct 2017	
EPA7	30 mm	Northbound	01S-0333 (D)	7,322 m	7,660 m	338 m	Both	Downer	Apr 2018	Descending abutment
EPA 7	30 mm			6,895 m	7,260 m	365 m				Ascending abutment

Table 3 Thickness trial sections – Western Belfast Bypass ("WBB")

Mix	Thickness	Carriageway	Rs	Start	End	Length	Lanes	Contractor	Construction date	Notes
EPA7	30 mm	Northbound	01S-0327 (D)	4,864 m	5,126 m	262 m	Both	Fulton Hogan	Nov 2018	
EPA7	40 mm			4,585 m	4,845 m	260 m				
EPA7	50 mm			4,292 m	4,566 m	274 m				

Table 4 Epoxy dilution trial sections – Christchurch Southern Motorway ("CSM")

Mix	Thickness	Carriageway	Rs	Start	End	Length	Lanes	Contractor	Construction date	Notes
EPA10 (SB, 25% epoxy)	40 mm	Southbound	076-0003 (I)	7,250 m	7,466 m	216 m	Left	Fulton Hogan	Jun 2012	
EPA10 (SB, 50% epoxy)	40 mm			6,842 m	7,050 m	208 m				
EPA10 (SB, 100% epoxy)	40 mm			5,685 m	5,900 m	215 m				
PA10 (SB, control)	40 mm			5,900 m	6,100 m	200 m				100% epoxy control
PA10 (SB, control)	40 mm			7,050 m	7,250 m	200 m				25% and 50% epoxy control
EPA10 (NB, 25% epoxy)	40 mm	Northbound	076-0003 (D)	6,232 m	6,530 m	298 m	Left	Fulton Hogan	Jun 2012	
PA10 (NB, control)	40 mm			5,670 m	6,164 m	494 m				

Measurement details

Details of the CPX testing sessions are given in Table 5.

The table includes measurements taken before raw data capture was incorporated into the CPX trailer system. The early measurements are affected by an error in the on-board trailer software and enclosure reflections; the affected measurement results are not presented in this report but the measurement session details are included in *italics* in Table 5 for reference.

Table 5 CPX testing sessions

Location	Trial section	Date	Age	Tyres	Notes
S2G	High void	<i>21/02/2017</i>	<i>1 week</i>	<i>P1</i>	<i>Early measurement (affected by averaging error and enclosure reflections)</i>
		<i>10/04/2017</i>	<i>8 weeks</i>	<i>P1</i>	
		<i>26/04/2017</i>	<i>10 weeks</i>	<i>P1</i>	
		21/03/2018	13 months	P1	Early measurement (affected by averaging error) 1 run of raw data
		18/07/2018	17 months	P1	Left lane only
		17/12/2018	22 months	P1, H1	
		21/03/2019	2 years	P1, H1	
		11/09/2019	2½ years	P1, H1	
		09/03/2020 & 12/03/2020	3 years	P1	
		01/10/2020 & 11/10/2020	3½ years	P1	
Clearwater to Groyne	Small chip	21/03/2018	5 months	P1	Early measurement (affected by averaging error) 1 run of raw data
		18/07/2018	9 months	P1	Left lane only
		17/12/2018	14 months	P1, H1	
		07/03/2019	17 months	P1	Single run, left lane only
		21/03/2019	17½ months	P1, H1	
		11/09/2019	23 months	P1, H1	
		09/03/2020 & 12/03/2020	2½ years	P1	
		01/10/2020 & 11/10/2020	3 years	P1	

Location	Trial section	Date	Age	Tyres	Notes
Memorial Ave bridge	Small chip	08/06/2018	7 weeks	P1	
		04/07/2018	3 months	P1	
		11/09/2019	17 months	P1	
		09/03/2020 & 12/03/2020	23 months	P1	
		01/10/2020 & 11/10/2020	2½ years	P1	
WBB	Thickness	17/12/2018	6 weeks	P1, H1	
		07/03/2019	4 months	P1, H1	Single run, left lane only
		21/03/2019	4½ months	P1, H1	
		11/09/2019	10 months	P1, H1	
		09/03/2020 & 12/03/2020	16 months	P1	
		01/10/2020 & 11/10/2020	23 months	P1	
CSM	Epoxy dilution	26/04/2017	5 years	P1	Early measurement (affected by averaging error and enclosure reflections)
		10/09/2019	7½ years	P1	
		12/03/2020	8 years	P1	
		11/10/2020	8½ years	P1	

Results

Average results for each surface mix and thickness are given in Table 6, Figure 1 and Figure 2.

Measurement session results by location and trial section are presented in Table 7 to Table 14. The $L_{CPX:P1,80}$ time series are shown in Figure 3 to Figure 6.

The measurement session tables include $L_{CPX:t,80}$ and s_t (acoustic variability) for each measurement date and test tyre, “t” (P1 or H1). The average air temperature and average testing speed are included for information. All corrections required by ISO 11819-2:2017 have been applied; however, the hardness correction procedure has been modified according to a recent conference paper² containing a proposed

² Bühlmann, E., Mioduszewski, P., Sandberg, U., An in-depth look at the tire rubber hardness influence on tire/road noise measurements. Inter-Noise 2018. Chicago.

modification to the hardness correction procedure. The new hardness correction procedure is expected to become part of a future version of ISO 11819-2.

Table 6 $L_{CPX:t,80}$ for each trial section (average of all measurement sessions)

Mix	Location	Lane	$L_{CPX:P1,80}$ (dB)	$L_{CPX:H1,80}$ (dB)
EPA7 30mm	Memorial Ave bridge	Left	94.2	-
		Right	93.8	-
	WBB thickness trial	Left	96.1	95.8
		Right	94.2	95.0
EPA7 40mm	Clearwater small chip trial	Left	93.6	92.9
		Right	91.4	91.6
	WBB thickness trial	Left	92.9	92.4
		Right	92.5	92.9
EPA7 50mm	WBB thickness trial	Left	91.6	91.0
		Right	90.6	91.2
EPA10 30mm	S2G high void trial	Left	95.8	94.5
		Right	94.4	93.7
EPA10HV 30mm	S2G high void trial	Left	97.3	96.0
		Right	95.9	95.1
EPA14 30mm	S2G high void trial	Left	99.8	98.8
		Right	97.7	97.0

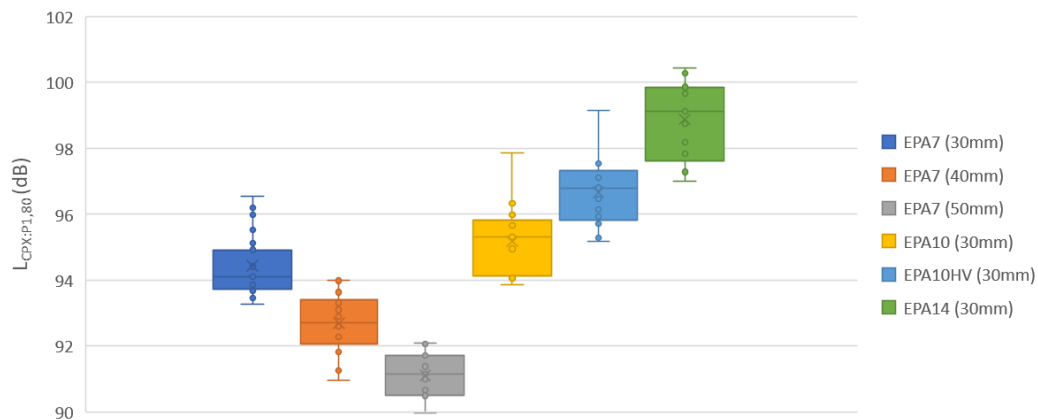


Figure 1 $L_{CPX:P1,80}$ for all available measurement sessions, arranged by surface mix type

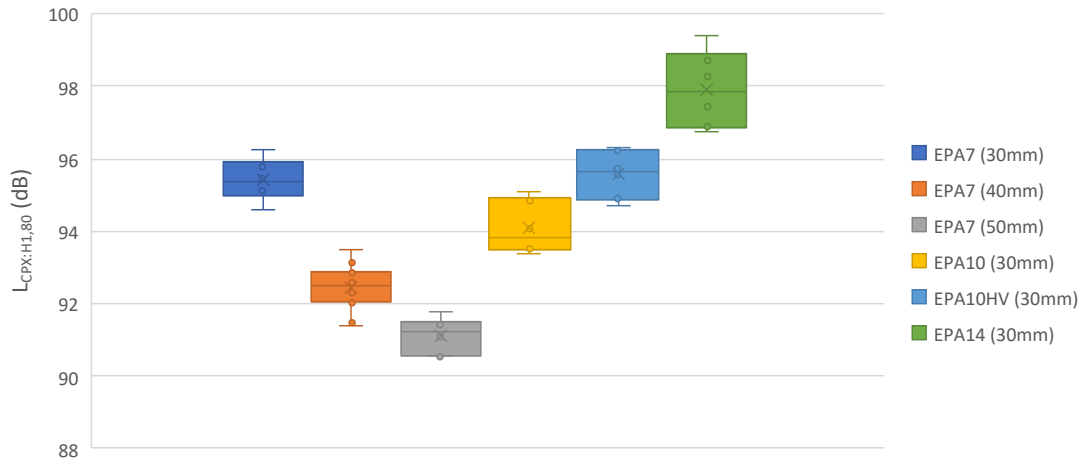


Figure 2 $L_{CPX:HI,80}$ for all measurement sessions, arranged by surface mix type

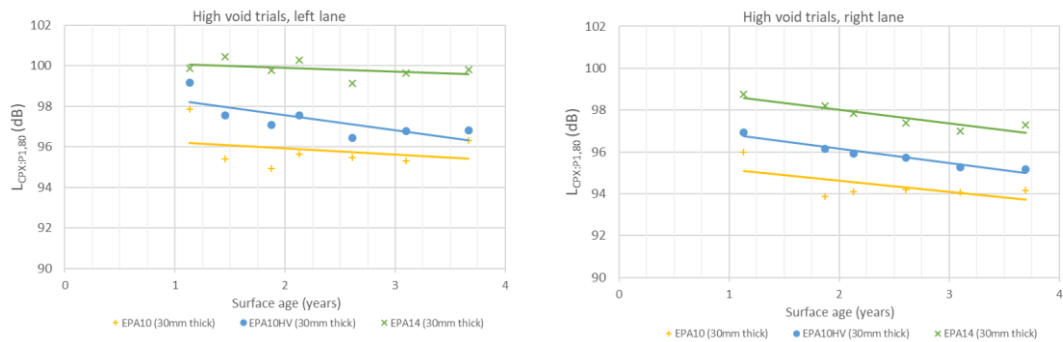


Figure 3 High void trials $L_{CPX:P1,80}$ time series (30mm thick EPA10, EPA10HV and EPA14)

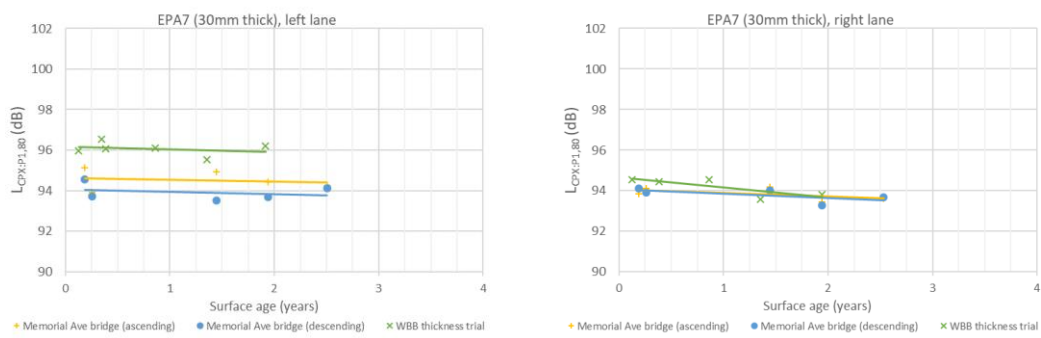


Figure 4 30mm thick EPA7 $L_{CPX:P1,80}$ time series

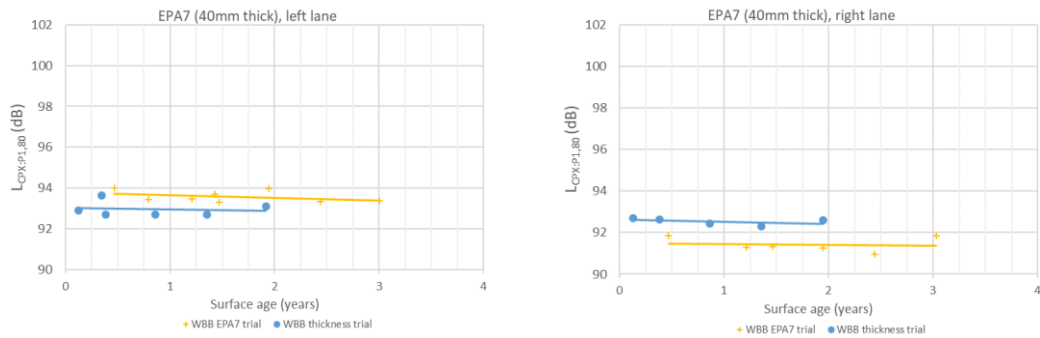


Figure 5 40mm thick EPA7 $L_{CPX:P1,80}$ time series

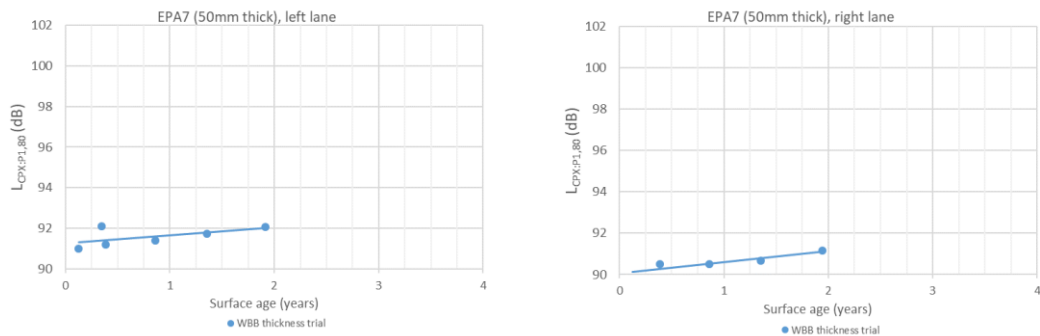


Figure 6 50mm thick EPA7 $L_{CPX:P1,80}$ time series

Table 7 High void trial sections – Sawyers Arms Rd to Greywacke Rd (“S2G”) – P1 tyre

Mix	Lane	Date	Runs	$L_{CPX:P1,80}$ (dB)	SP1 (dB)	Speed (km/h)	Air temperature (C)
EPA10 (30mm thick)	Left	21/03/2018	1	97.9	0.4	77.3	23.0
		18/07/2018	3	95.4	0.5	80.3	17.5
		17/12/2018	4	94.9	0.5	79.3	22.9
		21/03/2019	4	95.7	0.5	78.6	18.0
		11/09/2019	8	95.5	0.6	79.8	7.7
		9/03/2020*	5	95.3	0.6	79.5	18.6
		1/10/2020	3	96.3	0.4	79.4	14.7
	Right	21/03/2018	3	96.0	0.4	77.5	26.5
		17/12/2018	3	93.9	0.5	79.6	23.1
		21/03/2019	3	94.1	0.4	79.1	17.9
		11/09/2019	3	94.2	0.4	80.3	8.8
		9/03/2020	3	94.1	0.3	79.4	20.6
		11/10/2020	3	94.2	0.7	79.6	23.5

EPA10HV (30mm thick)	Left	21/03/2018	1	99.2	0.4	76.9	23.5
		18/07/2018	3	97.6	0.6	80.3	17.3
		17/12/2018	4	97.1	0.5	79.6	23.0
		21/03/2019	4	97.5	0.4	78.7	18.1
		11/09/2019	8	96.5	0.6	79.9	7.6
		9/03/2020*	5	96.8	0.7	79.2	18.4
		1/10/2020	3	96.8	0.6	79.4	14.6
	Right	21/03/2018	3	96.9	0.3	77.9	26.1
		17/12/2018	3	96.1	0.6	80.2	23.2
		21/03/2019	3	95.9	0.5	79.2	18.0
		11/09/2019	3	95.7	0.4	80.0	8.7
		9/03/2020	3	95.3	0.6	80.3	20.2
		11/10/2020	3	95.2	0.6	80.1	23.5
	EPA14 (30mm thick)	Left	21/03/2018	1	99.9	1.0	76.6
18/07/2018			3	100.4	1.0	79.8	17.2
17/12/2018			4	99.8	0.9	78.8	23.0
21/03/2019			4	100.3	0.8	78.3	18.0
11/09/2019			8	99.1	0.9	78.2	7.6
9/03/2020*			5	99.7	1.1	78.5	18.3
1/10/2020			3	99.8	0.5	78.9	14.5
Right		21/03/2018	3	98.7	0.6	77.6	25.9
		17/12/2018	3	98.2	0.4	78.7	23.1
		21/03/2019	3	97.8	0.6	77.8	18.0
		11/09/2019	3	97.4	0.6	79.8	8.6
		9/03/2020	3	97.0	0.7	80.2	19.9
		11/10/2020	3	97.3	0.5	79.7	23.4

* Includes runs from measurement session on 12/03/2020.

Table 8 High void trial sections – Sawyers Arms Rd to Greywacke Rd (“S2G”) – H1 tyre

Mix	Lane	Date	Runs	L _{CPX:H1,80} (dB)	S _{H1} (dB)	Speed (km/h)	Air temperature (C)
EPA10 (30 mm thick)	Left	17/12/18	3	93.5	0.6	79.4	19.4
		21/03/19	3	94.9	0.6	78.9	17.8
		10/09/19	3	95.1	1.1	80.2	7.5
	Right	17/12/18	3	93.4	0.5	79.6	20.7
		21/03/19	3	94.1	0.5	79.3	17.9
		10/09/19	3	93.5	0.4	79.7	6.6
EPA10HV (30 mm thick)	Left	17/12/18	3	95.5	0.6	79.8	19.2
		21/03/19	3	96.2	0.8	79.8	18.0
		10/09/19	3	96.3	0.8	79.5	7.5
	Right	17/12/18	3	94.9	0.5	80.1	20.5
		21/03/19	3	95.7	0.5	78.4	18.1
		10/09/19	3	94.7	0.5	79.3	6.5
EPA14 (30 mm thick)	Left	17/12/18	3	98.3	1.0	79.2	19.1
		21/03/19	3	99.4	0.9	78.5	18.0
		10/09/19	3	98.7	1.4	79.1	7.5
	Right	17/12/18	3	96.9	0.4	79.0	20.5
		21/03/19	3	97.4	0.6	77.7	18.1
		10/09/19	3	96.7	0.7	78.7	6.4

Table 9 Small chip trial sections – Clearwater Roundabout to Groyne Rd offramp – P1 tyre

Mix	Lane	Date	Runs	L _{CPX:P1,80} (dB)	S _{P1} (dB)	Speed (km/h)	Air temperature (C)
EPA7 (40mm thick)	Left	21/03/2018	3	94.0	1.1	77.6	24.3
		18/07/2018	3	93.4	1.0	81.1	17.5
		17/12/2018	3	93.5	1.0	80.5	22.4
		7/03/2019	1	93.7	0.6	81.8	30.9
		21/03/2019	3	93.3	0.8	80.2	18.0
		11/09/2019	3	94.0	0.9	79.0	9.3
		9/03/2020*	6	93.3	0.8	80.4	19.2
		1/10/2020	3	93.4	0.7	80.0	14.2
		Right	21/03/2018	3	91.8	0.7	79.1
	17/12/2018		3	91.3	0.6	80.8	20.8
	21/03/2019		3	91.3	0.6	79.9	18.3
	11/09/2019		3	91.3	0.6	81.4	6.6
	9/03/2020		2	91.0	0.4	80.2	19.3
			11/10/2020	3	91.9	0.8	79.3

* Includes runs from measurement session on 12/03/2020.

Table 10 Small chip trial sections – Clearwater Roundabout to Groyne Rd offramp – H1 tyre

Mix	Lane	Date	Runs	L _{CPX:H1,80} (dB)	S _{H1} (dB)	Speed (km/h)	Air temperature (C)
EPA7 (40 mm thick)	Left	17/12/18	3	92.6	0.9	80.1	19.5
		21/03/19	3	93.1	0.8	80.2	18.1
		10/09/19	3	92.9	0.8	80.0	7.2
	Right	17/12/18	3	91.4	0.7	80.4	20.3
		21/03/19	3	92.0	0.6	79.8	18.3
		10/09/19	3	91.5	0.5	80.0	5.7

Table 11 Small chip trial sections – Memorial Ave bridge – P1 tyre

Mix	Lane	Date	Runs	L _{CPX:P1,80} (dB)	S _{P1} (dB)	Speed (km/h)	Air temperature (C)
EPA7 (30mm thick, ascending)	Left	8/06/2018	3	95.1	1.0	79.4	14.4
		4/07/2018	3	93.9	0.8	80.2	15.2
		11/09/2019	4	94.9	0.6	77.6	8.9
		9/03/2020*	6	94.4	0.8	77.3	17.7
		1/10/2020	4	94.3	0.5	77.5	14.2
	Right	8/06/2018	3	93.9	1.0	80.2	14.5
		4/07/2018	3	94.1	0.8	79.8	15.3
		11/09/2019	3	94.2	0.7	78.5	8.3
		9/03/2020	1	93.5	0.7	78.8	20.1
		11/10/2020	3	93.6	0.6	79.8	23.0
EPA7 (30mm thick, descending)	Left	8/06/2018	3	94.5	1.1	81.2	14.4
		4/07/2018	3	93.7	0.8	79.8	15.2
		11/09/2019	4	93.5	0.7	78.7	8.9
		9/03/2020*	5	93.7	0.8	76.7	18.4
		1/10/2020	4	94.1	0.7	77.2	14.2
	Right	8/06/2018	3	94.1	0.8	83.3	14.4
		4/07/2018	3	93.9	0.8	80.1	15.3
		11/09/2019	3	94.0	0.5	79.0	8.4
		9/03/2020	1	93.3	0.6	79.9	20.3
		11/10/2020	3	93.7	1.0	79.7	23.0

* Includes runs from measurement session on 12/03/2020.

Table 12 Thickness trial sections – Western Belfast Bypass (“WBB”) – P1 tyre

Mix	Lane	Date	Runs	L _{CPX:P1,80} (dB)	S _{P1} (dB)	Speed (km/h)	Air temperature (C)
EPA7 (30mm thick)	Left	17/12/2018	3	96.0	0.2	80.2	22.1
		7/03/2019	1	96.5	0.4	79.0	29.9
		21/03/2019	3	96.1	0.3	78.6	18.1
		11/09/2019	3	96.1	0.4	78.9	9.3
		9/03/2020*	6	95.5	0.4	79.9	19.1
		1/10/2020	3	96.2	0.4	79.9	14.3
	Right	17/12/2018	3	94.5	0.5	79.4	20.7
		21/03/2019	3	94.5	0.3	78.9	18.3
		11/09/2019	3	94.6	0.5	78.6	6.9
		9/03/2020	2	93.6	0.4	79.0	19.0
		11/10/2020	3	93.8	0.3	79.5	24.4
	EPA7 (40mm thick)	Left	17/12/2018	3	92.9	0.4	79.9
7/03/2019			1	93.6	0.4	77.8	29.5
21/03/2019			3	92.7	0.5	79.9	18.2
11/09/2019			3	92.7	0.7	79.5	9.2
9/03/2020*			6	92.7	0.5	80.5	19.0
1/10/2020			3	93.1	0.4	80.5	14.3
Right		17/12/2018	3	92.7	0.4	79.6	20.5
		21/03/2019	3	92.6	0.4	80.0	18.3
		11/09/2019	3	92.4	0.5	79.6	6.8
		9/03/2020	2	92.3	0.3	78.8	18.7
		11/10/2020	3	92.6	0.4	79.2	24.2
EPA7 (50mm thick)		Left	17/12/2018	3	91.0	0.4	79.6
	7/03/2019		1	92.1	0.4	79.2	29.0
	21/03/2019		3	91.2	0.3	79.1	18.1
	11/09/2019		3	91.4	0.3	80.1	9.1
	9/03/2020*		6	91.7	0.3	80.5	18.9
	1/10/2020		3	92.1	0.3	79.3	14.3
	Right	17/12/2018	3	90.0	0.2	80.2	20.3
		21/03/2019	3	90.5	0.3	78.8	18.3
		11/09/2019	3	90.5	0.2	79.0	6.6
		9/03/2020	2	90.7	0.4	79.3	18.4
		11/10/2020	3	91.2	0.3	79.8	24.1

* Includes runs from measurement session on 12/03/2020.

Table 13 Thickness trial sections – Western Belfast Bypass (“WBB”) – H1 tyre

Mix	Lane	Date	Runs	L _{CPX:H1,80} (dB)	S _{H1} (dB)	Speed (km/h)	Air temperature (C)
EPA7 (30 mm thick)	Left	17/12/18	3	95.5	0.4	79.1	18.8
		21/03/19	3	96.2	0.3	78.8	18.2
		10/09/19	3	95.8	0.4	79.3	7.4
	Right	17/12/18	3	95.1	0.4	79.6	19.7
		21/03/19	3	95.3	0.5	78.0	18.4
		10/09/19	3	94.6	0.3	79.3	5.9
EPA7 (40 mm thick)	Left	17/12/18	3	92.3	0.4	80.2	18.3
		21/03/19	3	92.9	0.5	79.5	18.2
		10/09/19	3	92.1	0.3	79.8	7.2
	Right	17/12/18	3	92.9	0.4	80.5	19.4
		21/03/19	3	93.5	0.5	77.7	18.3
		10/09/19	3	92.3	0.4	79.9	5.7
EPA7 (50 mm thick)	Left	17/12/18	3	90.5	0.3	80.4	18.0
		21/03/19	3	91.4	0.3	78.2	18.2
		10/09/19	3	91.1	0.3	79.8	7.0
	Right	17/12/18	3	90.5	0.2	79.1	19.3
		21/03/19	3	91.8	0.3	78.5	18.4
		10/09/19	3	91.4	0.4	79.1	5.6

Table 14 Epoxy dilution trial sections – Christchurch Southern Motorway (“CSM”) – P1 tyre

Mix	Lane	Date	Runs	$L_{CPX:P1,80}$ (dB)	SP_1 (dB)	Speed (km/h)	Air temperature (C)
EPA10 (25% epoxy)	Left	10/09/2019	3	99.3	1.1	79.2	5.6
		12/03/2020	3	99.2	1.0	78.9	16.3
		11/10/2020	3	100.1	0.6	79.4	20.3
EPA10 (50% epoxy)	Left	10/09/2019	3	100.8	0.2	80.2	5.9
		12/03/2020	3	100.2	0.2	78.8	16.3
		11/10/2020	3	100.2	0.4	80.3	20.3
EPA10 (100% epoxy)	Left	10/09/2019	3	101.0	0.3	79.5	6.2
		12/03/2020	3	100.8	0.4	81.7	16.7
		11/10/2020	3	101.3	0.2	78.6	20.3
PA10 (100% epoxy control)	Left	10/09/2019	3	101.7	0.2	78.0	6.1
		12/03/2020	3	101.6	0.2	78.3	16.6
		11/10/2020	3	101.7	0.2	77.4	20.3
PA10 (25% and 50% epoxy control)	Left	10/09/2019	3	101.0	0.3	79.8	5.7
		12/03/2020	3	101.1	0.3	78.0	16.3
		11/10/2020	3	101.2	0.3	80.1	20.3
EPA10 (25% epoxy)	Left	10/09/2019	3	100.8	0.6	79.8	5.8
		12/03/2020	3	100.9	0.5	78.2	15.9
		11/10/2020	3	100.6	0.5	80.3	20.2
PA10 (25% epoxy control)	Left	10/09/2019	3	101.1	0.4	80.8	6.0
		12/03/2020	3	101.3	0.4	80.3	15.8
		11/10/2020	3	101.1	0.4	80.0	20.2