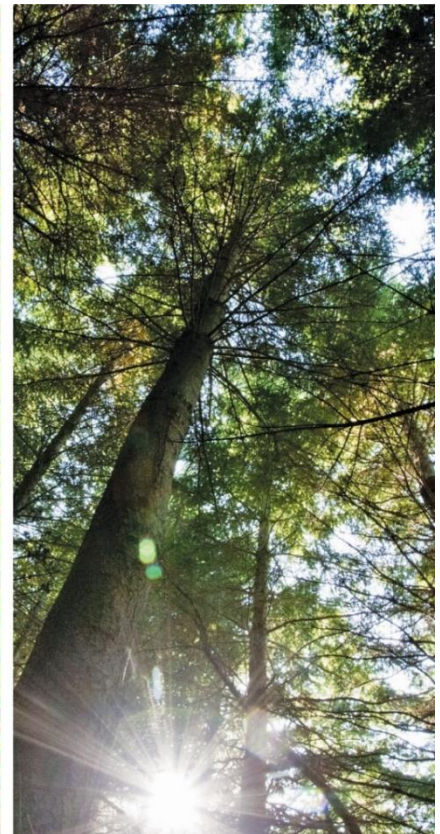
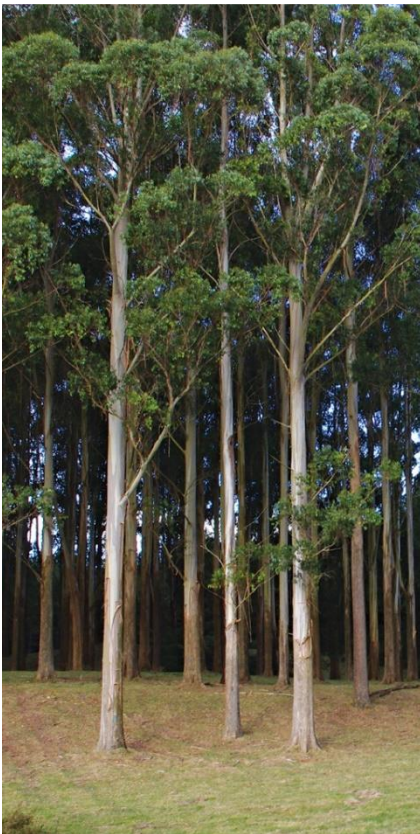


The condition of thermally modified cypress and Douglas fir flat panels after one year's field exposure

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Date: May 2023

Publication No: SWP-T171

TABLE OF CONTENTS

EXECUTIVE SUMMARY	1
INTRODUCTION	2
METHODS.....	3
Source of timber.....	3
Sample exposure	3
Assessment methods.....	3
RESULTS	3
Assessment results	3
Conclusions	5
Acknowledgements.....	5
Appendix 1: Source of timber for Flat panel test.....	7
Appendix 2: Rating system	8
Appendix 3: Individual assessment details.....	9

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EXECUTIVE SUMMARY

After one year exposure at the Whakarewarewa test field site in Rotorua, there was no decay on any of the untreated *Cupressus macrocarpa*, *Cupressus lusitanica*, *Cupressus x.ovensii* and Douglas fir flat panel samples. No decay was observed on any of the thermally modified *Cupressus lusitanica* and Douglas fir flat panel samples. No decay was observed on any of the commercial benchmark samples (Accoya, Kebony, Vulcan or Linea fibre cement).

Well-established decay was observed on one of the untreated radiata pine samples. No decay was observed on the unstained sapwood radiata pine samples or on the H3.1 LOSP treated or H3 CCA treated radiata pine samples.

The unstained samples had turned a silver colour. The level of surface checking was generally minor.

INTRODUCTION

A flat panel trial was installed for *Cupressus macrocarpa*, *Cupressus lusitanica*, *Cupressus x.ovensii* and Douglas fir. Samples of *Cupressus lusitanica* and Douglas fir were thermally modified (TM) before exposure. Samples were either solely sapwood, heartwood, or a heart/sap mix, and were uncoated or stained. Untreated and treated (CCA, LOSP) radiata pine were included in the trials for comparative purposes. Commercial benchmarks of Accoya, Kebony, Vulcan and Linea were included in the trial. The trials were installed in the Whakarewarewa test area on the Scion campus, Rotorua in July 2021. The flat panel groups included in the test are shown in Table 1.

Table 1: Groups of flat panels included in the test

Group	Species	Heart/sap mix	Treatment	Coating
1	<i>Cupressus macrocarpa</i> (young)	Heartwood	-	None
2	<i>Cupressus macrocarpa</i> (old)	Heartwood	-	None
3	<i>Cupressus lusitanica</i>	Sapwood	-	None
4	<i>Cupressus lusitanica</i>	Sapwood	-	Stained
5	<i>Cupressus lusitanica</i>	Heartwood	-	None
6	<i>Cupressus lusitanica</i>	Heartwood	-	Stained
7	<i>Cupressus lusitanica</i>	Heart/sap mix	TM ¹ 220°C	None
8	<i>Cupressus lusitanica</i>	Heart/sap mix	TM 220°C	Stained
9	<i>Cupressus x ovensii</i>	Heartwood	-	None
10	Douglas-fir	Heartwood	-	None
11	Douglas-fir	Heartwood	TM 230°C	None
12	Douglas-fir	Heart/sap mix	TM 230°C	None
13	Radiata pine	Sapwood	-	None
14	Radiata pine	Sapwood	-	Stained
15	Radiata pine	Sapwood	H3.1 LOSP	None
16	Radiata pine	Sapwood	H3.1 LOSP	Stained
17	Radiata pine	Sapwood	H3 CCA	None
18	Radiata pine	Sapwood	H3 CCA	Stained
19	Western red cedar	Heartwood	-	None
20	Western red cedar	Heartwood	-	Stained
21	Accoya	Sapwood	Commercial benchmark	None
22	Accoya	Sapwood	Commercial benchmark	Stained
23	Kebony	Sapwood	Commercial benchmark	None
24	Kebony	Sapwood	Commercial benchmark	Stained
25	Vulcan TM radiata pine	Sapwood	Commercial benchmark	None
26	Vulcan TM radiata pine	Sapwood	Commercial benchmark	Stained
27	Linea fibre cement	-	-	None
28	Linea fibre cement	-	-	Stained

¹ TM indicates Thermal modification treatment

This report includes results for flat panel above ground tests from the July 2022 assessment.

METHODS

Source of timber

Table 2 shows the source of the timber used in this study, where known. Further details are listed in Appendix 1.

Table 2: Source of timber used in this study

Species	Treatment	Source of timber
<i>Cupressus macrocarpa</i> (young)	-	Manawatu, trees 22 years old
<i>Cupressus macrocarpa</i> (old)	-	Central North Island forest, trees 60-80 years old
<i>Cupressus lusitanica</i>	-	South Auckland sawmill Thermally modified at Scion
<i>Cupressus x ovensii</i>	-	Rotoehu forest, trees 22 years old
Douglas fir	-	Central North Island sawmill Thermally modified at Scion
Radiata pine	-	Rotorua sawmill
Radiata pine	H3.1 LOSP	Rotorua sawmill, treated at Scion
Radiata pine	H3 CCA	Rotorua sawmill, treated at Scion
Western red cedar	-	Auckland retailer
Accoya radiata pine	Acetylation	Auckland retailer
Kebony radiata pine	Furfurylation	Australian retailer (Mafi)
Vulcan radiata pine	Thermal modification	Auckland retailer
Linea fibre cement	-	Rotorua retailer

Sample exposure

The flat panel trial was installed on a North facing frame at approximately 45° (Figure 1). Some of the flat panels were stained with a dark black stain prior to exposure, the other samples were uncoated. The bottom edge of each flat panel sits in a wooden slot made from untreated radiata pine. The top edge of the panel rests on a 20 x 45 mm strip of H3.2 (CCA) treated radiata pine.

Assessment methods

The flat panels were removed from the wooden supports (Figure 2) and assessed according to the rating systems in Appendix 2.

RESULTS

Assessment results

Table 3 shows a summary of the flat panel condition after one year's above ground exposure. A complete set of data is contained in Appendix 3.

Table 3: Summary of flat panel condition (Index of Condition¹) after one year's exposure

Group	Species	Heart\sap mix	Treatment	Coating	Decay ₁	Surface	Checking
1	<i>C. macrocarpa</i> (young)	Heartwood	-	None	10.0	2.0	1.3
2	<i>C. macrocarpa</i> (old)	Heartwood	-	None	10.0	2.0	1.6
3	<i>C. lusitanica</i>	Sapwood	-	None	10.0	2.0	2.1
4	<i>C. lusitanica</i>	Sapwood	-	Stained	10.0	1.0	1.9
5	<i>C. lusitanica</i>	Heartwood	-	None	10.0	2.0	1.5
6	<i>C. lusitanica</i>	Heartwood	-	Stained	10.0	1.0	1.6
7	<i>C. lusitanica</i>	Heart/sap mix	TM 220°C	None	10.0	2.0	1.8
8	<i>C. lusitanica</i>	Heart/sap mix	TM 220°C	Stained	10.0	1.0	1.7
9	<i>C. x oversii</i>	Heartwood	-	None	10.0	2.0	1.6
10	Douglas fir	Heartwood	-	None	10.0	1.6	1.8
11	Douglas fir	Heartwood	TM 230°C	None	10.0	2.0	1.6
12	Douglas fir	Heart/sap mix	TM 230°C	None	10.0	2.0	2.2
13	Radiata pine	Sapwood	-	None	10.0	1.8	1.2
14	Radiata pine	Sapwood	-	Stained	9.7	1.0	1.4
15	Radiata pine	Sapwood	H3.1 LOSP	None	10.0	2.0	1.9
16	Radiata pine	Sapwood	H3.1 LOSP	Stained	10.0	1.0	1.4
17	Radiata pine	Sapwood	H3 CCA	None	10.0	1.0	1.9
18	Radiata pine	Sapwood	H3 CCA	Stained	10.0	1.0	1.6
19	Western red cedar	Heartwood	-	None	10.0	2.0	1.1
20	Western red cedar	Heartwood	-	Stained	10.0	1.0	1.0
21	Accoya radiata pine	Sapwood	Acetylation	None	10.0	2.0	1.0
22	Accoya radiata pine	Sapwood	Acetylation	Stained	10.0	1.0	1.1
23	Kebony radiata pine	Sapwood	Furfurylation	None	10.0	1.0	1.8
24	Kebony radiata pine	Sapwood	Furfurylation	Stained	10.0	1.0	1.6
25	Vulcan radiata pine	Sapwood	Thermal modification	None	10.0	1.0	1.9
26	Vulcan radiata pine	Sapwood	Thermal modification	Stained	10.0	1.0	1.9
27	Linea fibre cement	-	-	None	10.0	1.0	1.0
28	Linea fibre cement	-	-	Stained	10.0	1.0	1.0

¹ Index of Condition is the average decay rating for all of the samples in a group.

No decay was observed in any of the *Cupressus macrocarpa*, *Cupressus lusitanica*, *Cupressus x.ovensi* and Douglas fir.

One of the untreated radiata pine samples which had been stained had a well-established pocket of decay.

No decay was observed in any of the Western red cedar, Accoya, Kebony, Vulcan or Linea samples.

The exposed face of the unstained samples had turned a light silver colour after one years exposure (Figure 2). Some minor mould spots were observed on the Accoya samples. Black mould was observed on the back of many of the untreated unstained radiata pine samples.

Minor surface checking was observed on many of the samples. The greatest amount of surface checking was observed on the *C. lusitanica* sapwood without stain, and the thermally modified Douglas fir without stain. Delamination had occurred at the gluelines on many of the Vulcan samples.

CONCLUSIONS

After one years exposure, no decay was observed on any of the untreated or thermally modified *Cupressus macrocarpa*, *Cupressus lusitanica*, *Cupressus x.ovensi* and Douglas fir flat panel samples. No decay was observed on any of the commercial benchmark samples (Accoya, Kebony, Vulcan or Linea fibre cement). Well-established decay was observed on one of the untreated radiata pine samples.

The surface of the unstained samples has turned a silver colour. The level of surface checking was generally minor.

ACKNOWLEDGEMENTS

The authors acknowledge the assistance of Rosie Sargent in sourcing the timber for this study and conducting the thermal modification of some samples.



Figure 1: General view of flat panel trial at the time of installation (July 2021).



Figure 2: General view of flat panel trial after one year's exposure (July 2022).

APPENDIX 1: SOURCE OF TIMBER FOR FLAT PANEL TEST

Table 5: Source of timber for flat panel tests

Type of wood \ Treatment	Source of timber	Number of trees	Tree age (years)	Selected by	Approximate quantity of timber delivered
Accoya	ITI Timspec	-	-	ITI Timspec	3-4 lengths
<i>Cupressus macrocarpa</i> , young trees, heartwood	Ruapehu sawmill; Bulls region	-	22	Vaughan Kearns	400 lm
<i>Cupressus macrocarpa</i> , old trees, heartwood	Ruapehu sawmill; Waimarino	-	60 - 80	Vaughan Kearns	400 lm
<i>Cupressus lusitanica</i>	MacDirect sawmill, South Auckland	-	-	Scion staff	40-60 lengths
<i>Cupressus x ovensii</i> , heartwood, laminated	SWP sawing study; Rotoehu forest	7	22	Scion staff	182 lm
Douglas fir, mixed heartwood/sapwood	Donelleys sawmill, Reporoa	-	-	Scion staff	-
Kebony	Mafi, Australia	-	-	Mafi, Australia	8 lengths
Linea fibre cement	Rotorua timber retailer	-	-	Scion staff	5 lengths
Radiata pine, mixed heartwood/sapwood	Scion stock	-	-	Scion staff	-
Radiata pine, mixed heartwood/sapwood, H1.2 boron treated	Rotorua timber retailer	-	-	Scion staff	-
Vulcan	Abodo	-	-	Abodo	10 lengths
Western red cedar	ITI Timspec	-	-	ITI Timspec	4 lengths

APPENDIX 2: RATING SYSTEM

Rating systems used for sample assessments

DECAY/INSECT DAMAGE

- 10 = No decay or insect damage.
- T = "Trace" discolouration, decay suspected but not positively identified.
- 9 = Minor decay or damage at defects, less than 3% of the cross section.
- 8 = Minor but established decay, 3 - 10% of the cross section.
- 7 = Well established pockets or extensive surface damage, 10 - 30% of the cross section.
- 6 = Extensive established and deepening decay, 30 - 50% of cross section.
- 4 = Deep and severe decay, more than 50% of cross section.
- 0 = Disintegrating, failed.

UNCOATED SURFACES

- 1 = As new, no discolouration or mould.
- 2 = Slight surface mould or weathering, light even colour.
- 3 = Prominent mould or weathering, minor surface erosion.
- 4 = Extensive mould or lichen, uneven surface due to erosion.
- 5 = Extensive surface breakdown, original profile details gone.

SURFACE COATINGS

- 1 = Clean and intact, original colour and gloss retained.
- 2 = Surface dulling and colour loss, minor failure on sharp corners.
- 3 = Extensive discolouration, failure and minor loss at defects and sharp corners.
- 4 = Patches failed with substrate exposed over <50% of surface.
- 5 = Extensive failure, >50% of substrate exposed.

CHECKING

- 1 = No surface checks, fine knot checks not visible in damp weather.
- 2 = Minor checks to 0.5 mm wide, not obvious in damp weather.
- 3 = Well established checks to 1 mm wide and 50% board thickness.
- 4 = Many or deep and severe checks over 1 mm wide.
- 5 = Board completely split and allowing obvious water egress.

APPENDIX 3: INDIVIDUAL ASSESSMENT DETAILS

Individual flat panel sample assessment details after one year's exposure

Sample number	Decay	Surface	Checking	Comments ¹
Group 1: <i>Cupressus macrocarpa</i> (young), heartwood, no coating				
4011	10	2	1	
4012	10	2	1	
4013	10	2	1	
4014	10	2	1	
4015	10	2	1	
4016	10	2	1	
4017	10	2	2	
4018	10	2	1	2 small knots
4019	10	2	1	
4020	10	2	3	
Group 2: <i>Cupressus macrocarpa</i> (old), heartwood, no coating				
3861	10	2	1	
3862	10	2	2	
3863	10	2	3	
3864	10	2	1	3 splits on surface
3865	10	2	1	
3866	10	2	2	
3867	10	2	1	
3868	10	2	2	
3869	10	2	1	
3870	10	2	2	
Group 3: <i>Cupressus lusitanica</i> , sapwood, no coating				
3781	10	2	2	
3782	10	2	2	Grey surface
3783	10	2	2	
3784	10	2	3	
3785	10	2	1	
3786	10	2	1	
3787	10	2	3	Light patches on end
3788	10	2	2	
3789	10	2	2	Small knot
3790	10	2	3	
Group 4: <i>Cupressus lusitanica</i> , sapwood, stained				
3791	10	1	2	
3792	10	1	2	
3793	10	1	2	
3794	10	1	2	
3795	10	1	1	
3796	10	1	1	
3797	10	1	2	Large split on back
3798	10	1	3	Knot on edge
3799	10	1	2	
3800	10	1	2	

¹ Comments include other observations.

Sample number	Decay	Surface	Checking	Comments ¹
Group 5: <i>Cupressus lusitanica</i> , heartwood, no coating				
3771	10	2	2	
3772	10	2	2	Small knot
3773	10	2	1	
3774	10	2	1	
3775	10	2	1	
3776	10	2	2	
3777	10	2	1	
3778	10	2	2	
3779	10	2	2	
3780	10	2	1	Small knot
Group 6: <i>Cupressus lusitanica</i> , heartwood, stained				
3761	10	1	2	Large knot
3762	10	1	2	Small knot
3763	10	1	1	
3764	10	1	1	
3765	10	1	2	
3766	10	1	2	
3767	10	1	1	
3768	10	1	1	
3769	10	1	2	Moderate knot
3770	10	1	2	Moderate knot
Group 7: <i>Cupressus lusitanica</i> , heart/sap mix, TM 220°C, no coating				
3741	10	2	2	Grey surface
3742	10	2	2	
3743	10	2	2	
3744	10	2	2	
3745	10	2	2	
3746	10	2	1	
3747	10	2	2	
3748	10	2	2	
3749	10	2	1	
3750	10	2	2	
Group 8: <i>Cupressus lusitanica</i> , heart/sap mix, TM 220°C, stained				
3751	10	1	2	
3752	10	1	2	
3753	10	1	2	
3754	10	1	2	Large knot
3755	10	1	1	Large knot
3756	10	1	1	
3757	10	1	2	Large knot
3758	10	1	2	Small knot
3759	10	1	1	
3760	10	1	2	

¹ Comments include other observations.

Sample number	Decay	Surface	Checking	Comments ¹
Group 9: <i>Cupressus x ovensii</i>, heartwood, no coating				
3801	10	2	2	
3802	10	2	1	
3803	10	2	2	Knots on edge
3804	10	2	1	
3805	10	2	1	
3806	10	2	1	
3807	10	2	2	
3808	10	2	2	
3809	10	2	3	
3810	10	2	1	
Group 10: Douglas-fir, heartwood, no coating				
3831	10	2	2	
3832	10	2	1	Pith on front face
3833	10	2	2	
3834	10	1	2	
3835	10	2	2	
3836	10	2	2	
3837	10	1	2	
3838	10	1	2	
3839	10	1	1	
3840	10	2	2	
Group 11: Douglas-fir, heartwood, TM 230°C, no coating				
3811	10	2	2	Small knot
3812	10	2	2	
3813	10	2	2	
3814	10	2	1	Small knot
3815	10	2	1	
3816	10	2	1	
3817	10	2	2	Split along growth ring
3818	10	2	1	
3819	10	2	1	
3820	10	2	1	
Group 12: Douglas-fir, heart/sap mix, TM 230°C, no coating				
3821	10	2	1	
3822	10	2	2	
3823	10	2	2	
3824	10	2	3	
3825	10	2	3	
3826	10	2	3	
3827	10	2	2	
3828	10	2	2	
3829	10	2	2	
3830	10	2	2	

¹ Comments include other observations.

Sample number	Decay	Surface	Checking	Comments ¹
Group 13: Radiata pine, sapwood, no coating				
3891	10	2	1	
3892	10	2	1	
3893	10	2	1	Small black mould spots
3894	10	2	1	
3895	10	1	2	Black mould on back
3896	10	2	2	
3897	10	1	1	
3898	10	2	1	Black mould on back
3899	10	2	1	Black mould on back
3900	10	2	1	Black mould on back
Group 14: Radiata pine, sapwood, stained				
3901	10	1	1	
3902	10	1	1	
3903	10	1	1	
3904	10	1	1	
3905	10	1	2	
3906	10	1	2	
3907	10	1	1	
3908	7	1	2	Soft rot
3909	10	1	1	
3910	10	1	2	
Group 15: Radiata pine, sapwood, H3.1 LOSP, no coating				
4021	10	2	1	Small black mould spots
4022	10	2	2	Small black mould spots
4023	10	2	2	Small black mould spots
4024	10	2	2	Small black mould spots
4025	10	2	2	Small black mould spots
4026	10	2	2	Small black mould spots
4027	10	2	1	Small black mould spots
4028	10	2	2	Small black mould spots
4029	10	2	3	Small black mould spots
4030	10	2	2	Small black mould spots
Group 16: Radiata pine, sapwood, H3.1 LOSP, stained				
4031	10	1	1	
4032	10	1	1	
4033	10	1	2	
4034	10	1	1	
4035	10	1	1	
4036	10	1	1	
4037	10	1	1	
4038	10	1	2	
4039	10	1	2	
4040	10	1	2	

¹ Comments include other observations.

Sample number	Decay	Surface	Checking	Comments ¹
Group 17: Radiata pine, sapwood, H3 CCA, no coating				
3871	10	2	3	Green tinge
3872	10	2	1	Green tinge
3873	10	2	1	Green tinge
3874	10	2	2	Green tinge
3875	10	2	2	Green tinge
3876	10	2	1	Green tinge
3877	10	2	1	Green tinge
3878	10	2	2	Green tinge
3879	10	2	2	Green tinge
3880	10	2	1	Green tinge
Group 18: Radiata pine, sapwood, H3 CCA, stained				
3881	10	1	3	
3882	10	1	2	
3883	10	1	1	
3884	10	1	1	
3885	10	1	1	
3886	10	1	1	
3887	10	1	1	
3888	10	1	2	
3889	10	1	3	
3890	10	1	1	
Group 19: Western red cedar, heartwood, no coating				
3991	10	2	1	
3992	10	2	1	
3993	10	2	2	
3994	10	2	1	
3995	10	2	1	
3996	10	2	1	
3997	10	2	1	
3998	10	2	1	
3999	10	2	1	
4000	10	2	1	
Group 20: Western red cedar, heartwood, stained				
4001	10	1	1	
4002	10	1	1	
4003	10	1	1	
4004	10	1	1	
4005	10	1	1	
4006	10	1	1	
4007	10	1	1	
4008	10	1	1	
4009	10	1	1	
4010	10	1	1	

¹ Comments include other observations.

Sample number	Decay	Surface	Checking	Comments ¹
Group 21: Accoya, no coating				
3721	10	2	1	Black mould
3722	10	2	1	Black mould
3723	10	2	1	Black mould
3724	10	2	1	Black mould
3725	10	2	1	Black mould
3726	10	2	1	Black mould
3727	10	2	1	Black mould
3728	10	2	1	Black mould
3729	10	2	1	Black mould
3730	10	2	1	Black mould
Group 22: Accoya, stained				
3731	10	1	1	Black mould
3732	10	1	1	Black mould
3733	10	1	1	Black mould
3734	10	1	2	Black mould
3735	10	1	1	Black mould
3736	10	1	1	Black mould
3737	10	1	1	Black mould
3738	10	1	1	Black mould
3739	10	1	1	Black mould
3740	10	1	1	Black mould
Group 23: Kebony, no coating				
3841	10	1	2	
3842	10	1	2	
3843	10	1	1	
3844	10	1	2	
3845	10	1	2	
3846	10	1	2	
3847	10	1	1	
3848	10	1	1	
3849	10	1	2	
3850	10	1	2	
Group 24: Kebony, stained				
3851	10	1	2	
3852	10	1	1	
3853	10	1	1	
3854	10	1	2	
3855	10	1	2	
3856	10	1	2	
3857	10	1	1	
3858	10	1	1	
3859	10	1	2	
3860	10	1	2	

¹ Comments include other observations.

Sample number	Decay	Surface	Checking	Comments ¹
Group 25: Vulcan TM radiata pine, no coating				
3971	10	1	2	
3972	10	1	2	
3973	10	1	1	
3974	10	1	2	
3975	10	1	2	
3976	10	1	2	
3977	10	1	2	
3978	10	1	2	
3979	10	1	2	
3980	10	1	2	
Group 26: Vulcan TM radiata pine, stained				
3981	10	1	2	
3982	10	1	2	
3983	10	1	2	
3984	10	1	2	
3985	10	1	1	
3986	10	1	2	
3987	10	1	2	
3988	10	1	2	
3989	10	1	2	
3990	10	1	2	
Group 27: Linea fibre cement, no coating				
4041	10	1	1	
4042	10	1	1	
4043	10	1	1	
4044	10	1	1	
4045	10	1	1	
4046	10	1	1	
4047	10	1	1	
4048	10	1	1	
4049	10	1	1	
4050	10	1	1	
Group 28: Linea fibre cement, stained				
4051	10	1	1	
4052	10	1	1	
4053	10	1	1	
4054	10	1	1	
4055	10	1	1	
4056	10	1	1	
4057	10	1	1	
4058	10	1	1	
4059	10	1	1	
4060	10	1	1	

¹ Comments include other observations.